Starting Strength

A SIMPLE AND PRACTICAL GUIDE FOR COACHING BEGINNERS

Mark Rippetoe
with Lon Kilgore

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A human being should be able to change a diaper, plan an invasion, butcher a hog, conn a ship, design a building, write a sonnet, balance accounts, build a wall, set a bone, comfort the dying, take orders, give orders, cooperate, act alone, solve equations, analyze a new problem, pitch manure, program a computer, cook a tasty meal, fight efficiently, and die gallantly. Specialization is for insects.

- Robert Heinlein

Foreward

This book is the result of a conversation between Lon Kilgore, Michael Hartman, and me, in the summer of 2004. These guys basically accused me of laziness in having not yet written down what I knew about teaching the lifts. I hadn't actually considered that I had anything especially valuable to say about teaching them, but I have in fact been coaching barbells a while so I said I would start with the squat chapter and see what happened. I had written a few things for publication before, having started in 1980 with a small article for Mike Lambert's legendary publication Powerlifting USA. At the time it wasn't legendary, and I'm afraid my little piece didn't really do much toward propelling it in that direction.

I was working in Colorado then and was not yet in the gym business as an owner. I had been working in the health club business for several years, was just starting a competitive career in powerlifting, and was in Colorado on a working sabbatical from a geology degree and a personal tragedy that had deeply affected my general usefulness. I had continued to train, and had in fact intended to continue writing while I was there. But I actually didn't have much useful to say at that point in my career, so any writing I might have done at that time will not be missed anyway.

Shortly after returning home to Wichita Falls from Colorado to see to my mother's health and finish my degree, I had the opportunity to buy the gym I was training in, and the gym business in Wichita Falls has never been the same. I decimated the competition, and rendered it embarrassing to be caught training anywhere else. A slight exaggeration, granted, but Wichita Falls Athletic Club is one of the oldest sole-proprietorship black iron gyms in the country.

The writing started back up years later, once I had become entitled to an opinion through more years of experience and study. I had made it the policy of Wichita Falls Athletic Club that everyone who joined and who was physically capable of doing squats would learn how to do them correctly. My intention was that all my members be at least exposed to the classic barbell exercises, so as to carry on the traditional approach to gym exercise that had been the norm prior to the advent of Nautilus-style health clubs. In teaching everybody that joined to squat (in excess of 2500 people over more than 20 years), I had established the mechanism for accumulating a rather large body of experience and empirical data regarding the problems associated with teaching squats. The other barbell exercises suffered the same fate, being taught to thousands of more or less willing innocents who trusted me with their training.

It is still interesting to me that I waited five years to unpack my boxes, my intentions always being to go back to Colorado.

Actually, this book is the result of my having met my coach and friend Bill Starr in the summer of 1979. He was in town during and after the April 10 tornado taking care of a daughter who was injured in the storm. I ran into him at one of the two miserable little weight rooms in existence in the Falls at the time, where I and a couple of equally poorly-informed training partners were trying to get big, or at least bigger. Billy graciously took me under his tutelage and gave me the tools I needed to get done whatever I might have later accomplished. There are many of us, "Friends of Bill", who owe competitive and professional careers to his guidance and influence.

There have been other people from whom I have learned a great deal, and to whom I owe a great deal. My years of self-employment – the situation that allowed me to be in a position to know some few things about training and coaching – is due in large part to my oldest friend and associate Mark Tucker, who told me many years ago how success would be measured. He and my father were good examples of men that trusted themselves first. Glenn Pendlay has been a tremendous help over the past few years, with his ability to examine and analyze huge amounts of data, distilling important concepts from the background noise in a way no one else has done. The range of his abilities continues to amaze me. Some of the most important concepts in this book are the result of our working, training, and thinking together. Dr. Kilgore has been the catalyst for most of what has occurred in the development of Olympic weightlifting in North Texas since he came to Midwestern State University in 1997. His obvious artistic talents and organizational skills have made this book possible, and I would not even consider a project like this without him. Dr. Philip Colee, who served as the finish editor for this text, has been teaching me things for a very long time. I hope he continues to be willing to do so. Stef Bradford has been by my side the entire time, with good advice, dispassionate analysis, and many different types of support. And my many members are due a great deal of thanks, both for providing me with "lab rats" that also pay dues, and for putting up with religious and political diatribe while trying to train. The opportunity to learn how large numbers of humans respond to exercise has been invaluable.

It is my sincerest hope that my version of the way things are done contributes to the success of your athletes and your program.

Rip

Strength: Why and How

Physical strength is the most important thing in life. This is true whether we want it to be or not. As humanity has developed throughout history, physical strength has become less critical to our daily existence, but no less important to our lives. Our strength, more than any other thing we possess, still determines the quality and the quantity of our time here in these bodies. Whereas previously our physical strength determined how much food we ate and how warm and dry we stayed, it now merely determines how well we function in these new surroundings we have crafted for ourselves as our culture has accumulated. But we are still animals – our physical existence is, in the final analysis, the only one that actually matters. A weak man is not as happy as that same man would be if he were strong. This reality is offensive to some people who would like the intellectual or spiritual to take precedence. It is instructive to see what happens to these very people as their squat strength goes up.

As the nature of our culture has changed, our relationship with physical activity has changed along with it. We previously were physically strong as a function of our continued existence in a simple physical world. We were adapted to this existence well, since we had no other choice. Those whose strength was adequate to the task of staying alive continued doing so. This shaped our basic physiology, and that of all our vertebrate associates on the bushy little tree of life. It remains with us today. The relatively recent innovation known as the Division of Labor is not so remote that our genetic composition has had time to adapt again. Since most of us now have been freed from the necessity of personally obtaining our subsistence, physical activity is regarded as optional. Indeed it is, from the standpoint of immediate necessity, but the reality of millions of years of adaptation to a ruggedly physical existence will not just go away because desks were invented.

Like it or not, we remain the possessors of potentially strong muscle, bone, sinew, and nerve, and these hard-won commodities demand our attention. They were too long in the making to just be ignored, and we do so at our peril. They are the very components of our existence, the quality of which now depends on our conscious, directed effort at giving them the stimulus they need to stay in the condition that is normal to them. Exercise is that stimulus.

Over and above any considerations of performance for sports, exercise is the stimulus that returns our bodies to the conditions for which they were designed. Humans are not physically normal in the absence of hard physical effort. Exercise is not a thing we do to fix a problem – it is a thing we must do anyway, a thing without which there will always *be* problems. Exercise is the thing we must do to replicate the conditions under which our physiology was adapted, the conditions under which we are physically normal. In other words, exercise is substitute cave-man activity – the thing we need to make our bodies, and in fact our minds, normal in the 21st century. And merely normal, for most worthwhile humans, is not good enough.

An athlete's decision to begin a strength training program may be motivated by a desire to join a team sport that requires it, or it might be for more personal reasons. Many individuals feel that their strength is inadequate, or could be improved beyond what it is, without the carrot of team membership. Whatever the motivation, they need to be taught what to do by somebody, and that somebody is *you*. It is for those people that find themselves in this position that this book is intended. Many people have started lifting weights on their own – either at home, at school with equally inexperienced buddies, or under the unqualified supervision of inexperienced coaches who do more harm than good. It is *extremely* difficult for a novice lifter to learn correct technique from pictures in magazines or by trial and error, without an experienced eye providing the feedback on position and form that he cannot feel and see himself. The vast majority of people who start without good supervision either get hurt or fail to make sufficient progress to reinforce their enthusiasm, and end up quitting.

So, your role here is very important. You can coach correctly – from the standpoint of a proper biomechanical analysis of the exercises – and produce athletes that will be able to use correct form and obtain great progress toward their potential strength throughout the rest of their careers in sport. Or you can follow the trends established in the popular fitness media and produce typical health club members. Novices carry with them the habits acquired as they first learn to train. Although some can un-learn the bad and rise above a poor start, most do not. It is infinitely better to first learn correctly from a well-trained and experienced professional. This book is an attempt to provide some insight into the things that are necessary to know to *be* that professional.

Coaching

Coaching, at its most essential, is being able to tell someone the thing he needs to hear to get him to do with his body the thing he is trying to do. Coaching football on the playing field during a game is not coaching in the sense used here – that is more generalship, or command, a different type of skill altogether. The development of gymnasts, or fencers, or Olympic weightlifters requires the skills of the coaching of movement. Some people are good at this, and some are not. Interestingly enough, very good natural athletes often make very poor coaches. They have never been in the situation of not being able to perform well, and cannot understand how to explain something that they never actually had to *learn* themselves.

The best coaches are usually former athletes of modest accomplishment. They worked hard with less-than-perfect genetic abilities and achieved some success through perseverance and acquired skill. They learned how the hard way, and gained the experience necessary to teach others the same things. If they also happen to be articulate individuals, they are able to communicate their experiences to others. If they are intelligent, they can continue to analyze the ever-growing data pool that a bunch of novice trainees provides, and obtain new insights into what works and what doesn't. And if they are the kind of folks whose egos can remain in check, they stay receptive to learning from other coaches and experienced professionals. People who possess all these traits are exceptional – most coaches are less effective because one or more of these key components is lacking.

There are two key elements to coaching complicated physical movement: knowing what the movement looks like when it is done correctly, and understanding what the athlete experiences when the movement is done correctly. The first is an observational skill, the primary way the coach obtains information about the athlete's performance of the movement. The second is acquired by doing the movement, and it is why some experience with the sport is necessary to coach it. It is critical to an understanding of the athlete's problems in learning the movement, and provides insight into what to say to get him to do it right. Many coaches rely primarily on their ability to observe, and this works fine most of the time. But a truly effective coach brings both talents to bear when he helps his athletes improve their performance.

The "coaching eye" is the name for a set of observational and analytical skills necessary to evaluate athletic performance. Most sports are explosive (or at least quick) in nature, and coaching them requires that the movements involved be assessed accurately at the speed with which they actually occur. It is not possible to slow down a pitch or a back flip for the convenience of the coach. It is usually inconvenient, albeit possible, to use video technology to evaluate movements repeatedly in slow motion. This would slow down the workout, and delay the immediate feedback necessary for technique improvement. So the coach must develop the ability to see all the relevant angles, distances, and relationships in real time under the actual conditions of performance.

The coaching eye is developed through practice, even as the skills of the sport are acquired by your trainees. It takes many hours of observation – with the focused intent to analyze that which is being seen – to get good at it. For most of the movements we will do in this program, the best position to observe is the 45° oblique, either from the front or back, depending on the exercise and facility layout. In this position, all the body segment angles can be accurately observed. The exception is the bench press, which is best coached from the spotting position directly behind the lifter's head. If the path of the bar needs to be observed, it is best seen end-on, from a position directly perpendicular to the lifter (figure 1).

Those of us whose interest is in human performance are concerned with producing the best examples of the human phenotype that we can, in ourselves and in those we have been trusted with training. For this reason, most effective coaches train themselves - either with their athletes or by themselves after practice. The effective coach understands what his trainees are feeling and experiencing as he coaches them, and the only way he can know these things is to have done them himself, preferably recently. The best coaches have learned from themselves as they train, and the continued experience of doing it firsthand is invaluable in explaining it to others.

Coaches who themselves train also have another important advantage over their sedentary, disengaged counterparts. Their own motivation to improve puts them in the shoes of their athletes, and builds an important bond between athlete and coach that cannot exist unless the athlete knows that the coach trains and occasionally sees him do it. This connection should not be underestimated: athletes respect a coach who is willing to do the same things he asks of his trainees. Even older coaches who cannot perform as they previously could, need to train, both for themselves as a matter of continued fitness and coaching competence, and as a way of "practicing what you preach."

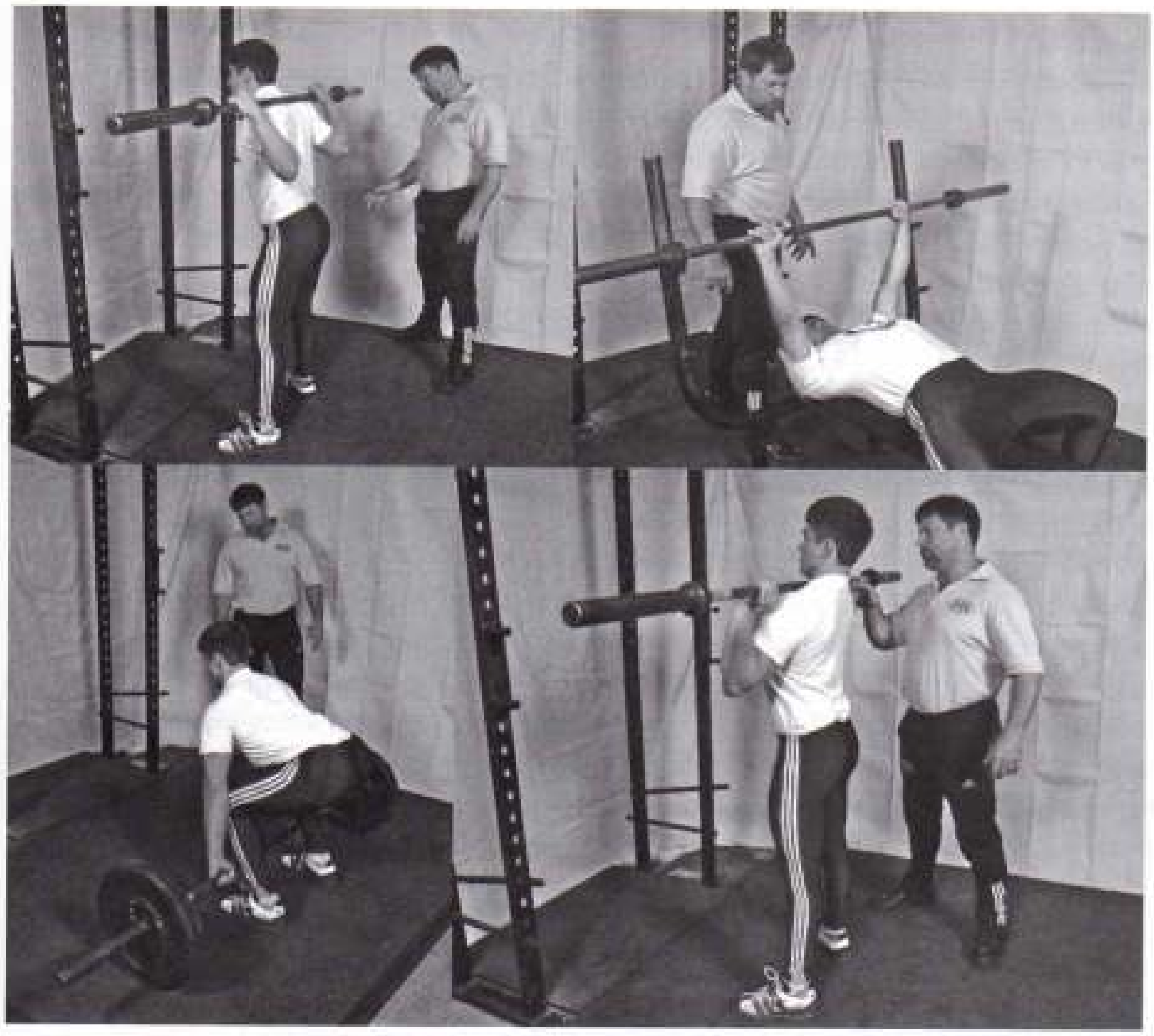


Figure 1. Coaching is about observation. Good vantage points are a must for effective analysis and feedback. Clockwise: Coaching positions for the squat, bench press, press, and deadlift (and power clean).

Different types of athletes (and in fact all athletes are different) respond differently to coaching. An older professional man cannot be dealt with in the same way that a 14-year old boy must be dealt with. An accomplished female masters athlete needs a different approach to her coaching than her novice daughter. Groups of athletes are coached differently than individuals. Some basic social skills are necessary if the coach is to correctly approach diverse coaching situations. Depending on the nature of the job, the coach may only see one general type of athlete – the high school coach does not normally encounter experienced master athletes. But he does encounter very different types of high school athletes, and individuals respond as such. One coaching style is never appropriate for all trainees. The style must vary with the situation, as common sense dictates. And like everything else involved in professional development, wide experience improves this coaching talent.

Why barbells?

Training for strength is as old as civilization itself. The Greek tale of Milo serves to date the antiquity of an interest in physical development, and an understanding of the processes by which it is acquired. Milo is said to have lifted a calf every day, and grew stronger as the calf grew larger. The progressive nature of strength development was known thousands of years ago, but only recently (in terms of the scope of history) has the problem of how best to facilitate progressive resistance training been tackled by technology.

Among the first tools developed to practice resistance exercise was the barbell, a long metal shaft with some type of weight on each end. The earliest barbells used globes or spheres for weight, which could be adjusted for balance and load by filling them with sand or shot. David Willoughby's superb book, The Super Athletes (A.S. Barnes and Co., 1970) details the history of weightlifting and the equipment that made it possible.

But in a development unforeseen by Mr. Willoughby, things changed rapidly in the mid-1970s. A gentleman named Arthur Jones invented a type of exercise equipment that revolutionized resistance exercise. Unfortunately, not all revolutions are universally productive. Nautilus utilized the "principle of variable resistance", which claimed to take advantage of the fact that different parts of the range of motion of each limb were stronger than others. A machine was designed for each limb or body part, and a cam was incorporated into the chain attached to the weight stack that varied the resistance against the joint during the movement. The machines were designed to be used in a specific order, one after another without a pause between sets, since different body parts were being worked consecutively. And the central idea (from a commercial standpoint) was that if enough machines – each working a separate body part – were added together in a circuit, the entire body was being trained. The machines were exceptionally well made and handsome, and soon most gyms had the obligatory, very expensive, 12-station Nautilus circuit.

Exercise machines were nothing new. Most high schools had a Universal Gladiator multi-station unit, and leg extensions and lat pulldowns were familiar to everybody that trained with weights. The difference was the marketing behind the new equipment. Nautilus touted the total-body effect of the complete circuit, something that had never before been emphasized. We were treated to a series of before-and-after ads featuring one Casey Viator, an individual who had apparently gained a considerable amount of weight using only Nautilus equipment. Missing from the ads was the information that Mr. Viator was regaining size he previously had acquired through more conventional methods as an experienced bodybuilder.

Jones even went so far as to claim that strength could be gained on Nautilus and transferred to complicated movement patterns like the Olympic lifts without having to do the lifts with heavy weights, a thing which flies in the face of exercise theory and practical experience. But the momentum had been established and Nautilus became a huge commercial success. Equipment like it remains the modern standard in commercial exercise facilities all over the world.

The primary reason for this was that Nautilus equipment allowed the health club (at the time known as the "health spa") industry to offer to the general public a thing which had been previously unavailable. Prior to the invention of Nautilus, if a member wanted to train hard, in a more elaborate way than Universal equipment permitted, he had to learn how to use barbells. Someone had to teach him this. Moreover, someone had to teach the heath spa staff *how* to teach him this. Such professional education was, and still is, time consuming and not widely available. But with Nautilus equipment, a minimum-wage employee could be taught very quickly how to use the whole circuit, ostensibly providing a total-body workout with little invested in employee education. Furthermore, the entire circuit could be performed in about 30 minutes, thus decreasing member time on the exercise floor, increasing traffic capacity in the club, and maximizing sales exposure to more traffic. Nautilus equipment quite literally made the existence of the modern health club possible.

The problem, of course, is that machine-based training did not work as it was advertised. It was almost impossible to gain muscular bodyweight doing a circuit. People who were trying to do so would train faithfully for months without gaining any significant muscular weight at all. When they went to barbell training, a miraculous thing would happen: they would immediately gain – within a week – more weight than they had gained in the entire time they had fought with the 12-station circuit.

The reason that isolated body-part training on machines doesn't work is the same reason that barbells work so well, better than any other tools we can use to gain strength. The human body functions as a complete system – it works that way, and it likes to be trained that way. It doesn't like to be separated into its constituent components and then have those components exercised separately, since the strength obtained from training will not be utilized in this way. The general pattern of strength acquisition must be the same as that in which the strength will be used, a principle known as Training Specificity. The nervous system controls the muscles, and the relationship between them is referred to as "neuromuscular." Neuromuscular specificity is an unfortunate reality, and exercise programs must respect this principle the same way they respect the Law of Gravity.

Barbells, and the primary exercises we use them to do, are far superior to any other training tools that have ever been devised. **Properly performed, full range-of-motion barbell exercises are essentially the functional expression of human skeletal and muscular anatomy under a load.** The exercise is controlled by and the result of each trainee's particular movement patterns, minutely fine-tuned by each individual limb length, muscular attachment position, strength level, flexibility, and neuromuscular efficiency. Balance between all the muscles involved in a movement is inherent in the exercise, since all the muscles involved contribute their anatomically determined share of the work. Muscles move the joints between the bones which transfer force to the load, and the way this is done is a function of the design of the system – when that system is used in the manner of its design, it functions optimally, and training should follow this design. Barbells allow weight to be moved in exactly the way the body is designed to move it, since every aspect of the movement is determined by the body.

Machines, on the other hand, force the body to move the weight according to the design of the machine. This places some rather serious limitations on the ability of the exercise to meet the specific needs of the athlete. For instance, there is no way for a human being to utilize the quadriceps muscles in isolation from the hamstrings in any movement pattern that exists except on a machine *designed* for this purpose. No natural movement can be performed that does this. Quadriceps and hamstrings *always* function together, at the same time, to balance the forces on either side of the knee. Since they *always* work together, why should they be *exercised* separately? Because somebody invented a machine that lets us?

Even machines that allow multiple joints to be worked at the same time are less than optimal, since the pattern of the movement through space is determined by the machine, not the individual biomechanics of the human using it. Barbells permit the minute adjustments during the movement that allow individual anthropometry to be expressed.

Furthermore, barbells *require* the individual to make these adjustments, and any other ones that might be necessary to retain control over the movement of the weight. This aspect of exercise cannot be overstated – the control of the bar, and the balance and coordination demanded of the trainee, are unique to barbell exercise and completely absent in machine-based training. Since every aspect of the movement of the load is controlled by the trainee, every aspect of that movement is being trained.

There are other benefits as well. All of the exercises described in this book, and most other barbell assistance exercises, involve varying degrees of skeletal loading. After all, the bones are what ultimately support the weight on the bar. Bone is living, stress-responsive tissue, just like muscle, ligament, tendon, skin, nerve, and brain. It adapts to exercise just like any other tissue, and becomes denser and harder in response to heavier weight. This aspect of barbell training is very important to older trainees and women, whose bone density is a major factor in continued health.

In practical terms, five or six very functional weight rooms – in which can be done literally hundreds of different exercises – can be built for the cost of one circuit of any modern exercise machines. If cost is not a factor, utility should be. The number of people training at a given time per dollar spent equipping them might be an important consideration in deciding which type of equipment to buy.

The only problem with barbell training is the fact that the vast, overwhelming majority of people don't know how to do it correctly. This is sufficiently serious and legitimate a concern as to justifiably discourage many people from training with barbells in the absence of qualified instruction. And if most people don't know how to use barbells correctly, even fewer know how to teach their use. Most people who claim to know how don't. Adding to the problem is the fact that there are very few places to learn how to teach barbell training. It requires extensive personal experience with barbells, an ability to communicate this experience, and the capacity to adjust to the needs and abilities of the individual being instructed.

This method of teaching the barbell exercises has been developed over 25 years in the commercial fitness industry, the tiny little part of it that remains in the hands of individuals committed to results, honesty about what works, and the time-honored principles of exercise science. It is suggested that the prospective coach use the methods herein described to teach himself the movements, and then pass this now-firsthand knowledge along to those trainees in his charge. In this way, these teaching methods can be adapted to the individual coach's style and approach, filtered through the lens of his personal experience, and strengthened by his commitment to the success of his athletes.

The Squat

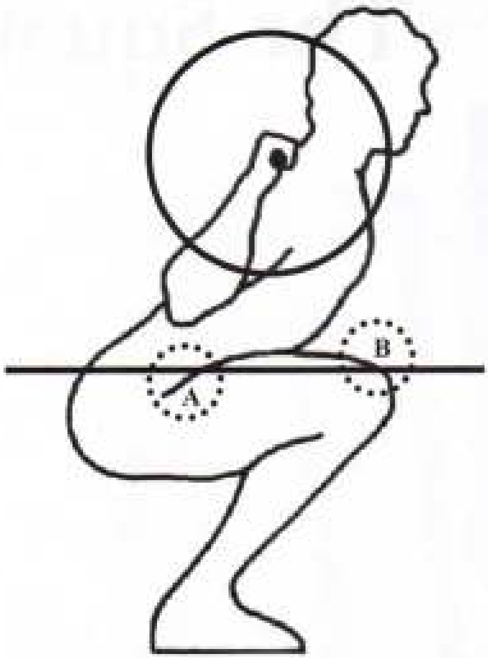


Figure 1. In the full squat, the anterior surface of the thigh at the hip (A) must be lower than the top of the knees (B).

The squat has been the most important yet most poorly understood exercise in the training arsenal for as long as there have been motivated athletes with barbells and orthopedic surgeons that didn't themselves do squats. The full range of motion exercise known as the squat is the single most useful exercise in the weight room. It would be interesting to see an orthopedic surgeon tell a kid not to play football, basketball, or soccer, the sports that result in the bulk of his knee practice, and leave full squats alone. It would also be interesting to know what percentage of the same surgeon's practice is the result of full squats. Orthopedic surgeons are not exercise professionals. They are surgeons. They study surgery, and some are even good at it. But they are not trained in exercise theory or technique, most of them have never trained correctly, many have never been in a gym. The same thing is true for physical therapists and other quasi-medical types, whose training and expertise is in returning the physically dysfunctional to function. Exercise for healthy individuals is not the same thing as therapy, and a good working knowledge of anatomy and kinesiology, while important and necessary, is not the only requisite for expertise in exercise prescription and programming. Medical professionals used to dealing with injured patients may tend to apply the wrong set of principles to healthy populations, being conservative to the point of being silly. As strength and conditioning professionals, we deal with healthy athletes, and we must learn the most effective ways to make their bodies and minds adapt to the rigors of sport. The squat is our most valuable tool.

The squat is so effective an exercise because of the way it uses the muscles around the core of the body. Much is made of core strength, and fortunes have been made selling new ways to train the core muscles. A correct squat perfectly balances all the forces around the knees and the hips, using these muscles in exactly the way the skeletal biomechanics are designed for them to be used, over their anatomically full range of motion (figure 1). The postural muscles of the lower back, the upper back, the abdominals and lateral trunk muscles, the costal (ribcage) muscles, and even the shoulders and arms are used isometrically. Their static contraction supports the trunk and transfers kinetic power from the prime movers to the bar. The trunk muscles function as the transmission while the hips and legs are the engine. Notice that the core of the body is at the center of the squat, that the muscles get smaller the farther away from the core they are, and that the squat works them in exactly this priority

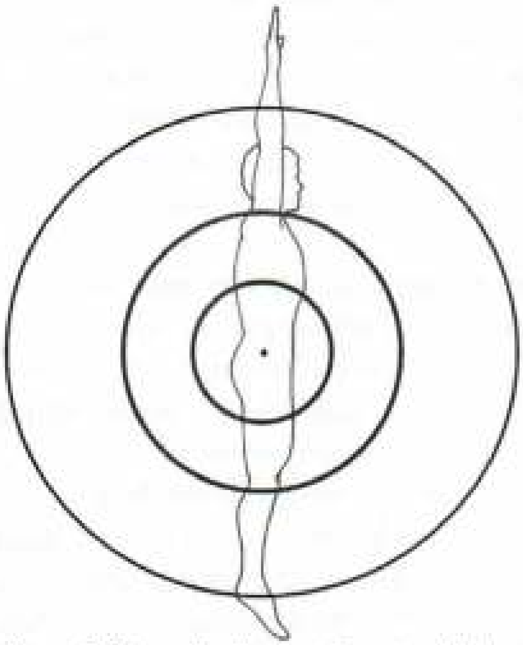


Figure 2. Power development is centered in the hips and the ability to generate power diminishes with distance from the hips. From a concept by David Webster, versions of which have been used by Tommy Kono and Bill Starr. This concept has received much attention under the new names "core strength" and "functional training". It is the opinion of the authors that an athlete with a 500 pound squat has a stronger core than an athlete with a 200 pound squat.

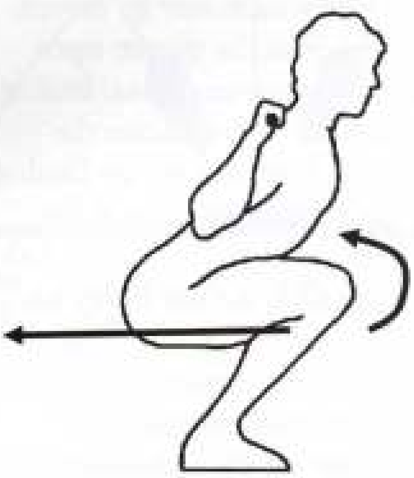


Figure 3. Direction of muscular action on the knee.

(figure 2). Balance is provided by the interaction of the postural muscles with the hips and legs, starting on the ground at the feet and proceeding up to the bar, and controlled by a massive amount of central nervous system activity under the conscious direction of the athlete's mind. In addition, the systemic nature of the movement when done with heavy weights produces hormonal responses that affect the entire body. Not only is the core strengthened, it is strengthened in the context of a total physical and mental experience.

Squat Depth:
Safety and Importance

The full squat is the preferred lower body exercise for safety as well as athletic strength. Yet physical therapists, orthopedic surgeons, chiropractors, nurse practitioners, and inexperienced athletic trainers regularly condemn the time-honored full range of motion squat as being harmful to the knees and apparently, as a result, the soul. The squat, when performed correctly, is not only the safest leg exercise for the knees, it produces a more stable knee than any other leg exercise. The important part of the last statement is the "when performed correctly" qualifier. Correctly is deep, with hips dropping below level with the top of the patella. Correctly is full range of motion.

Any squat that is not deep is a partial squat, and partial squats stress the knee and the quadriceps without stressing the glutes and the hamstrings. The hamstrings and glutes perform their function in the squat when the hip is stretched to the point where they get tight, at full hip flexion - the deep squat position (figure 3). The hamstring muscles, attached to the tibia and to the ischial tuberosity of the pelvis, reach a full stretch at the very bottom of the squat, where the pelvis tilts

forward with the torso, stretching the two ends of the muscle apart. At this stretched position they provide a slight rebound out of the bottom, which will look like a "bounce," and this in fact is a useful thing to coach into the movement if done carefully and with good explanation to the trainee. The tension of the stretch pulls the tibia backwards, the posterior direction, balancing the forward-pulling force produced by the quadriceps, which pull from the front. The hamstrings finish their work, with help from the glutes, by straightening out, "extending," the hip (figure 3).

In a partial squat, which fails to provide a full stretch for the hamstrings, most of the force against the tibia is forward, from the quadriceps and their attachment to the front of the tibia below the knee. This produces an anterior shear, a forward-directed sliding force, on the knee, with the tibia being pulled forward from the patellar tendon and without a balancing pull from the opposing hamstrings. This shearing force - and the resulting strain on the prepatellar area - may be the biggest problem with partial squats. Many spectacular doses of tendinitis have been produced this way, with "squats" getting the blame.

The hamstrings benefit from their involvement in the full squat by getting strong in direct proportion to their anatomically proper share of the work in the movement, as determined by the mechanics of the movement itself. This fact is often overlooked when considering anterior cruciate tears and their relationship to the conditioning program. The ACL stabilizes the knee; it prevents the tibia from translating forward relative to the femur. As we have already seen, so does the hamstring group of muscles. Underdeveloped, weak hamstrings thus play a role in ACL injuries, and full squats work the hamstrings while partial squats do not. In the same way the hamstrings protect the knee during a full squat, hamstrings that are stronger due to full squats can protect the ACL during the sport we are squatting to condition for. In fact, athletes who are missing an ACL can safely squat heavy weights, because the ACL is under no stress in a correctly performed full squat.

Another problem with partial squats is the fact that very heavy loads may be moved, due to the short range of motion and the greater mechanical efficiency of the quarter squat position. This predisposes the trainee to back injuries as a result of the extreme spinal loading that results from putting a weight on his back that is possibly in excess of three times the weight that can be safely handled in a correct deep squat. A lot of football coaches are fond of partial squats; it allows them to say that their 17 year old linemen are all squatting 600 lbs. Don't let this happen to you or your program - you don't need the problems that come with trainees handling unsafe loads. **If it's too heavy to squat below parallel, it's too heavy to have on the back.** Olympic weightlifters provide a perfect illustration of the safety and benefits of the full squat. Currently 167 of the 192 countries in the world compete in Olympic Weightlifting. More than 10,000 individuals compete in International Weightlifting Federation events alone, and the number of participants in total from the 167 countries would be staggering, likely on the order of 2 to 5 million (China alone boasts over 1 million lifters - per Ma Jian Ping). All over the world, weightlifters squat way below parallel safely, most often using some form of the exercise, either back squats or front squats, every day. That is correct: they squat way below parallel every training day, and most programs call for six days per week. Isn't it fascinating that they are both strong and not under the care of an orthopedic surgeon?

There is simply no other exercise, and certainly no machine, that produces the level of central nervous system activity, improved balance and coordination, skeletal loading and bone density, muscular stimulation and growth, connective tissue stress and strength, psychological demand and toughness, and overall systemic conditioning as the correctly performed full squat. In the absence of an injury that prevents their being performed at all, everyone that lifts weights should learn to do them correctly.

Now, let's learn how to teach the movement.

Squat Teaching Order

1. The squat begins at the rack, or the squat stands, whichever is available. The rack height should be set so that the bar in the rack is at about the level of the trainee's sternum, right in the middle. (We will be carrying the bar in the low position, on the posterior delts instead of the traps - more about this later.) Many will perceive this as too low, but explain that it's better to be a little low with the bar out of the rack than to have to tiptoe back into the rack with a heavy weight. Often the empty rack at this position will look low, because the diameter of the bar sitting in the hooks tells the eye a different story about its true height in the rack. When the bar is placed in the rack, the eye will be more comfortable with the setting.

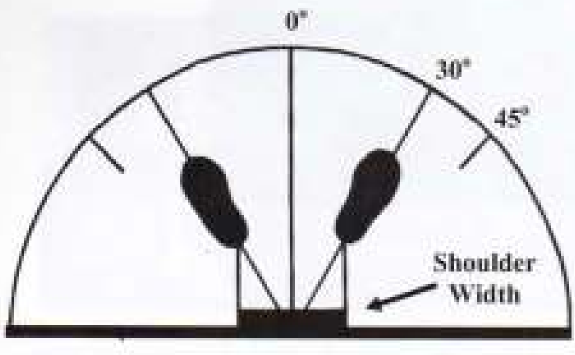


Figure 4. Foot placement should be at 30 degrees with the heels placed at shoulder width.

2. We will use a fairly neutral foot placement, with the heels about shoulder width apart, the toes pointed out at about 30 degrees (figure 4). Excessive width tightens the hips at the bottom, and excessive narrowness prevents adductor stretch and causes the quads to jam against the belly in heavier trainees, both of which prevent proper depth. (Most trainees seem to self-select too narrow a stance, possibly due to the evil influences of muscle magazines. All these influences must be purged, lest every workout turn into a bicep-fest.)

This is also a good time to familiarize the trainee with where on the foot his weight is carried. Have him lift his heels - his weight is now on his toes. Then have him pick his toes up off the platform - his weight is now on his heels. These will be useful things later.

3. Now comes the crucial part of teaching the movement. We are going to place the trainee in the position he will be in at the bottom of a correct squat.

This is far superior to having him do it first with the bar, because any errors in position can be easily corrected without the bar adding to the complexity of the system. Have the trainee assume the correct stance, and tell him to "squat down, all the way." This command encourages the trainee to go to the proper depth immediately, without even addressing the idea that there might be an intermediate position to stop in, thus avoiding the problem of stopping high. Some trainees, due usually to a lack of flexibility in the adductors and hamstrings, will stop above parallel involuntarily. This is to be expected of a high percentage of trainees, and will be addressed during this next phase. Make sure that proper foot position has been maintained, then, tell the trainee to "put your elbows against your knees, palms of your hands together, and shove your knees out" (figure 5). This is usually a decent bottom position, and if the inflexible trainee maintains it for a few seconds, depth starts to be attained. In these inflexible kids, the lack of depth is sometimes accompanied by a round lower back. This usually resolves itself when the bar is added later and the elbows are correctly raised to hold the bar.

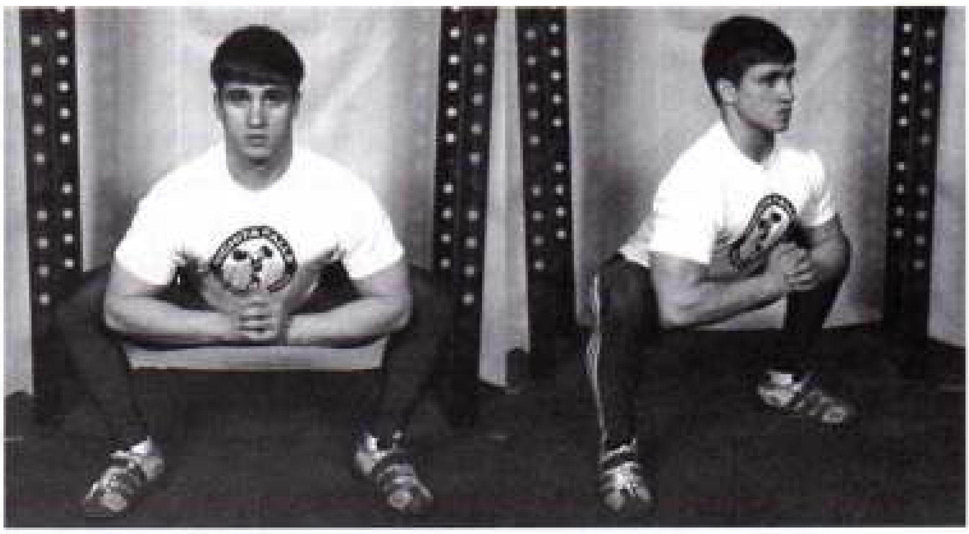


Figure 5. Use of elbows to demonstrate correct squat position to the trainee.

The trainee will have been in the bottom now for a few seconds, and this time allows for some stretching. If fatigue is producing discomfort, as it might be in exceptionally unconditioned individuals, let him stand up to rest a few seconds, and then place him back in the correct bottom position.

4. Now is the time to explain why this position is important, and how to assume it correctly. Tell him to "notice these things about where you are now. Your feet are flat on the floor (they should be), your knees are shoved out to where they are in a parallel line with your feet, and your knees are just a little in front of your toes" (figure 6). The back may or

Figure 6. Knee-over-toe position can easily be demonstrated to the trainee.

may not be flat enough to qualify as correct, depending on individual flexibility, but this is not crucial, yet.

A word now about knee position and adductor function. This method utilizes a knees-out position, both at the bottom and on the way down. Knees-out does two important things for the squat: it allows for easier depth, and it adds the adductors, the "groin" muscles, to the movement. As for depth, the aforementioned jamming effect of the thighs against the belly affects most trainees, regardless of the degree of chubbiness. The tendency to stop the descent of the hips when the belly contacts the thighs is almost universal, as is the tendency to round the lower back when this happens. This, in combination with the fact that if the toes point forward, as is usual with a narrow stance, the knees will go forward too, makes good depth hard to reach. The knees can travel forward until they literally touch the floor, and the hip will not drop below the patella (figure 7).

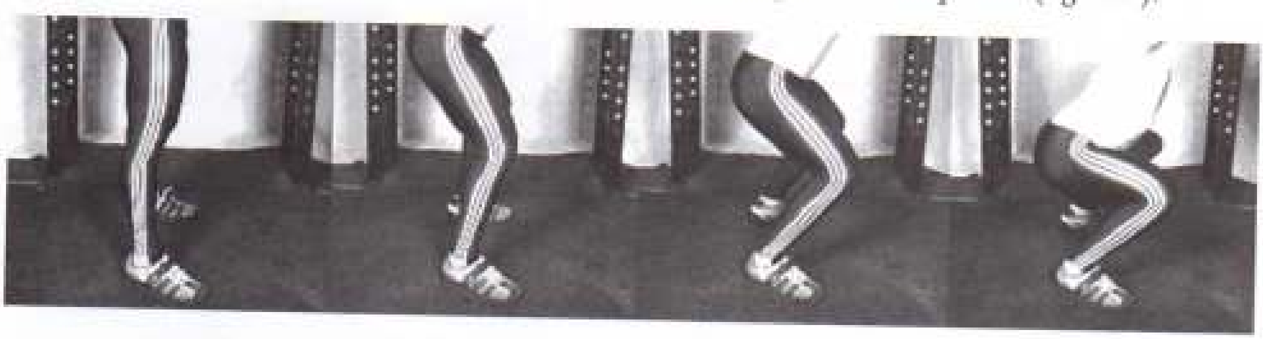


Figure 7. Demonstration of the knee's ability to move forward without dropping the hip below parallel.

The knees can go to a point just in front of the toes, and this position will vary with the anthropometry (a fancy way of saying individual physical dimensions) of the trainee. If the knees are too far back, too much forward lean will be required to balance. Knees too far forward produces too acute a knee angle, throwing the weight on the toes and making hip drive out of the bottom inefficient.

The role of adductors in the squat is a bit more difficult to understand. A good understanding of the anatomy here is important (figure 8). Note that all these muscles essentially originate in the groin area and insert on the medial

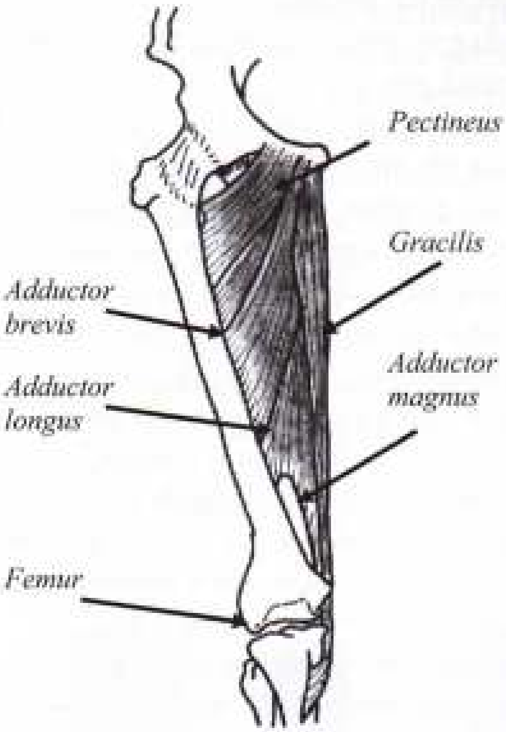


Figure 8. The adductors of the thigh.

Figure 9. Demonstration of the length difference in the musculature originating in the pelvis and inserting into the knee during the squat. Note that the rope is taut at the bottom (stretch - left) and loose after rising (right).

femur area. As such, their function will be to shorten the distance between these two points. When you squat, or simply squat down, notice what happens to the distance between these two points - it increases, as can be easily demonstrated by placing one finger on the origin in the groin area (do this in the privacy of your office) and another finger placed on the inside of the knee. As you come back up, the points get closer together, defining the role of these muscles in the squat (figure 9). The adductors function in the squat when the knees are out, and thus contribute to the movement; since we are trying to strengthen more muscles and lift more weight, it makes sense to use the adductors during the squat. One sure indication of weak adductors is the inability to keep the knees out during the squat, a symptom that sometimes gets interpreted as weak abductors, the muscles on the outside of the hip. If the groin is injured, this information is useful as well - have the trainee squat with a closer stance until it heals.

5. This phase of instruction teaches the very important concept of hip drive. Electromyography studies have shown that the glutes and hamstrings are the prime movers out of the bottom of the full squat, and this command will begin to embed the idea of hip drive into the trainee's movement pattern. Stand facing the trainee's profile, at right angles to his front, close enough to touch him with your hands. Tell the trainee to "now come up out of the bottom." No matter how he does this, touch him on either side of the sacrum with the thumb and middle finger of your hand (figure 10). Say the following: "Notice that you raised your butt/hips/ass (term depending on the coach/athlete relationship) out of the bottom." He will

Figure 10. Hand placement for ensuring trainee is aware of hip contribution during exercise.

Figure 11. Hand placement for teaching correct hip drive.

usually say "I did?" or something to that effect. Immediately say, "This is correct. The squat is a hips movement, and you come up from the bottom using your hips first." Continue by saying, "Don't think about your knees straightening out, don't think about your feet pushing against the floor, don't think about your legs. Just drive your hips up out of the bottom and the rest will take care of itself." And it will.

6. This important point should not be missed. Our previous discussion about the use of the hamstrings in the squat is brought to application here. The squat is not a leg press, and pushing the floor with the feet provides an inadequate cue for the hamstrings and glutes to provide their power out of the bottom. Hip extension is the first part of the upward drive out of the bottom. When the hip/butt is given a command like "raise your butt up out of the bottom" the nervous system has a better way to fire the correct motor units, and to engage hip extension. If the trainee has trouble with this concept, it will be apparent from the side. If correct hip drive is being used, the butt will actually rise a little faster than the shoulders, possibly making the back angle decrease relative to the floor. This is fine at this stage, and can be easily corrected later. It might actually help a trainee who is having trouble with this to assume the bottom position, and then for the coach to place a hand against his sacrum, right below the lumbar and just above the tailbone, followed by the command, "Drive up against my hand. Push my hand straight up vertically out of the bottom" (figure 11). If the trainee can do this in balance, he will be using correct hip drive.

7. We are now ready to squat. Have him chalk his hands. Chalk is always a good idea, because it dries out the skin, and dry skin is less prone to folding and abrasion than moist skin, and therefore is less prone to problem callus formation. If the weight room is not equipped with chalk, the trainee should provide his own. Now, take him to the bar. ALWAYS an empty bar at first. Always. The preferred bar placement is NOT high on the traps, just below the neck, although that is the preferred placement for Olympic weightlifters. We advocate the use of the lower powerlifting-style position, where the bar is carried just below the spine of the scapula, on top of the posterior deltoids (figure 12).

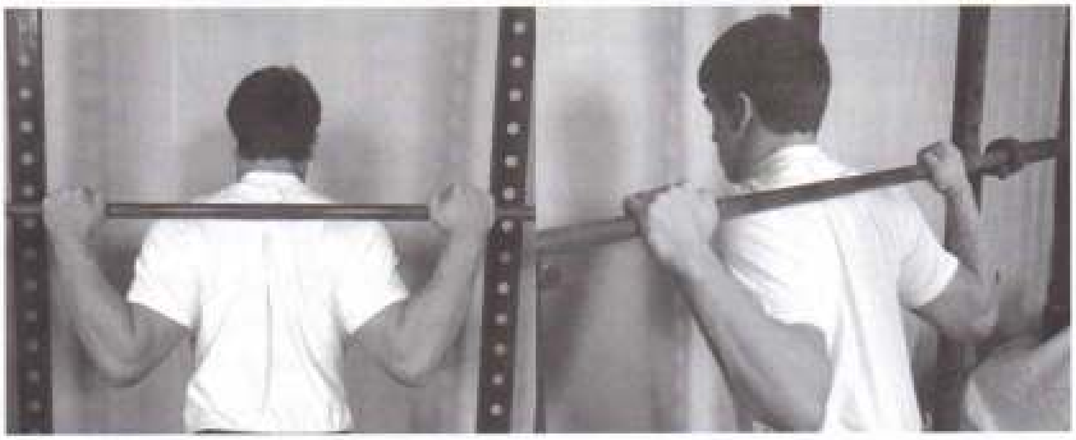


Figure 12. Bar placement on shoulders for the squat exercise.

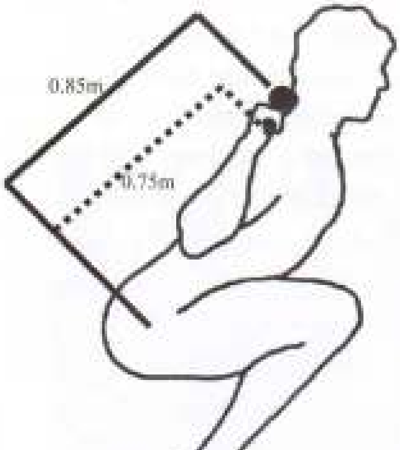


Figure 13. Torque against the lower back increases with the distance the bar is from the hips. The rigid trunk segment constitutes a lever arm acting at the point of rotation at the hips. The longer the distance between the point of rotation and the force of the loaded bar, the greater the torque against the lower back.

This lower position shortens the lever arm formed by the weight of the bar transmitted down the back to the hips, producing less torque at the low back and a consequently safer exercise (figure 13). For trainees with very inflexible shoulders, the high bar position is, of course, preferable to not squatting at all, but a little stretching can usually fix this problem in a couple of weeks.

Take an even grip on the bar, measured from the markings placed on the bar for this purpose. A standard power bar has 17" between the ends of the outside knurl, and 32" between the score marks, the 1/8" gap in the knurl indicating a legal bench press grip. Grip width for the squat will obviously vary with the size of the trainee, and with shoulder flexibility, but in general the hands will be between these two markings on this type bar

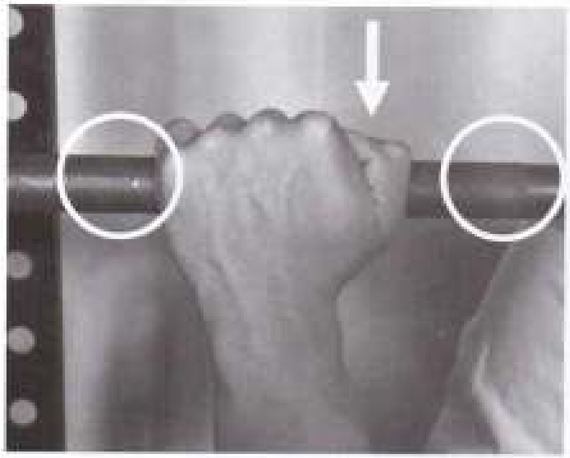


Figure 14. Hand placement. Note the thumb is on the top of the bar and in between the outer ring and the inner edge of the knurling.

(figure 14). A narrower grip allows a flexible person to support the bar better with the muscles of the posterior shoulder when the elbows are lifted, and a wider grip allows an inflexible person to get more comfortable under the bar. In either case, a narrower grip tightens the shoulder muscles so that the bar is supported by muscle and doesn't dig into the back (figure 15).

The thumb should be placed on top of the bar, so that the wrist can be held in a straight line with the forearm. If a lack of flexibility (usually in the chest and shoulders, not the wrists) prevents this position, most trainees can hold it in the less desirable high-bar position until proper stretching can establish enough flexibility to get it down to a better position. More on this later.

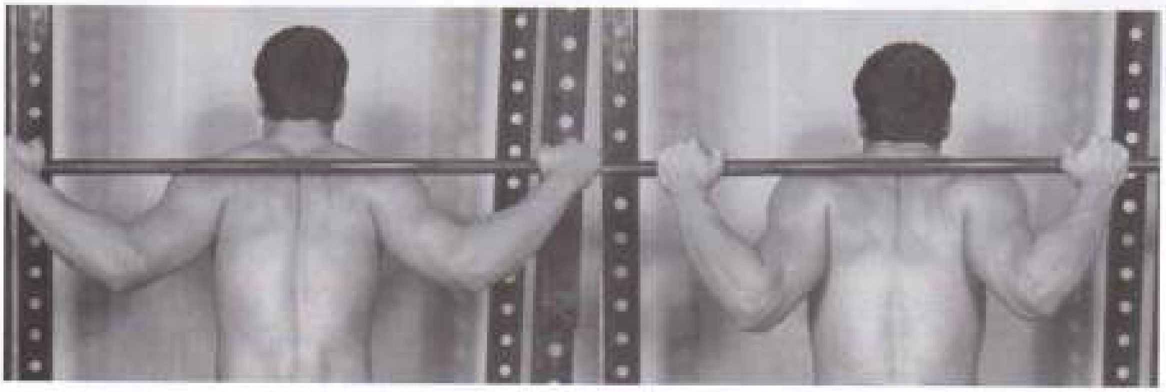


Figure 15. Comparison of wider grip to narrow (recommended) grip. Note the difference in tightness in the upper back muscles.

So the bar should be placed in the correct position just immediately under the "bone" you feel at the top of the shoulder blades, with the hands and thumb on top of the bar, and then secured in place by lifting the elbows and the chest at the same time (figure 16). This action tightens the muscles of the back, and lifts the chest, placing the thoracic spine in an extended, "straight" position, and fixes many of the problems often encountered earlier with a round-back position. Enormous weights can be safely handled this way later.

"Lifting the chest" is an important cue, one that will be used many times a day in your weight room, and this is a good time for the trainee to get used to hearing it. It may be confusing for some, who may interpret this as making the torso angle more vertical (figure 17). It can be demonstrated by touching the

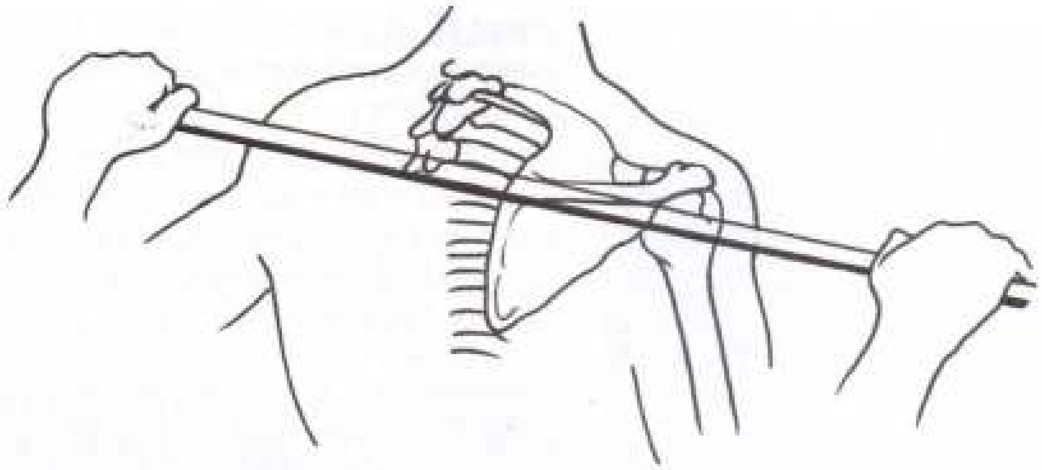


Figure 16. Bar placement in relation to skeletal structure of the shoulder.

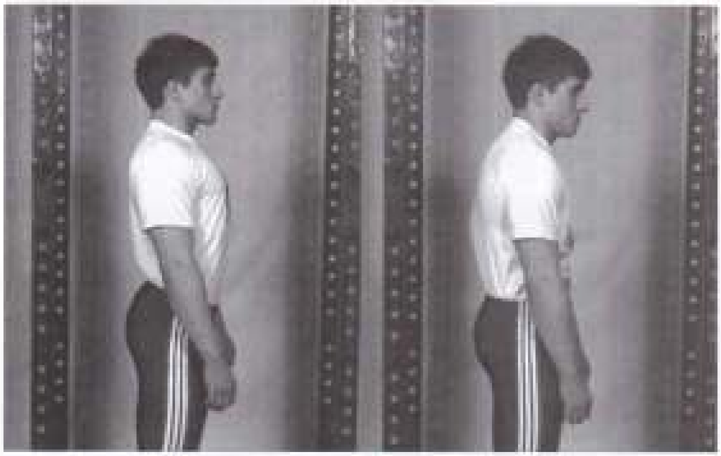


Figure 17. Comparison of "chest up" position to a vertical but rounded back position.

Figure 18. Physical cue for trainee to raise the chest into proper position.

trainee on either side of the sternum with the thumb and middle finger and the command "Lift this up" given (figure 18). Most will arch their upper back at this cue. It will be important for them to learn how to arch the lower back also. More about this later.

8. First and foremost, ALWAYS STEP BACK OUT OF THE RACK. ALWAYS. NEVER PUT THE BAR BACK IN THE RACK BY STEPPING BACKWARDS. NEVER. This cannot be done safely. A trainee should never be in a position to have to step backwards and rack a weight at the end of a set. He cannot see the hooks, and even with spotters there will be a wreck.

Now, the bar should low enough in the rack that a short squat is required to get it out of the rack. Some trainees tend to try to do this with their hips only, doing a "goodmorning" with the bar. This is fine with an empty bar, but as weight is added it becomes rather unsafe.

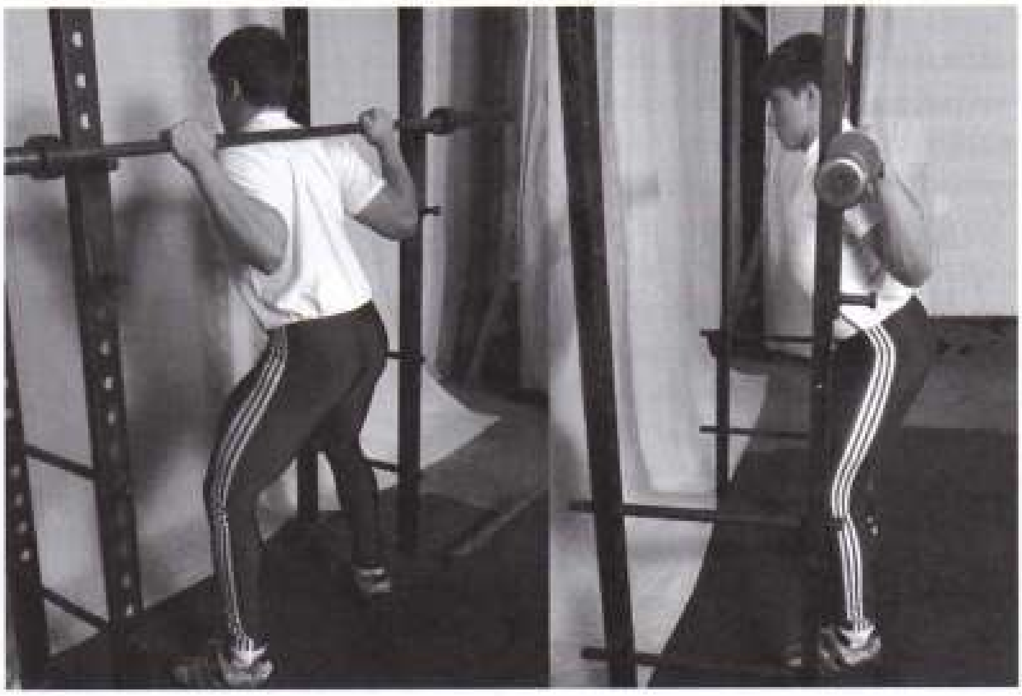


Figure 19. Proper position to receive the bar from the racks.

The bar should be taken out of the rack in the same position it is to be squatted, with the torso and shoulders tightened, the chest and elbows lifted, and the head position down (more on this below) (figure 19). Everything should be the same as for the full movement. In this way, any weight can be walked safely out of the rack. Many problems are caused by doing this wrong. It is very common to see the trainee take the bar out of the rack on a loose back and chest, and then attempt to tighten everything right before squatting. It is obviously much easier to tighten the muscles and THEN take the weight, than it is to take the weight, let it mash down into the back until it stops on some crucial skeletal component, and then try to tighten everything up underneath it.

Many trainees like to take a hike with the bar, backing up three or four steps before setting up to squat. This is unnecessary, and could become a problem if the set is heavy, spotters are unreliable, and the trip back to the rack is just too far on this particular day. One step back out of the rack for a trainee with good form is enough to clear the rack and allow for spotters to do their job while permitting minimum trouble getting back home.

The stance should be the same as the one used during the stretch. Again, heels should be about shoulder-width apart, toes pointed out about 30 degrees. Some trainees need to be told to "point the toes out more than you want to."

9. At this point, the trainee is ready to squat with the empty bar. THE EMPTY BAR. All of the groundwork has been laid, the correct bottom position is fresh in his mind, and he is now in the correct starting position. Everything

should work well for most trainees. At this point, it is useful to say the following things: "Everything you are about to do is the same as you did during the stretch. Only two things are different. One, you don't have your elbows available to push your knees out, so you need to do this without them. Two, don't stop at the bottom. Just go down and immediately come back up, driving your butt out of the bottom." At this point, the final instructions should be given. Say, "Now, take a big breath and hold it, look down right there," pointing to a spot on the floor about 6' in front of his position, "and squat."

Watch the first rep. If it is pretty good, have him do a set of five and rack it. If it is crazy bad, have him rack it and repeat the pre-squat procedure. To rack the bar, have him walk forward until the bar touches the vertical part of the rack. Tell him to "find the uprights, not the bottom of the hook. You can't miss the uprights, and if you touch there, you'll be over the hook, but if you try to find the flat part, you can miss it and be low on one side. Big wreck."

If his form is acceptable, the general plan is to do a couple more sets with the empty bar to nail down the form, and then add weight, do another set of five, and keep increasing in even increments until form is compromised by the weight. Increments will vary with the trainee - lightweight, unconditioned kids need to go up in 10lb or 5kg jumps, older, stronger trainees can use 20 or possibly 30lb, or 10-15kg increments. When it becomes apparent to your eye that the next increase would alter the form, stop there and do two more sets of five. That is the first squat workout.

About a third of your trainees will do a perfect squat the first time. Another third will require minor corrections that produce a correct squat on the second or third set. The last third will need work. Now, it's time to coach.

Faults and Corrections

Head and neck

The single most common problem encountered by professional strength coaches is the trainee who has already been shown to "squat" by someone who has never himself done a correct squat. Invariably these kids will have been taught to "look up at the ceiling" when they squat, presumably because up is the direction the bar must go, and if you look up you'll go up, or some such twaddle. This is a very difficult habit to break once it is established, and it has so many detrimental effects on squat execution that some law against it will eventually have to be adopted.

Looking up when squatting is the enemy of depth, hip drive out of the bottom, and correct chest position, the three most important factors in a safe, correct squat. This bizarre neck position is inherently unsafe anyway. To place the cervical spine in extreme hyperextension and then to place a heavy weight on the trapezius muscles directly underneath it is, at best, imprudent (figure 20). But the form errors created by looking up combine with the bad neck position to produce a movement that is so unsafe as to almost make it understandable that so many health-care professionals advise against the squat.

Figure 20. Don't do this.

If we realize that hip drive is critical to power out of the bottom of the squat, the rest is easy. Try this: assume a good deep bottom position as described earlier, with knees out, toes out, and heels down. Put the chin slightly down and look at a point on the floor five or six feet in front of you. Now drive your hips up out of the bottom, and make note of how this feels. Now do the same thing while attempting to look at the ceiling (figure 21). You will discover an amazing thing - that chin-down (looking down keeps the chin down) with the neck in a normal anatomical position facilitates hip drive. It facilitates chest-up, the normal anatomical position for the thoracic spine under load, and this is also a good thing.

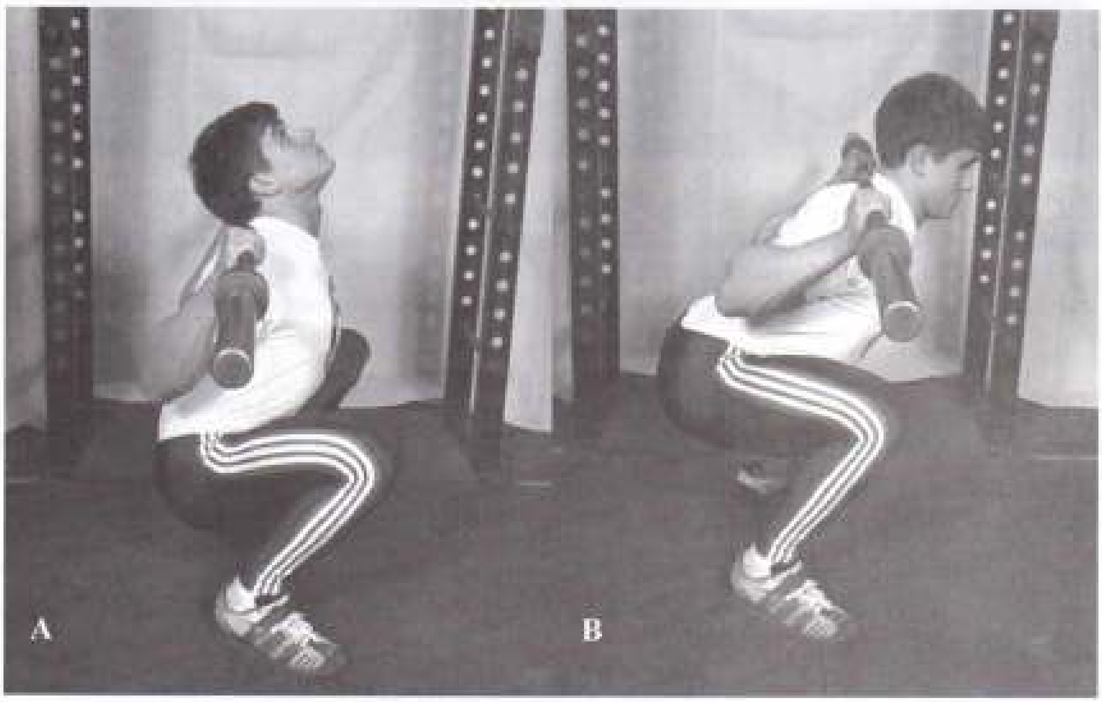


Figure 21. How looking up and looking down affects trainee balance. Note that in A the trainee's center of balance is shifted to the rear. In B, moving the head down brings the center of balance forward.

And correct chest position is an important factor in placing the lumbar spine in the correctly extended, slightly arched position. Correct lumbar position is essential for full utilization of the hamstrings and glutes out of the bottom,

because when they are stretched more completely they can contract more completely and generate more power over a longer range (more on this later). So bad neck position sets up a series of bad positions that greatly diminishes the safety and effectiveness of the squat.

Most people bend over slightly when they look up. Again, try this yourself. Notice that tilting the head back changes the center of gravity slightly, enough so that most people lean forward a little to compensate (figure 22). When this is done with a bar on the back it alters the position of the spine, usually resulting in a tendency to shift the weight forward the toes and away from a balance, efficient squat.

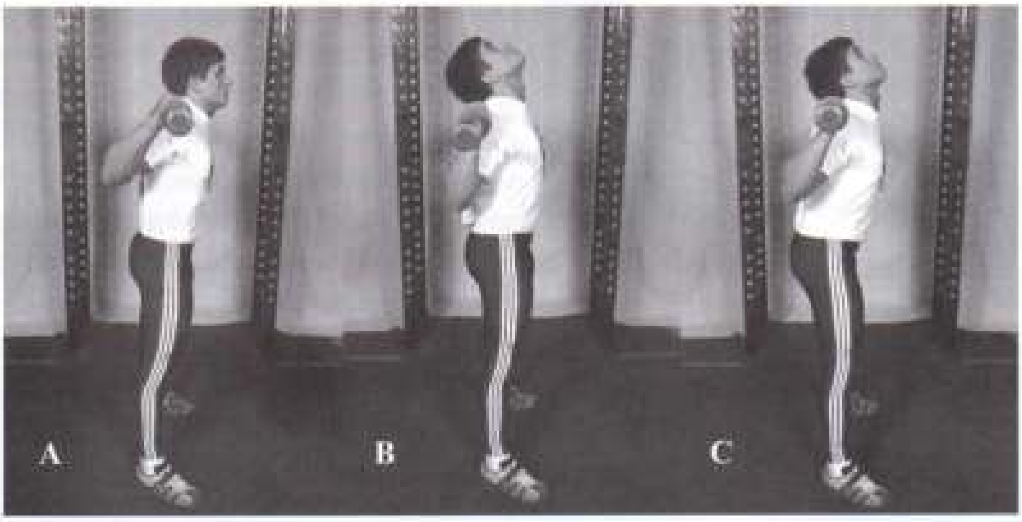


Figure 22. The effect of looking up on standing posture. In A, the trainee is in proper neutral balance with the center of mass over mid-foot (See where the bar is over the foot?). If the trainee looks up, two things may happen: (1) as in B, the entire body may lean back and the center of balance may shift to the heel, or (2) as in C, the trainee may kick the hips back and throw the chest forward in order to maintain balance.

Looking at the floor also provides the eye with a fixed position reference. Any movement of the body is detectable against the fixed position, and the correct squat becomes familiar against this reference. Any deviation from the correct movement pattern gets feedback against this reference and can be adjusted as it happens. The ceiling also provides a reference, but at the expense of safe neck position. And, generally speaking, the floor is closer to the eyes than the ceiling, and is therefore more useful as a reference – smaller movements can be detected against a closer point.

One problem associated with failing to keep the chest up when squatting is that this incorrect position tends to alter the perception of depth. Many trainees, when told that they are squatting high through failure to lower the hips, will lean over more at the bottom, thus lowering the bar more (figure 23). It feels deeper this way, but depth is judged by hip position, and merely lowering the bar more by bending over more increases the chance of injury while decreasing the amount of work done by the muscles we are trying to use.

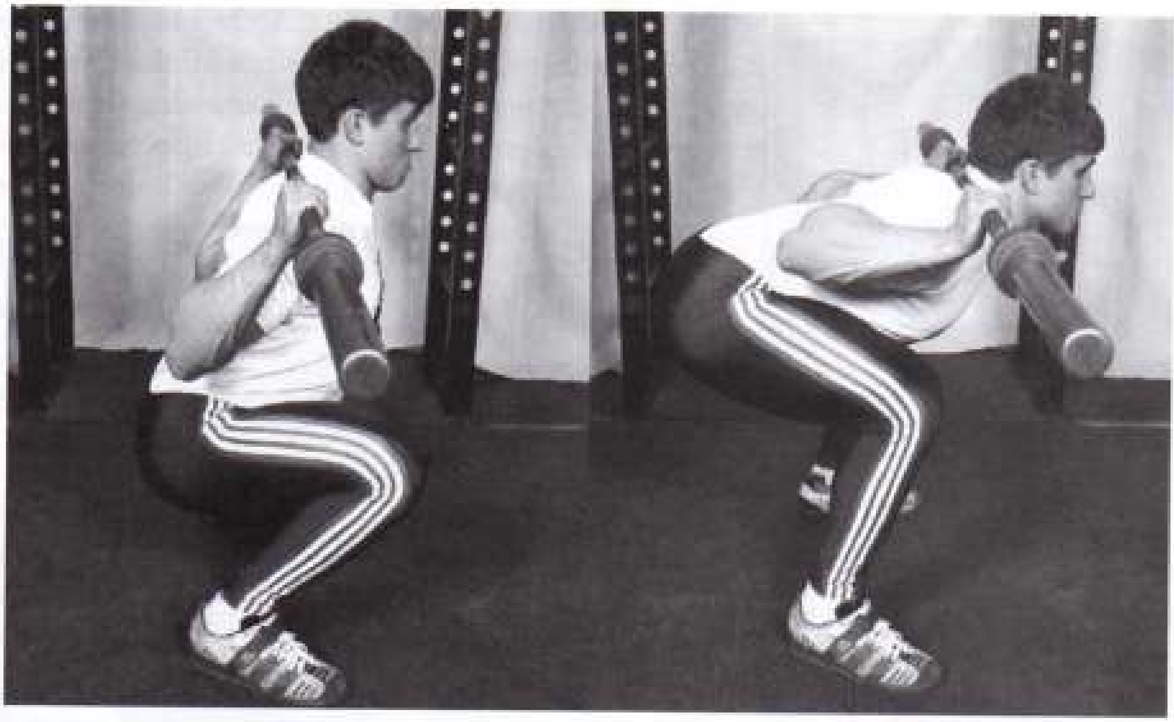


Figure 23. The perception of squat depth is distorted by not keeping the chest up. This leads to incomplete range of motion and potentially dangerous positioning. Note that in the above, even though the bar is at the same distance from the floor, a full squat depth has not been achieved on the right.

To correct looking up, fix the eyes on a position on the floor six to ten feet in front of you, or if training close to a wall, on a place on the wall that results in the same neck position (figure 24). Stare at this point, and get used to looking at it so that it requires no conscious

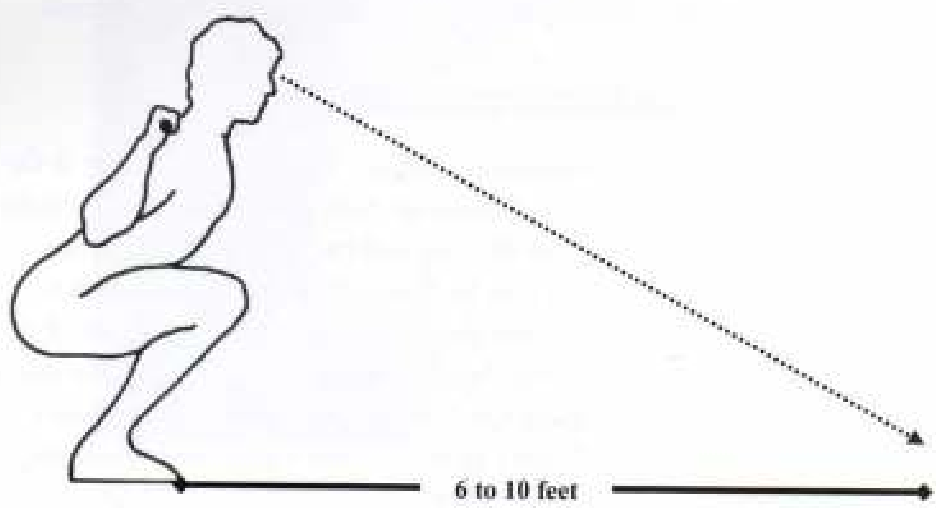


Figure 24. Visual focus should be at a relatively neutral head position and at a distance of 6-10 feet.

Figure 25. The tennis ball exercise.

effort. Most people will not raise their heads to the point where neck position is affected if they are looking down. Some stubborn trainees may need to hear "chin down!" a couple of times before they understand. A useful thing for some to hear is, "Play like you're holding a grapefruit between your chin and your chest." Inventive coaches have used tennis balls for this purpose, and have noticed that it corrects chest position at the same time (figure 25).

It will be the rare trainee who looks down too much, but you might have one. If the kid is actually able to look down to the extent that he's looking at a point between his heels, you have a very flexible trainee. Just tell him to look up a little, remembering the place on the floor or wall. It would be good if all coaching problems were this easy to fix.

Squatting in front of a mirror is a really bad idea. Many weight rooms have mirrors on all the walls, making it impossible to squat without a mirror there, within eyesight, giving the trainee its bad feedback. A mirror is a bad tool because it provides information about only one plane, the frontal, and depth cannot be judged by the trainee under the bar from the front. Some obliqueness of angle is required to see the relationship between patella and hip crease, and a mirror set at an oblique angle would produce a neck twist. Cervical rotation under a heavy bar is just as bad an idea as cervical hyperextension under a heavy bar. But the best reason not to use a mirror in front of any multi-joint exercise is that the trainee should be developing kinesthetic sense of movement by paying attention to all the sensory input provided by proprioception, rather than focusing merely on visual input from a mirror. "Learn to feel it, not just see it," is excellent advice.

Grip and arms

Grip errors are common even with experienced trainees. The grip on the bar is the first movement made in the trainee's temporary relationship with the barbell that we refer to as a "set." If that grip is wrong, none of the reps in that set will be optimal, because the relationship of the body to the bar is determined first by hand position on the bar. For instance, an uncentered placement of bar on back results in asymmetrical loading of all the components under the bar: more weight on one leg, hip, and knee than the other, as well as a spinal shear. A careless approach to grip placement could result in problems with heavy weights. Most trainees, as discussed earlier, will need to take an even grip somewhere between the score mark and the end of the knurl.

There is, however, an important exception to this rule: for a trainee with markedly different flexibility between shoulders, a symmetrical grip on the bar will result in an asymmetric bar position on the back. When the athlete goes under the bar, the tight shoulder keeps the upper arm out from the ribs. Thus, the tight shoulder will drag the bar out toward that side, resulting in the bar being off-center on the back, and centered loading of the back is our primary concern (figure 26). For these trainees, the coach will have to determine which grip centers the bar and remind the kid to set it that way every time.

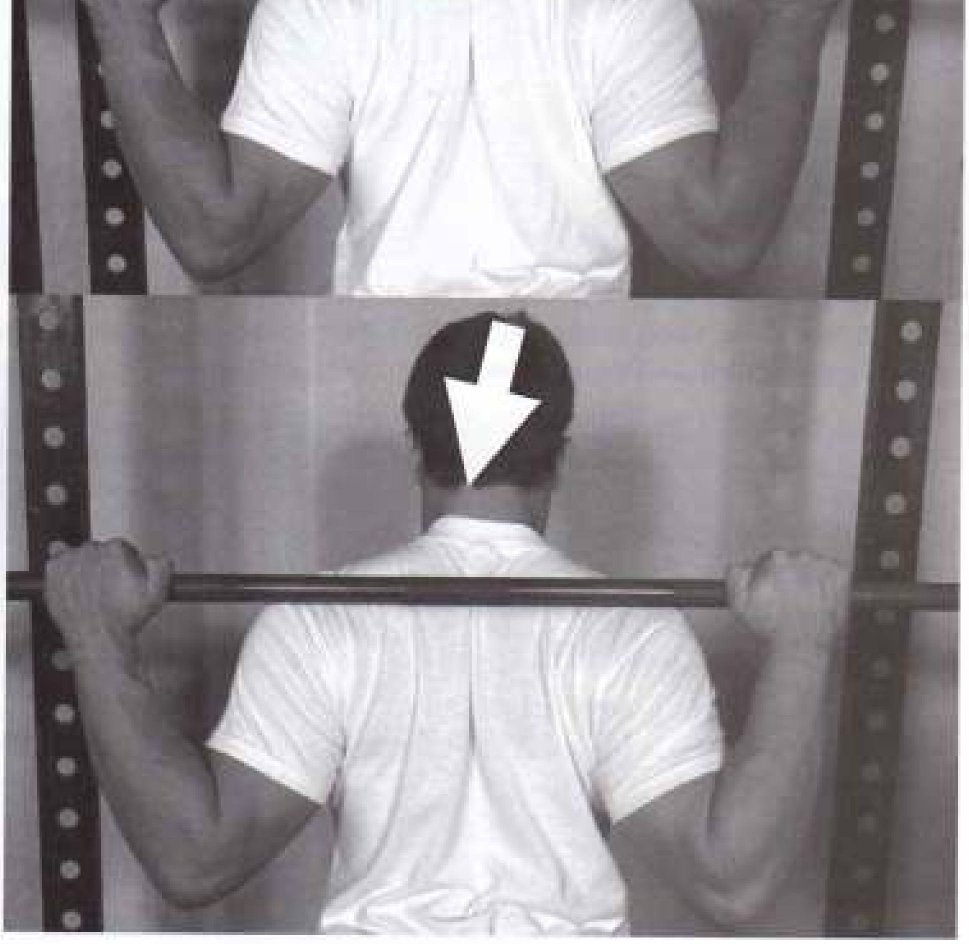


Figure 26. Symmetrical (top) vs. asymmetrical bar placement (bottom). Asymmetrical is not good, it leads to uneven spinal loading and affects the basic kinematics of the entire movement.

The thumb should be placed on top of the bar, so that the wrist can be held in a straight line with the forearm (figure 27). There is a tiny little place in

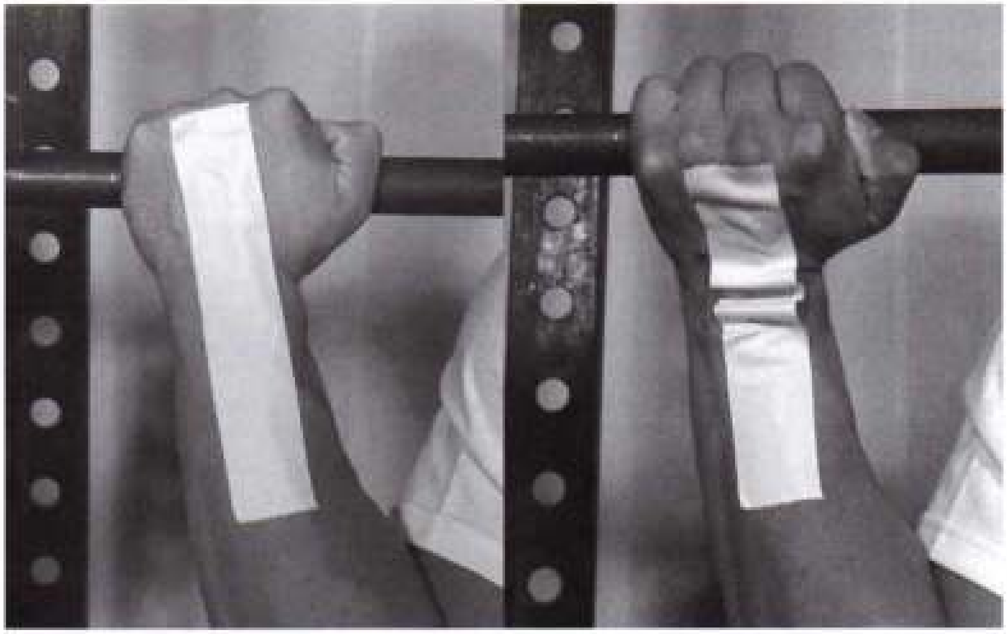


Figure 27. An easy illustration of proper wrist alignment. Note the wrinkled tape with improper position (right).

some people's brains that tells them that they are holding up the bar with their hands and arms. People that do this will have sore elbows, a horrible, headache-like soreness in the inside of the elbow that makes them think the injury occurred doing curls. If the elbows are underneath the weight, and force of the weight is straight down (as gravity is wont to make it do), then the elbows will intercept some of the weight (figure 28). This produces a shearing force on the elbow ligaments and causes a most unpleasant inflammatory problem that is difficult to heal. If the thumb is on top of the bar, the hand can assume a position that is straight in line with the forearm when the elbows are raised up. In this position, none of the weight is over any part of the arm, wrist, or hand, and all of the weight is on the back.

Occasionally a trainee has been misled by his brother-in-law into thinking that it is okay to put his hands out so wide on the bar that the fingers or even the palms of the hands are in contact with the plates. As bizarre as this sounds, we older guys have seen this. As grip width increases, upper-back muscle tightness decreases, and muscular support for the bar is diminished. If the posterior deltoids, rotator cuff muscles, traps, and rhomboids relax due to a widened grip, the skeleton becomes the default support structure. This is less than desirable. And then to add to the problem by placing the hands on the plates, a ROTATING pair of objects at the far end of the bar, well, this is just silly. We must be in control of the bar, and the bar must be secure on the back, and we must purge all silliness from our training halls.

As is often the case in athletics, one problem is intimately associated with another, and the solving of one fixes the other. A lack of shoulder tightness and failure to keep the chest up are almost the same problem, and may be coached from either direction. If the elbows drop, the shoulders have relaxed; if the elbows are lifted, the shoulders tighten. Most trainees will raise their chests when told to raise the elbows, because not to do so would cause them to lose balance forward. Lifting the chest requires a contraction of the upper back muscles, especially the superior portion of the longissimus dorsi complex. So lifting the chest is thoracic spinal extension, a back movement. Tightening the shoulders and lifting the elbows aids the thoracic

Figure 28. Elbows should be elevated to the rear, not directly underneath the bar. In proper position, the shoulders carry the weight (right). If the elbows are dropped (left) then the wrists and elbows start carrying the weight ... this is bad.

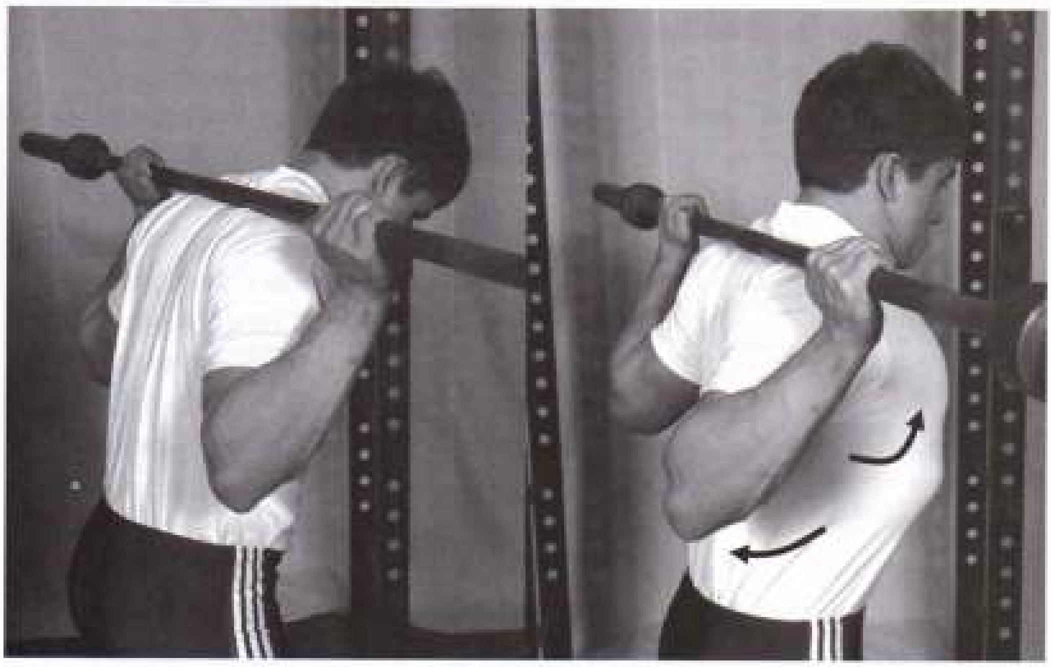


Figure 29. As the chest is raised anterior and the elbows posterior, the bar is "locked" into place. The arrows indicate the direction of movement for the chest anterior and the elbows posterior.

extension muscles by contributing to bar support at the point where it is mashing down into the back.

Many trainees seem to be making a flat, level spot for the bar to sit on by keeping the chest parallel to the floor. It must be demonstrated to these creatures that the bar will not roll off the back if they properly grip the bar and raise the elbows with the hands in the right position on the bar. When the elbows come up and the chest comes up, the hands are pushed forward and the bar is actually forced *forward* into the back, and the bar cannot go anywhere at all (figure 29).

Back

Back errors may be the most serious problem for the trainee because they carry the highest potential risk of injury. It is extremely important to understand this. Although the squat has an undeserved, baseless reputation for knee injury potential, its actual greatest danger is to the spine. A basic understanding of spinal anatomy is necessary to appreciate the nature of the problem, and why correct form is so critically important in the squat.

The spine is a stack of bones that are separated by tough, rubbery gaskets with soft centers. The bones, or vertebrae, line up in a column which, when in normal anatomical position, has two distinct curves in it (figure 30). The curves, called the kyphosis in the thoracic (upper back) region and the lordosis in the lower back (lumbar) region, are normally present in everybody at varying degrees of expression. Too much curve is bad, too little curve is bad. The spinal discs, the rubbery things with the soft centers, are shaped in a way that reinforces these normal curves in the spine. Because the discs are shaped to hold the back in this slightly curved position, the back likes to bear its load when in this position. If the back is loaded in a way that puts too much force on either the front or the back of the disc (if the normal curve is altered too much in either direction, or to the side as in a loaded rotation), the disc can be injured by the uneven compression. The injury can take the form of a fracture of the tough rubbery body of the disc, allowing the soft center (the nucleus pulposus, the material that absorbs shock and compression) to herniate - to squirt out in an inconvenient direction (figure 31).

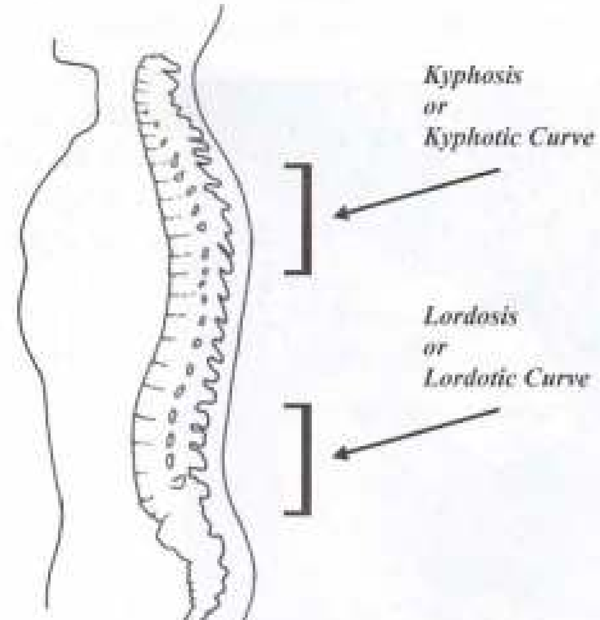


Figure 30. Spinal Curves. Excessive curvature in either region can be pathological.

The compressive forces of a heavy squat are not dangerous to a conditioned intervertebral disc if they are applied evenly across the entire surface of the disc, as they are when the back is in normal anatomical

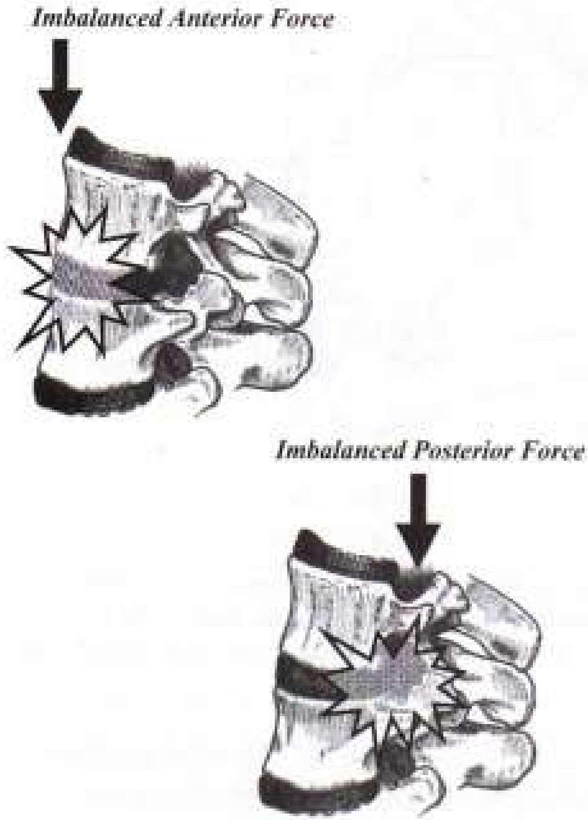


Figure 31. Application of unbalanced forces stemming from improper postural maintenance during loading may cause injury to the intervertebral discs.

position. Massive weights have been safely squatted, yet many people suffer disc injuries while picking up the newspaper. Injury occurs when force is applied to discs in a position other than normal. **Proper squat form IS normal anatomical position for the spine.**

The vertebrae touch each other at another point, the facet joints. These lie on the posterior side of the bones, and are a synovial joint like many other joints in the body, with cartilage and fluid contained by ligamentous material comprising the articulation. The vast majority of minor back injuries are facet joint injuries, basically inflammatory in nature and treatable with NSAIDs, rest, or manipulation. These can be sufficiently painful to prevent training or even normal activity, as any back owner can tell you.

Back errors can be divided into upper back and lower back. We have already beaten the upper back situation pretty much to death. For most people, the middle back is not a discernable region, and is therefore not a useful thing to consider. The lower back presents a tremendous challenge to the coach, in that these problems are often very difficult to solve, but it is extremely important to solve them. At the national level, lower back injuries account for a huge percentage of work hours lost due to injury, a huge percentage of workmen's compensation claims, and are the most expensive health care problem for people ages 30–50. Many of the low back injuries that are a problem later in life were first acquired in sports while young, and continue to plague us for many years. If we as coaches are able to prevent injury to our athletes while they are in our charge, and teach them the proper way to use their lower backs while lifting, we will have done them a greater service than the little snots will ever be able to appreciate.

Most lower back errors fall into two broad categories: (1) inadequate flexibility, and (2) a lack of kinesthetic sense. First, inadequate flexibility as it relates to squat form requires, as usual, an understanding of the anatomy of the hip and leg musculature (figure 32). The hamstrings are the key to good low back position. The hamstring group consists of the biceps femoris, the semimembranosus, and the semitendinosus, all three of which arise from the ischial tuberosity of the pelvis. They all insert at

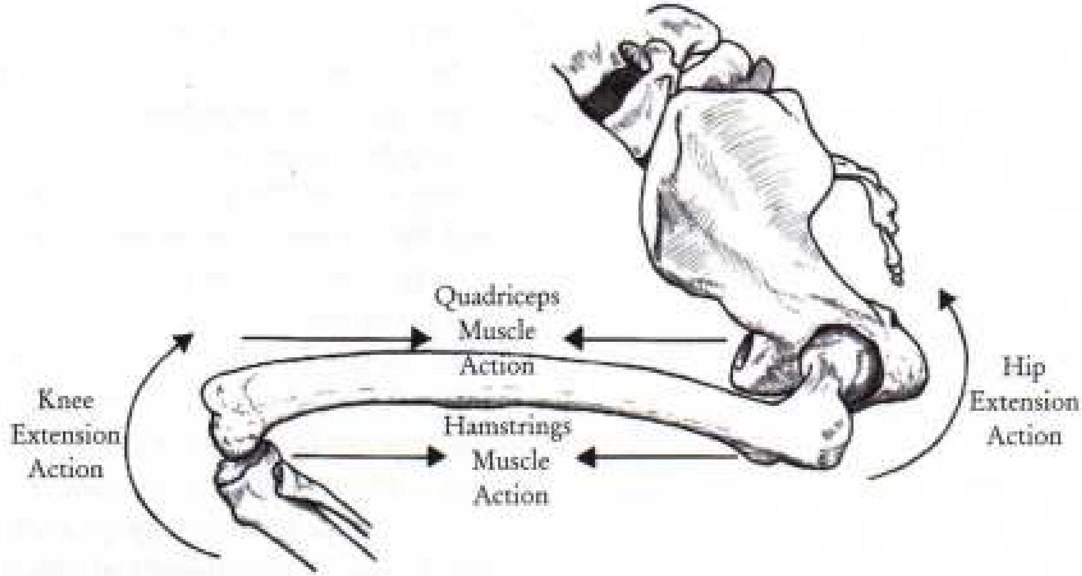


Figure 32. The relationship of the bones of the lumbar spine, pelvis, femur, and the upper tibia in profile. Note the opposing direction of actions of the quadriceps and hamstrings to joint actions. Many coaches think of the squat as a great way to develop the quadriceps. This is true, but it is more than that - the hamstrings are strongly developed by doing the full squat.

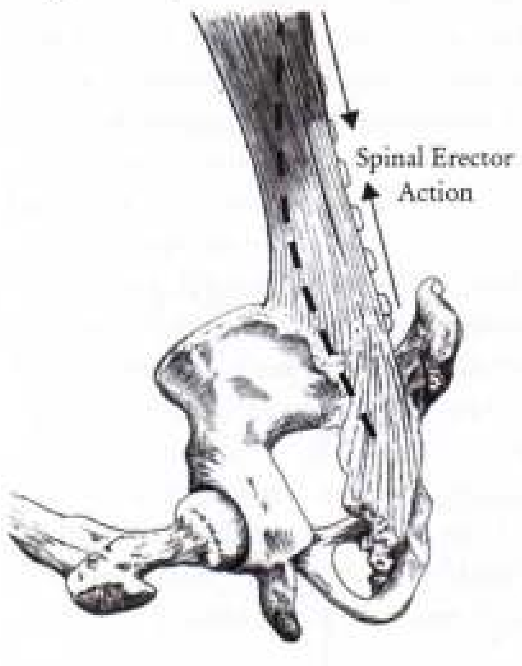


Figure 33. The spinal erectors (left lateral shown above) attach to the pelvis, costals and vertebrae and contract to extend the spine. This action (arching) is accomplished in conjunction with the underlying multifidis, rotatores, interspinales, and intertransversarii muscles. Muscles attaching to the anterior pelvis and spine also contribute. When contracted, these muscles will move the spine to take on a line similar to the dashed line above, i.e., an arch.

various points on the tibia. This configuration means that the hamstring group crosses two joints, the hip and the knee, and therefore has two functions: the proximal function, hip extension, and the distal function, knee flexion. When we squat, hip extension, or straightening-out, is what we do with the hamstrings, along with the glutes (figure 32). Drive out of the bottom is hip extension, and the more efficiently we use hamstrings and glutes, the more hip drive we have. This is another reason why good depth is important: the deeper we can squat with good form, the more the hamstrings are stretched, and the longer they are stretched, the longer they can produce force when they contract.

When we squat, or lift anything off the floor, the power is generated by the hips and legs and is transmitted up the rigid trunk segment to the load, either resting on the shoulders or hanging from the arms. The spinal column is held rigid in normal anatomical position by the muscles of the back, sides, ribs and abs, so that the force may be safely transmitted to the load through the trunk. These muscles contract isometrically, that is, they stay in contraction but cause no movement to occur, and in doing so they *permit* no movement to occur. The pelvis articulates with the spine in the L5/S1 area of the lower back, the area right above the tailbone. The muscles of the lower back, the erector spinae group, insert on the pelvis and at numerous points all along and up the spinal column, so that when these muscles are in contraction the pelvis remains in a constant position relative to the lumbar vertebrae. The erector spinae serve to lock the pelvis and the lower back together to protect the vertebral column and spinal cord from movement under load, and to hold all these joints in normal anatomical position when lifting heavy loads so that the intervertebral discs are not damaged. These muscles, along with several layers of ligaments and other connective tissue, act to keep the lower back from assuming any position of flexion under a load. This area needs to stay "arched" to stay safe when lifting (figure 33). Thus we use the coaching cue to "Arch your low back." And thus the pelvis tilts forward at the same angle as the lower back as we lean forward with the back locked in a safe extended position.

However, as the squat approaches the bottom position, the necessary forward lean of the trunk has a tendency to make the lower back assume a flexed, "rounded" position (figure 34). This is due to the hamstring anatomy. As the squat depth increases and the torso assumes a more forward tilt, the bottom of the pelvis (the origin point of the hamstrings), locked into the rigid spine, tilts *away* from the knee (the insertion point of the hamstrings). As these muscles reach the limit of their ability to stretch, they become tighter and begin to exert more pull on both the knee and the pelvic origin. Here is the source of the lower back problem: if the hamstrings lack sufficient flexibility, they will exert enough tension on the bottom of the pelvis to pull it out of its locked position in the lower back, breaking muscular tension in the erector spinae, and permitting the entire lower back to come out of extension into a "round" position (figure 35).

Figure 34. Example of correct back position (lumbar extension or arching) that decays into inappropriate position (lumbar flexion or rounding) as the trainee descends. We never want to squat this way.

Figure 35. Effect of rounding of back on spinal alignment. The dashed line represents the anterior surface of the spine during an arching of the back.

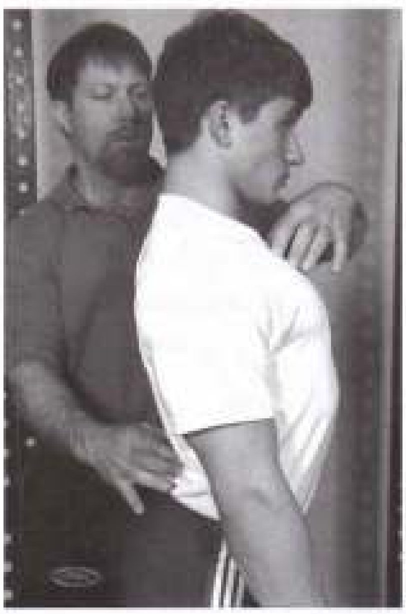


Figure 36. Physical position cues for chest up, butt out.

Once the cause of this problem is understood, it can be corrected through diligent stretching. The squat itself acts as a stretch, and with careful attention to this position it can correct itself in a short time - just a few workouts. Often, unfortunately, the lack of flexibility is paired with another problem – the inability to identify which position the lower back is in.

A lack of kinesthetic sense, the ability to identify the position of the body or a body part in spatial relation to the ground or the rest of the body, is very common, especially in younger trainees. This might be due to a lack of emphasis on "sitting up straight" as we older individuals remember hearing from our parents and teachers back in the Bronze Age. Many of these kids have absolutely no idea that their lower back is round at the bottom of the squat, or that it is arched correctly at the top of the squat, or any idea what position it is in at all. It is as though all proprioceptive activity has ceased in this particular area of the body. Many inflexible trainees exhibit this problem, but many perfectly flexible kids cannot assume a position of lumbar extension and hold it though a squat.

There are several ways to introduce the awareness of lower back position. They all involve causing the trainee to contract the lower lumbar muscles and then making him aware of what has just happened, so that he can do it every time he needs to. The ability to put a muscle group into contraction is an important part of strength training, and no better illustration of its importance can be found than good lower back position. Sometimes this is easy: stand beside the trainee, facing his profile. Take the thumb and middle finger of your hand and touch him on either side of the sternum, and say, "Lift the chest," then touch him with the other hand on either side of the spine at about the level of the L3 vertebra, and say, "Now, stick your butt out" (figure 36). The fingers against his erector spinae muscles will cause him to feel these muscles as they contract under the touch, and the fingers on his chest will keep him from just leaning over. If he is wearing a t-shirt, notice that as his lower back goes into extension, the shirt wrinkles perpendicular to his spine, parallel to the floor (figure 37). This is an excellent marker for the correct contraction of the lumbar muscles, visible for some distance across the room. Have him relax and repeat this movement until he can correctly do it without the aid of your hands.

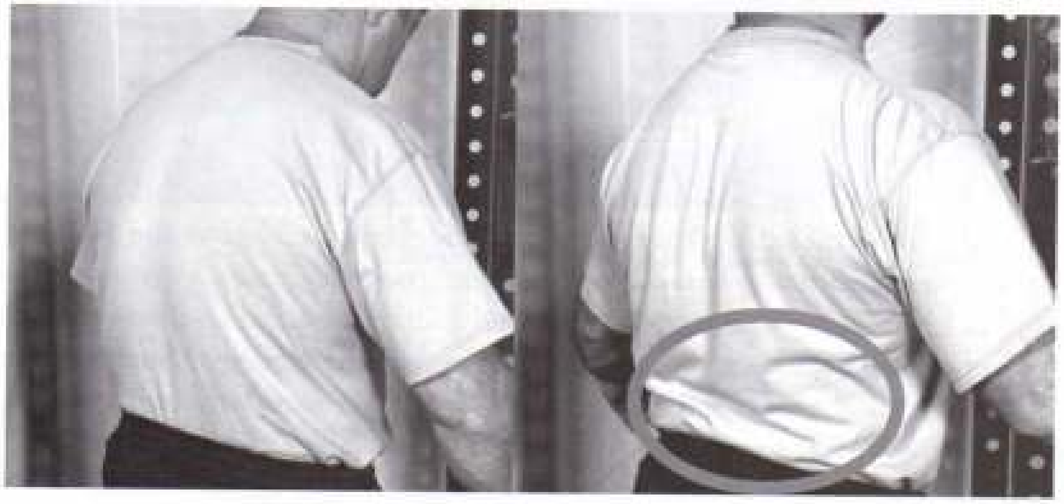


Figure 37. Visual check for spinal extension is accomplished by looking for shirt folds that are near parallel to the floor (right circle). The folds become apparent when the trainee arches his back.

This will work for most people, and should be used immediately if the trainee exhibits a round back when squatting the first set. If improvement is not noted after this correction, assume it is a hamstring flexibility problem and address it with stretching. After a couple of hamstring stretches, try it again, and if radical improvement is not seen, try this next trick. Have the trainee lie down on his belly on the platform. Tell him to put his hands behind his head and raise his chest up off of the floor. You might have to remind him to lift his elbows when he does this. Most of his back will now be in extension. Then tell him to lift his knees up off of the floor too. Many trainees will do this by pushing the toes down and lifting the knees up, so you'll have to then tell him not to use his toes. When he does this correctly, he'll bend his knees slightly and use his glutes, hamstrings, and most importantly his low back to make this movement. When he gets it right, the only thing touching the floor will be his belly. Now say to him, "This is what it feels like to have your lower back in contraction. Feel this arch. Relax and do it again." Have him repeat this until the light goes on (figure 38). It usually doesn't take many times since this is such a weird position and it feels different than anything he's ever done with his back. Movement patterns that are significantly different from those that are familiar are actually easier to learn, since they do not conflict with existing similar patterns. By placing the trainee in a position where he has to contract his erector spinae repeatedly without trying to do anything else at the same time, he can embed this new motor pathway quickly and easily, without having to try to distinguish it from other elements of an unfamiliar movement.

Figure 38. Practical exercise to get the trainee to understand back extension.

Now have him stand up and reproduce this movement while standing. Then put the bar on his back and again have him repeat it several times. Just to be sure, have him unlock his knees and hips to about a half-squat position and see if he can still perform this lumbar extension. If he is still with you at this point, he should be able to keep his back arched through the whole squat, if he is sufficiently flexible. If he can't, then stretch him out and go through the whole procedure one more time, and call it a day.

A word now about difficult trainees: as a coach, you learn more from the hard cases than you do from natural athletes. Any idiot could teach Greg Henderson (quarterback for Rice 2001-04) how to squat. These people just do things correctly because their bodies understand biomechanics, even if their brains don't. You are a good coach if you can teach complicated things to people who have never been able to learn them before. Find a 35 year-old woman who never played sports, or a 50 year-old sedentary executive, and teach them to squat. This is how you get to be a good coach. And a good coach recognizes a trainee's limits. There is nothing to be gained from frustrating a novice trainee with either his own inability or your lack of resourcefulness. The next workout will always be better.

Hips

The hips are the guts of the squat. Hips provide the power out of bottom, with the transition to the quads above parallel taking care of itself. Knees and hips are tied together, conceptually as well as by the femur. If the hips are too forward, the knees are too. In the rare instance that the hips are too far back, then the knees are not in their correct position relative to the toes. It is easier to correct forward/back errors of the hips by correcting the knees, so we will do this later. For now, we will concern ourselves with hip drive.

As introduced earlier, hip drive can be taught with the hands, as can many things in the weight room that have to do with position. Placing the trainee at the correct bottom position and having him drive up against your hand is usually all that is necessary to demonstrate the power of this technique. A verbal reminder, "Drive the hips!" as the weight increases is helpful in reestablishing this movement. For the coach, there is only a subtle difference in appearance between good strong hip drive and a squat that lacks this. A slight change in back angle may be observed, and it becomes more apparent as the bar gets heavier. Bar speed increases markedly with the same weight when a good hip drive is added out of the bottom, the increased power being evident in the whole ascent as the momentum generated by good rebound and drive is carried through. As the trainee does his work sets, this may be the only cue he needs, the rest of the movement having been cleaned up during warmups.

A common error is the tendency for some lifters to drive the hips forward instead of upward, especially right before the transition between hip drive and quads at the point just above parallel (figure 39). If the hips go forward, the knees will too, causing the weight to shift forward to the toes and possibly producing a small lumbar flexion at the same time. This is bad - for power and for safety. If the center of gravity of the lifter/barbell system shifts forward, then a forward component has been introduced into the movement. This complicates things, because anything but the whole system moving straight up is less efficient and will have to be compensated for before lockout occurs at the top. The best power is achieved when the hips continue straight up out of the bottom, the weight stays in the middle of the foot, the quads exert their force against the floor through this balanced foot position, and the knees and hips lock out simultaneously at the top. Once again, it is not necessary to think about the quadriceps – they will do their job when they are supposed to if the trainee stays in balance coming up. (The above comments apply specifically to the BACK SQUAT. The Front Squat is another matter entirely, and outside the scope of this discussion. The two are completely different movements, and for this reason it is always prudent to learn one completely and correctly before moving to the other. Since the back squat is a more generally applicable exercise, and can be used with much heavier weights, it is the one presented here.)

Many times when the trainee shifts the hips forward coming up, he will also unlock the lower back to do this (figure 40). This lumbar flexion occurs as he attempts to drive hips forward and stay off of the toes, essentially leaving the bar behind as the hips shift. This "fishing" of the back is extremely dangerous, as the lumbar discs experience a change to non-anatomical position while loaded. The back goes from arched to rounded with weight on the back, and the discs are not designed for this type of silliness. If this fault is observed, have the trainee rack the bar immediately and explain the situation. Usually a word or three about what was observed and a reminder to drive UP, not forward, will correct the problem.

We have already introduced the concept of the "bounce" out of the bottom. Since it is accomplished with the hips, and with the part of the brain that's thinking about the hips, this seems like a fine time to discuss it. Once again, the bounce DOES NOT INVOLVE THE KNEE. It happens when the hamstrings reach the limit of their normal range of motion due to the slight forward motion of the knee and the pronounced backward motion of the hips. Remember: the pelvis is locked in position with the torso by the low back muscles, the hamstrings attach to the ischial tuberosity at the bottom of the pelvis, and the pelvis tilts forward with the torso as squat depth increases, thus

Figure 39. Hip drive is best developed in the position shown in the top photograph, not in the knees forward position (bottom).

Figure 40. Rounding of the back, as in the lower photo, during the drive up is a problem.

stretching out the hamstrings (Figure 41). The bounce at the bottom of the squat is essentially a correct use of the stretch reflex inherent in any dynamic muscle contraction. It is safe, it is correct, and it is necessary if heavy weights are to be lifted. The only way it can hurt the knees is if the hamstrings are relaxed at the bottom, which would result in the knees

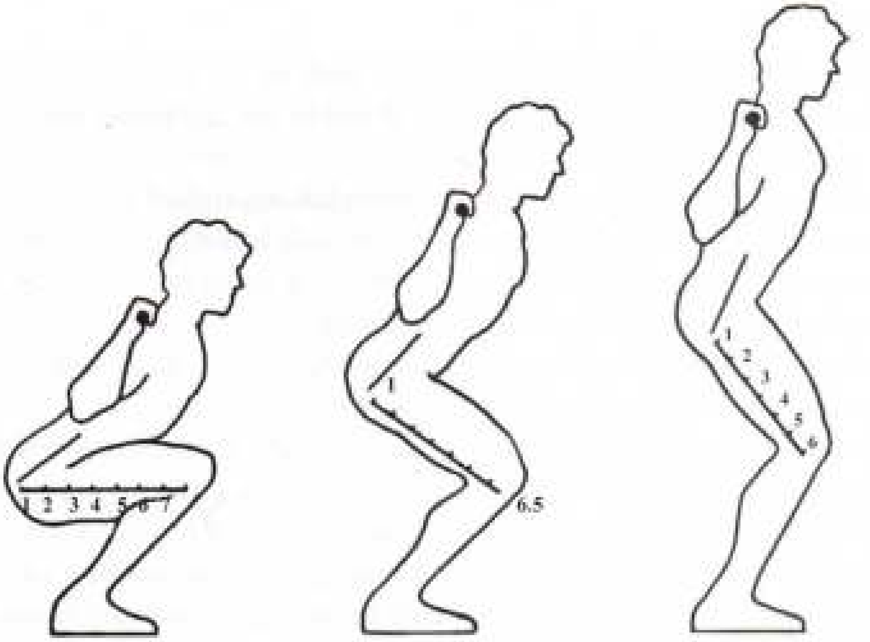
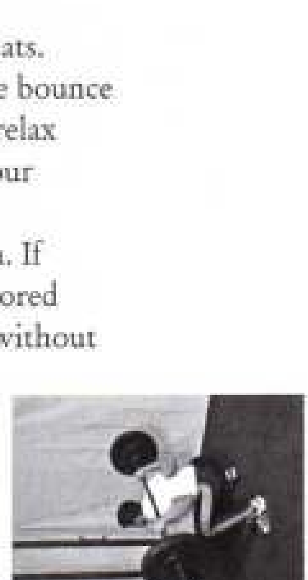


Figure 41. Note that in the bottom position the hamstrings are stretched. Also observe that the hamstring unit length shortens during ascent. "Bounce" out of the bottom utilizes hamstring stretch, and this rebound is critical for squatting efficiency.

traveling forward, more about this later. If the hips are shoved back at the bottom, the hamstrings will tighten, the knee will be protected, and power out of the bottom is increased. Timing here is important. If the bounce is used correctly, it will be immediately followed by a hard drive up of the hips. It is important to note that the bounce is not followed by a pause and then a drive up. The bounce must be incorporated into the drive – it must be anticipated as the first part of the drive. One way to coach this is to tell the trainee, "Think about the 'up' drive all the way down. Don't think about going down while you're going down - think about coming up the whole time." This reduces the tendency to separate the drive from the bounce, since it's being anticipated even before the bounce occurs. (This cue works well on all lifts with an eccentric phase preceding the concentric.)

Timing of the descent and rebound is critical to the performance of good squats. Bounce occurs optimally at the correct speed of descent. If the descent is too fast, the bounce will be less effective, and much less safe, because the only way to drop too fast is to relax something. Tight muscles in the squat descent store elastic energy, as illustrated by our specific example of the hamstring rebound.

Tight muscles also keep the back, hips, and knees in the correct, safe position. If enough looseness exists to permit a cannonball-like drop into the hole, there is no stored elastic energy to use in a rebound, and all the upward force must then be generated without the benefit of a stretch reflex. (This is essentially the purpose of a paused box squat, an advanced exercise that makes the lifter create the entire explosion out of the bottom, and quite outside the scope of our discussion.) And this loose descent



can permit joints to be jammed into positions for which they were not designed, a seriously bad deal. At best, the squat will be heavy, and will feel heavy due to the added momentum produced by the excessive speed.

Momentum is calculated by the weight of the bar multiplied by the speed of the descent. Some momentum is measurable in every bar movement, an inevitable consequence of mass and motion. The difference between a 1974 Cadillac going two miles per hour and the same car going 70 mph. is that you can step out in front of the slow one and stop it by absorbing its small amount of momentum, if it's in neutral. So, a slower-moving bar is easier to turn around than one dive-bombed into the platform.

By the same token, if the descent is too slow, insufficient rebound will be generated and a similar situation will occur – rebound will be inadequate due to the lack of stretch reflex efficiency. The weight will feel heavy, and the squat will be hard. Also, the trainee uses too much gas on the way down to have much left in the tank for the trip back up. An entire system of training has been based on this apparently cool new observation, the hook being the fatigue produced by the slow movement and subsequent lactate accumulation. However, we are trying here to learn how to squat the most weight, not a little weight in as inefficient and uncomfortable a manner as possible.

Knees

The knees are the area where the greatest variety of form problems will be observed. In a correct back squat, there is essentially one correct place for the knees: slightly out in front of the toes, the exact distance being determined by the anthropometry of the individual, directly in line with the foot so that the femur and the foot are parallel and congruent. This basically means that the femur and the foot should be in a straight line as seen from directly above, so there is no twisting of the knee. Depending on the femur/tibia/trunk dimensions of the trainee, the knee could be anywhere from directly plumb to the toes to three or four inches in front of the toes (figure 42). The angle of the stance relative to the frontal plane will

Figure 42. Differing leg and trunk lengths affect the bottom position. What is "correct" can look different in different trainees.

therefore determine the angle of the knee as well. In general, about 30 degrees out from the perpendicular works for most people, although this also varies. This angle allows the torso to clear the legs at the bottom so that good depth can be attained. These general positioning landmarks may vary slightly among individuals, but they are very close to the optimum for correct execution of a deep squat and should be followed as closely as possible.

The two most common knees errors by far are knees in too much and knees too far forward. It is actually unusual to see a novice trainee not make one or both of these errors the first time he squats, as both are related to flexibility and positional awareness. These two parameters are specifically developed and corrected by squatting. They are easy errors to fix, and fixing them develops flexibility and movement skill, two of the main reasons we are here anyway.

When the trainee adducts the knees, allows them to come closer together at any point during the squat, the cause is usually weak adductors (figure 43). This has been previously discussed, and an understanding of this anatomy and function is essential to the coach. Correcting this problem is important: leaving it uncorrected creates a potential for knee injury due to the non-anatomical position of the loaded knee out of line, and leaves the adductor muscle group untrained. A straight knee line is important, so that the menisci stay loaded evenly. The medial and lateral meniscus bear weight in the squat, as they lie directly between the condyles of the femur and tibia, and enable these two bones to rotate against each other. When the knee is extended at the top of the squat, the skeletal components, including the menisci, are bearing the entire weight of the bar as compression. As the knees unlock, the angle at which the load is transmitted through the knee changes. At the bottom of the squat, the femur is still transferring the load to the tibia, but if the stance is correct and the knee is in straight flexion, each side of the meniscus bears its normal share of the load. Muscular tension, on both the anterior and posterior sides, provides support for the knee in this position. This assumes that the femur and tibia are parallel, and therefore that the condyles are parallel. If they are not, the menisci between the condyles are differentially loaded. When the knees go in on the way down or up, the lateral meniscus gets mashed between the lateral condyles (figure 44).

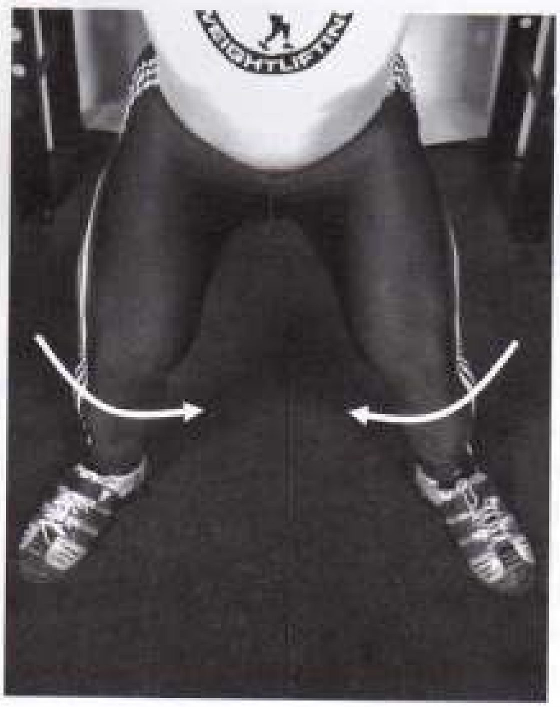


Figure 43. A "knees-in" position must be corrected for appropriate muscular development and safety.

Some coaches wrongly assume that the cure for knees-in is to strengthen the abductors in isolation, usually through the use of an exercise machine designed for this purpose. These devices are no

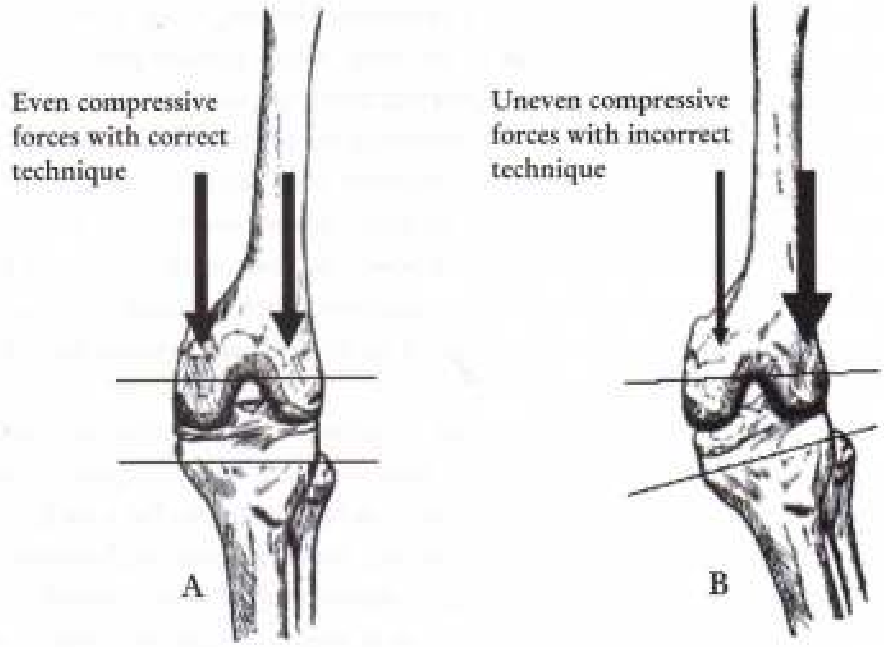


Figure 44. Distribution of compressive forces during a correct (left) and incorrect, knees-in (right) squat.

Figure 45. Coaching by exaggeration can get the trainee to adopt the correct knee position.

more useful than any other machine, and this one is especially distracting since the problem isn't with the abductors anyway. The lifter is not having trouble using the muscles on the outside of the hip, he is having trouble using the muscles of the groin, which are weak. In an attempt to make up for the lack of adductor function, his knees are moving closer together so that the quadriceps can do the job instead. When the quads are forced to pick up the role of the adductors, they have to move to an adducted position to do so. Strengthening the abductors, a couple of small muscles on the most lateral aspect of the hip, will not solve the problem, because they are not involved in the problem. The only way to fix weak adductors is to make the trainee keep his knees out so that the adductors will get stronger. So good form is actually the cure for bad form.

Often correction of this problem is as simple as telling the trainee to "Keep your knees out," and illustrating this visually by pointing to his knees with both hands as you stand in front of him and moving your hands out toward either side to illustrate exactly the direction you mean (figure 45). You can enhance this verbally by exaggerating your description of what to do by saying something like, "I want you to touch your right knee on that wall over there to your right, and touch your left knee on that rack over there on your left," as you gesture wildly with your hands to indicate the movement.

Exaggeration is often a useful coaching tool. It can convey ideas to hardheaded kids that are not terribly good at understanding the subtleties of fine motor skills and the nuances of language. In this particular example, it might be necessary to "overcorrect" to get a correction. Tell the trainee to "shove your knees out on each side until your knees are outside your feet. Keep pushing them out until it feels like your knees are too wide. Way too wide". This position, were it attainable by an inflexible kid, would obviously be wrong, but he can't get there anyway or he wouldn't have this form problem. But in an *attempt* to get there, he might just end up in the correct position. The attempt at exaggeration will often average out to exactly the correct position you want him in (figure 46). The utility of this coaching principle cannot be overstated. It is useful in a wide variety of situations and sports, and is limited only by the coach's resourcefulness.

Figure 46. Trainee kinesthetic awareness is quite variable. You may have to exaggerate your cues to make him think he's pushing his knees way out (left) in order to get them in correct position (right).

The concept of the "cue" is another extremely important coaching tool. A cue is a very short word or phrase, or even a noise that corrects a movement error by reminding the lifter of an already-coached correction. It must be short, and it must have been used before, so that it triggers the correction without the need for much mental processing. Sentences cannot be cues; they are like symbols in that they must contain much meaning in a small package. They are sometimes highly individual, and may not be understood by anyone other than the coach and the trainee. Cues are very useful in a competitive setting, where time and efficiency are crucial.

Knees too far forward presents a different challenge to the coach, as its cause can be either flexibility or perception. If the kid's hamstrings are tight, it can throw the knees forward, but if his mental model of the movement he's trying to do is wrong, the correction will need to be made in his little walnut-sized brain.

Quite often, the trainee has a concept of the squat that involves a picture of himself doing the movement with his back in a vertical position, to hold the bar up better, you know. If the torso is vertical, the knees will be too far forward, because if they weren't he would be off balance backward. Ask him about this if you observe his knees too far forward and his back at too steep an angle. "Let me ask you this: are you thinking you need to keep your back vertical when you squat?" He'll usually say yes. Tell him, "You can't do that. It's okay to lean over. It's part of the movement to lean over. Go ahead and try it." He's been waiting for you to tell him this anyway, because something doesn't feel right about it. Now watch him squat at the better back angle and remind him to use his hips. This fixes it most of the time.

Figure 47. Have the trainee pick up his toes while keeping the heels and balls of the feet on the ground.

If it doesn't, there are other things that can get the knees back. If the weight is on the heels during the squat, the knees can't be forward. Suggest that he keep his weight on his heels while he squats. "Think about the heels." If this doesn't work after two or three reps, tell him to stand with the bar in squat stance, and pick up his toes (figure 47). You obviously can't pick up your toes without going on the heels. This just shows him what it feels like to have the weight back on the heels. Once weight is on the heels, have him squat. When he squats from the heels, his knees will stay back. Now, he will not be able to continue to squat on his heels, because this is also an unbalanced position, but after three or four reps this trick will have done its job and he will have settled into the middle of his foot where he should be. Once knees are back, most will adopt this form because it feels more balanced and strong.

Another problem encountered, often in more advanced trainees, is the tendency to let the knees slide forward at the bottom (figure 48). This can be a very challenging coaching problem, because it is usually a problem developed over time, while the lifter is getting strong, and is a rather embedded movement pattern. When the lifter lets his knees move forward at the bottom of the squat, you know he has relaxed his hamstrings, because they pull the knee back. They insert on the tibia and provide posterior tension, which should increase with the depth of the squat as the other attachment point on the pelvis tilts away. If this tension is insufficient to keep the knees from translating forward as full depth is approached, something is wrong. And when knees move forward at the bottom, tension is put on the hip flexors as they insert on the ASIS, the anterior superior iliac spine, or hip pointer.

Figure 48. The knees sliding forward below parallel as in the far right photo is indicative of the trainee relaxing the hamstrings.

The muscles in question, the rectus femoris, the sartorius, and the tensor fascia latae, cross both the hip and the knee joints, and therefore produce movement around both joints (figure 49). In the squat, their knee extensor function (the distal function) is our concern, since active hip flexion does not occur. At the bottom of the squat, these muscles act with the other knee extensors in the quadriceps group to, you guessed it, extend the knee. All the muscles in the group are under tension, but only the three hip flexors cross the hip to attach at the ASIS.

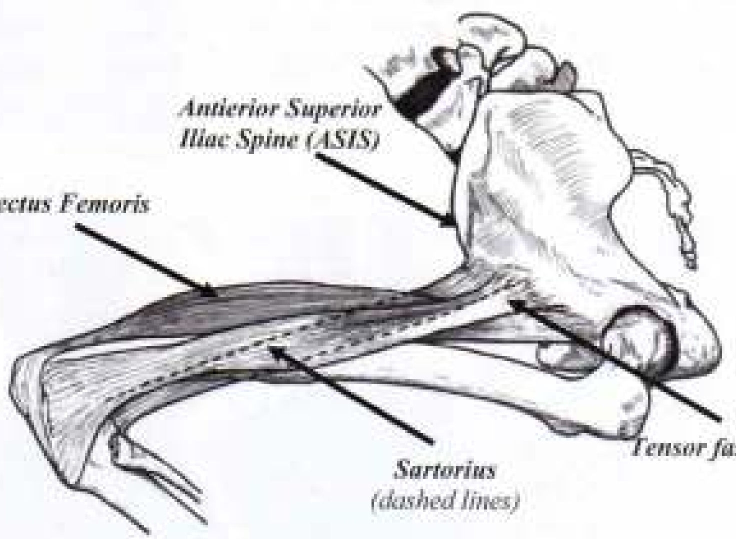


Figure 49. The relationship of the hip flexor muscles to the bones of the hip and knee. The action of these muscles is to both extend the knee, their primary function during the squat, and to flex the hip, a function not used in the squat.

Now, if at the bottom of the squat the knee should be allowed to move forward, tension is increased on these muscles and their attachment at the hip as the knee angle becomes more acute. The ASIS is yanked by these muscles at their attachment, and a marvelous dose of the weirdest tendinitis you have ever

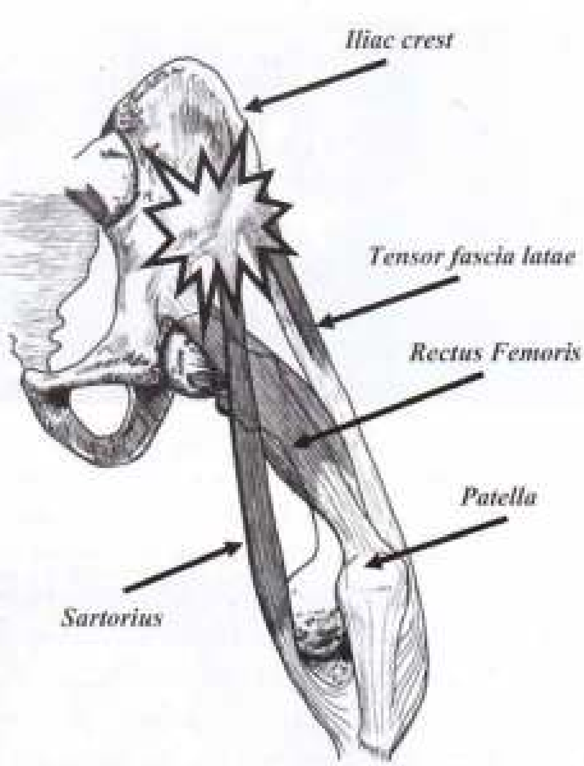


Figure 50. The hip flexors (sartorius, rectus femoris, and the tensor fascia latae from left to right above) attach to the anterior iliac crest and the knee. Pain at these muscles' origin (the front of the hip) may be indicative of inappropriate squatting technique.

seen can be the result (figure 50). This condition is thankfully rare, and some people squat this way for years without trouble, but if it develops, it takes many weeks to heal.

The answer is to learn to squat with the knees in the proper place, and to move them correctly during the descent. One approach is to make all of the forward knee travel occur in the first third or half of the descent. The lifter should shove the knees forward to the place they will end up in front of the toes, and then the rest of the movement will consist of the hips moving back and down. Some trainees make two movements out of this, and that is fine for a couple of reps, but they should be encouraged to reduce this to a smooth single motion (figure 51).

Figure 51. Note that the knees, once they move forward over the toes, do not significantly move during the remai ler of the squat. The glutes and hamstrings are doing their job. Contrast this sequence to figure 48.

A terribly useful piece of equipment for teaching this technique is a block of wood, approximately 18" x 10" x 4", although any size that is a little taller than knee-high that will stand balanced on end will do (figure 52). Have the trainee assume the squat stance with

Figure 52. A terribly useful piece of wood. The knees touch the block at about the vertical jump takeoff point then do not move forward significantly afterwards.

the bar, and place the block about one or two inches in front of the toes, wide enough so that the knees must be parallel to the feet to touch it, thus killing two birds with one stone. One block for one side is sufficient, or should be anyway. Have the trainee squat, and tell him to "touch the block with your knee, first thing, but don't knock it over." The block will limit the forward travel of the knee, and as he solves the problem of how to continue to depth with knees stationary, he will learn how to use his hips correctly. Use the block for a couple of sets, then use it for three reps of a set of five, then use it for the first rep only, then take it away. Some difficult trainees require refreshing on this correction periodically, as an embedded movement pattern is always hard to overlay with a similar, more correct one. But when working this technique with novices, it usually fixes the problem permanently. And it has the advantage of being able to correct both knees-forward and knees-out at the same time.

Another technique that can be used to correct all of these knee position problems is to have the trainee actually look at his knees. In his squat stance, at the top with the bar in position on his back, have him look straight down at a point on the floor between his toes. He will see a picture of his knees relative to his feet, and the movement of his knees relative to his toes as he goes down. Have him look at his knees all the way down and back up a couple of times with the empty bar before he gets much weight on it; he will need to practice this because it will seem awkward at first. But as he watches his knees change position through the movement and as the sets get heavier, he will see exactly what the problems are and, more importantly, he will have immediate feedback on what he needs to do to fix it. If his concept of the squat is correct – if you have done a good job of describing it to him – he can see what his knees are doing wrong and fix them.

Very rarely, a coach will encounter an extremely flexible younger kid who can manage to go both too deep at the bottom and too wide with the knees (meaning the knees are outside the feet, not that the stance is too wide) (figure 53). This doesn't happen very often, as this degree of joint and muscle belly laxity is unusual. These kids must be taught how to stop at correct depth before they get so deep they get into their actual knee ligaments. Such kids will relax at the bottom, and a reminder to stay tight at the bottom will usually help a lot. If the trainee insists on continuing to relax too

deep with knees out, it may be necessary to have him stop dead at the correct depth and knee position for a few reps until he learns where this position is and can reproduce it without a stop. He can learn the rebound technique after a few workouts, but this will be more difficult for him because he will have to consciously produce the hamstring tightness that comes naturally to most other lifters.

Figure 53. Some thin, very flexible kids can go deep into the hole due to anthropometrics and a habit of relaxing the hamstrings. With a little coaching they are able to recruit hamstring contraction in order to hit proper depth and to invoke the stretch reflex in those muscles.

Feet and stance

The feet are the first element of the kinetic chain that runs from the ground to the bar on the shoulders. As such, they are important in that they are usually the trainee's first opportunity to do something wrong. We have already discussed some foot problems, such as weight on toes, as they relate to elements higher up the kinetic chain. Stance width and geometry merit a serious examination, since they have so much bearing on the mechanics of the lift.

The recommended stance is heels at about shoulder width apart, toes pointed out at about 30 degrees. "About" refers to the uncertainty inherent in trying to make humans move like we want them to when we don't know whether they can. Stance is a highly individual thing, and will vary with hip width, hip ligament tightness, femur and tibia length and proportion, adductor and hamstring flexibility, knee joint alignment, and ankle flexibility. Everybody's stance will be slightly different; any effort to make all trainees conform to footprints painted on the floor is evidence of fuzzy thinking. An experienced coach can look at a novice trainee and have a decent idea of his stance, but the trainee must actually take the stance and squat in it so that any necessary fine adjustments can be made.

For example, a tall trainee with very long femurs and relatively narrow shoulders needs a wider stance than the usual, since his shoulders are not his hips' fault. Or a kid with a very long torso and short legs (not that uncommon a body type) will need a bit narrower stance than our model would predict. Sometimes the angle needs to be adjusted. A practiced coaching eye will sometimes catch evidence of the need for this: in a kid that is pigeon-toed, the foot angle will need to be slightly more forward-pointing than the model, or more commonly in the case of out-toeing the foot will need to be pointed out more. These corrections are necessary to keep the correct neutral relationship between the femur and the tibia, so that no twisting occurs in the capsular and medial/lateral ligaments of the knee.

Figure 54. Mike Bridges used a wide stance squat to set numerous records. This is fine for powerlifting but not for training for sport or fitness.

Figure 55. Bodybuilders frequently use a narrow stance squat to develop contest quality quads. In the photo above, Dave Draper, one of the most famous bodybuilders of the 60s, uses narrow stance front squats to develop his Mr. Universe winning form.

A trainee with very tight hips can benefit from a slightly wider stance until flexibility is increased; in fact, if this adjustment allows him to squat, it will cause the problem to correct itself, and very quickly allow him to assume a more useful narrower stance. But, you ask, what is wrong with a wide, powerlifting-type sumo-style Mike Bridges (for those of you old enough to remember him – figure 54) squat stance? Especially if it allows the kid to squat more weight? The thing that is wrong with it is the same thing that is wrong with having him half squat more weight above parallel: we are trying to get him strong for sports; we are not trying to see how much weight we can have him squat, especially if that squat style is not specific to our program nor safe for our trainees. The two things are not the same, and you as a coach MUST understand this. A wide stance does allow more weight to be squatted, but no sport except powerlifting can use strength developed in this stance, because that stance does not occur in other sports. Strength is both general and specific: general in that it is always good to be stronger, specific in that the strength needs to be acquired in a way that allows it to be applied to movement patterns used in the sport for which we are conditioning. An extremely wide-stance squat omits much of the quadriceps function, and as such is not very specific to sports that use the quads. This includes pretty much all of them.

In the same way, a narrow-stance squat, such as those frequently pictured in the muscle magazines, develops an aesthetically pleasing set of quads (figure 55), but we plan on using the rest of the hip musculature too, and it seems unwise to omit it from the training program. It is very difficult for people of normal flexibility to get deep enough with a narrow stance, and thus the hamstrings are never engaged as fully as with a more generalized wider stance. Also, the narrow stance does not involve the groin muscles, as discussed earlier. As such, it can be useful in the event of a groin injury, and can be used for several weeks while the adductors are healing. If used all the time, narrow stance predisposes for a groin injury due to the lack of conditioning for these muscles.

It is very common to see lifters at all levels of proficiency squatting with their toes pointing almost forward. The really strong ones do it to increase the joint tightness and resultant rebound obtained by placing additional torque on the knee ligaments, and the novices haven't been corrected yet. It is very important to have all the bones of the legs and hips in the best position to generate force without being injured. Here is a way to see this relationship: sit in a chair with your knees slightly bent and your feet out in front of you. Put your legs together, and note that your toes are pointing straight forward. Spread them out wide and note that your toes are pointing out. In both positions your feet assume a parallel position to your femur, and your knee is in an anatomically neutral position, with no twisting (figure 56). As your knees point out, your toes point out. The wider the knees, the more the toes point out. As the knees widen, the femur rotates externally, and the tibia must rotate with it to keep the knee ligaments in normal anatomical position, and the toe points out more because it is attached to the end of the tibia. This anatomical relationship must be understood and respected, lest patellar tracking injuries result from inattentive coaching or trainee hardheadedness.

Figure 56. Look at the angle of the femur then look at the angle of the foot. They are the same and maintenance of this relationship is crucial for effective and safe squatting.

The practice of placing a block or a 2x4 under the heels is not as common as it once was (see figure 55). The purpose of this is to make the full squat position easier to reach, and an understanding of the reason this works is necessary to the understanding of why it should not be done. A block under the heel throws the knees forward by tilting the shin forward.

This shin angle causes the insertion point of the hamstrings to move back closer to its origin on the pelvis, thus decreasing the amount of stretch necessary to get to the bottom (figure 57).

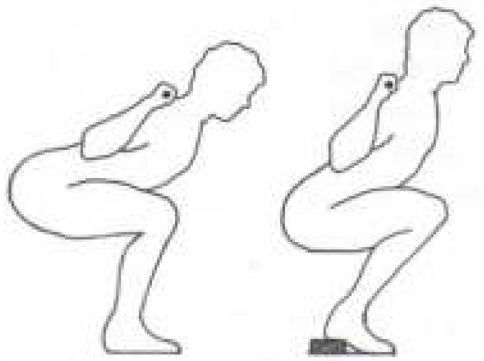


Figure 57. Placing a block under the heels allows the knees and hips to move forward allowing the trainee to assume a better, more upright position. A quick fix, but not a long-term solution to lack of flexibility.

A trainee having flexibility problems severe enough to need a block under his heels will not benefit by being prevented from stretching the muscles that are too tight. The squat, being a full range of motion exercise, provides a better stretch than most stretches do. Far better to approach full squat depth incrementally, with an exercise that will very quickly stretch out the trainee in just a couple of workouts, than to use an artificial aid that will prevent him from obtaining enough stretch to ever fix the problem.

Breathing

Much controversy exists about breathing patterns during exercise, largely due to a misapplication of the CYA principle. It is thought by some that "inhaling on the way down and exhaling on the way up" is a good way to eliminate the possibility of cerebrovascular accidents during exercise, by lowering the peak blood pressure during the rep. This may very well limit a momentarily elevated systolic/diastolic pressure, but such advice overrates the likelihood of a cerebrovascular injury, an extremely uncommon event, and underrates the likelihood of an orthopedic injury, an all-too-common occurrence. It behooves us to understand the function of the Valsalva maneuver, the breath held against a closed glottis while pressure is applied by the abdominal and thoracic muscles, during the squat. The Valsalva is a technique that the vast majority of humans will use anyway until "professionally trained" personnel interfere.

If your car runs out of gas in an intersection, and you have to push it out of the way or get killed, you will open your car door, put your shoulder on the doorframe, take a great big breath, and push the car. You will probably not exhale except to take another quick breath until the car and you are out of the way. Furthermore, you will not even think about this, as many millions of years of your species pushing on heavy things has taught your central nervous system the correct way to push. "Professionally trained" personnel probably do it this way too, yet they insist on ignoring the good advice of their DNA while in the weight room.

When you inhale, pressure increases in your thoracic cavity. When you hold your breath and tighten your trunk muscles, this pressure increases more. Since your thoracic and abdominal cavities are separated by only your diaphragm, abdominal pressure increases too. Thus, pressure is being applied to the anterior

side of your spine. The spinal vertebrae are being held in correct position by the back musculature, and this correct position is reinforced by a static pressure head transmitted to the anterior side of the spine by the hydrostatic column of the gut, the essentially non-compressible contents of the abdominal cavity. As pressure in the thoracic cavity increases with a big breath held, and this pressure is increased by the tightening of the abs and obliques, more anterior support develops for the spine. The back muscles support the back from the back; the abs, with the aid of a big breath, support it from the front (figure 58). A weightlifting belt adds to this effect, its main function being to add to anterior support rather than to apply pressure from the back.

The concern of our "trained professionals" is that this thoracic and abdominal pressure is also being applied to the cardiovascular system embedded in the trunk, and that the increase in pressure is being transmitted up the big vessels to the head, and that this increase in pressure has the potential to cause a cerebrovascular accident, such as a stroke or an aneurysm. This ignores the fact that the same pressure is being applied to the cerebrospinal fluid, which transmits pressure up through the subdural space in the skull and throughout the cranium, balancing cardiovascular pressure across the blood/brain interface (figure 59). Furthermore, no one gets under 405 lbs. and squats it without training. The cardiovascular system adapts to resistance training just like all of the other tissues and systems in the body, and this adaptation occurs as strength increases. Anyone who is capable of squatting extremely heavy weights is adapted for it in all the necessary ways. It is far more likely that the advice to "inhale on the way down and exhale on the way up" will actually cause an orthopedic injury than that it will prevent a cerebrovascular injury.

In fact, it is good advice to teach trainees to take and hold the biggest breath they can. The Valsalva maneuver will prevent far more problems that it has the potential to ever cause.

Spotting the squat

It would be a better world if the squat could safely be spotted by one spotter: it would save time, require fewer people in the weight room when training heavy, and would simplify powerlifting meets. Unfortunately, we do not live in that world. Weights used in the squat can be sufficiently heavy and are in such a position that it is not safe for one spotter to work alone. Any squat attempt or set of squats the lifter is worried about or is uncertain that he can do should be spotted by two people (figure 60). The squat requires two spotters, and they have to learn to watch each other and work carefully to minimize an uneven bar if they have to help. The differential loading caused by one guy jerking the bar up while the other guy doesn't is a bad thing, a potential wreck, and it has caused many back injuries. But this is a thing that can be managed, by spotters learning how to do it better and by lifters learning how to avoid needing a spot. A one-person spot for a squat cannot be safely accomplished. One spotter standing behind the lifter, leaning over with arms wrapped around and under the lifter's chest, is not only an embarrassing position but a terribly ineffective and unsafe one. After all, if the lifter is so ungracious as to drop the bar off his back, as some will, what does the guy plan to do? Catch it? Coupled with the fact that any help given the lifter by the

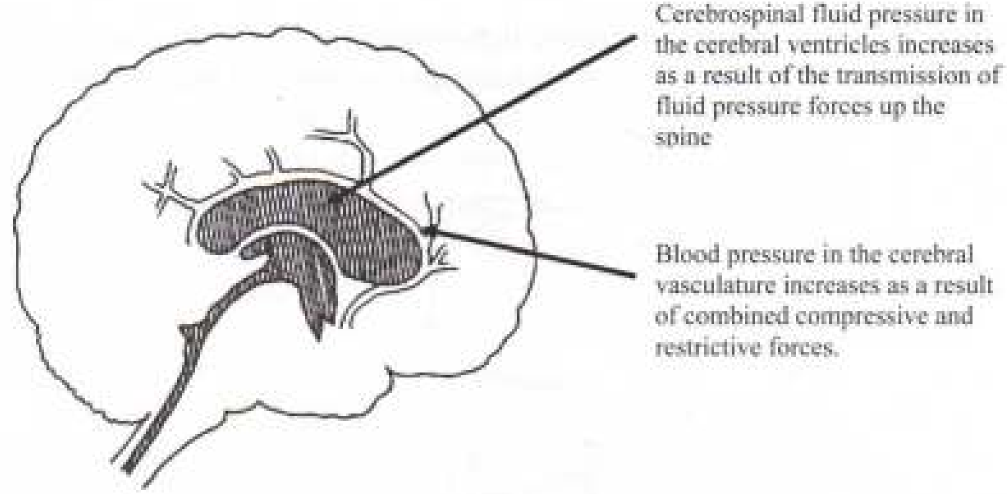


Figure 59. Cerebral vascular pressure does rise with strain and the Valsalva Maneuver, however the likelihood of vascular rupture is greatly reduced by a simultaneous increase in cerebral ventricular pressure. Essentially, with the skull as a volume limit these two pressures stabilize vessel structure rather than predispose them to rupture.

Figure 61. Single person spotting is not the best situation. It is imperative that the trainee understand that the spotter will provide ONLY ASSISTANCE lifting and replacing the weight in the rack, not bear the entire mass. The proper spotting technique has the spotter apply upward force ***to the bar*** in the case of a failure to rise (top). We do not bear hug the trainee as this will effectively alter balance of both parties and prevents the possibility of rapid escape from under the bar if it falls (bottom).

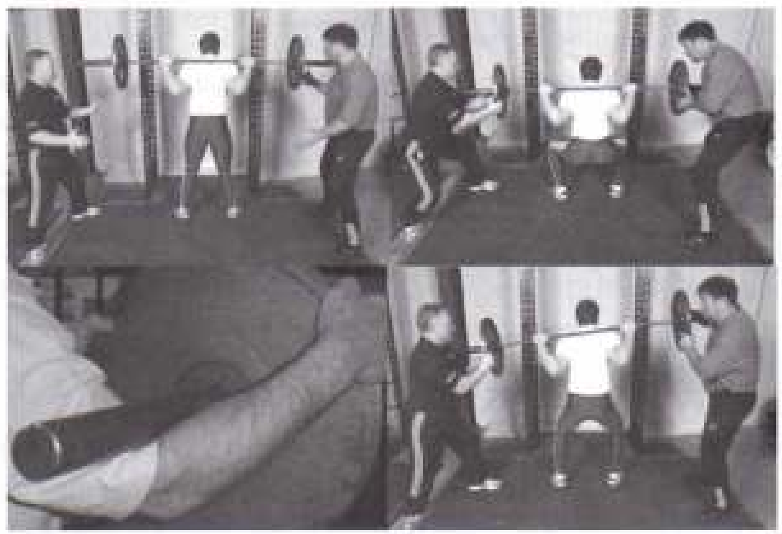


Figure 60. Spotting requires attention and teamwork. Spotters assume the ready position prior to the start of the set (top left). If the trainee fails the rep, the spotters use both hands on the plates and the forward crook of the elbow acts to lift the end of the bar (top right, bottom left). The trainee must understand that spotters are not a reason to quit! If the spotters are not attentive and coordinated in their effort, asymmetrical loading and torsion can occur and result in injury (bottom right).

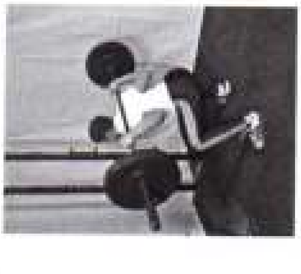
In a *dire* emergency, a spotter might be able to help by standing directly behind and pushing up on the bar with as even a hand position as can be managed around the squatter's grip and bar placement. This may not work, and if so everybody needs to take care of himself by getting away from the bar as safely as is possible. This is a completely avoidable situation, one that indicates that either the wrong weight is on the bar, or that there is not enough help in the weight room. Things should be changed so that it does not happen again.

Squatting inside a power rack is sometimes necessary. If the weight room is not set up correctly, i.e. the surface of the platform against the power rack is not flush with the inside floor of the rack, or if your rack lacks a floor, it will be necessary to stay inside the rack to avoid stepping down or over things with the bar on the back. And if there are absolutely no spotters and it is absolutely necessary to squat anyway, it will have to be done inside the rack with the pins set at the correct height. Power racks should be designed with a heavy floor that can be made flush with an adjacent platform, so that most of the time squats can be walked out, and with uprights built with the correct dimensions so that if necessary it can be used to squat inside. Squatting inside the rack as a matter of regular practice is something that might be dictated by the lack of proper equipment, but when squatting heavy it creates a potentially dangerous situation for the spotters and their hands if the bar is inside the rack. For the lifter, the uprights visible peripherally may be a distraction, their presence possibly altering the bar path in an attempt to stay away from contact with them. A large rack with sufficient depth fixes most of this. But squatting outside the rack is preferable, since available spotters remove the only reason to squat inside one in a properly equipped weight room.

"Squatting" in a Smith machine is an oxymoron. A squat cannot be performed on a Smith machine, as should be obvious from all previous discussion. Sorry. And a leg press machine – the "Hip Sled" – may be even less useful. Both of these devices restrict movement in body segments that normally adjust position during a squat, thus restricting the expression of normal biomechanics. The leg press is particularly heinous in that it allows the use of huge weights, and therefore facilitates unwarranted bragging. Please slap the next person that tells you he leg-pressed a thousand pounds. A 1000 lb. leg press is as irrelevant as a 500 lb. quarter-squat.

Personal equipment

There exists a wide variety of personal equipment that lifters like to use in the weight room. The relevant question is, which equipment is useful, which is not, and which has no place at all in a strength program? Most of it actually falls in the last category. Supportive apparel has absolutely no place in your strength program or your weight room. These things are designed to help powerlifters lift more weight at a meet where such equipment is permitted. Please understand this: lifting more weight is not always the same thing as getting stronger. For the same reasons of safety and strength production, we do not do half squats, and we do not use squat suits, bench shirts, deadlift suits, really tight underwear, and anything else developed by retired powerlifters for sale to not-yet-retired



powerlifters to artificially add weight to their lifts. This should be obvious in light of the principles already discussed regarding squatting and strength.

Less obvious is the role of belts and knee wraps. A properly designed and adjusted belt is useful as a safety device when squatting heavy weights. The role of the weightlifting belt having just been discussed, it should be stated that a belt protects the spine while lifting heavy weights, but a suit actually makes heavy weights easier to lift. By storing some of the kinetic energy of the descending bar as elastic energy in the suit material and the compressed skin and muscle under the suit, and then making that energy available to the lifter as he rebounds up, the suit is in fact an artificial aid. It could be argued that the belt is too, but spinal support and safety are necessary, while a squat 20% or more in excess of that which could be done unaided is certainly not.

A properly designed belt is four inches wide, all the way around. Many millions of cheap, junky belts have been produced with two-inch buckles and fronts, and either four or six inch backs. These amusing devices were designed by someone that did not understand how a belt works. For it to function correctly it must act against the abs, not the back, and there is no reason for it to be wider in the back than in the front. Four inches is about the widest belt that most people can get between ribs and hips, and some shorter kids may need to make a three-inch belt. Thickness is important in that a very thick, laminated suede belt feels very good under a big weight. Its almost complete lack of stretch makes for a comfortable ride. Such belts are expensive though, and any good single-ply 4" leather belt with a good buckle will work. Even a well-made Velcro belt will work (figure 62).

Figure 62. Many different belt types are appropriate for use. They can be leather or fabric just as long as they are made well and are sturdy.

A belt should be used judiciously, possibly restricted to the last warm-up and work sets, if then. Some trainees will not require a belt at all, for much of the early part of their training career, and if the abs are strong and the back uninjured, may prefer to never use one. This is a judgement call, one that must be made with the input of the trainee, but it is probably prudent to err on the side of safety if there is any question at all about it. A belt will not prevent the trunk from getting and staying strong – there is plenty of work for the trunk muscles even if a belt is worn on heavy sets – and it may help the trainee to safely squat enough weight to radically improve his strength, something he might not be able to do without it.

Knee wraps are another matter. The vast majority of the time a trainee uses tight wraps, the one-meter or longer heavy kind with the various-colored stripes, he is doing so to lift more weight. The mechanism is the same with wraps as with squat suits. In the absence of an injury, knee wraps must be considered aids used to lift more weights, and should not be worn. If the weight cannot be squatted without a suit and wraps, it is too heavy. But in the event of certain knee injuries, wraps can be helpful IF USED CORRECTLY. If the trainee has an old ligament injury that has healed as well as it's going to, wraps are useful to add stability to the knee (figure 63). A light wrap adds some pressure to the whole knee assembly,

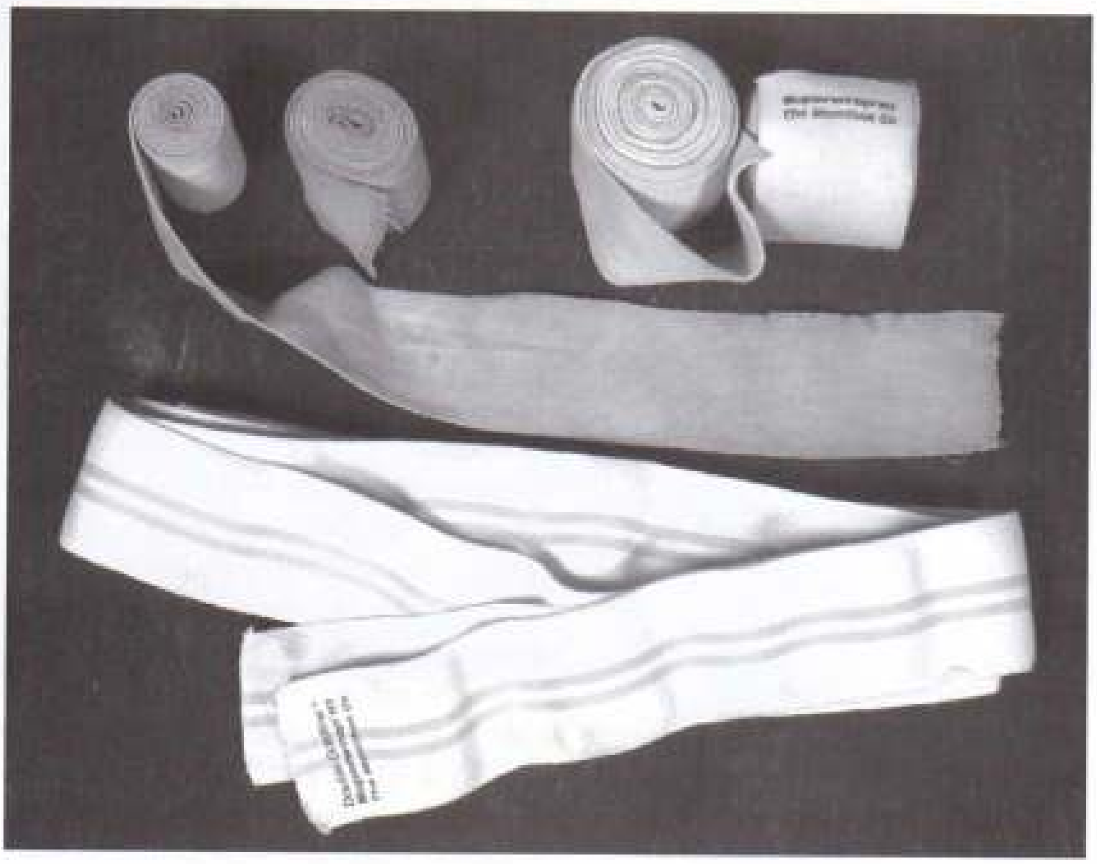


Figure 63. Wraps are used to assist in training with minor injuries and to aid in prevention of injuries, NOT to squat bigger weights. The latter works in powerlifting competition but is not suitable for optimal muscular development.

acting almost like an external capsule, as well as maintaining warmth and providing some proprioceptive input to the skin and superficial structures (a belt does the same thing if used correctly). The caveat is this: if the wraps are so tight that they must be loosened during the workout, then they are acting as aids and not as support. If the wraps can be kept on for the whole workout without occluding bloodflow to the lower leg, they are loose enough to consider as only supportive. Some heavier powerlifting

wraps are so heavy that they cannot actually be used as a loose support wrap. Lighter wraps are available at most sporting goods stores, and they work fine for our purposes, or rubber/cloth knee sleeves can be used if warmth is the primary objective.

If chalk is not provided by the facility, as it should be, the athletes will need to bring their own. Chalk is necessary and important as a way to prevent sore hands and excessive callus formation. Yes, it makes a mess, and kids must not be allowed to actually bathe in it, but they should be encouraged to use it properly and to try to keep it over the chalk box whenever possible.

Shoes are the only piece of equipment that the trainee actually needs to own. Belts and wraps, not being sized items, can be owned by the facility, provided that measures are in place to prevent them from "walking off." But a good pair of squat shoes adds enough to the efficiency of the movement that the cost is easily justified. For anywhere from $50 for a used pair to $170 for a full retail pair of the newest Adidas weightlifting shoes, a pair of shoes makes a big difference in the way a squat feels (figure 64). The main feature of a squat shoe is its lack of heel compressibility. The drive out of the bottom starts at the floor, where the feet start the kinetic chain. If the contact between the feet and the floor is a squishy gel or air cell of a running shoe, a percentage of the force of the drive will be absorbed by the compression of the cell. This compression is fine for running, but when squatting it reduces power transmission efficiency and destroys foot stability. Unstable footing interferes with the reproducibility of the movement pattern, rendering virtually every squat a whole new experience and preventing the development of the best technique. Squatting in running shoes is like squatting on a bed. Many people get away with it for years, but serious trainees invest in squat shoes. They aren't that expensive, especially compared to brand new name-brand athletic shoes, and they radically improve squatting efficiency.

Figure 64. Weightlifting shoes must provide a solid footing with little sole compressibility and little slippage. Some court shoes can suffice for this purpose but for the same, or less, money the trainee can buy a good pair of lifting shoes designed specifically for training.

Finally, a brief word about clothing is in order (figure 65). It is best to squat in a t-shirt, as opposed to a tank top, because t-shirts cover more skin than tanks and skin is slick when sweaty, and slick is not good for keeping the bar in place. By the same token, the shirt should be cotton or 50/50, not nylon or all synthetic for the same reason. Shorts, sweats, or training pants should always be of stretch material. This is very important, because if the pants grab the legs, and they will because of the sweat, a non-stretch garment will restrict the movement of the legs and alter the form. Ditto with shorts that stop right below the knee, even if they are stretch. Mid-thigh stretchy shorts or simple gray sweats are the best pants for training. Clothing should not affect movement in any way, and should never, ever make it harder to do a thing that is hard already – squat correctly.

Figure 65. A variety of clothing types are appropriate for training. T-shirts are always the preferred shirt. Singlets, shorts, standard sweats, or tights are all good choices for pants. Baggy shirts and baggy pants are not appropriate.

The Bench Press

The bench press is the most popular exercise in the weight room. There are several reasons for this, some of them good, some of them not quite so good. The good reasons involve the incredible benefits of the exercise, and its reputation as an unequalled builder of upper body strength. The silly ones involve the exercise's tendency to make the "pecs" grow excessively when high reps are used (and many trainees' impression that these are cool), and the fact that you get to lie down while you do it.

There are few gyms left in the world that don't have a pressing bench, and for good reason: the bench press, since the 1950s, has become the most widely-recognized resistance movement in the world, the one exercise most representative in the public mind of barbell training, the exercise the vast majority of trainees are most likely to want to do, and the exercise most often asked about by most people if they are interested in how strong you are.

Many incredibly strong men have benched big weights, long before the advent of modern supportive shirts, and even good benches. Men like Doug Hepburn, Pat Casey, Mel Hennessy, Don Reinhoudt, Jim Williams (who lifted in excess of 700 lbs. in a thin, cheap, white t-shirt), and Ronnie Ray were strong back in the early days of powerlifting, although the weights they lifted would, sad to say, scarcely turn a head at a 21st century national meet. Accomplished powerlifters of the 1980s, men like Larry Pacifico, the incredible Mike McDonald, George Hechter, John Kuc, Mike Bridges, Bill Kazmaier, Rickey Dale Crain, and the great Doug Young were masters of the bench press, using all the tricks at their disposal to establish national and world records in the lift (figure 1).

The modern version of the bench press, like the squat, depends on another piece of equipment for its execution. Until the upright support bench came into widespread use in the 1950s, the bar had to be pulled into position while lying on the floor, or while lying on a flat bench pulled up from the floor over the head into position over the chest. Controversy abounded as technique was evolving, with questions about the legitimacy of assistance in getting the bar into position, the use of a heave from the belly, even the use of an arch in the lower back, causing debate among physical culturists all over the world. Nowadays, the fancy-schmancy newfangled bench-press bench is standard equipment, and only a few innovative thinkers in the powerlifting community bother with doing the exercise the old, harder, and maybe better, way. After all, the more involved the exercise, the more the exercise involves, in terms of muscle, nerve, and control.

In fact, the dumbbell version of the exercise, which actually predates the barbell version due to its less specialized equipment requirements, is probably a better exercise for most purposes other than powerlifting competition. This is especially true if the weights used are sufficiently heavy, challenging the ability of the lifter to actually finish a set. Most trainees use them as a light assistance movement, and never appreciate how hard they are or how useful they can be. They are performed on a simple flat bench, and taking the dumbbells out of the rack or off the floor, getting into position on the flat bench, and getting up with them after the set is a large part of the fun. Dumbbells – being not tied together in the hands as

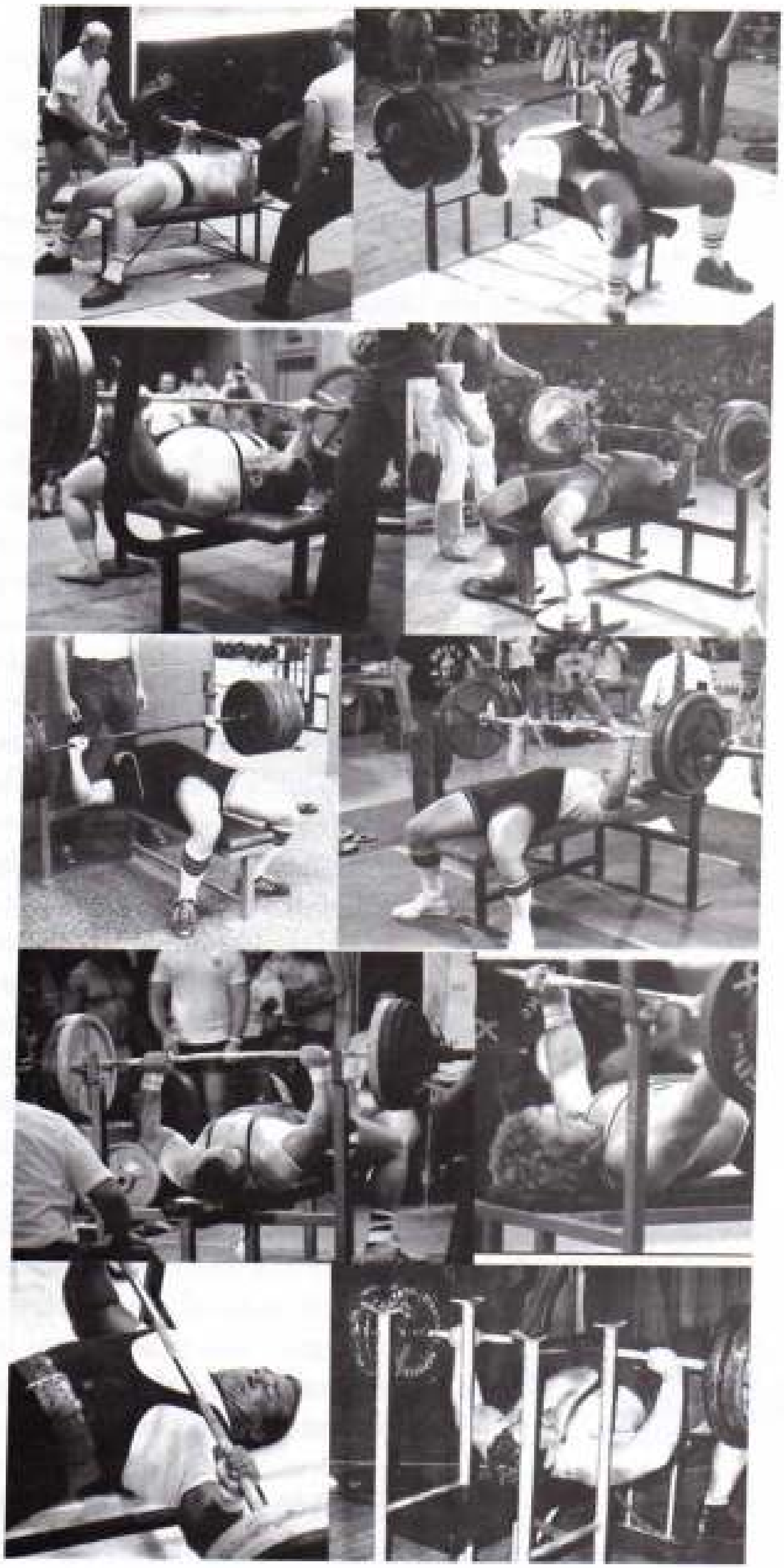


Figure 1. Big bench presses have been around for as long as the lift has been contested. Clockwise from top left: Mel Hennessy, Jim Williams, Larry Pacifico, Mike Bridges, Rickey Dale Crain, Pat Casey, Doug Young, Bill Kazmaier, Mike McDonald, Ronnie Ray.

with a barbell – require more active, conscious control, and are therefore harder to do. This is why they are not done as commonly – to the novice, it is much more impressive to lift bigger weights than it is to work harder, a thing to be kept in mind as you coach all the lifts.

Nevertheless, we will all be bench pressing with a barbell, as the weight of history and precedent demands. The bench press, or supine press (one occasionally sees old references to the "prone press" in badly edited sources), is a popular, useful exercise, and we must be prepared to learn it and teach it correctly. The bench press is arguably the best way to develop raw upper-body strength, and done correctly it can be a valuable addition to any strength and conditioning program.

The bench press actively works the muscles of the anterior shoulder girdle and the triceps, as well as the forearm muscles isometrically. The primary movers are the pectoralis major and the anterior deltoid, which drive the bar up off the chest, and the triceps, which drive the elbow extension to lockout. The pectoralis minor and the posterior rotator cuff muscles act to stabilize and prevent the rotation of the humerus during the movement. The other posterior muscles – the trapezius, the rhomboidius, and other smaller muscles along the cervical and thoracic spine – act isometrically to adduct the shoulder blades and keep the back stable against the bench. The lats, or latissimus dorsi muscles, act to rotate the ribcage up, arched relative to the lower back, decreasing the distance the bar has to travel and adding to the stability of the position. They also act as a counter to the deltoids, preventing the elbows from adducting, or rising up toward the head, while the humerus is driving up out of the bottom, thus preventing the angle between the upper arm and torso from changing during the lift (more on this later). The muscles of the lower back, hips, and legs act as a bridge between the upper body and the ground, anchoring and stabilizing the chest and arms as they do the work of handling the bar. And the neck muscles contract isometrically, stabilizing the head against the bench; bench pressing makes the neck grow too, making new dress shirts inevitable. Since the bench press is a free weight exercise, control of the bar is integral to the movement, and improvement in control is part of the benefit of doing it (figure 2).

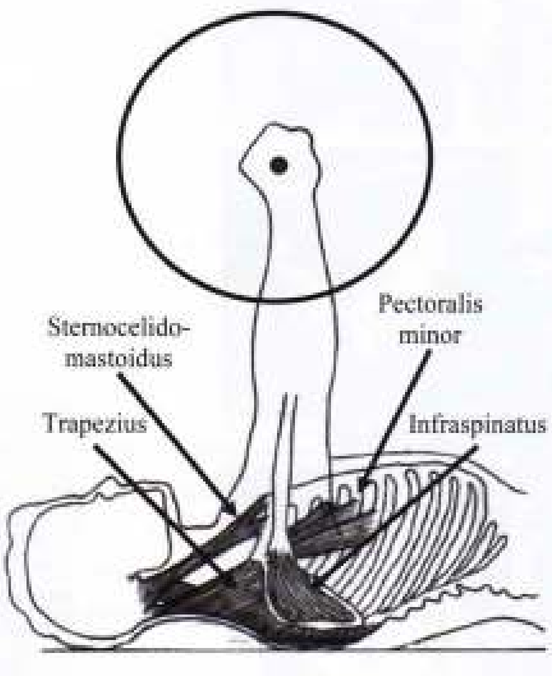


Figure 2. The musculature of the neck acts to stabilize the body during the execution of the exercise. At the same time the rotator cuff muscles and the pectoralis minor stabilize the shoulder joint throughout the exercise. This makes the bench press a great preventive exercise in addition to its role in developing upper body strength.

First, a small disclaimer: this is not a book about powerlifting, and it is not designed to be used as such. The bench press as a competitive lift will probably be approached differently than herein described. If aspiring powerlifters are able to obtain useful information from these comments, that is very cool. The author was never an accomplished bench presser, and this method was not derived from, nor is it intended to be used to develop, any special level of skill in the modern competitive powerlifting version of the bench press. So many strength coaches have successfully produced strong bench pressers that there will obviously be disagreements – some superficial and some basic and fundamental. This method is derived from the author's experience in 25 years of teaching the movement to novices, and no claims are made otherwise. Any disagreements the powerlifting community may have with it will just have to wait until the author's many injuries heal, and then we can take it outside.

We will be using standard power bars and benches for learning and training the bench press, because there is no need to reinvent the wheel. Power standard bars are widely available, and this configuration has proven itself as the most useful over the years. The specifications are simple: the bar diameter should be 28.5 to 29.5 mm., length should be 7', the knurling should be adequate but not too sharp, and should extend in from the sleeves so that a 17" gap is left in the middle, with center knurling of about 6" provided (figure 3). The knurling should be scored at either end of the bar with a distance of 32" between the marks, denoting the maximum legal grip width for competition. The steel should be of sufficient quality that the bar doesn't bend under normal use, but flexes when appropriate, and this should be covered by a warranty that will actually be honored by a good company (just in case things aren't as they are represented to be). These bars can be used for all the lifts, if it becomes necessary to use them for cleans and snatches (although this is not optimal). If these are simply not available, use what you have until better equipment can be provided. Bars are absolutely the wrong place to save money.

The benches should also be to standard specs, although there is no standard configuration. Many designs are available, in a wide range of prices, but a good, simple, inexpensive bench press bench was developed years ago, and is every bit as useful as any design ever made. It has the advantage of not needing adjustable uprights and is designed so that all but the very shortest-armed lifters can use it easily. It has been manufactured by several companies, and should be widely available (figure 4). Standard specifications require the height of the bench surface to be 17", and if this is too tall for short trainees, blocks for the lifter's feet (usually just barbell plates) will need to be provided.

Most benches are provided with some type of vinyl upholstery, although auto seat fabric has proven itself over the years to last longer and provide better traction for the back during the lift.

Some facilities that are cramped for space or funds may choose to use the power rack and a flat bench as the bench press station. This has the advantages of efficiency, utilizing space twice instead of once, and flexibility, since the

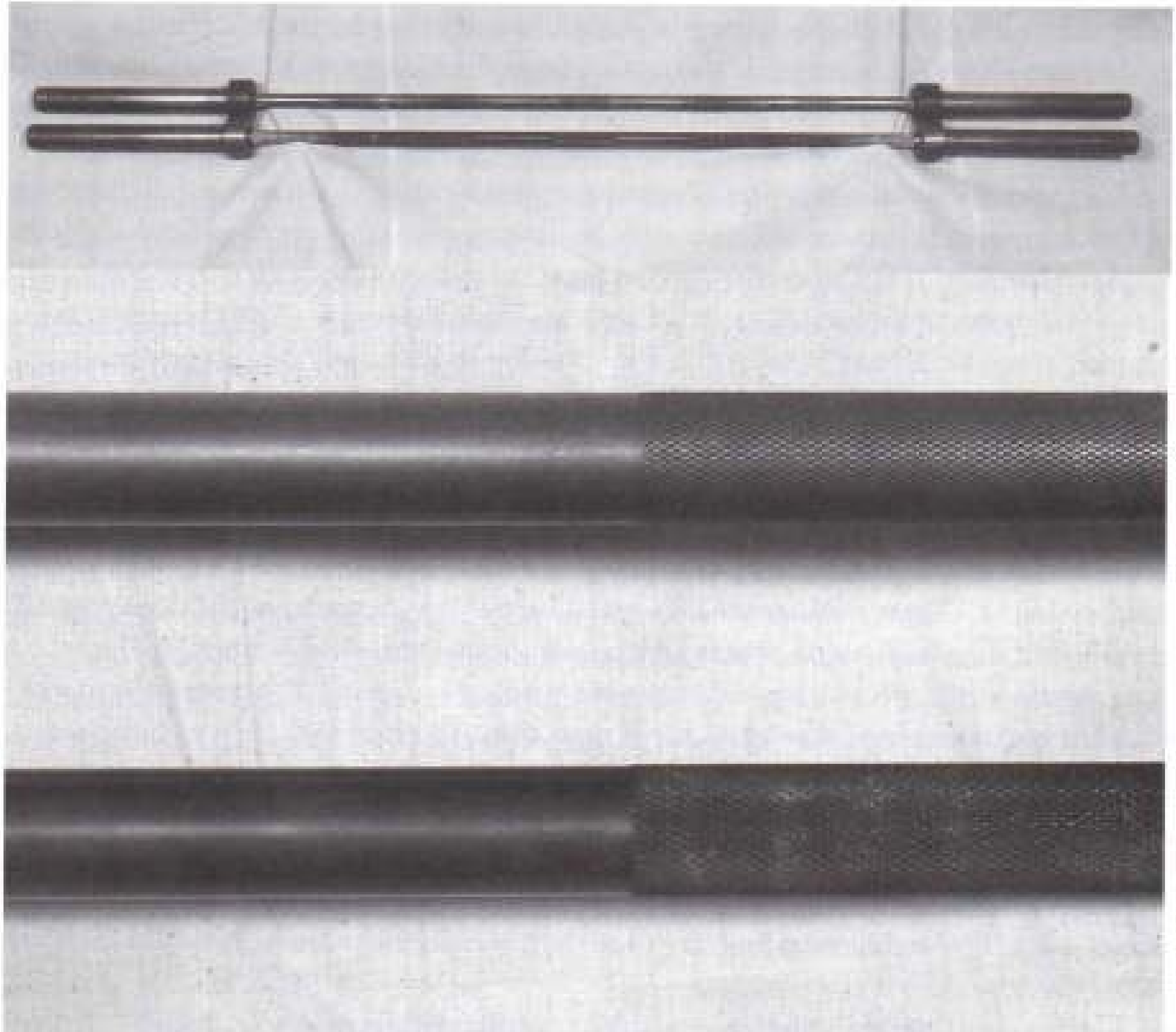


Figure 3. There are any number of companies producing weightlifting bars. You need to purchase "power" bars from reliable manufacturers ("Olympic Standard" will also suffice). Bars such as these have uniform dimensions and similar mechanical characteristics. But all bars are not created equal. Note that in the lower photo comparison, the bottom bar has much more aggressive knurling than the top bar. Before you buy, shop around, go to different gyms to evaluate their bars or go to powerlifting or weightlifting events to check out the bars (and the lifting). You can even go to professional conferences and test out equipment.

power rack is adjustable for trainees of all sizes and dimensions. The 17" flat bench is an inexpensive piece of useful equipment, and many home gyms use this configuration to maximize the function of the space set aside for training. In fact, a power rack, a flat bench, and a set of weights is a fairly complete training facility (figure 5).

All competitive benches are made with a distance between the uprights of about 45 inches, which places the support hooks just inside the loading sleeves of the bar. Occasionally one will see a narrow-upright bench in a garage sale, or even on the sales floor of a home-exercise equipment store. The wide support configuration is absolutely essential for safe loading and use of the bench, due to the annoying tendency of gravity to tip an unevenly

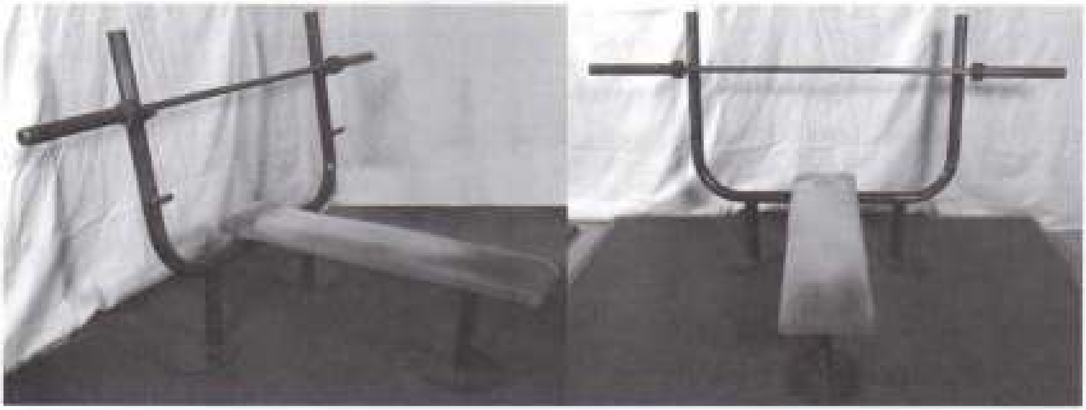


Figure 4. The MAC Barbell Bench (named after Doug Patterson's Metro Athletic Club in Arlington, Texas), a sturdy, durable, and useful piece of equipment.

loaded bar if not supported in a stable configuration. This, in addition to the fact that hands tend to get damaged badly when racking the bar if the grip is close to narrow uprights, renders these old style, cheap benches useless for most purposes.

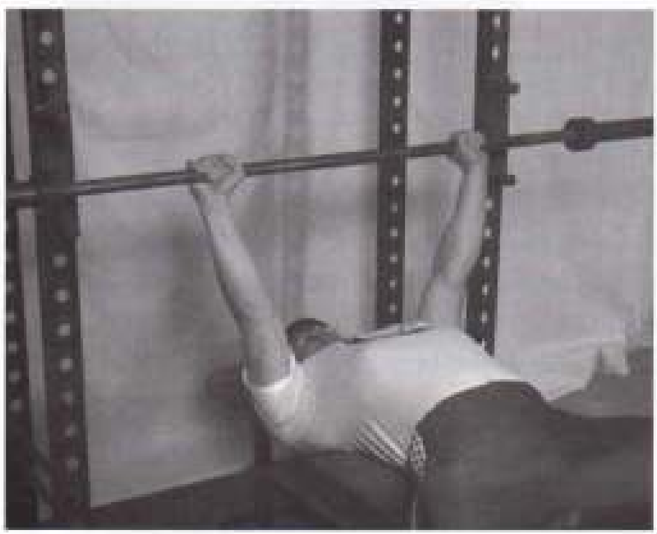


Figure 5. A simple flat bench used in conjunction with a power rack makes for a very versatile work station.

Teaching the Bench

As usual, start with an empty bar. ALWAYS start every lift with an empty bar, whether teaching it for the first time or warming up for a personal record. Position yourself in the standard place for coaching the bench, in the center between the uprights facing the end of the bench (figure 6). Have the

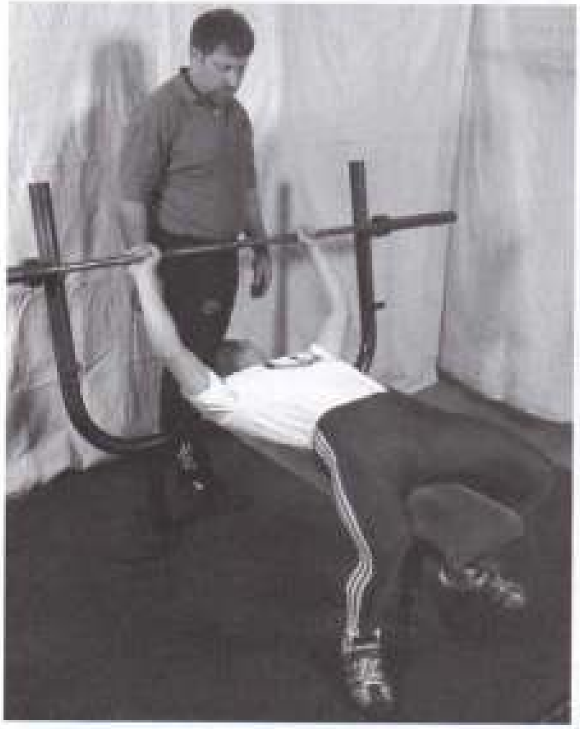


Figure 6. The coach should position himself in a manner to maximize observation, instruction, and safe practice.

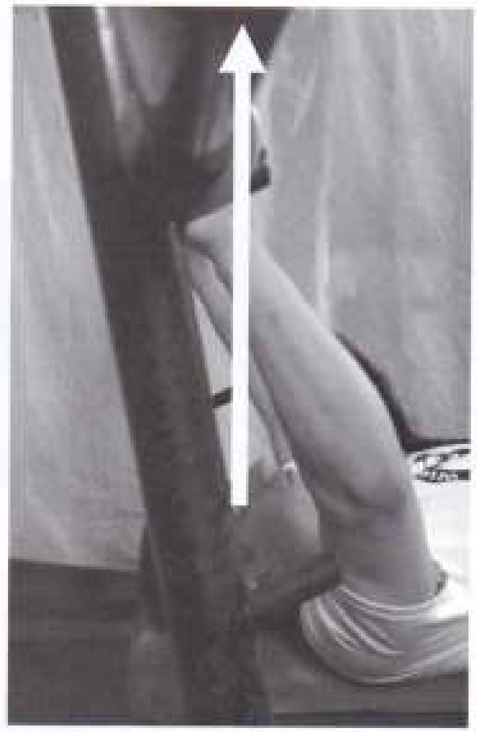


Figure 7. Trainee's position on the bench. Note that the eyes, looking straight up, see the ceiling on the "thumb" side of the bar.

trainee lie down on the bench with his eyes looking straight up. In this position, he should be far enough down (always meaning toward the foot-end of the bench) from the bar that when looking up his eyes are on the thumb side of the bar (figure 7). His feet should be flat on the ground at a comfortable spacing comparable to the squat stance, with the shins approximately vertical (figure 8). His upper back should be flat against the bench, with the lower back in an anatomically normal arched position (figure 9).

When this position has been established, have him take an overhand grip on the bar. The grip should be somewhere between 22 and 28 inches, measured between the index fingers, and this will vary widely based on shoulder width (figure 10). An excessively wide or narrow grip is to be avoided, on which more will be discussed later. The bar should rest on the heel of the palm, directly over the bones of the forearm, and not in the palm near the fingers, so that power being transmitted to the bar up the arms goes directly to the bar without being channeled through the wrist (figure 11). The fingers should wrap around the bar AFTER the bar has been set correctly on the heel of the hand. This grip is best accomplished by turning the hands and elbows out, with a slight internal rotation of the arm. This has the advantage of placing the bar in a good position on the hand, and placing the elbows in a useful position as well.

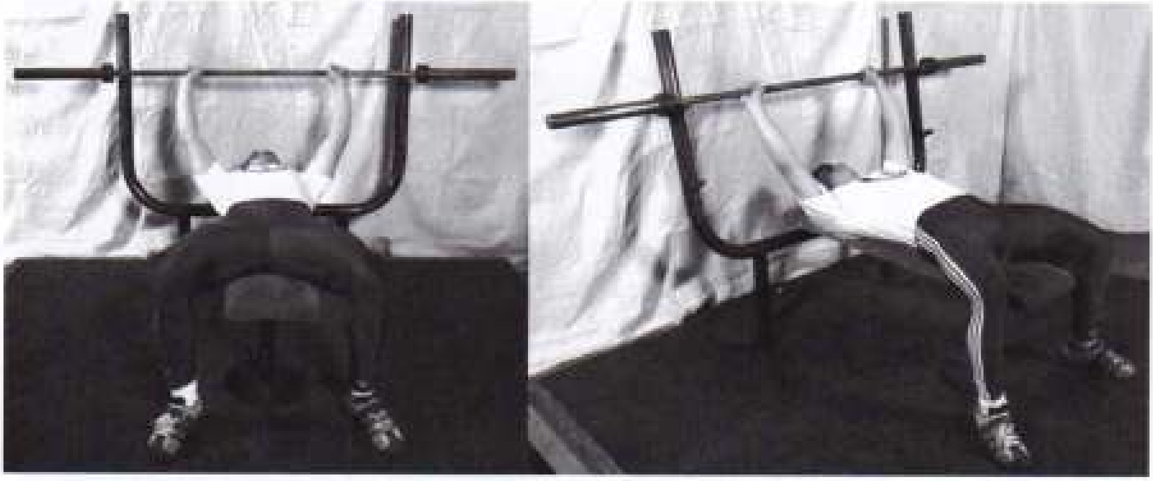


Figure 8. Position of the trainee on the bench.

He is now ready to take the bar out of the rack. As you stand behind him, tell him to push up on the bar, and as he does this, use both hands to help him move the bar out to a position directly over his chest, with his arms in a perfectly vertical position relative to the floor. Most trainees will try to stop over the chin or throat, so be prepared for this and make sure the bar gets out to the place it needs to be, right over the nipple line. This position is easy to see, and with practice you can identify it quickly and automatically. Make sure the bar is stable as you let go of it, and be ready to re-grip it quickly if he wobbles with it too much. This procedure should be accomplished quickly and positively, so that he learns to take it out of the rack himself quickly and positively.

As he becomes stable in the starting position, take your hands away from the bar and let him see the very important picture directly over his position. He will be looking at the

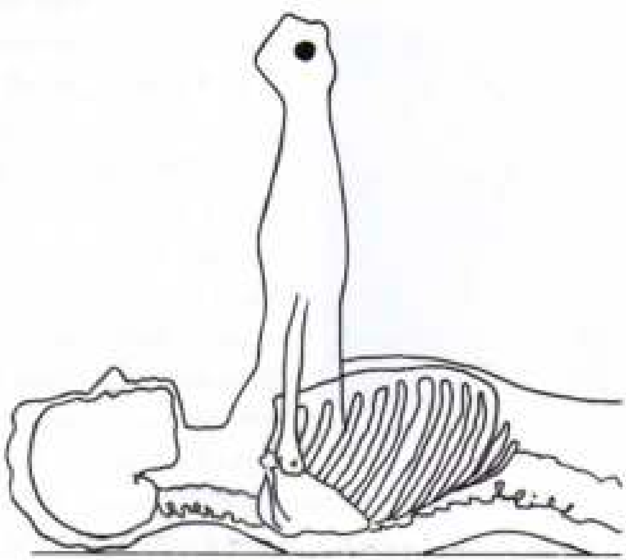


Figure 9. As in the squat, the trainee should assume a neutral spinal position maintaining both kyphotic and lordotic curves.

Figure 10. The width of grip on the bar varies with the individual, but is generally 22-28".

ceiling (assuming of course that the weight room has a ceiling) and this picture is his reference for the path the bar will take as he moves it down and up. Tell him to "look up at the ceiling. Notice the picture you see against the ceiling. You see the bar against the ceiling. Look at its position." Now, take your hands and move the bar a tiny bit. Say to him, "Notice that if the bar moves even a little that you can tell by the change it makes with the ceiling."

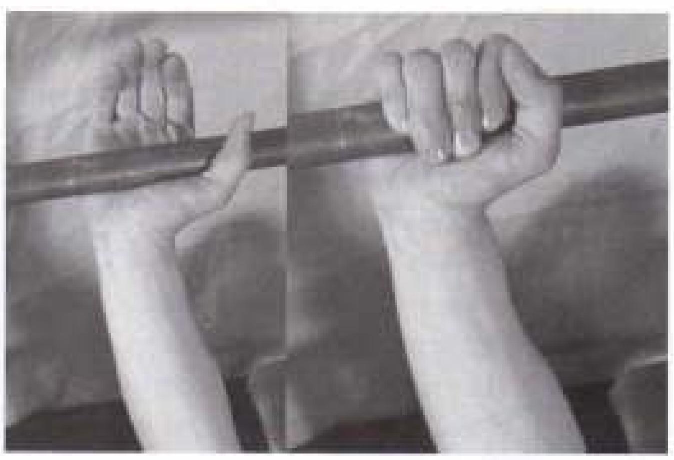


Figure 11. The bar should be gripped at the base of the palm by setting the heel of the palm in position first, then wrapping the fingers around the bar second.

Now tell him this: " See the place the bar is in now?" Make sure, of course, that it is in the correct place when you tell him this. "Lower the bar to your chest, touch the chest, and then drive it right back to where it is now." This next thing is the most important part of the instructions: "Stare at the place on the ceiling where the bar is to go. DO NOT look at the bar as it moves; do NOT follow the bar with your eyes, but just stare at the ceiling. Make the bar go to that place every rep." This is the key to the whole method. If he uses a fixed reference for the bar position, he can make it go to the same place each rep, but if he follows the bar with his eyes he will have no way to direct the bar to that fixed, correct place since he is looking at the thing he is moving and not the place he wants it to go. This is the same principle as is used to hit a golf ball or a tennis ball: the implement moves to the target, and the target is the object of the eyes. Granted, tennis balls move while golf balls don't, but the brain coordinates the hands to go to the target with the club, or racquet, or bar because the target is the reference for the eyes. When a tennis ball moves, the head moves with it and renders it stationary relative to the eyes. Fortunately, most ceilings don't move in most weight rooms, so our task is easier than McEnroe's, but it is similar in that we are driving an object in our hands toward a thing we are actively looking at (figure 12).

Figure 12. View from the trainee's position on the bench. The position of the bar at lockout is referenced against the ceiling.

This little trick works 90% of the time, the first time it is used. Even badly coordinated kids can do a fairly good bench press within a couple of sets using this technique. Bar path, or "groove," as the bar path is often referred to by bench pressers, is the first and most frustrating problem that novice trainees will experience, and by focusing their eyes on the ceiling they can eliminate this problem the vast majority of the time. If the bar finds the groove automatically, as it does with this method, attention can be directed to other aspects of the exercise.

Have him do a set of five with the bar, reinforcing his eye position if necessary, and then have him rack the bar. With locked elbows after the last rep is finished, have him move the bar back to the uprights of the bench, touch them with the bar, and then set it down in the hooks. This should be done while you hold the bar lightly, not taking any weight off, but providing guidance in case he misses. Another set of five reps with the empty bar is a good idea, to reinforce the focus position and the technique, and then add weight a little at a time, 10 pounds at a time for smaller kids, 20 or even 30 pounds for bigger trainees, until the bar speed begins to slow and form starts to change. Stay there for two more sets of five, and that is the first workout. Now, on to the problems.

Hands and grip

The bar (being in a position over the head, face, and neck during the bench press) presents some significant safety problems if certain common-sense precautions are not observed. The subject of spotters and spotting will be dealt with in detail later, so these comments will involve things the lifter must do. Maybe the biggest, dumbest, most common problem involving the hands is the use of the thumbless grip. This is absolutely the worst habit a trainee can develop with regard to safety, and is detrimental to performance as well (figure 13). Many trainees start with a thumbless grip in an attempt to get the bar over the very end of the arm, off of the wrist. But doing this with a thumbless grip is unnecessary, as the same position can be obtained with the thumb hooked around the bar with little change in the elbow position, and the risk of having an unsecured bar over the face and throat is just too great to tolerate in a public facility. The danger of this cannot truly be appreciated until one sees the effects firsthand. If a lifter insists on using a thumbless grip on the bench, he needs to do it at home, so that when the ambulance comes it doesn't disrupt anyone else's training.

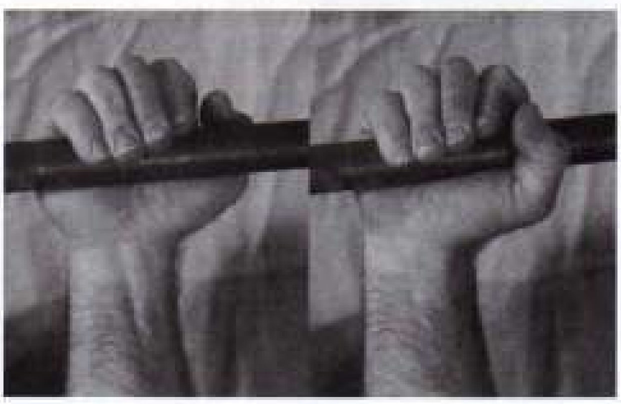


Figure 13. You will see trainees trying to use the thumbless grip (left). This is an immediate safety issue. The number one killer in the weight room each year is the bench press. It is possible that the average eleven fatalities each year were caused by not using the correct, safe grip (right).

Another disadvantage to the thumbless grip is that it creates an efficiency problem. What the hands cannot squeeze, the shoulders cannot drive. This phenomenon is observed when using large diameter bars and fat-handled dumbbells: for no apparent reason, a 2" bar is about twice as hard to press as a standard 28.5 mm (1 1/8") bar. This is due to the inability of a person with a normal-sized hand to effectively squeeze a bar that fat with a good tight grip. Squeezing involves closing the thumb and fingers around the bar until effective pressure can be applied with the forearm muscles in isometric contraction, increasing the tightness of the muscles on the distal side of the elbow, making rebound out of the bottom more efficient, and increasing motor unit recruitment throughout the arms and upper body. The thumbless grip is an excellent way to voluntarily reduce the ability to squeeze the bar. Try it yourself for demonstration purposes, with a light weight, please.

Some people can effectively use a thumbless grip on the press, and many big bench presses have been done with a thumbless grip too. The point is that since the standard grip is safer and more effective, it should be used by everybody that has thumbs.

The thumbless grip is an attempt, as previously stated, to get the bar into a better position in the hand. The force generated by the shoulders and triceps is delivered to the bar through the bones of the forearm. The most efficient transmission of power to the bar would be directly from the heel of the palm to the bar (figure 14).

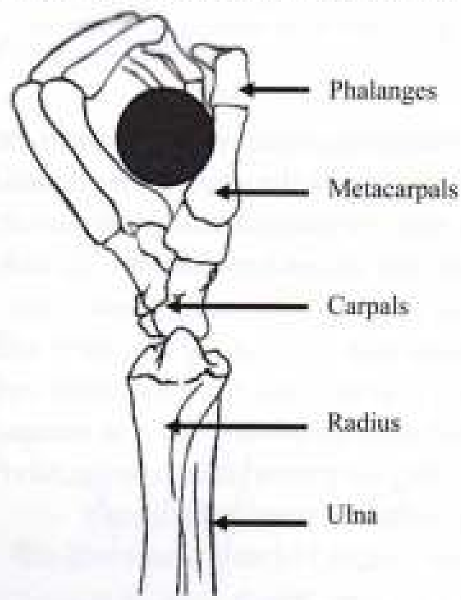


Figure 14. For maximal transfer of power to the bar, the bones of the forearm and wrist should be in alignment, the bar sitting directly over the bones of the forearm.

The grip should be positioned with this in mind, with the bar placed directly over the palm heel and then the hand rotated out so that the thumb can hook around the bar. Once the hand is in position, the palm of the hand should be tightened so that the bar is well supported and does not move during the rep. Tell the trainee to "squeeze your hand like you are trying to squeeze the bones of your forearm together." The thumb does not interfere with this position at all. Once the thumb position is secured, the fingers should wrap around the bar. Finger position is less important, as the bar is secured by the thumb, and most people will hold the bar too far back in the hand if the fingers are thought to be the thing that grips and controls the bar (figure 15).

It is common to see the bar shift back in the hand towards the fingers during the set, such that the bar ends up in a completely different position than where it started. This is the result of the trainee not maintaining tightness during the set. If the bar shifts much at all, it can change the lifting mechanics by altering the position of the load relative to the muscles driving it up, making a change in elbow or shoulder position during the lift likely. If the bar rolls back in the hand, it has rolled back from the elbow and shoulder, and they have to adjust to maintain their drive. The bar should remain locked firmly in place during the set, for efficiency and safety.

Grip width, within extremes, is largely a matter of individual preference. Since we are trying to develop strength, and not specifically a big contest

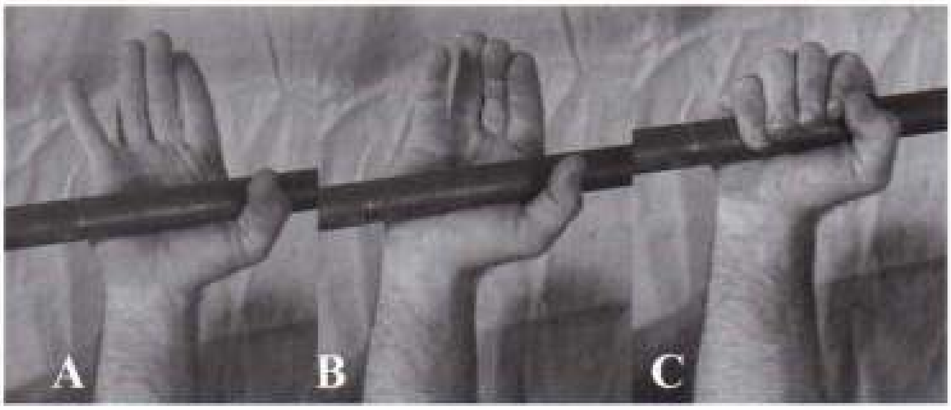


Figure 15. Note that most trainees will begin and end the grip process with the bar lying perpendicular to the line of the fingers (A). The best position is achieved by slightly rotating the hand in (by rotating the elbows out as in B) then gripping the bar (C).

bench press, our form should be generalized, without too much emphasis on any one muscle group and a lot of work for all of them. A very wide grip emphasizes the chest at the expense of the triceps, and a narrow grip emphasizes the triceps to such an extent that it is used as an assistance exercise for that bodypart. But as long as the grip falls somewhere between 22 and 28 inches between index fingers, the purpose is served. This range allows enough leeway for people of all shoulder widths to find a grip they feel strongest with. Too much narrower will, for most people, take pounds off the work sets, and a wider grip shortens the movement and takes out too much tricep. (Heavier weights can be benched with a wide grip for this reason - the bar doesn't have to move as far. The maximum legal width for powerlifting competition is 32". But again, we are trying to make people strong using the bench press, which isn't necessarily the same thing as making people bench a heavier weight.) Most trainees will self-select a medium grip anyway. It feels more natural than a wide grip, which must be practiced extensively before it will be productive. A medium grip gives all the muscles of the shoulder girdle a share of the work, and produces the kind of overall shoulder and arm strength we want from the exercise.

Elbows

An understanding of elbow position is essential for lifting efficiency and, once again, safety. The elbow represents the distal end of the humerus, as it articulates with the radius and the ulna. The pecs and delts attach to the anterior side of the humerus up by the shoulder, and the triceps attach to the olecranon process, the pointy part of the ulna that forms the outside of the elbow. Essentially, all the force being generated by the muscles involved in the bench press moves the elbow. The shoulder joint works at the same time, but it doesn't (or shouldn't) change its position against the bench; the action around the shoulder joint contributes to the movement through space of the elbow (figure 16). The position of the elbow while it moves the bar is crucial to the success of the movement.

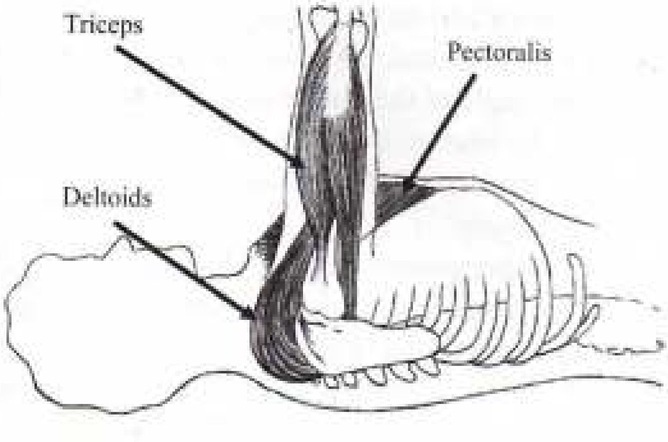


Figure 16. The major movers of the bench press.

For our purposes here, position is determined by the angle the humerus makes with the torso, as seen from above. An angle of 90 degrees to the torso would have the arm at right angles to the bench, parallel to the bar, a rather extreme position. The other extreme would be allowing the elbows to come down to a position parallel with the torso, with the arms sliding against the ribcage at the bottom. The preferred position will be somewhere between these two extremes, but higher rather than lower (figure 17). The forearm will always be vertical (figure 18); since gravity operates in straight lines perpendicular to the floor, overcoming gravity must occur in exactly the opposite direction. The forearm must stay vertical or some of the load will begin to exert a rotational force, or torque, against the elbow.

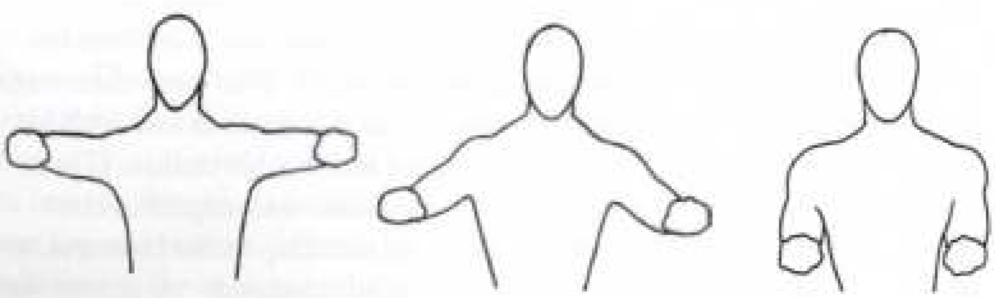


Figure 17. The best angle for the upper arm relative to the line of the body is about 60 degrees (center). Ninety degrees (left) and zero degrees (right) are too extreme for both optimal development and comfort.

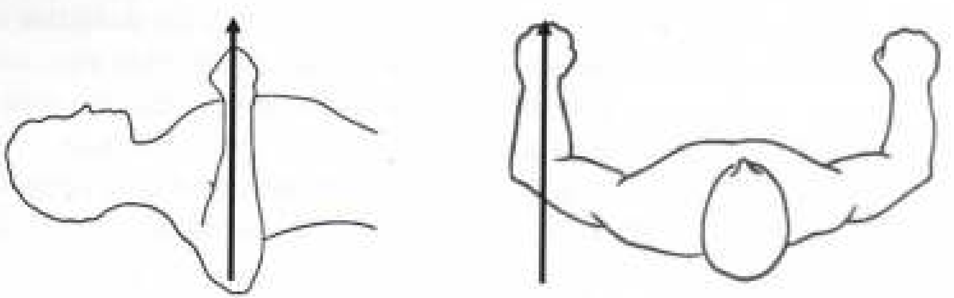
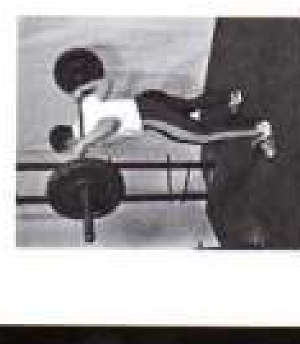


Figure 18. The forearm must be vertical from all angles of observation in order to ensure optimal force transmission to the bar and safety.



Since the forearm must always be vertical, the elbow will always be directly under the bar. Because the forces driving the bar act on the elbow and on up through the forearm, this is a very good place for it to be. And since the forearm is vertical, the point on the chest the bar touches at the bottom is determined entirely by the angle of the humerus with the torso, and thus, the elbow (figures 17 & 19). The bar follows the elbows: if the elbows rotate up away from the ribs, the bar goes up the chest toward the throat, and if the elbows slide down toward the ribcage, the bar moves down toward the belly.

The elbow position is therefore related to the bar position, and to the individual anthropometry of the trainee. For example, an experienced, proficient lifter with good upper back flexibility can arch his chest up high, thus allowing the bar a shorter trip down and up. This will have the bar touching lower on the chest towards the bottom of the sternum, as the ribcage rotates up. For a person with less flexibility in the upper spine, this bar position on the chest would require the elbows to be at an angle of perhaps 45 degrees to the torso, about halfway between touching the ribcage and in line with the shoulders. But since our experienced, flexible lifter has his chest up higher, his shoulders are closer vertically to the bottom of his sternum, when viewed from the side. This is due to the steeper angle his flexibility allows his upper back, and thus his chest, to attain (figure 20). This steep chest angle allows his elbows to stay more in line with his shoulders than the less flexible trainee. (There are other considerations with regard to chest position and its relationship to the humerus, to be discussed more fully below.)

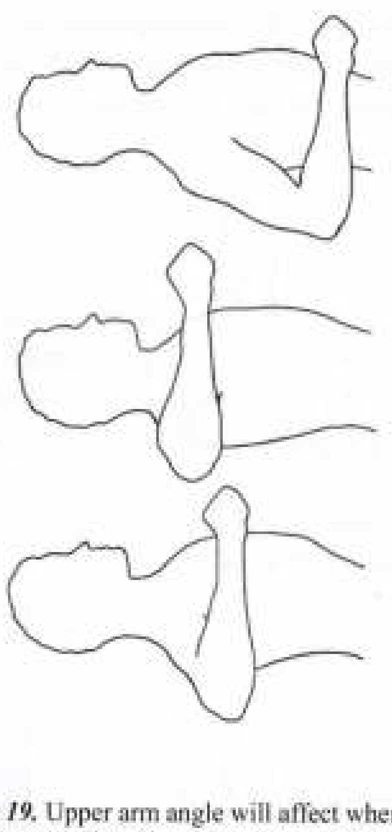


Figure 19. Upper arm angle will affect where the bar encounters the chest. The arms parallel to the body will put the bar near the navel (top), the arm at 90 degrees puts that bar up high or near the throat (middle). Our recommended angle puts it over the chest, where it should be (bottom).

The correct humeral angle can vary quite a bit among individual trainees, from 45 degrees, halfway between right angles and touching the ribs, to about 80 degrees. If the elbows are at a full ninety degrees, in line with the shoulders, the tendons of the biceps are placed in an anatomically unfriendly position that can produce a rather common type of chronic shoulder pain. In contrast, the other extreme position, where the humerus is essentially parallel to the torso, is not particularly hazardous, but has the disadvantage of eliminating most of the pec function from the movement, reducing the efficiency of the lift as an exercise for the whole upper body.

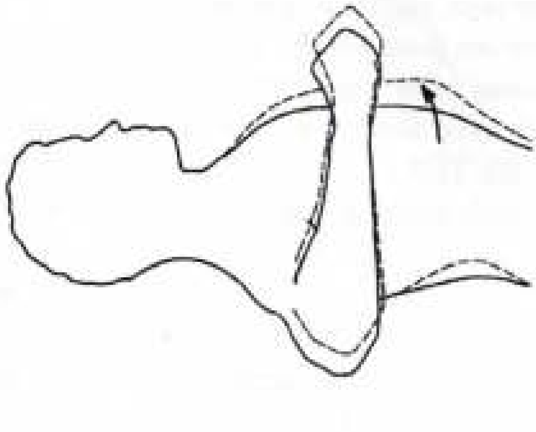


Figure 20. The angle of the chest may be more steep in flexible trainees (dashed line). Note the change in bar position on the chest with the change in chest steepness.

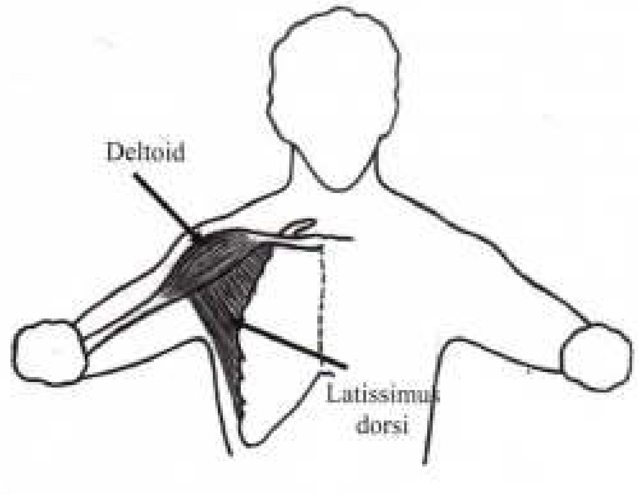


Figure 21. The latissimus dorsi and the deltoids help stabilize the humerus while the pectorals do their work.

No matter what humeral angle is used, it is important that the angle not change during the rep. The eccentric phase of the movement should use the same elbow angle as the concentric. Stated another way, the elbows should be in the same vertical plane on the way down and on the way up. The humerus is kept in this constant position by the action of the lats and the deltoids, stabilizing the humerus by exerting equal opposing forces on the bone from top and bottom (inferior and superior) at the same time (figure 21). Any variation in angle during the movement indicates that one of these two muscles is not countering the force of the other effectively. Shoulder problems are commonly associated with the bench press, because of this elbow movement. The tendons of the biceps, as they arise from and cross the shoulder joint on their way down to the elbow, are not very tolerant of the abrasion they are subjected to when the elbows flail around during an uncontrolled trip to the chest and back. Bicep tendon injuries are probably the most commonly encountered shoulder injury in the weight room; they are hard to treat, and hard to heal up. Be careful about this.

Coaches should watch elbow position with these factors in mind. Elbow position will vary among trainees, and as long as the humeral angle is in the ballpark and the angle does not change during the rep, or change much during the set, it will not need to be corrected. If it doesn't need correcting, don't even comment on it to him. This is true for most things coaches do - novices have enough stuff to think about anyway while they learn new movements, and they don't need their attention called to something that does not require their attention.

Chest

The chest, for bench pressing purposes, is the anterior ribcage and the muscles attached to it. The main chest muscles - the pectoralis major, or pecs, and their Siamese twins the anterior deltoids - attach to the humerus at a long insertion point along the upper third of the bone. They wrap across the ribcage to a long origin along a line from the bottom of the sternum, up to the clavicle, and along the clavicle back to its distal end at the shoulder, with the muscle fibers fanning out in a broad angle (figure 22). This wide angle of origin allows the pec/delt muscle to apply force to the humerus over a wide range of angles of insertion, thus permitting the range of effective elbow positions.

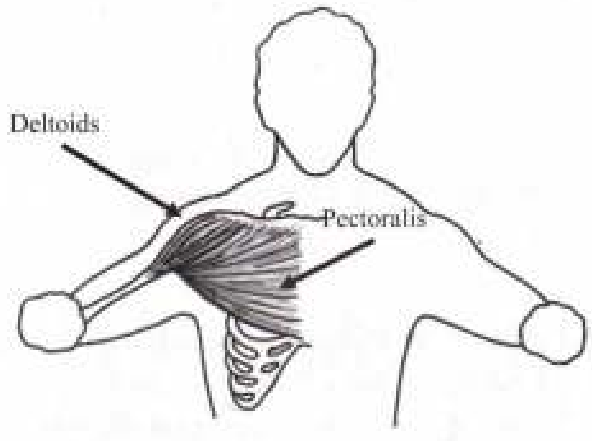


Figure 22. The primary musculature responsible for moving the upper arm (humerus).

It is also important to understand the relationship between the pec/delt muscle attachment to the humerus, and the angle of that attachment. Viewed from the horizontal, (a cross-section parallel to the long axis of the bench) the pec/delt attachment occurs at an angle that varies with chest position (figure 23).

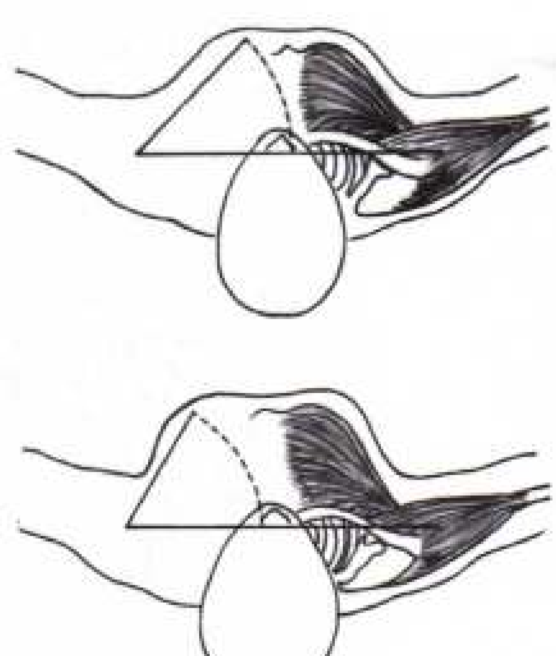


Figure 23. A bigger chest (from genetics or from adding muscle mass) increases bench press efficiency. Note what happens to the angle of the pectoral muscle to the humerus with increased chest size (bottom).

The higher the top of the chest - the highest point on the ribcage above the bench - the steeper the angle the pec/delt attaches to the humerus. The steeper the angle, the better, because of the increased mechanical efficiency of the pec/delt contraction caused by the steeper angle of attack on the humerus. In a classic example of simple mechanics, a third class lever exhibits greater efficiency the more closely the force is perpendicular to the resistance (figure 24). So the higher the chest position above the arms, the better the pull the pec/delt has on the arms. The attainment and

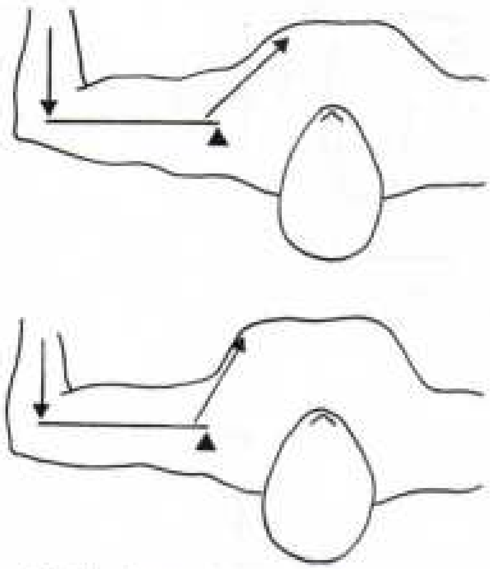


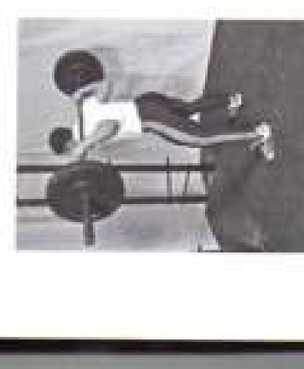
Figure 24. The change in mechanical efficiency noted with a larger chest is a result of the changed angle of action. With a larger chest, the angle of action is more perpendicular.

maintenance of this position is a function of the muscles of the upper back, and will be discussed below.

First, let's address a common problem with the chest: not touching it with the bar every rep. Sometimes this is accidental; the trainee intends to touch but misses. If this is the case, he'll get it next rep. But usually it is just laziness. It is, after all, easier to move a load a shorter distance than a longer distance. Work equals the force of gravity acting on the barbell multiplied by the distance the barbell moves (figure 25). If, over the course of 3 month's training, the barbell doubles in weight but is only traveling half the distance it did on the first day of training, the work has stayed the same and 3 months have been wasted.

Sometimes it may be on purpose. There is a school of thought that justifies the use of less than full range of motion by claiming that the pecs stop contributing to the movement when the humerus reaches a 90-degree angle with the forearm. (This same "analysis" requires an above parallel squat because the quads stop contributing when the femur gets to 90 degrees with the tibia.) The problem with this model is that full range of motion, multi-joint exercises are not *supposed* to isolate any one muscle; we use them because they don't. We *want* them to work lots of muscles through a long range of motion. We like it when some muscles are called into function as other muscles drop out of function. This is because we are training athletes, not models or bodybuilders. We are concerned with improving the functional motion around a joint. We are not just concerned about our favorite muscles. We do not have "favorite muscles".

The use of full range of motion is therefore important for two very good reasons. First, it allows us to quantify work: if we hold the range of motion of an exercise constant, we are holding constant the distance variable in our work equation. Then, if the force we can exert on the load increases (if we lift more weight) we know that our work has increased for a given number of reps. We know we're moving the weight the same distance, and the weight is heavier, so we know we're stronger. It allows us to compare performances, both between lifters and between our own performances over time. If everybody touches his chest with the bar every time he benches, progress – or lack thereof – can be assessed. This obviously applies to every exercise with a prescribed range of motion.



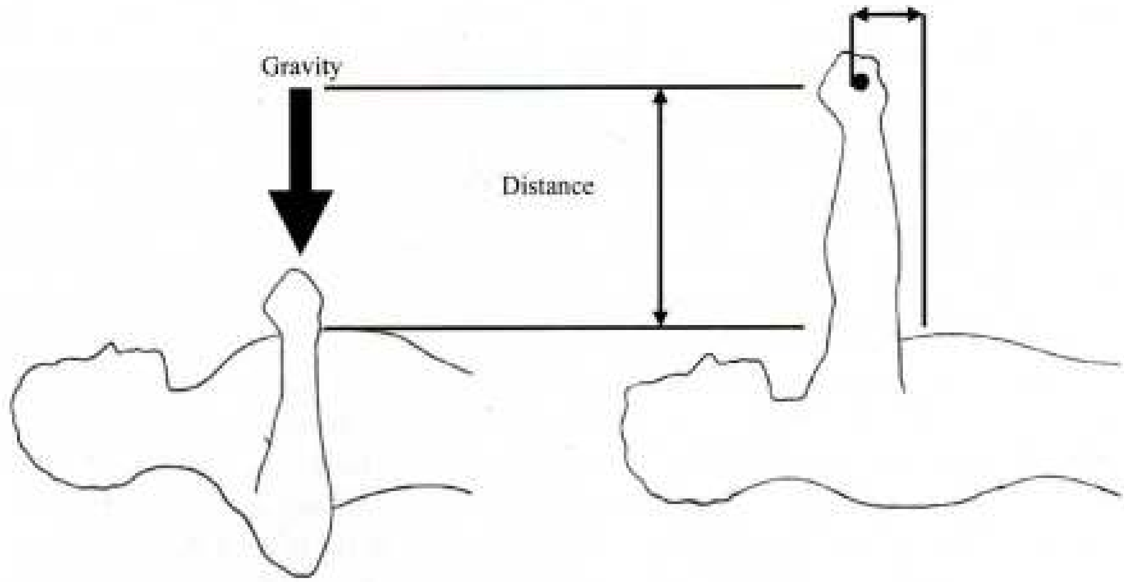


Figure 25. We can calculate the amount of work accomplished in the bench press by using the simple equation: Force generated x Distance moved = Work done. Although the bench press is slightly curvilinear to varying degrees in different trainees, this linear equation demonstrates the concept.

Second, full range of motion exercise ensures that strength is developed in every position that the joint can work. Strength development is extremely specific: muscles get strong in the positions in which they are made to get strong, and in precisely the way they are trained. For instance, a leg worked through 30 degrees of its range of motion on a leg extension machine will adapt to this work by improving its ability to work in that 30 degrees of motion. It will not get much stronger anywhere else in its range. If we want to prepare an athlete to use his legs for a sport where he might be called upon to use them in a variety of positions, then he must train through a full range of motion in a way that strengthens the whole range. Any joint about which movement can occur will benefit from having its entire function improved. So, all the muscles that move a joint should be exercised using a movement that calls into play as many of them as might be used in the sport for which we are training.

The bench press, like the squat, likes a certain amount of rebound out of the bottom, using the handy stretch reflex phenomenon that is a feature of skeletal muscle (figure 26). The problem is that the sternum gets whacked with the bar before rebound occurs in the unskilled trainee. It takes practice and good timing to tighten up the bottom of the movement enough that a correct rebound can be done every rep. A competition bench press, theoretically at least, has no rebound due to the technical rules, which specify that the bar must cease its motion at the bottom before being driven up off the chest. A touch-and-go bench press allows the trainee to lift more weight than a paused bench press. It must be said that a cheated bench, where a heave of the chest, a hard bounce off the pecs, and a bridge with the hips is used, allows more weight to be lifted than a strict touch-and-go. So why allow a rebound but not a bounce and bridge? It is not always our objective, as noted earlier, to lift more weight, but

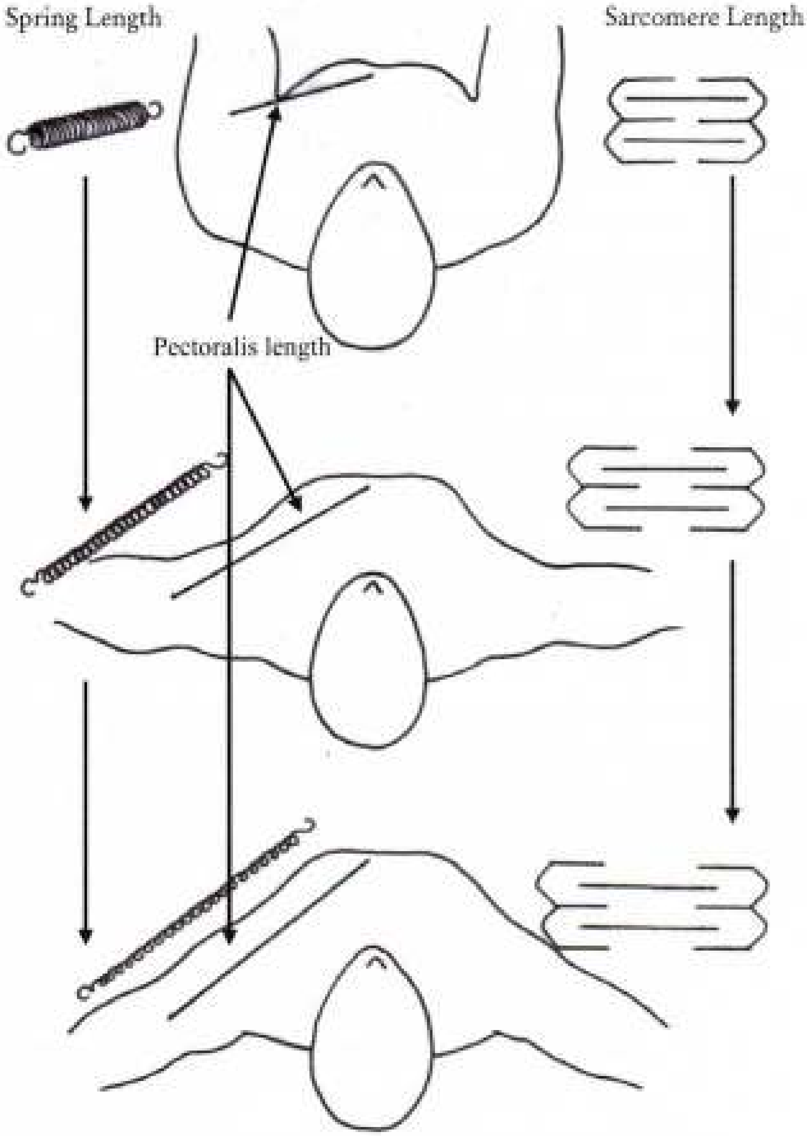
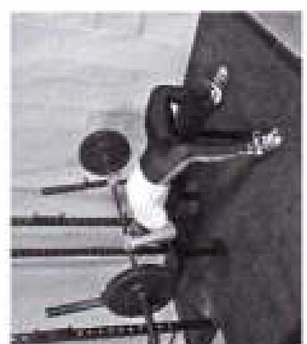
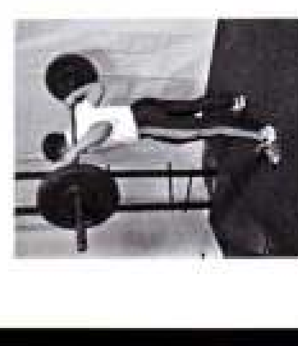


Figure 26. Several physiological and mechanical phenomena produce a "rebound" that makes for a stronger contraction. First, the viscoelastic nature of muscle makes it act like a spring – the longer you stretch it (up to a certain point) the more forceful the return. Second, there is an optimal degree of sarcomeric length that results in the most force being generated by a contraction, and this "optimal" length can be associated with a mild stretch. Lastly, the stretch reflex mediated by muscle spindles (intrafusal fibers) is activated by stretching and results in a more forceful contraction.



the touch-and-go is actually easier to learn than a paused bench, and is easier to teach to novices (staying tight at the bottom during the pause is a skill difficult to master, apparently even for competitive powerlifters). The bounced, heaved, bridged, butt-in-the-air version of the bench press uses ribcage resilience and hip extension to aid in driving the bar up, taking work away from the targeted muscles. So a strict touch-and-go is a good compromise, letting the trainee lift more weight but still giving lots of work to the pressing muscles.



A coach should be able to recognize excessive bounce and know when a correction needs to be made. Your trainee bounces too much when he rebounds to the point that the bar slams the chest hard enough to change his position with the impact, and then slows down markedly a couple of inches up from the chest, because the velocity of the bar was due more to the bounce than his active drive off the chest. If it's bad enough, the bar path will change right there as his elbows shift position from the lack of tightness in lats and delts. The whole messy thing is a result of a lack of tightness on the way down, and can be remedied in a couple of ways.

One way to teach the trainee to stay tight off the chest is to teach him to just barely touch the chest. He can't cheat it if he can't bounce it, and he can't bounce it if he just barely touches his chest. Have him get in position and take the bar out. When he is set, looking at the ceiling, have him come down to the highest point on the chest and back up. This is where he will touch the bar. Have him do it a for a few reps, then tell him, "Touch your shirt with the bar, not your chest." Or you might say, "Play like there is a piece if glass on your chest that you have to touch, but don't break it." This usually gets the point across, although it deals only with symptoms. (Please do not actually try this with a piece of glass. We'll all be out of a job if you do.)

The best way to fix a bad bounce is to address the problem at its root, by teaching the trainee to be tight during the movement in a way that he can understand, and that he can apply to other lifts as well. It is a way to conceptualize the lift so that tightness is built in and elastic energy can be stored in the eccentric (negative) phase for use in the concentric drive-up. The bench press, like the squat, consists of two movements, lowering the bar and raising the bar. Tell him this: "Don't think about lowering the bar, just think about driving it up. On the way down to the chest you should be thinking about driving up hard, not about down. Focus on UP only." In an attempt to get ready for the upward drive, he will slow down the descent and be tighter as he approaches the chest, thus improving rebound efficiency and minimizing

Figure 27. Get the trainee to think about the drive up on the way down, to prepare the neuromuscular system to do its work more effectively.

bounce. By thinking about driving up while on the way down, he will have focused on the thing we are actually try to do: drive the weight up. Lowering the bar is awfully easy, and if he thinks past that to the drive, he will slow his descent as he prepares to actively drive the bar up (figure 27). This excellent technique works for any exercise with an initial eccentric component.

Shoulders and Upper Back

"Shoulders" here refers to the lateral and posterior aspect of the shoulders, since we have included the anterior deltoids in our discussion of the chest, for functional reasons. Although they are used in the bench press, they are not used in such a way that they need to be actively thought about separately. This important group of muscles has two functions. First, the shoulders need to be planted firmly against the bench, and taken together with the muscles of the upper back (the ones between the shoulders), used as a platform to drive against while pushing the bar. When this is done correctly, the scapulae will be adducted, or pulled together, to make a flat spot on the upper back to push against the bench. This stable platform is the anatomical surface on which the kinetic chain begins. Stated another way, when we bench press, we drive the bench and the bar apart - the bar moves and the bench doesn't, but we push against both (figure 28). The upper back and shoulders push the bench and they need to be tight while doing so, just as the hands are tight against the bar. Second, the shoulders in their adducted position and the upper back muscles, as they contract and rotate or "tilt" the upper back into a chest-up position, push the ribcage up and hold the chest higher above the bench. This increases the mechanical efficiency of the pec/delt contraction by steepening the angle of attack on the humerus, as discussed earlier.

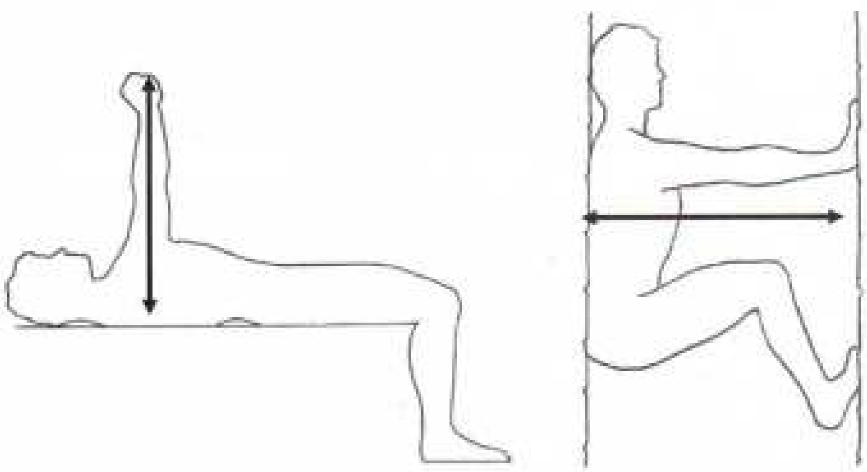


Figure 28. Just like we do when we climb up a narrow hall or rock chimney, when benching we are in between and pushing against two opposing things. The difference is that when bench pressing, the bar moves and the bench doesn't.

Figure 29. A simple position command to get the trainee to understand proper position and how the upper back helps in the bench press drive. "Pinch my hand between your shoulder blades".

Keeping the back tight is a difficult thing for some novice trainees to do. They have difficulty focusing on this with so many other things going on at the same time. So it needs to be taught to them in such a way that it requires little active attention. Tell your trainee about the "driving against the bench" model, and why he needs his chest up, to plant the idea and start the process. Then have him sit on the bench in the same position he assumes before lying down to take the bar. Before he lies down, touch him with your hand right between the scapulae and say, "Pinch my hand between your shoulder blades" (figure 29).This will also cause him to raise his chest as his upper back tightens, further reinforcing this good position. Tell him "this is the position you need to take against the bench, before you take the bar out of the rack." Have him lie down and take the bar out, and reinforce the point again by making him adduct his shoulder blades. When he gets it right, call his attention to the way it feels, have him rack it and try it again, each time making sure he assumes full adduction. By doing this, the position becomes embedded quickly and he can assume it without a lot of conscious thought or direction.

During the lift, minimal shoulder movement should occur. The thing that moves is the elbow. If the shoulder moves much, something in the upper back has loosened and the chest has lost some of its "up" position. Some minimal scapular movement is unavoidable, particularly in a set of more than a couple of reps, but if it is excessive it will compromise efficiency by adding to the distance the bar has to travel to lockout. This can be illustrated to the trainee by showing him what happens during a shoulder shrug and the distance it adds to the bar movement.

Lie on the bench yourself, and pull the shoulders back into full adduction, with chest up in a good position and your back arched. Put your arms up with straight elbows in a position that simulates the start of the bench press. Have him note the position of your hands. Now shrug your shoulders up off the bench so that your shoulder blades come out of adduction, and have him note the difference in position. There will be a 4" to 6" difference in the distance from your hands to your chest from shrugged-back to shrugged-up (figure 30). Say to him, "This is the extra distance you have to push the bar if you don't keep your shoulders back." You can illustrate this while standing as well, by shrugging one shoulder back and shrugging the other one forward and showing him the difference in distance from the chest between the two hands (figure 31).

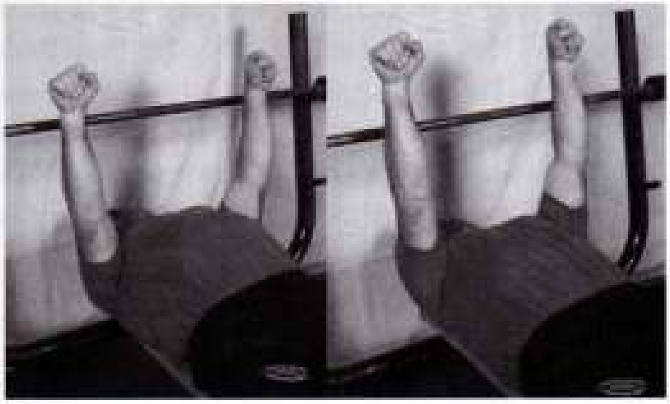
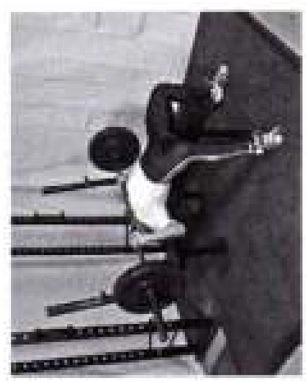


Figure 30. Note that by using the shoulder musculature improperly, the bar will travel about 4 to 6 extra inches. Don't shrug the shoulders up at lockout.

Figure 31. A visual demonstration of the difference in bar travel between shoulders kept back and shoulders shrugged forward.

During a longer set (more than just a couple of reps) most novice trainees will let their upper back deteriorate out of the shrugged position. If this happens, each rep is a little looser than the previous one and the bar must travel a little further each time. This can be demonstrated effectively to him. At the end of a set of five, have him reset his shoulder blades and chest-up. If he is able to move them much at all, they have come out of position. His goal is to be able to do all his reps without losing the set position.

It is possible to have the back set correctly against the bench and still have the chest wobble. From the top it will look like the chest is moving from side to side in an irregular, loose manner as the bar is driven up from the bottom. This is due to insufficient general tightness in the ribcage and shoulders, and is very common to see in the first few workouts. It is remedied by simply calling the trainee's attention to it and telling him to make it stop. Show him what's happening by reproducing the movement he's making while he lies on the bench between sets. From your position at his head, place one hand on either side of his chest with palms flat against his ribs and slowly shake his chest, mimicking the looseness you observed during the set (figure 32). Ask him, "Can you feel yourself letting your chest move like this?" He'll acknowledge that he can, and tell him, "Tighten up and make it stop." Any movement being generated by the body that does not contribute to the bar going up is wasted movement, and when this is explained to him, he'll usually try hard to fix it.



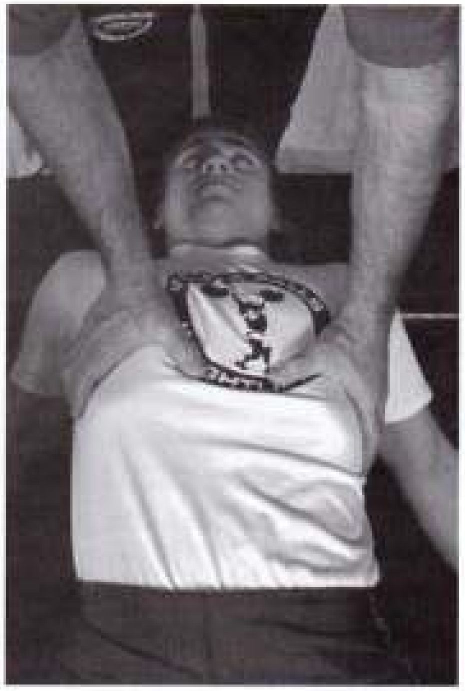


Figure 32. Placement of hands on the rib cage for looseness demonstration. Roll the rib cage side to side to let the trainee feel what he is doing wrong.

Neck

The function of the neck muscles is to maintain head position, and to protect the cervical spine during the loading of the chest and upper back as the bar comes down on the chest. As such, the neck muscles work isometrically to maintain position, in a function similar to that of the lower back muscles during the deadlift. But unlike the back muscles, they should not transfer power along the neck to help with the lift. In other words, you do not use your head to bench press. *Do not push the head into the bench.* This is an excellent way to injure the neck. If you see this happening, tell your trainees to tighten up their necks without pushing the bench with the back of the head. As a practical matter, this involves holding the head about a half-inch off the bench during the rep, and if the head is held off the bench the neck muscles are tight. It is tempting to use the neck to push the bench, as it adds contracted muscle and tightness to the upper back area, but it is too dangerous a habit to allow. Watch for this closely.

Lower back, hips, and legs

The bench press is an upper body exercise, but since the feet are on the floor, everything between the feet and the upper body has the potential to be involved in the exercise. The lower back and the hips and legs are thus the connection between the ground and the upper back. Strictly speaking, the kinetic chain begins at the bar and ends at the upper back/bench interface, but the correctly utilized back, hip, and leg position actually represents an extension of the kinetic chain down to the ground. The legs do more than stabilize the lower body as the bar is moved through its path, although that is a major part of their function. Used correctly, the legs drive against the floor, transferring force horizontally up the bench through the hips into the arched back to reinforce the arch and keep the chest in its high position, established when the shoulders were pulled back. The legs and hips thus function as a brace for the chest and shoulders, giving the upper body a connection to the floor, and allowing the lower body to contribute to the movement (figure 33).

Before you have a chance to misinterpret, this is *not* the same thing as bridging or heaving the bar. That happens when the butt actually comes off the bench (figure 34). Correct use of the legs and hips involves *only* the maintenance of chest and back position, with the force directed horizontally along the bench and not vertically up off of the bench. The descent of the bar unavoidably drives the elevated chest back down, by taking arch out of the back. The legs drive from the feet against the floor back up along the bench using a controlled isometric knee extension, with a slight hip extension produced by isometric contraction of the glutes and hamstrings. They actively counter the loss of arch in the back and chest height by reinforcing the arch from the floor.

To teach this position, have the trainee

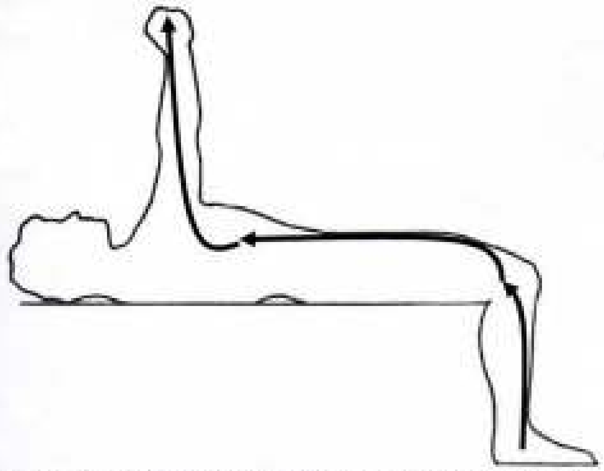


Figure 33. Force applied by the legs to the floor acts as a stabilizing force during the bench press and contributes to proper exercise posture.

Figure 34. Don't do this. The butt belongs on the bench.

lie down in position on the bench. After a warm-up set, lean over the bar above his chest and place a hand on each shoulder, with thumb and forefinger around his deltoid. Make sure his feet are planted correctly (figure 35). Push his shoulders down into the bench and say, "This is the weight of the bar holding your shoulders down. Now, push back towards me with your legs, but keep your butt down while you do." You should observe his ribcage come up as his back arches. Look at his hips - they should not elevate much more than can be accounted for by tightening the glutes, but they should slide up the bench towards the shoulders a little. Now take your hands away, have him take the bar out and reset the back and do a set of five. Watch to make sure he maintains the chest and back position for all five reps.

An obvious problem with teaching this technique is its tendency to lead to bridging, like chewing gum leads to heroin. Bridging - the intentional heaving of the hips clear of contact with the bench - occurs as the lifter attempts to increase the chest height by using the lower body to steepen the angle of the upper back on the bench. Bridging takes work away from our target muscles by making the movement mechanically easier. (The popular gym exercise known as the decline bench press takes advantage of this position of increased mechanical efficiency. Most people can decline more than they bench, thus the popularity.)

Figure 35. Coaching hand placement to ensure the trainee understands the proper way to push the shoulders into the bench. The weight of the bar holds the shoulders down the same way the coaches hands do.

Some purists believe that we are cheating when we arch the back at all, but this program seeks to use all reasonable means to increase strength on the bench press. Bridging is a good place to draw the line. If your trainee bridges, be sure you explain these principles so that he understands why he is doing this, and tell him that he cannot lift his butt up off the bench. Threaten him if you have to. Lifting the butt has got to be learned as *verboten* in the same way that use of the hands is in soccer. The temptation is always there, but if the correct habits are instilled early it will not usually be a problem.

The back arch is easy to teach. After you have yelled about the butt staying down, have him assume his position on the bench and arch his back. Slide your hand between the bench and his low back and tell him to arch. As his back comes away from the bench, make a fist under it, further encouraging him to arch (figure 36). Make sure he hasn't raised his butt during this process. If his butt is up, you will see daylight under it as you look from the side, eyes about level with the bench.

Figure 36. Teaching correct arching of the back.

One advantage of having a bunch of people training in a weight room together is the potential for peer enforcement of good technique. Bridging the bench, like squatting high or not locking out the press, needs to be made socially unacceptable to your athletes, tantamount to cowardice and irresponsibility. We are trying to lift as much weight as we can, but we are more concerned about getting strong while doing it, and correct form keeps us honest while we get strong. If cheating like this is anathema to your troops, then your weight room is self-policing, and coaching will involve less yelling and bitching.

Feet

The feet are the connection to the ground. If we use the lower body correctly, the feet are important because they are the link in the chain most likely to fail. If a foot slips during a heavy bench, everything supported by the lower body collapses. The feet must be in the correct position *on* the floor, and they must be positioned *against* the floor correctly.

Foot placement on the floor has two variables: up/down and in/out (figure 37). The feet need to be wide enough apart to provide lateral stability for the hips and – through the tightness in the trunk muscles – the torso as it is planted on the bench. Excessive foot width is seldom observed, as it is uncomfortable and hard to maintain. Narrow feet are much more commonly seen in trainees of all levels of experience, many people having used it without problems and never being corrected. Narrow feet do not guarantee disaster. They are merely a little less efficient, and should be corrected early as a matter of good coaching.

Figure 37. The main parameters of foot placement for the bench press are "up/down" (A) and "in/out" (B).

Figure 38. Too much "up" may lead to excessive arching.

More a problem is placing the feet up too far, back under the hips (figure 38). This position predisposes the lifter to bridge the butt up in the air, and is usually selected for this reason – if a guy has his feet too far up under him, and usually too close together with his heels up off the floor, he's going to bridge the heavy reps. If the feet are up too high, the knee extension, being done from a more acute knee angle, tends to raise the hips; a more moderate knee angle generates force more parallel to the torso (figure 39). Feet too far down are commonly seen in novice lifters who have yet to learn how to use the hips and legs, and this position makes it difficult to get enough "bite"

against the floor to generate good tension in the upstream components (figure 40). Foot position should be set so that the shins are nearly vertical, give or take a few degrees either way, in both axes. This way, knees are almost directly over the feet at any width without any adduction of the femurs. This position allows for efficient use of the legs in reinforcing the arch, but doesn't create a predisposition to bridge.

Figure 39. Check for correct positioning in these photos. Notice the angles at the ankle and knee first. Now look at the angle of the pelvis to the bench. In good position (left) the pelvis angle is flat. In the too much "up" photo (right) the pelvic angle is steeper.

Figure 40. Too much "down" leads to poor stability, poor technique, and reduced performance.

Figure 41. Proper foot position. The entire foot should be in contact with the floor.

This is not to say that all lifters with their feet up under the hips will bridge. But most lifters that bridge do so with narrow feet up under the hips. One correction for this is to move the lifter's feet out to a significantly wider position, where most people find it difficult to bridge because the slack has been taken out of the hips.

Proper foot position should be flat against the floor so that heels can be used as the base of the drive up the legs (figure 41). As with most other things in the weight room, heels need to be down. If the lifter is up on his toes, he cannot use the force of knee extension nearly as efficiently as he can if heels are planted and the ankle is removed from the kinetic chain. Just like the wrist, the ankle is an unnecessary piece of floppiness that should not be allowed to compromise power transmission. And if the ankle is plantar-flexed (a term favored by scientifics, as opposed to the more obvious *ankle extension*), the force obtained is directed up, raising the knee and causing the force generated by knee extension to be directed at a slightly different angle up the legs.

Granted, this is picky. So just consider that flat feet are stickier feet, better connected to the ground through more surface area, and make a better connection to the ground. A less than flat position represents a less than complete kinetic chain. Any rolling of the feet to either side during a rep implies that knees have moved, that the chain has loosened, or that the floor connection has been interrupted. If you coach the heels, driving off them with flat feet, the problem goes away.

A bad problem when it occurs is an actual foot slip. Knees don't usually disarticulate during the bench press, nor do ankles, hips, or spinal columns. But a foot slip does occasionally occur. It usually happens when the weight is very heavy and the floor connection is pressured up and therefore crucial. A foot dislocation results in a disruption and collapse of the kinetic chain, and most usually a missed rep or attempt. Any miss with a heavy bar can be dangerous, if the spotters are not sharp. This is a very irritating thing, learned about by the author the hard way, at a meet. It is usually caused by conditions on the surface of the floor or the soles of the shoes, like the presence of baby powder (as is used in meets on the legs in the deadlift, or as an aid in putting on a tight suit), or just a dirty floor. The exercise of reasonable care will prevent this unnecessary, easily avoidable, and still personally aggravating silliness from happening.

Figure 42. The knees-up position in the bench press is of very little use to beginners and is an unstable position.

Figure 43. You can use any matched pair of stable objects, such as plates, to elevate the feet of shorter trainees in order to maintain proper position.

There are people – usually casual trainers, fitness enthusiasts, or retired powerlifters – who insist on benching with their feet up on the bench, or possibly held up in the air (figure 42). The effect of this is to eliminate the effective use of the lower body during the movement and to make the bench press harder. This might be useful to an advanced trainee who, for various possible reasons, is not particularly concerned with benching heavy weights, but who wants to work hard during the

exercise. It is also useful in the case of a trainee with lower back injury that makes spinal extension painful, distracting, or otherwise contraindicated, but who still needs to bench. If you find that an uninjured trainee seems to prefer his feet up, it might be due to lower back discomfort caused by a lack of lumbar flexibility; if the spinal ligaments are too tight to permit the degree of spinal extension that the normal bench position requires, stretching is in order. An uninjured trainee should be able to keep his feet down. Blocks or barbell plates can be used to add height to the floor for these inflexible people until they stretch out, or to accommodate shorter-legged trainees (figure 43). The net effect of the use of the lower body is to increase the weight that can be lifted, but the exercise can still be done without it. The decision to allow a feet-up bench should be made by an informed coach who realizes the benefits of training around injuries, but who also realizes the limitations of doing it this way.

For reasons that are poorly understood, the vast majority of rank novice trainees will, on the heaviest set of the workout and on the rep they miss, do a very strange thing. As your trainee gets stuck in the middle of the rep he misses, he will kick one foot out by reflexively straightening that knee. You will see this occur if you have not already. It should stop by the second or third workout as he gains more control over his movements. If it doesn't, you will have to focus his attention on this problem and tell him to plant his feet. This is a strange phenomenon, still in search of an explanation.

Racking/un-racking errors

Taking the bar out of the rack and putting it back may seem like rather innocuous parts of the exercise and most trainees and coaches give it no thought. Please be aware of the fact that any time a loaded bar is located above the face and throat of a 14-year-old kid, held up only by the kid, you have a potential safety situation. The unrack/rack procedure needs to be clear from the beginning of the teaching process. At all times, when the bar is moving over the face and throat coming out of or going back into the rack, the elbows *must* be locked out straight.

When un-racking the bar, the elbows must lock out while the bar is still over the hooks of the rack. This means that the elbows drive the bar up along the uprights until they lock out, and only then does the bar move down over the nipples to the start position. Many trainees get in the habit of taking the bar out on bent elbows and straightening them out as they move the bar down. Not good! The triceps should lock the elbows over the rack hooks so that the bones of the arm are in a straight line and the weight is being supported by the skeletal components instead of the muscles when the bar moves over the head and neck.

The bar should move all the way out over the chest to the start position, without stopping above the chin or throat. It is common to see novices stop the bar short of the starting position, lower the first rep to the chest, and finally end up in the correct position just in time to start the second rep. When the bar gets all the way there and the eyes have found their place against the ceiling, the bar should start down, but not until then. If he stops short repeatedly, point out that the bar is over his throat, and that the throat is a bad place to lower the bar.

Some people get in the habit of taking it down to the chest right out of the rack. It should never start down before it is in place - there will be bar path problems if it does, due to the lack of an initial ceiling reference for position, and the fact that the bar is going back to a different place than it started from. It makes the first rep different from the next ones. It prevents the lifter from getting a good, tight start on the reps, since shoulders and upper back cannot be correctly set until the bar is in position over the chest. And it indicates a lack of patience, an unwillingness to take the few extra seconds to prepare properly.

Even more important than un-racking properly, when the arms are not tired, is racking it correctly after the set has fatigued the muscles. This is normally where a wreck will occur. If the trainee misses the rack hooks because a tired elbow is not locked out, and the spotter is not paying attention (believe it or not, this actually happens!), at least one side of the bar is going to come down. Whatever it takes, your trainees must be made to finish the last rep all the way to elbow lockout before they rack the bar. It is common to see impatient trainees drive the last rep towards the rack right off the chest, producing a bar path that ends over the eyeballs instead of the chest (figure 44). If a bench press is going to be missed, and the spotter fails, it is much preferable to have the bar come back down on the chest than on the eyeballs. If you see this happen, point out what would happen if he hadn't gotten the bar back to the hooks. Ask him what he'd rather drop the bar on, his chest or his mouth. You must yell and scream about this every time you see it happen, as it is a potentially dangerous error. The bench press *must* end in elbow lockout, directly above the chest, every time, or the rep should not be counted.

Figure 44. On the final rep, it is common to see individuals push the bar back towards the rack instead of to the correct lockout position. This should be corrected immediately.

When racking the bar, make sure that your trainees are taught to find the uprights with the bar, and not to try to set the bar down on the hooks. They should move the bar back with locked elbows until it touches the vertical part of the upright, and then slide it down onto the hooks without ever having to worry about whether it will rack. If the uprights are touched first, it will always be above the hooks; if straightening out the elbows got it clear of the hooks when taking it out, then locked elbows will ensure that it is high enough to get back over the hooks when putting it up. But if they try to set the bar down on the hooks *first*, they have bent their elbows, and they will eventually miss a hook by being too low. This same advice applies to the squat, for exactly the same reasons. Someone will do this in your weight room every week – hopefully without

too big a wreck. When you see it happen, use it as an opportunity to school everybody on how to do it right.

Breathing

As it is for all barbell exercises, air is support for the bench press. In the squat and deadlift, the Valsalva maneuver (as described in the Squat chapter) provides increased back support. In the bench press, it provides support for the chest. This takes the form of increased tightness throughout the thoracic cavity due to the increase in pressure provided by the big, held breath. A tight ribcage allows for a more efficient transfer of power to the bar by the muscles attached to it when they contract. If the pec and delt origins on the external chest wall contract against a tight structure that does not move when they contract, then more of the force of that contraction can be transferred to the end of the kinetic chain that does move; when it's tight, less force gets absorbed, or dampened, by movement of the chest. This is analogous to trying to pick up a heavy weight while standing in a floating canoe as opposed to standing on a concrete driveway (figure 45). This tightness, along with the support provided by the lower body connected to the ground, radically increases efficiency in the bench press. Also, in the extended spinal position that the arch requires on the bench, the abs cannot tighten. They cannot therefore increase intra-abdominal pressure, and cannot contribute to the needed increase in intra-thoracic pressure, thus making the big breath the sole source of support for the chest.

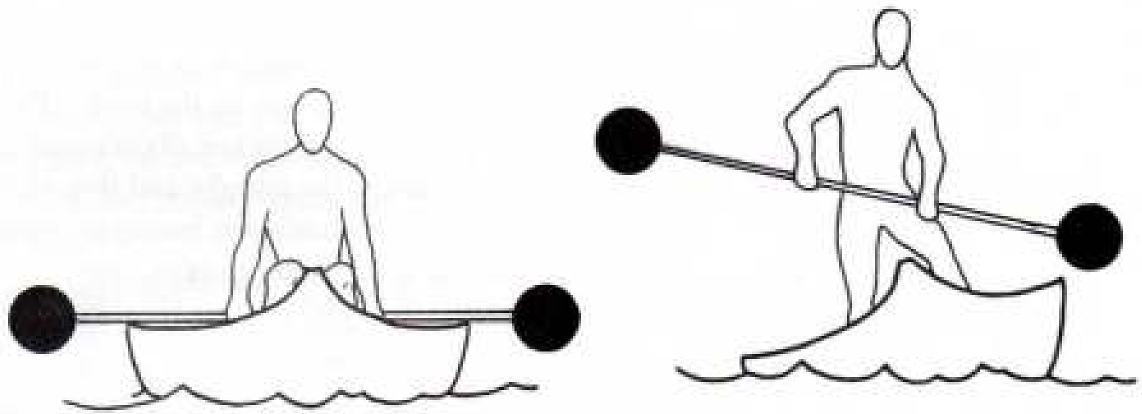


Figure 45. Getting into proper starting position with unstable structures is not a problem. The problems occur when force is applied against those unstable structures. In the analogy above, the boat moves erratically when the weight is lifted thus reducing the force applied to the bar and thereby reducing the height to which it can be lifted. An unstable spine reduces performance capacity for exactly the same reason. You cannot develop maximal strength pushing against unstable structures since maximal force cannot be developed against an unstable surface.

The pattern of breathing during the bench is dependent on the length of the set and the abilities of the lifter. Novices should be instructed to take a breath before each rep, hold it during the rep, and exhale at lockout, using the very brief break between reps to make sure everything is set correctly. More experienced lifters may prefer to use one breath for the whole set - any exhalation involves a certain amount of loosening of the chest to exhale and re-inhale, and some may elect to stay tight for all the reps if the set is important. Most people can only manage five reps this way before the discomfort from the hypoxia becomes too distracting. For a longer set, other arrangements will need to be made.

Notice that the breath is to be taken *before* the rep. If the breath is taken during the rep, the lungs will incompletely fill due to the loading of the ribcage by the now-contracted pecs. If the breath is taken at the top with locked elbows, the pecs are not pulling on the ribcage and a more complete inhalation can take place (figure 46). Moreover, when the rep starts everything should be tight, from the floor to the fingernails, and this tightness will prevent a really big breath. If you can breathe during a rep, you're not tight enough.

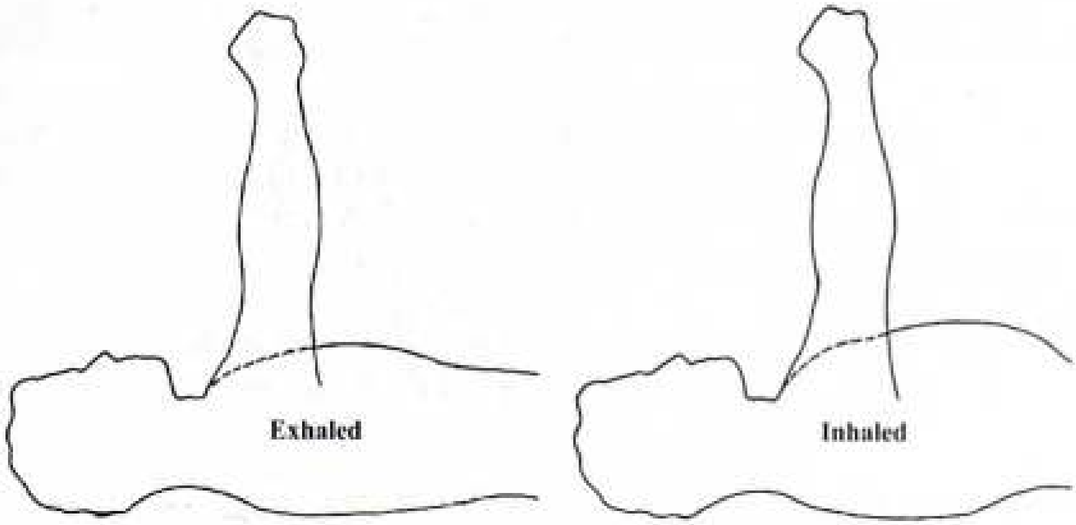


Figure 46. Inhalation at the top (arms extended) allows for more complete filling of the lungs, a better chest angle, and better stability.

No breath taken during a set will involve a complete exhale/inhale of full tidal volume. This takes too long, requires too much relaxation, and is unnecessary. Breathing during the set consists only of topping off the huge breath taken before the first rep, after a quick exhalation that might consist of only 10% of tidal volume. This short refresher of air accomplishes just enough to allow the set to be finished. The fact that it amounts to so little air is the reason many lifters decide to forego it in favor of maintaining tightness. Most of the time, if a lifter stops in the middle of a set to take two or more relatively full breaths, he is about to miss the next rep.

Spotters

In many gyms around the world, bench pressing is a team activity. The guy on the bench is "doing chest" while the guy standing over his head is working on his traps. It is truly amazing how much weight two guys working together like this can bench press. It is not an exaggeration to say that most claims of big bench presses are exaggerations. If the spotter puts his hands on the bar during the first rep, and keeps them there for the rest of the set, then who did what to whom, with whom, and why?

There is a perfectly legitimate place in the weight room for spotters, but it is not in the middle of someone else's work set. Spotters should be there for safety, when there is a question of safety – spotters should *not* be there to help with a set. Make this the rule in your weight room, and everybody stays honest: **No rep counts that is *touched* by anybody other than the lifter. Nobody touches any bar that is still moving up.** If this rule is followed, the lifters themselves will discourage their overzealous buddies from helping them bench. It only takes one PR set where the last rep is voided by a spotter to impress upon them the need to *stay away from any rep that the lifter might finish by himself.*

This policy must be enforced by the coaching staff, or very shortly it will be impossible to quantify the results of your entire strength program. This cannot be overstated: if the numbers being reported out of the program are not honest, you have absolutely no way to evaluate the program. This obviously applies to all lifts that customarily require spotters. The bench press has been particularly abused by bad spotters, with the result being inflated gym records and much unwarranted bragging, so it deserves the special attention of the Spotter Police.

Spotters are for safety, where a question of safety exists. For everybody except rank novices, the first warm-up sets are not a safety concern and do not require spotters, unless they are providing a coaching function. As the weight gets heavier, more trainees will need a spot, some needing one on the last warm-up, until the work sets, where everybody should be spotted because the weight is supposed to be heavy. Excessive caution, and the insistence that every set be spotted, is inefficient, unnecessary, and hard to enforce. It is much more productive to yell about spotters grabbing the last rep of a work set than to bother everybody about getting a spot for the first warm-up set.

For the bench press, a competent center spot will suffice for all but the very heaviest attempts. One of the actual functions of a spotter is the handoff. A good handoff guy is one of those rare commodities – there are more bad ones than good. A bad handoff interferes with the lifters timing, balance, view of the ceiling, and concentration, if he is one of those people that thinks his participation in the rep is essential. A good handoff spotter is experienced and appropriate with the timing and force of his bar contact, respectful of the mental requirements of the lifter, and, above all, conservative about when and how much to help.

An entire chapter could be devoted to the art and science of spotting, and will be someday. But briefly, the bench press spotter stands behind the head of the lifter, in the center of the bar (figure 47). This position can be adjusted a little if necessary. The primary requirement of the position is that it is close enough to grab the bar, but far enough back that after the handoff the lifter has an unobstructed view of the ceiling. From this position the spotter can do whatever might be necessary at the end of the set, from just watching the lifter

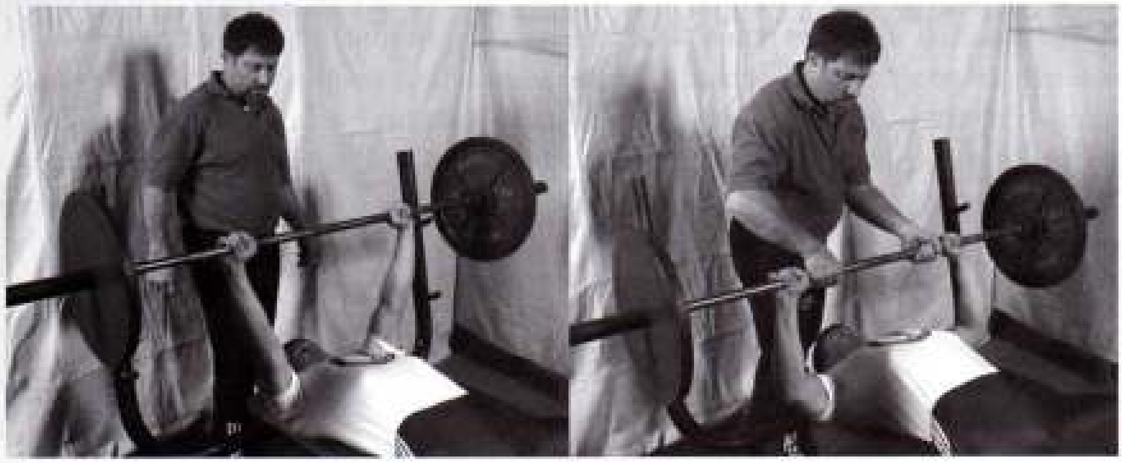


Figure 47. The coaching position allows for quick and safe responses to trainee problems. Once again, it must be understood by the trainee that a spotter is not an excuse to quit the rep. A spotter may help make it through the sticking point on the last rep if necessary and will ensure the bar is racked safely. The spotter WILL NOT assist with a rep, unless it is the last one.

finish the set, to securing the rack by shadowing the bar as it meets the uprights, to taking the bar out of a sticking point.

If the lifter actually gets stuck during a rep, the spotter has to be the one to decide that this has occurred, that he will take the bar, and how much of the bar to take when he does. The bar is stuck when it reaches a point of zero upward movement. This will shortly be followed by a deterioration in position as it begins to move down. Sometimes the lifter can tell the spotter to take the bar, and sometimes he can't. The spotter has to accurately evaluate the bar velocity, being certain that he does not take a bar that is still moving up, yet not failing to take it before it sticks for too long or goes back down too much or too fast. Some lifters will quit early, letting the bar drop on them if the rep even threatens to get hard, and the spotter must watch for this also.

After the spotter decides to take the bar, the amount of help he provides will depend on the situation and his correct assessment of it. If he is helping an intermediate lifter with the last rep of the fifth set of five, the situation will warrant a different amount of help than in the case of an experienced lifter being spotted on a PR single, or the case of a novice trainee doing the first heavy work set of his third workout. Each instance requires a different response in terms of how fast to react, how closely the bar should be followed, the amount of weight to take off, whether or not to help maintain bar velocity, or whether to take the bar to the rack or the safety hooks.

Certain circumstances might require the use of two spotters, as at a power meet during the heavy attempts, but normal weight room conditions seldom require more than one competent spotter. The problem with two spotters is the unalterable fact that two people cannot assist one lifter in a perfectly balanced way, especially in a situation where they must react quickly. The uneven loading that the lifter will inevitably experience is a potential source of injury. It is physically impossible for two people, even careful, experienced people, to take exactly the same amount of weight off of each side of a bar, thus subjecting the lifter to uneven loading at exactly the time when that stress is the most likely to cause an injury - during a rep that is too heavy to lift. This is true of both the squat and the bench press. The problem in the bench press is solved with the use of the single spotter, a perfectly reasonable way to spot for the vast majority of bench press workouts.

The Deadlift

Lower back strength is an important component of sports conditioning. The ability to maintain a rigid lumbar spine under load is critical for both power transfer and safety. The deadlift builds back strength better than any other exercise, bar none.

The basic function of the lumbar muscles is to hold the low back in position so that power can be transferred through the trunk. They are aided in this task by all the muscles of the trunk: the abs, the obliques, the intercostals, and all of the many posterior muscles of the upper and lower back. These muscles function in isometric contraction – their main task is to allow no skeletal movement in the structures they are supporting (figure 1). When the trunk is held rigid, it can function as a solid segment along which the force generated by the hips and legs can be transferred to the load - on the shoulders, as in the squat or the press, or down the arms to the hands, as in the deadlift.

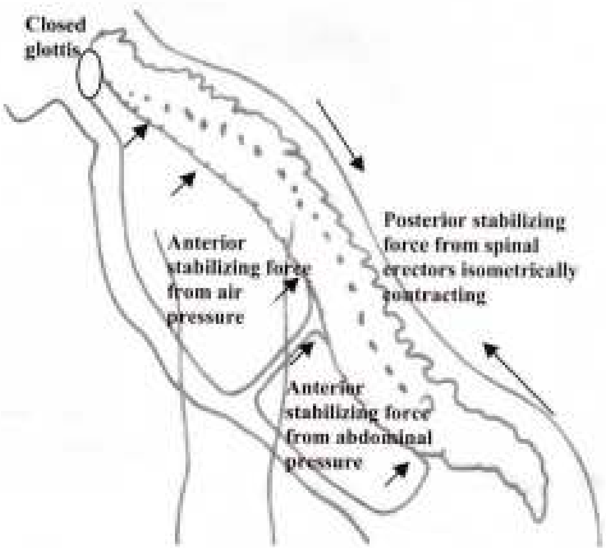


Figure 1. Stabilization of the spine during the deadlift is essential, and is accomplished in the same way as in the squat. Intra-abdominal and thoracic pressures rise in response to abdominal muscle contraction, spinal erector contraction, and the Valsalva Maneuver.

The deadlift is a simple movement. The bar is pulled off the floor up the legs with straight arms until the knees, hips, and shoulders are locked out. Immense weights have been moved in this way by very strong men (figure 2). In powerlifting, the deadlift is the last lift in the meet, and the expression, "The meet don't start till the bar gets on the floor!" is very telling. Many a big subtotal has been overcome by a lifter with a strong deadlift, especially in the days before squat suits and bench shirts. The meet was often won by a lifter with a bigger deadlift than his squat. It is hard to overstate the strength of a man with an 800lb.+ deadlift, a feat accomplished by only an elite few lifters. Nine hundred-pound contest deadlifts have occurred only a handful of times, although many more have accomplished this with straps (which eliminate the grip-strength aspect of the lift).

But the deadlift is brutally hard, and can therefore complicate training if improperly used. It is very easy to do wrong (this is the main reason the author does not attend high school powerlifting meets anymore – it is just too difficult and painful to watch strong kids pull heavy weights incorrectly, even worse than watching half squats passed as legal) and a wrong deadlift is a potentially dangerous thing. There will be a few trainees that simply

Figure 2. John Kuc and George Hechter demonstrate the end result of training the deadlift: brutal strength.

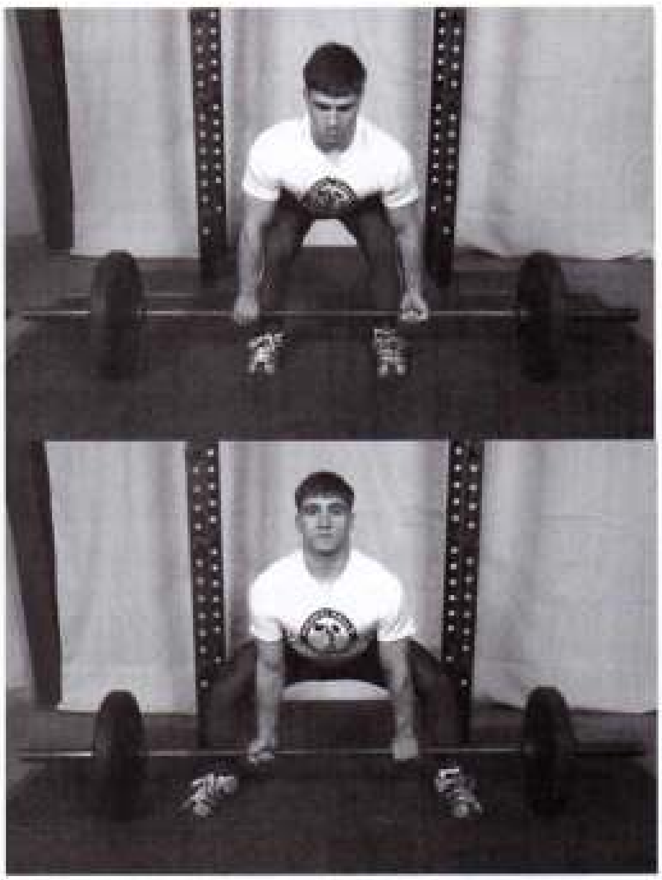


Figure 3. Conventional deadlift style (top), used in the training of athletes and the Sumo style (bottom), sometimes used in powerlifting competition.

cannot perform this movement safely with heavy weights, due to previous injury or an inability to learn the movement correctly. These people must be identified by the coach and given something else to do. The deadlift is also easy to overtrain; a heavy workout takes a long time to recover from, and this fact must be kept in mind when setting up the training schedule.

For the majority that can benefit from this important exercise, the deadlift will be an essential part of training: an important assistance exercise for the squat, and especially the clean (for which it is an important introductory lesson in position and pulling mechanics), as well as a way to train the mind to do things that are hard.

There are two ways to perform the deadlift used in competition: the conventional, with the feet inside the grip; and the "sumo" style, with the feet outside the grip. Good sumo deadlifters typically have long torsos relative to the legs and are good squatters. This version of the lift allows for a more upright back angle, and as such minimizes the force against the low back so that leg strength may be used more efficiently (figure 3). Since our purpose is the training of athletes other than powerlifters and the development of low back strength through the effective use of exercises that work these muscles, the sumo deadlift will not be used in this program.

First, some general observations about the deadlift, in no particular order. It can be used as a leg exercise if injury prevents squatting. It is not nearly as effective as the squat for this purpose, due to the lack of hip depth used in the starting position (figure 4). But this is the very reason it can be used if a knee or hip injury makes squats too difficult or painful, and at least some leg work can be done while healing takes place. A high rep deadlift workout can provide enough work to maintain some leg conditioning, even if the injury is of a nature that would prevent heavier, low-rep deadlifts, such as a groin pull or a not-too-severe quad tear.

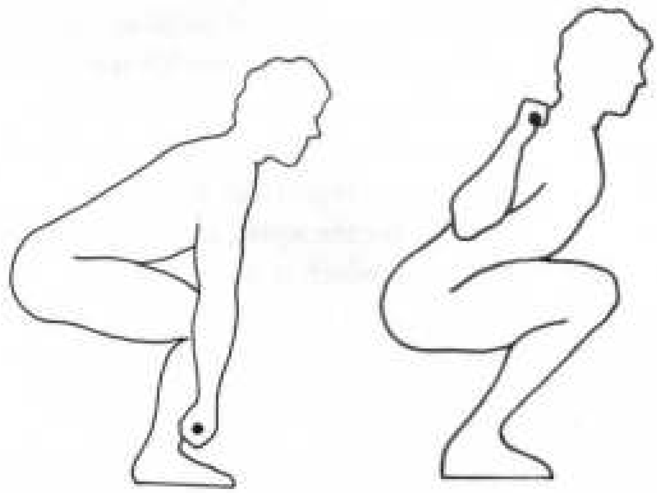


Figure 4. The deadlift begins with a higher hip position, and thus a lower degree of hip and knee flexion is used than in the squat.

Figure 5. The alternate grip. Most people prefer to supinate the non-dexterous hand. This trainee is right handed.

Tremendous leg power can be exerted in the deadlift starting position, essentially a half-squat depth, so the challenge to the lifter is to keep his back tight to break the bar off the floor. Leg strength is seldom the limiting factor in the deadlift for advanced lifters. If the bar comes off the floor, the legs can lock out what the back can support. If the bar stays on the floor, the problem is usually the grip, or an injury producing sufficient pain to distract from the pull.

Grip strength is crucial to the deadlift, and the deadlift works grip strength better than any other major exercise. It is the limiting factor for many lifters with smaller hands or short fingers, or those that rely too much on their straps when training. The lift is famous for its alternate grip, but the use of the double-overhand grip as much as possible makes for stronger hands. The alternate grip keeps the bar from rolling in the hands, since it is always rolling up one hand as much as it's rolling down the other (figure 5). So if all the warmups are done with a double-overhand grip, at least the ones light enough to do this way, and the alternate grip reserved for the really heavy sets, grip strength develops quickly. Novices are often able to pull their heaviest sets with a double-overhand grip; their hands are stronger than their backs. More advanced lifters find that it is necessary to flip a hand over to an alternate grip (most prefer the non-dexterous hand for the supine, or underhand, side) when the weight gets very heavy.

Most have had the experience of perceiving a weight as too heavy to pull when tried with a double-overhand grip, only to find that it goes up surprisingly easily when the grip is alternated. The back will not pull off the floor what the hands cannot hold, due to proprioceptive feedback that tells the back the weight is too heavy. When the grip is flipped and the hands don't slip as the load increases off the floor, the back doesn't receive the signal that makes it stop the pull. A long heavy deadlift can get dropped higher up the legs from any style grip, but most lifters cannot even break a weight off the floor that is so heavy that it opens the hands at the start of the pull. Deadlift straps have a place in training, but judgement must be exercised here; they can cause as many problems as they solve (figure 6). They can allow heavier back training if grip is the limiting factor, or they can cause grip to *be* a limiting factor by keeping it from getting strong.

Figure 6. Lifting straps are training aids that assist in removing grip strength as a limitation. Caution must be taken to use them with discretion so as not to eliminate the grip development characteristic of this exercise.

The hands are prone to callus formation as a normal part of training, and all lifters have them and need them to protect the hands from blisters and tears. Skin adapts to stress like all other tissues do; skin thickens precisely where it receives the stress of abrasion and folding. Calluses are only bad if they are excessive, and gripping the bar incorrectly causes excessive callus formation. Most lifters do this, and have never considered the role of grip in callus formation. Heavy calluses tear frequently, usually at the top of the palm (and most often into the base of the ring finger, because ring wearing has already produced a starter callus there). A torn callus makes the rest of the meet a challenge, eased only by some lidocaine gel that the coach hopefully

has in the meet bag. But if the bar is gripped correctly, callus buildup is kept minimal and the problem is not nearly as bad.

When setting the grip, if the lifter places the bar in the middle of the palm and wraps fingers from there, a fold forms at the top of the palm, the most distal end of the palm, right before the fingers start. When the bar is pulled, gravity shoves this fold further down towards the fingers, increasing the folding and stress on this part of the skin. Callus forms here as a result, and the presence of the callus amplifies the folding problem by making the fold even thicker. If the bar is gripped further down towards the fingers, it can't slide down much because it's already there (figure 7). "Put the bar where it's trying to go to, not where you *think* it needs to be."

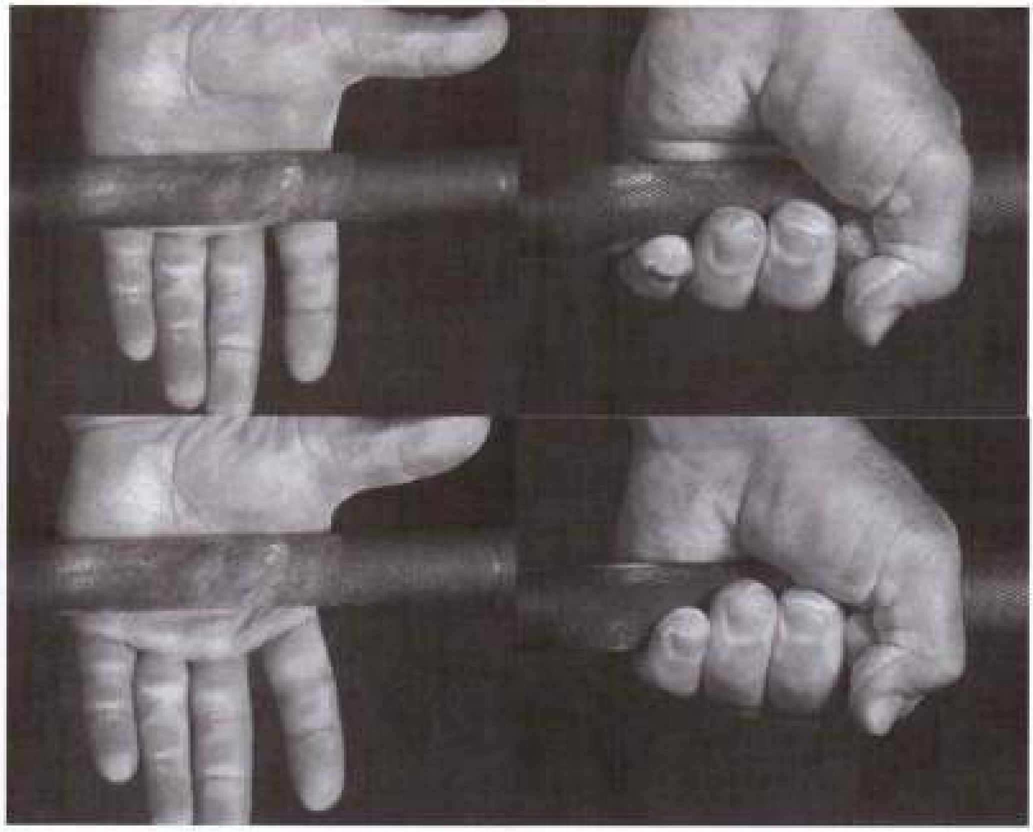


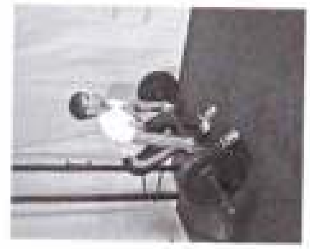
Figure 7. Gripping the bar correctly, well down into the "hook" of the fingers (top), will reduce the amount of callus development. Gripping the bar too high in the hand (bottom) will induce extra folding of the palm skin and sliding of the bar down the hand into the fingers, thus promoting callus development.

Other factors can contribute to callus formation, and this applies to all the lifts. A bar with an excessively sharp knurl is a terrible thing to have to use in the weight room. Uesaka, the Japanese company, is famous for making a bar with a huge, raspy knurl, while York Barbell has got it right. Some Texas Power Bars have a sharp, coarse knurl that causes problems with hands. Older bars usually have better knurls than newer bars: they are either worn smooth or made more correctly (it seems that companies decided to start making Texas Chainsaw Massacre knurls about 1990). Bad knurls can be improved with a file and about an hour's work.

And chalk is important for hand safety. It keeps the skin dry and tight, making folding under a load less of a problem. Trainees should be encouraged to apply chalk before they start training every day, for all the lifts. If your weight room is one of those that does not allow chalk, for reasons of cleanliness or whatever, you need to reevaluate your priorities.

Gloves have no place in a serious training program. A glove is merely a piece of loose stuff between the hand and the bar, reducing grip security and increasing the effective diameter of the bar. Gloves make bars harder to hold on to. The only legitimate use for a glove is to cover an injury, like a torn callus or a cut, where the workout is important enough to do with the injury. A desire to prevent callus formation (possibly so as to not snag one's pantyhose) does not constitute a legitimate use.

Deadlifts differ from squats in more than just depth at the bottom: the deadlift starts with a concentric contraction and ends with an eccentric. The squat begins eccentrically, as the bar is lowered from lockout, and then returns to lockout with the concentric contraction, like the bench press. The deadlift is like the press in that no stretch reflex helps the bar rebound to lockout. To review, an eccentric contraction occurs when the muscle lengthens under contraction, and a concentric contraction occurs when the muscle shortens during contraction. (Muscles don't "flex" - they contract. Joints flex and extend.) Sometimes referred to as the "negative," the eccentric phase commonly lowers a weight while the concentric phase raises it. The stretch reflex occurs at the transition between lowering and raising, and many studies have shown that a muscle contracts harder concentrically when preceded by a stretch, the very thing provided by an eccentric contraction. Demonstrate this to yourself by trying to do a vertical jump without doing a dip to start the jump. Or try applying this principle to barbell curls by starting them from the top instead of from extended elbows at the bottom. The down phase, if used skillfully, makes the up phase easier. But a deadlift is not preceded by any loaded stretch reflex, no matter how much drama the lifter engages in before the pull. It starts at the mechanically hardest part of the movement, and requires the lifter to generate the entire explosion necessary to break the bar off of the floor and get it moving up, without any help from a negative or anything else.



A deadlift is hard. Many trainees won't like to do them. Most people, even the ones who will squat heavy and often and correctly, will leave deadlifts out of the workout at the slightest provocation. This is the reason most powerlifters squat more than they deadlift – there was often no "time" to do them in the program. But doing them adds back strength, and back strength is necessary for the other lifts and for sports. So let's learn how to coach them.

Teaching the Deadlift

Have the trainee approach the bar. It should be loaded to a light weight relative to the trainee. A light weight for a novice 55 year-old woman will be different than that for an 18 year-old 205 lb. athlete. The room should be equipped to load weights as light as 55 lbs., making it necessary to obtain 5 lb. plastic training plates that space the bar off the floor to the same height as a standard plate (figure 8). Judgement must be exercised here; the starting weight must be light enough so that a trainee with bad form cannot hurt himself, just in case your instructions are not followed closely enough. So for some trainees 55 lbs. will be the starting weight, 40 kg. (88 lbs.) will work for most everyone else, and there is seldom a reason to start anyone heavier than 135.

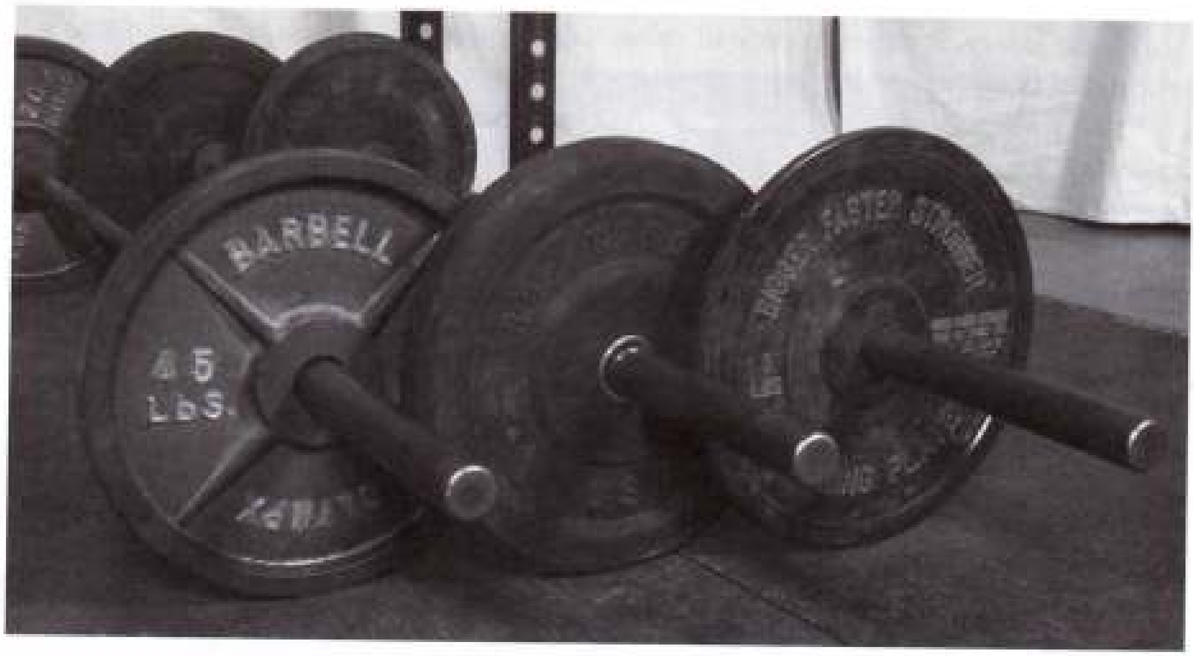


Figure 8. Correct bar height at the start of the deadlift is important. Do not use small plates to teach the lift. Use standard height Olympic style plates for teaching. A number of vendors sell training plates and lighter plates that will suffice. Above, from left to right, note that the 135lb, 89lb, and the 55lb barbells all have the same height from the floor.

The stance for the deadlift is about the same as the stance for a flat-footed vertical jump, about 12"-15" between the heels with the toes pointed slightly out (figure 9). Bigger, taller trainees with wider hips will use a proportionately wider stance. This stance is narrower, and thus more toes-forward, than the squat, because of the difference between the two movements. The squat is done from the top down, the hips lowered and driven up; the deadlift starts at the bottom, the feet pushing the floor, the back locked in place and the legs driving the bar up. The difference in stance is due to this difference in mechanics. (It might also be noted here that this is a natural stance angle for this stance width. The wider the stance, the more the toes will angle out, to match the femoral/tibial external rotation inherent in their angle at the hip, and vice versa.)

The bar should be about two to four inches from the shins. This is enough room for the knees to travel forward to a position just in front of the bar, but not so far that the heels get pulled off the floor. Once this correct stance has been assumed, have the trainee grip the bar, double-overhand, at a width that places the hands just wide enough that the thumbs just clear the legs (figure 10). Bar markings will vary, but with a standard Olympic bar, the grip will be one to two inches into the knurl, or about 20 inches between for most people (figure 11). Bigger trainees will need to use a proportionately wider grip to match their stance.

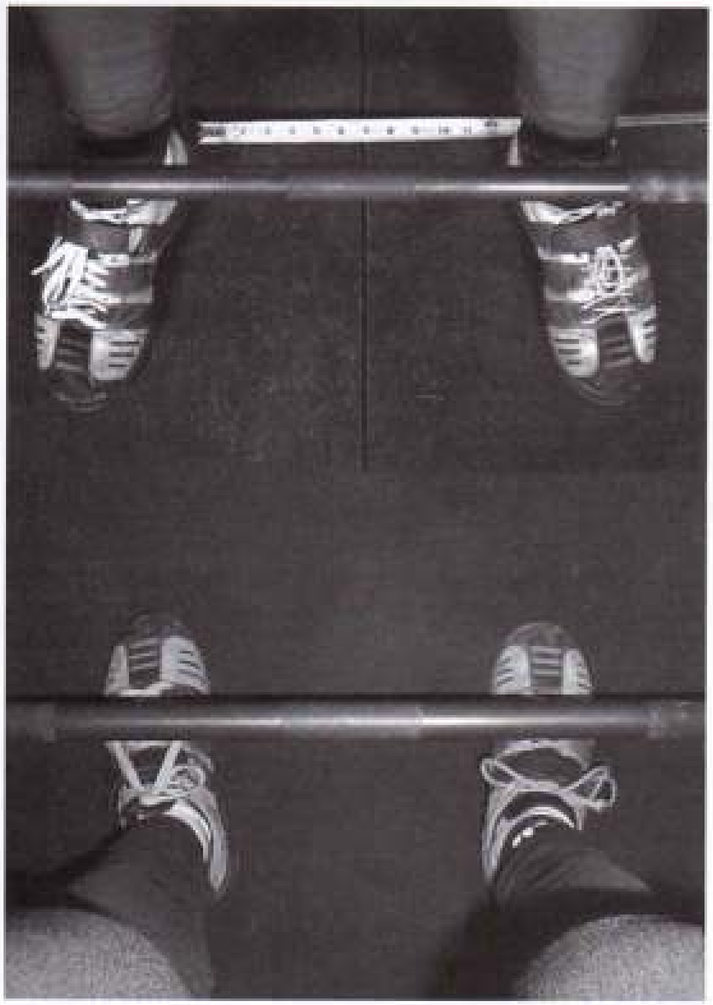


Figure 9. Starting stance for the deadlift will have the heels approximately 12-15 inches apart and the toes pointed slightly out (A). The trainee should always see the same viewpoint when approaching the bar (B). Have him note where the bar is relative to the foot. One easy way for the trainee to repeat his foot placement consistently is to line up shoelace eyelets and the bar.

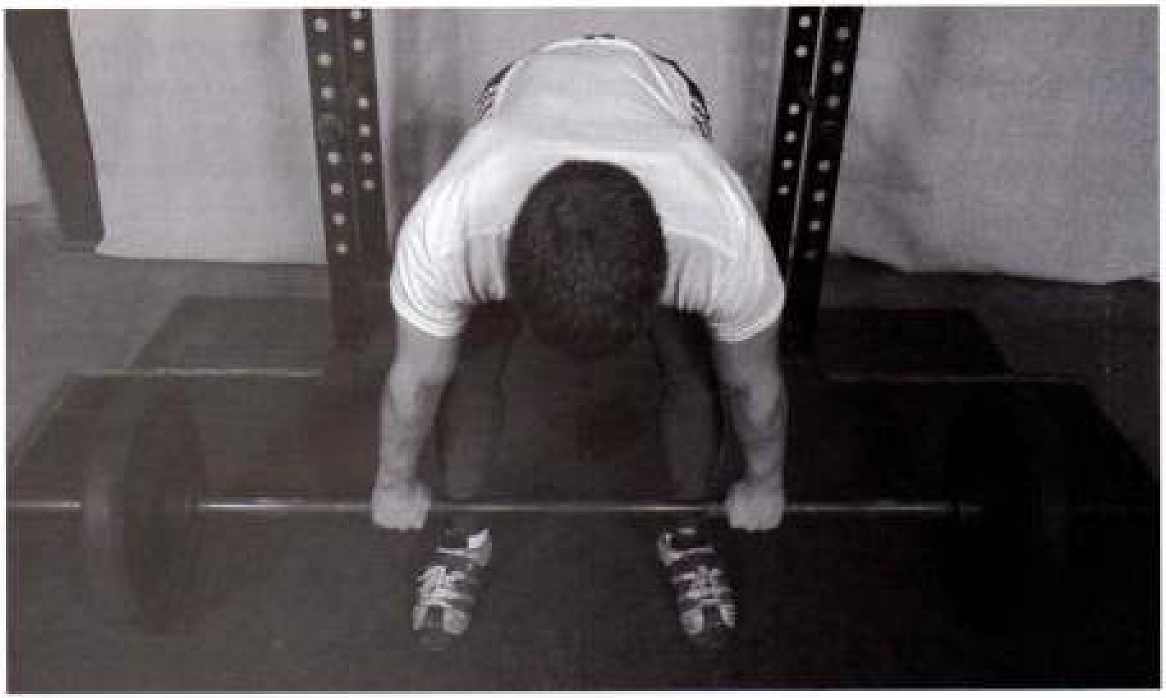


Figure 10. The grip should be wide enough to clear the shins and legs. This will prevent interference with the grip and abrasion of the thumbs as the bar comes up the legs.

Figure 11. The width of the grip on the bar will vary, but most people will use about 20" between the index fingers.

The main idea here is to get the trainee to pull the bar up his legs with straight elbows, with his back in an anatomically safe position. There are many ways to get him to do this, and as long as you know what the starting position is supposed to look like and what the back position and bar path should look like during the pull, you can usually get him to a correct deadlift without too much trouble. The following method is a good place to start.

Most trainees will take their grip on the bar by bending over at the waist, keeping their knees straight (figure 12). As soon as he takes his grip and before he has a chance to do anything else, tell him, "Now, bend your knees and lift the chest." Some trainees will do this correctly and assume a flat-backed position (figure 13). But nearly all trainees will leave the bar out away from the shins.

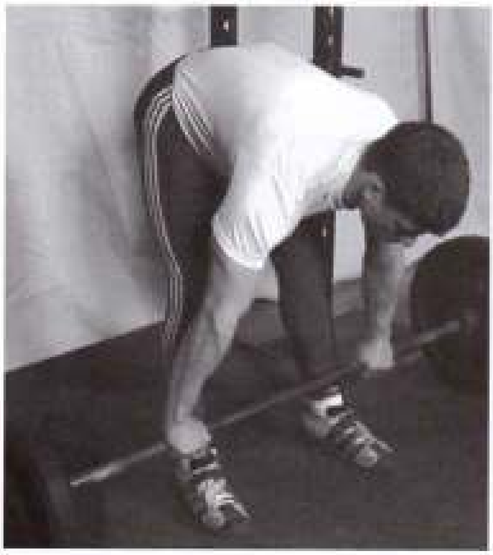


Figure 12. Position usually assumed by the trainee immediately upon gripping the bar.

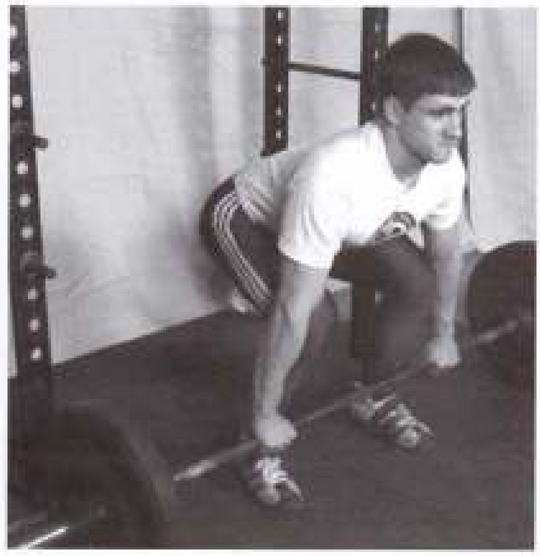


Figure 13. The correct starting position.

He is now ready to pull his first rep. Say this to him: "Now, take a breath, find your heels (or 'rock back on your heels'), look forward (NOT up), and drag the bar up your legs." Watch him pull the bar up. At the top of the pull, tell him, "Lift the chest, shoulders back." This should get him in a good position at the top (figure 14). Seen from the side, his position will be anatomically normal, with both lordotic and kyphotic curves in an unexaggerated position, eyes looking straight ahead, hips and knees fully extended, and shoulders back. This is the position the body must assume to safely bear weight, and the correct body position during the pull represents the safe way to transfer the load from the ground to this upright position. Make him aware of his good position at the top by pointing out the elements of it while he is there. Tell him, "Think about where you are here. Chest is up, knees and hips are straight, chin is straight ahead, shoulders are back." Now, tell him to set the bar down, and see how he

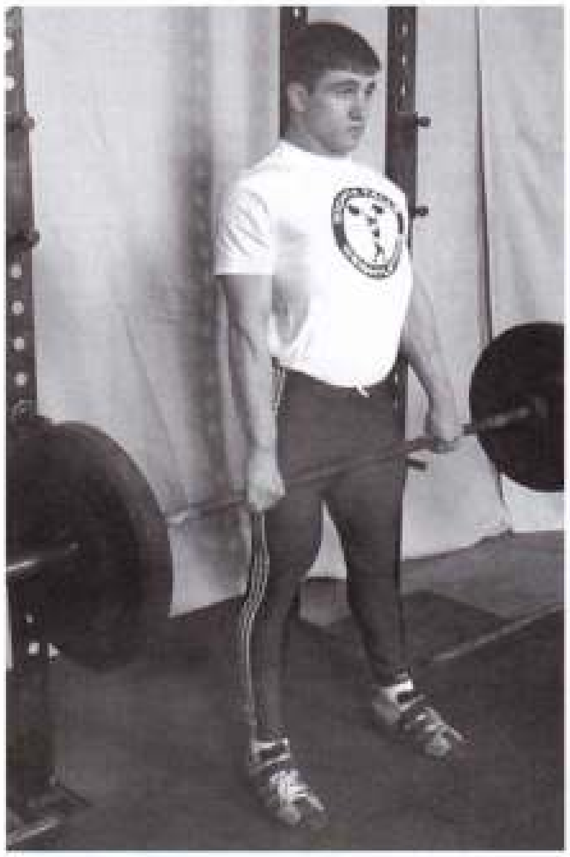


Figure 14. The finished deadlift.

Figure 15. The hand position (top) used to cue the contraction of the spinal erectors. By touching the back on either side of the spine (bottom), the coach can easily show the trainee exactly which muscles to contract.

does this. Down should be the perfect opposite of up with respect to back position, the only difference being that the bar can go down faster. It is just as easy to injure the back setting the bar down incorrectly as it is picking it up incorrectly, and it is extremely common for novice trainees to set the bar down wrong, with a round back, even if they have lifted it correctly off the floor. More on this later.

Most people will not have the bar close enough to the legs, and most will bend their elbows on the way up near the top of the deadlift. The bar out from the legs is due to the perfectly natural desire not to scrape the shins, and the subsequent path out away from the thighs is carryover from that. Bending the elbows is due to the large section of the novice brain that says "All things are lifted with the arms." But these concerns are secondary to the low back position, the most important part of the lift. Everything else can be wrong with the deadlift and nothing really bad happens, but if the low back is round under a big load, safety is compromised.

So now is the time to point out the back position to him and to teach him the most important part of the deadlift, "setting" the back correctly. After he sets the bar down, stand him up without the bar and show him the correct back position with your hands. Stand beside him, facing his profile. Tell him, "Your back position is the most important part of this lift. Lift your chest." As you say this, touch him on either side of his sternum with your index finger and thumb, to make him aware of what you want lifted. Then say, "Now, stick your butt out," and touch him with the other hand on his lumbar erectors, with your thumb and index finger on either side of his spine about four inches above his sacrum, right in the middle of the small of his back (figure 15). This gives him a point to rotate around as he sticks out his butt, the net effect of which is to contract the erector spinae muscles under his conscious direction (figure 16). Now, he will not be able to maintain this degree of lumbar extension at the starting position with the bar on the floor – hamstring tension will pull his pelvis and

Figure 16. Describing and making the trainee aware of his position through manipulation is a great way to increase kinesthetic awareness. Get him to push his chest up against your upper hand and to arch the lower back around the pressure of your bottom hand.

lumbar spine out of this position to an extent relative to his flexibility, and few people are so flexible that they can maintain absolute extension at the bottom (figure 17). This is not desirable anyway. The point is to get him to set the back and identify and control the muscles he must use to do this.

Once he shows you that he understands what his back must do, have him fix his eyes on a point about halfway up the wall facing the platform, to give him a position reference, and have him pull a set of five. Verbally reinforce his correct position, with praise and a treat if he's been good. If his form is good enough, add weight for a few sets until it looks like the next increase might be a problem, and that's the first deadlift workout. There will be problems to fix. There always are, and such is the stuff of coaching.

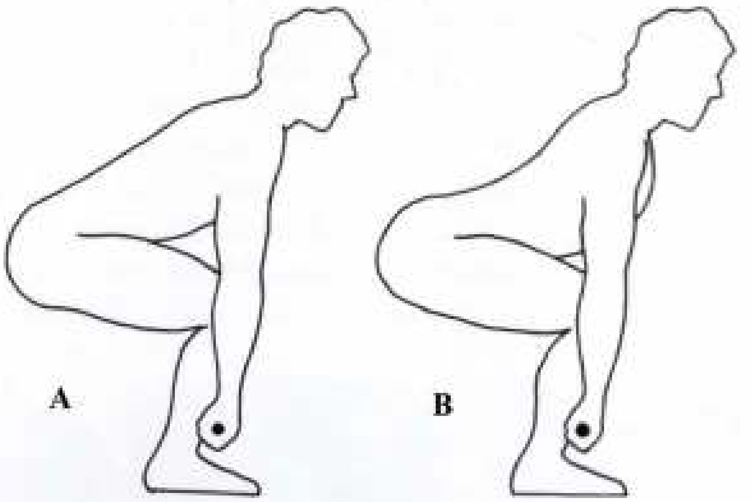


Figure 17. The start position of the deadlift is normal spinal extension (A) not an over-extension position (B). Lumbar hyperextension is actually a difficult position to assume at the start for trainees with normal flexibility, but some very flexible individuals can manage to do it. Extreme extension is a bad as not enough extension.

Low Back

The vast majority of the problems encountered in coaching the deadlift will involve an incorrect lower back position. Much of this has already been discussed in the squat section, but it bears repeating here. Most novice trainees that exhibit incorrect back position in the deadlift – a round lower back – are completely unaware of their back position (figure 18). They are unable to identify the correct position, the incorrect position, or any position in between. They lack the "kinesthetic sense," the ability to identify the spatial position of the body or bodypart, required to perform the movement correctly. The cause of this may be related to visual perception; they cannot see, and have not attempted to look at, their lower backs. They can tell you if their elbows are flexed or extended, but they have no idea if their low back is flexed or extended, probably because they haven't thought about it before, and this is because they can't see the muscles involved. Arms are in view, both in a normal field of vision and in a mirror, and it is natural to relate voluntary control to an observed, observable movement. In contrast, the lower back is behind you, and it would require an truly innovative mind to think of an excuse to look at the action of the lower back in a mirror from profile while picking up stuff in the garage.

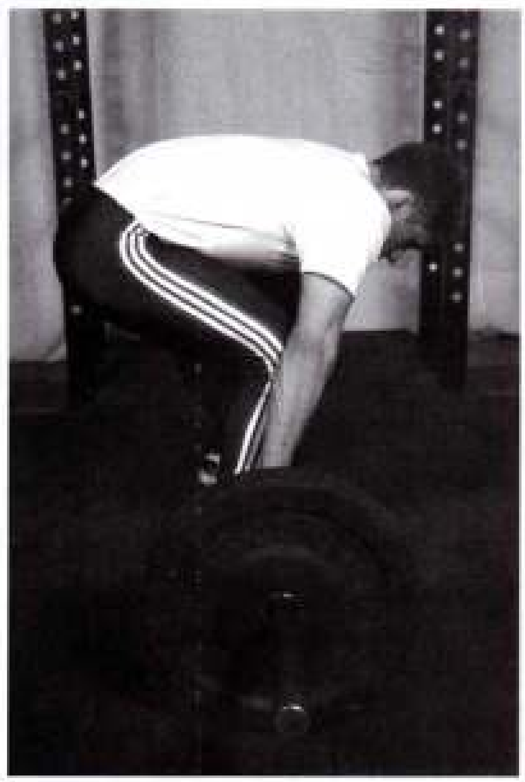


Figure 18. The dreaded rounded back, a common error and coaching challenge.

Fixing low back problems requires placing in the trainee's mind an awareness of what the lumbar muscles do, what it feels like when they are doing these things, and what must be done to

Figure 19. Walking the trainee down into correct starting position may take a few tries, but can be done very effectively by using both verbal and physical guidance as he lowers his body into the start position.

do them right every time. Standing beside the kid and cueing his back position with your hands may be enough to turn on the light for him. Have him repeat the action of lifting the chest and sticking the butt out several times to practice the voluntary contraction of these muscles. Just to be sure, put him on his belly on the platform, as described in the BACK section of the squat chapter, and do this drill a few times too. Setting the back is essentially the opposite of a sit-up, which is an active flexion of the spine. Our active extension of the spine activates the muscles on the other side of the torso, and explaining this sometimes helps the trainee understand what he is supposed to do.

The following drill can be used as the beginning of a technique that will work for even the hardest cases of round back. With the trainee facing the bar in a correct deadlift stance, stand beside him with your feet straddling the bar (not as dangerous as it sounds – you will be moving before you get seriously injured) in the same position facing his profile as the just-discussed setting the back drill. Have him do this several times standing fully erect. Then have him set the back and attempt to go down to the bar, carrying the correct position down instead of trying to establish it at the bottom. This will usually take several attempts, each one getting closer to the bar before the low back unlocks (figure 19). When he gets close enough to the position, move out of the way and have him pull it while holding his back in as correct a position as he can manage. It may take him several workouts before he can assume the correct position while at the absolute bottom and hold it during the pull off the floor.

This same technique can be used for kids that pull correctly but lower the bar with a round back. These trainees will usually unlock the knees forward (bad, explained below) and then set the bar down the remaining distance by rounding off the back, without any further knee movement. For some odd reason, this problem seems especially prevalent in taller, skinny kids, who have apparently gotten used to setting things down without using their legs. Since it is just as easy to hurt yourself lowering the bar wrong as it is pulling it up wrong, this problem needs to be fixed quickly.

Using the very light starting weight on the bar held at the top, have the trainee set his low back and attempt to set the bar down correctly, encouraging him to "use your legs" as the bar reaches his knees. Repeated attempts will get the bar a little lower with good low back position each time, until the floor is finally touched with the back in the same position as it should be to start the pull. Tell him that is his goal, to "set the bar down with your back in the same position you want it in when you start the pull."

Figure 20. The path of the bar as it is pulled from the floor to its final position is a shallow sweeping arc back towards the body. The bar is ALWAYS close to the body.

Pulling Mechanics

An explanation of the mechanics of the pull might be helpful at this point, to clarify why hips should travel back before knees go forward, and to further explain the proper way to get the bar off the floor.

The bar path in a heavy deadlift should theoretically be vertical, because that is the most efficient way to move an object through space from one point to another. Work is defined as force (the force of gravity acting on the mass of the loaded barbell) multiplied by distance (the measured distance the barbell has to travel), and can therefore be expressed in foot-pounds. The further it has to move, the more work must be done to move it there, and the shortest distance between two points is a straight line. Since there is no lateral displacement in a deadlift (we should not be walking around the room as we lift the bar), the shortest distance between the starting point and the lockout point of a deadlift is a straight *vertical* line. A bar path that is perfectly perpendicular to the floor is not actually possible, due to human biomechanical factors, but it should be recognized as the physical model we try to approach (figure 20).

There are three angles to consider when looking at the deadlift: the angle at the knee, formed by the tibia and the femur, the angle at the hip, defined by the femur and the trunk (assuming that the lumbar spine is locked in extension), and the angle the trunk makes with the floor (figure 21).

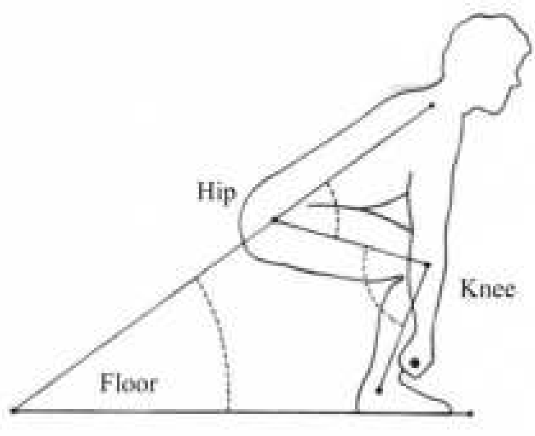


Figure 21. The basic angles of body position relevant to the deadlift. The coach should evaluate these angles for every trainee and shape the trainee's ability to consistently hit the same position with every rep.

In a correct deadlift, the knee angle is the first to change as the bar comes off the floor, indicating that the quadriceps are working to extend the knee under load. The back should stay at the same angle with the floor, and the hip angle opens up only slightly as the femur gets more vertical. It is only after the bar clears the knees that the back angle, and consequently the hip angle, begins to change significantly (figure 22). As hip extension begins to increase, the hip extensors, the glutes and hamstrings, become the predominant movers of

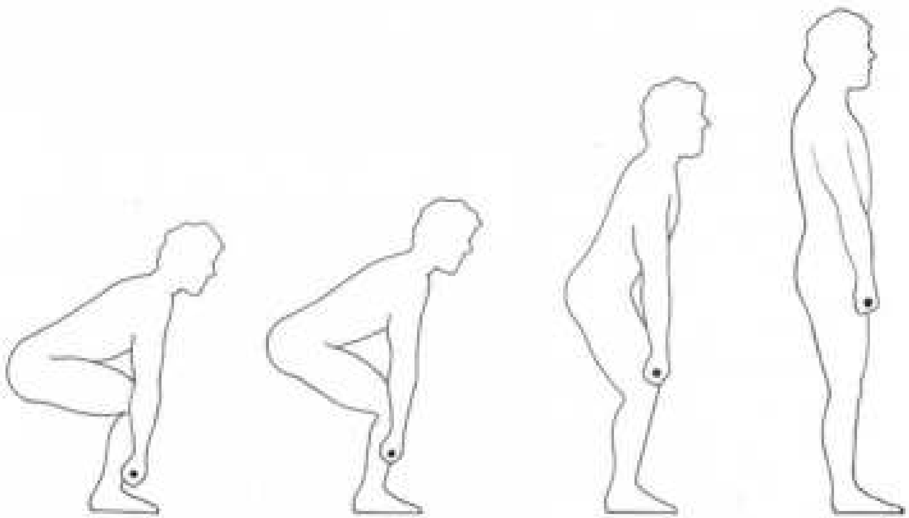


Figure 22. The back angle stays the same in the early stages of the pull off of the floor. Only after the bar passes the knee does the back angle become more vertical. This progression is best accomplished by using the knees to get the bar off the floor, and the hips after the bar passes the knees.

the load, the quads having essentially finished their work. The role of the back muscles during the pull is to hold the trunk rigid so that force generated by knee and hip extension can be transferred up the back and down the arms to the bar. Lockout at the top occurs when the knees and the hips reach full extension simultaneously, with the chest up and the shoulders back. All of the angles have straightened out and the line from the shoulders to the floor is essentially vertical. If this pulling sequence is followed, the bar will come up the legs in a vertical path.

If the back rounds off during this process, some of the force that would have gone to the bar never gets there. If the weight is sufficiently heavy, the rounded back cannot be re-straightened and the deadlift cannot be locked out; the knees and hips are already extended and their muscles cannot be used since they are already fully contracted (figure 23).

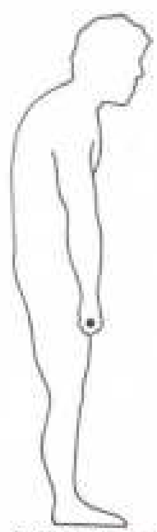


Figure 23. The function of the back muscles during the deadlift is the transmission of hip and leg power to the bar. If the back rounds during the process, it cannot be straightened after the knees and hips lockout.

The question of exactly what these three angles should be must be answered for each trainee individually. It will depend on the anthropometry of the trainee. Tall people with long femurs, long tibias, and relatively short torsos will have a different starting position than short people with long torsos and short legs. Each trainee will have a different set of knee, hip, and trunk angles, but they will have some key markers in common: the shoulders will be slightly in front of the bar, the bar will be touching the shins, the hips will be low enough to enable the legs to push the floor and high enough that the weight is on the whole foot, but not on the toes (figure 24). For the previous two examples, the tall, long-legged kid will have a flatter trunk angle, the back more parallel to the floor, than the kid with the short legs, who can easily get his chest up at a steep angle to the floor.

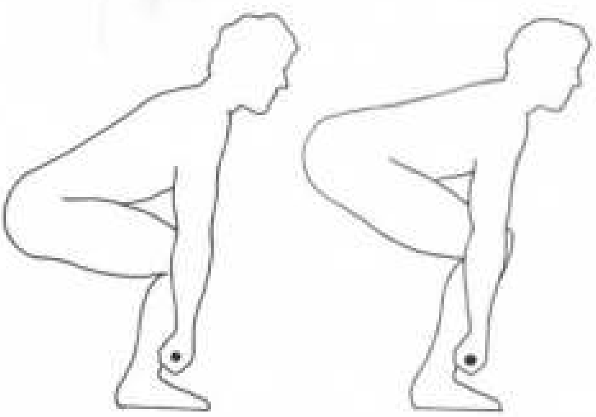


Figure 24. Different body segment lengths will make proper starting position look different. Longer legs relative to trunk length (right) necessitate a higher hip position at the start. Similarly, other anthropometric differences will require other variations. It is the coach's job to know how to make proper adjustments to safely accommodate each trainee's unique body style.

Many pulling problems can be analyzed with this model. For example, our problem of lowering the bar by leading with the knees: the down phase is the exact reverse of the pull – if the last thing that happens at the top of the deadlift is hip extension with a locked back, the first part of lowering the bar has to be hip "un-extension" with a locked back (figure 25a-b). This movement is eccentric hip extension, the "negative" part of the lift; the butt travels back with the back locked, closing the hip angle and using the hamstrings and glutes eccentrically. As the bar slides down the thigh, further closing the hip angle, it reaches a point as it passes the knee where the knee angle begins to close more than the hip (figure 25c-e). As the bar is lowered past the knees, they bend and the quadriceps do their eccentric work as the bar gets to the floor. This sequence of movements, the opposite of the pulling-up sequence, allows the bar to drop down in a vertical line.

Any deviation from this order will not work. If the knees move forward first when lowering the bar, they will be in front of the bar, and the bar cannot go straight down since it has to go forward to go around the knees. Knees can move forward only so far before the heels get pulled up, so most people then round the back to let the bar go forward far enough to clear the knees (figure 26).

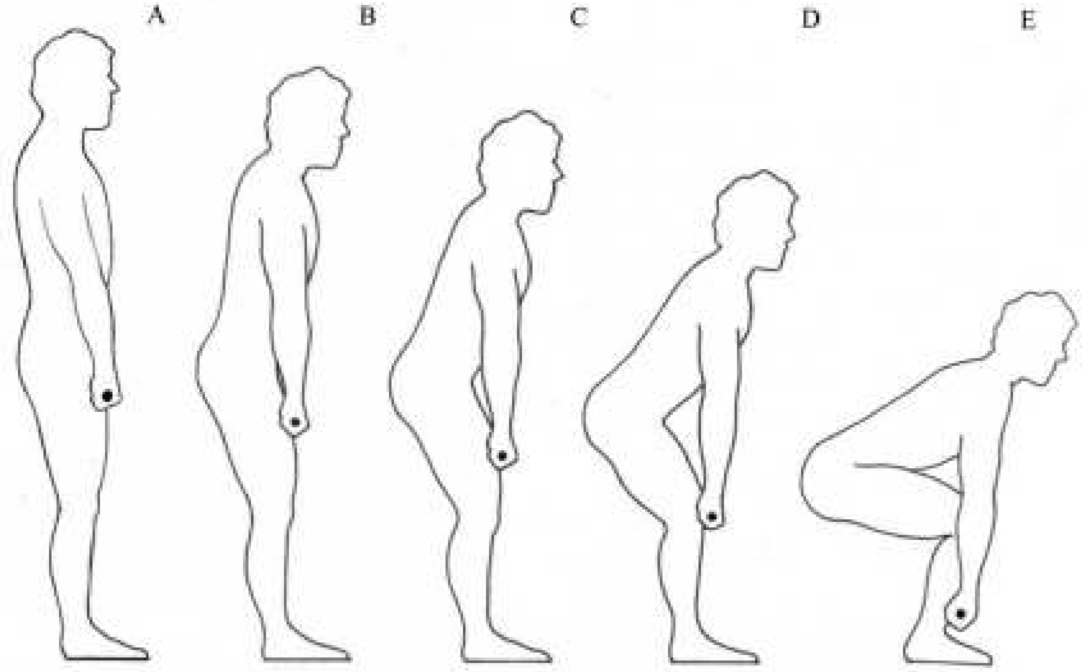


Figure 25. The descent of the bar should be controlled and completed in a manner that nearly mirrors the ascent of the bar. "hips lower the bar to the knees, and knees lower the bar to the floor". This will come in handy later during the power clean.

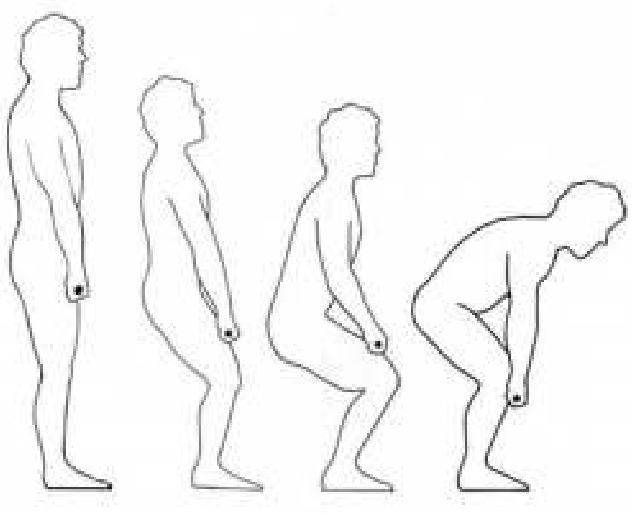


Figure 26. Lots of trainees want to sit back and let the bar slide down the thigh to the knee then round their back to let it pass the knee. Stop this error before it has a chance to become habit.

From off of the floor, an attempt to extend the hips first will result in a non-vertical bar path. This happens when the trainee lifts the chest first (different than "*keeping* the chest up", or keeping the trunk angle the same off the floor), opening the hip angle first. If this happens, the bar will move forward out away from the heels to clear the knees, which have not pulled back out of the way (figure 27). But when the knee angle opens first, the shins get more vertical and move back relative to the front of the foot, allowing the bar to travel in a vertical path up

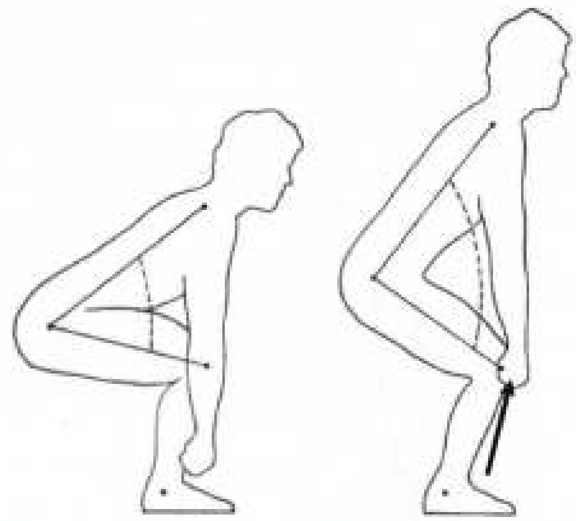


Figure 27. When the back angle rises at the start, it is common to see the bar move away from the shins in order to clear the knees (right). This moves the bar path away from vertical (towards the toes) and adds extra work and stress. Compare the back angle in the figure on the right to that in Figure 21.

the leg (see figure 22). If the knee angle changes first, the bar can move in a straight line up, the way heavy bars like to move. If the trainee pulls the bar out around his knees, you now can see what he's doing. Tell him to get his weight back on his heels, off his toes, and to pull the weight back toward *him* on the way up. He cannot do this unless the bar comes back into the correct path that lets his knees straighten out and his quads push the bar off the floor. Some trainees will need to be told to use their lats to actually pull the bar back into the legs (figure 28).

When the weight gets heavy, it is common to see the bar come away from the shins before it even leaves the floor. When this happens, note the position of the hips: they will have lifted too, also before the load moves. Using our pulling model, it is apparent that when this occurs, the knee angle has opened, the hip angle has closed, and the trunk angle has closed, all before the load moves (figure 29). In this situation, the muscles that extend the knees, i.e. the quadriceps, have done so, but have not moved any

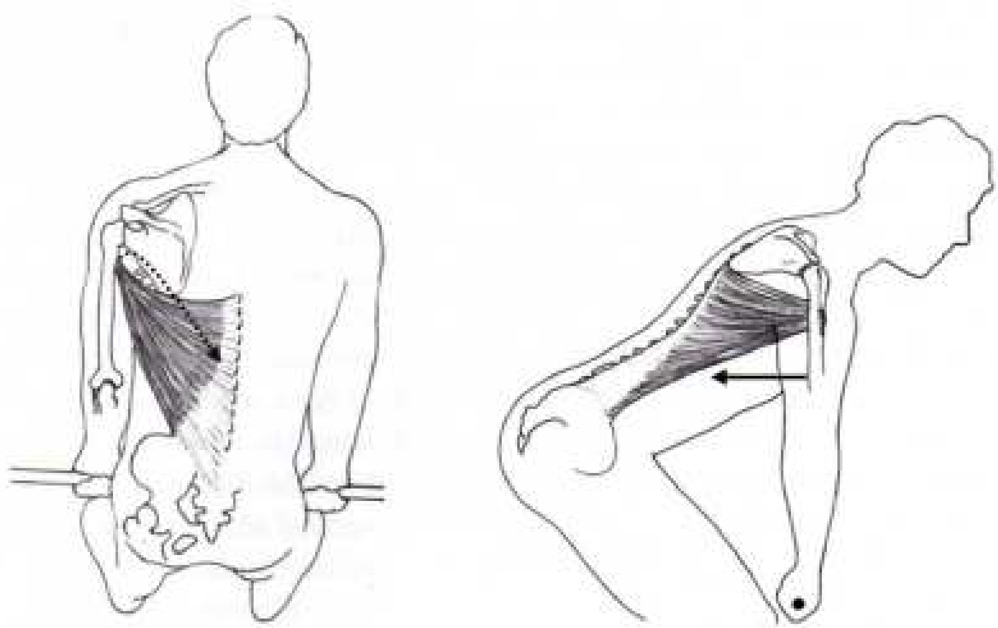


Figure 28. Some trainees will need to be told to use their lats to actively pull the bar towards them to keep the bar close to the body.

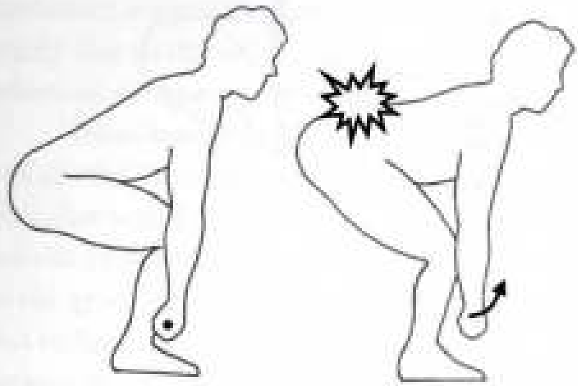


Figure 29. Raising the hips by extending the knees produces several problems. One is that the bar will swing away from the leg thus increasing the load on the low back and the potential for injury (right).

weight *while* doing so. In opening the knee angle unloaded, they have avoided participating in the lift and placed the entire job on the hip extensors, which now have more to do since they must move through more angle to get into extension. In addition, since the trunk angle is now almost parallel to the floor, the back muscles are in a position of decreased mechanical advantage: they have to stay in isometric contraction longer, rotate through more angle, and at a position of maximum torque. (Physics time – sorry! Torque, or rotating force, is at its maximum when applied at 90 degrees to the thing being rotated (figure 30). Think about turning a nut with a wrench; a weird angle to the nut is not strong, and the strongest position is when your hand is at a right angle to the wrench. Same thing in the deadlift: the force against the hips is highest when the back is parallel to the floor, and decreases as the chest gets higher and the back becomes more vertical.

The reason for this is not immediately apparent. Raising the hips before the chest is a common enough problem (in the deadlift, the clean, and all other pulling from the floor) that we should analyze it here. The quadriceps straighten the knees, and if the trunk angle stays constant, the bar comes up the shins. But it is the hip extensors, acting as stabilizers during the initial phase of the pull, that maintain the trunk angle by exerting tension on the pelvis from the posterior. They "anchor" the trunk angle so the chest can stay up while the quads do the work of straightening the knee. It is only after the bar crosses the knee that the hip extensors begin to actually change the trunk angle by opening the hip angle. So, the function of the hamstrings and glutes changes during the pull: initially they act to maintain the trunk angle as the quads straighten the knees, then they change the trunk angle as they extend the hips and finish the pull (figure 31). If the hamstrings fail to maintain the trunk angle, the butt comes up, allowing the quads to avoid their share of the work. The bar, however, must still be pulled, so the hip extensors end up doing it all, and in a much more inefficient way. They should be working through both the initial phase of the pull *with* the quadriceps, and through the lockout by themselves; now they have to close the whole angle at the end of the pull. Either way, the hip extensors work, but their job is easier if the work is distributed over the whole movement instead of concentrated at the end of it.

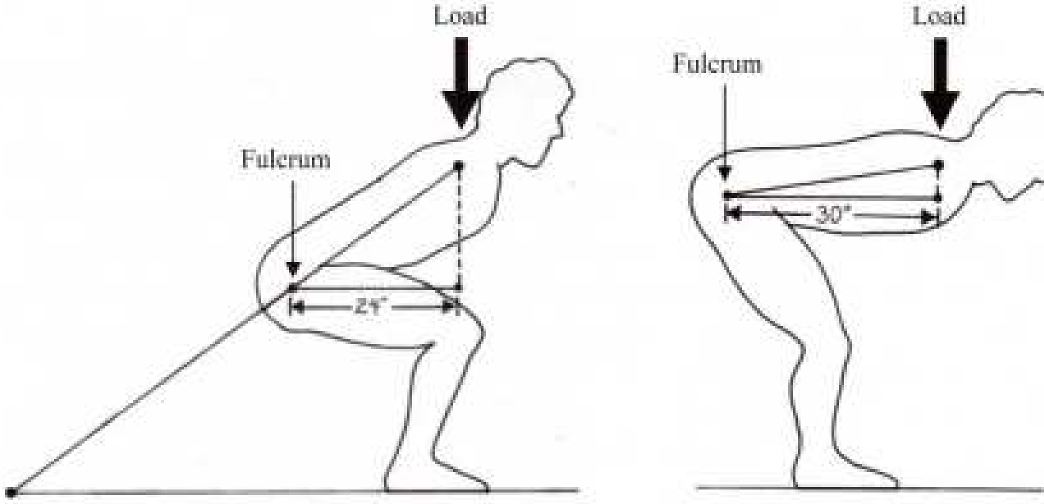


Figure 30. The most torque or stress applied to the hips and low back is when the back is most parallel to the floor. Notice the difference in the length of the lever arm between the correct starting position (left) and incorrect (right).

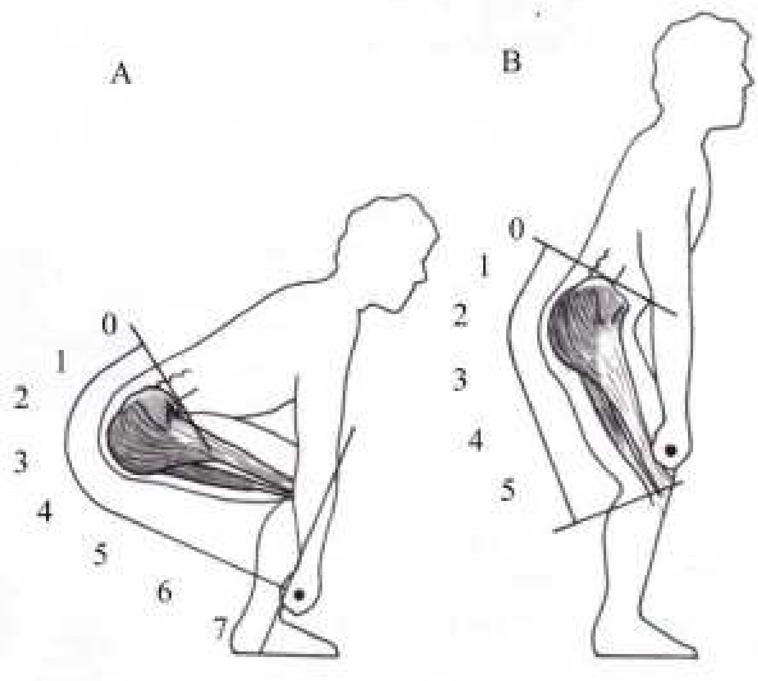


Figure 31. The hip extensors shorten initially only to maintain back angle as the bar rises THEN after the bar passes the knee they continue to shorten but change function in that they will now act to open the hip angle (right). Note how this movement shortens the distance between the lines identifying the top of the pelvis (A) and the knee (B).

The problem is not that the hamstrings are not strong enough – after all, they're strong enough to lock out the weight without the help of the quads when it's done wrong. The problem is one of motor learning, teaching the muscles to move the bones correctly, in the right order at the right time. The only way to correctly address this problem is to take weight off the bar and make the trainee do the deadlift with proper form, with all the angles correct, so that all the muscular contributors to the pull learn to do their job in the right order.

An interesting thing happens when all the pulling mechanics are correct: the deadlift feels "shorter," like the distance the bar has moved is reduced when compared to an uncorrected, sloppy deadlift. It obviously hasn't, but the increased efficiency obtained from the improvement in pulling mechanics is significant enough that the perception is one of a shorter movement. This is largely due to the reduction in extraneous hip and knee movement, and a consequent reduction in time the lift actually takes.

Most trainees are reluctant to keep the bar close enough to the legs during the pull, as well as when setting it down, and for that matter before the bar leaves the ground. This is often due to the fear of marring the beauty of the shins and thighs. In addition to the above analysis of the angles involved in the pull, consider this: the further the bar is from the place on the ground that the force is being applied, the longer the lever arm along the back from load to hips (figure 30). This inefficiency gets multiplied quickly, and it doesn't take much distance from the shins to drastically increase the effective weight of the bar. This is true going up and coming down. If the bar needs to be rolled back to the shins very much between each rep, something is wrong with the line of pull, and it should be analyzed using the "angles" criteria.

The closer the bar is to the point of drive against the ground, the easier it is to pull, and the closest it can get to this place is touching the shins. Make sure the bar is touching the skin or the socks before it leaves the floor. It is not necessary to bump the shins with the bar, or dig a ditch in the shins on the way up. Good control of the weight is necessary to avoid this, and it should be avoided or sores get established on the shins that will be a problem for a long time – every time the trainee deadlifts he will break the sore open and make a big mess on his socks or worse, the bar. The knurl of the bar might also be a problem if it extends in too close to the middle. A standard Olympic weightlifting bar has an opening in the knurl that is 17.5 inches wide, as are most power bars, and this is usually sufficient to accommodate all but the tallest people. Some bars are manufactured with no thought given to the possibility that they might someday be used to deadlift. Don't buy these bars. Weight room budgets, no matter how generous, are not large enough to permit the purchase of equipment that is not useful in all circumstances for all the barbell exercises.

To demonstrate the importance of proximity to the bar, have the trainee stand in his normal start position, close to the bar. Then have him step back about 18" and tell him, "Now, try to deadlift the bar from there." (This should be done with a very light weight.) He obviously will have trouble doing this, and he will understand why as soon as he grips the bar. Stop him before he pulls it, and say, "Now, come half the distance to the bar, and try again." He will immediately see that it is much easier at this position. "Come half the distance again. And again." Now say this: "So what is the moral of the story? The closer you are to the bar, the easier it is to pull. And what is the closest you can be to the bar? Yes, dragging it up your leg." This is a very easy, practical demonstration

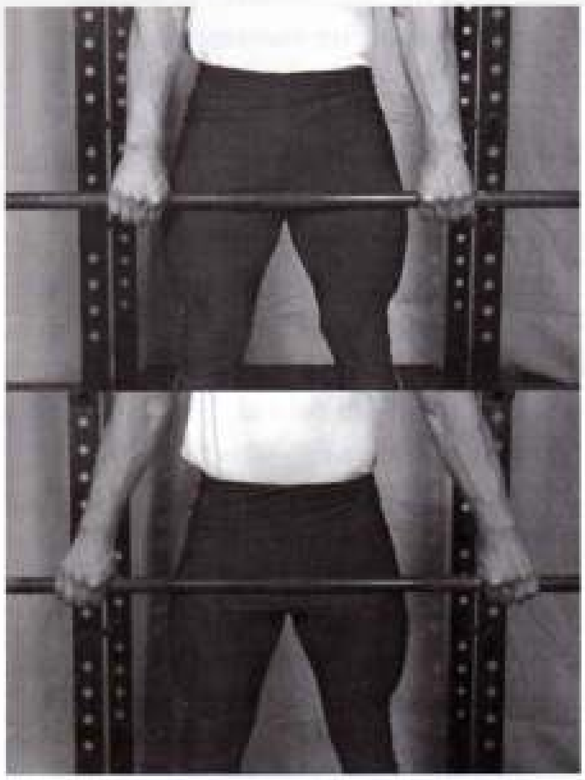


Figure 32. We want to teach and use the most mechanically effective grip and stance possible (top). Moving the hands wider (bottom) moves the bar closer to the waist at the completion of the rep, increasing the distance the bar must travel.

Figure 33. Vince Anello displays a unique deadlifting style with an extremely narrow stance. He was very successful with this uncommon technique.

of the essential mechanical principles involved in the start of the deadlift, and brings home to the trainee exactly why they need to be followed.

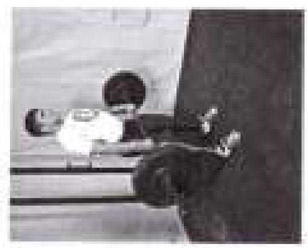
Feet

Foot placement has been discussed above. In a deadlift, we are pushing the floor, not lowering the hips as in a squat, and the stance is placed accordingly. If the feet are too wide, they will either rub the thumbs on the way up or force the grip out too wide to avoid this. The wider the grip, the farther the bar has to travel (figure 32). The grip and the stance are interrelated in that stance must be set to allow the best grip, and the best grip for the deadlift is one that allows the arms to hang straight down, perfectly vertically, which makes for the shortest possible distance from the floor to lockout for the bar. Too wide a stance (in a conventional deadlift – remember, Be Sumo Free!) necessitates too wide a grip, and confers no power advantage to the properly instructed trainee. Maybe the thinking is that since we squat wider, we should pull wider. But, of course, we are not squatting; we are pushing the floor with the feet, an entirely different thing.

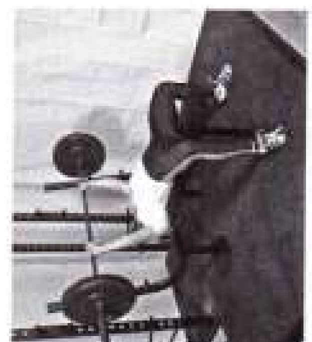
Too narrow a stance is less harmful, but is rather pointless, and is not a thing encountered very often. There have been great deadlifters, Vince Anello comes to mind, who pulled with a narrow stance, with heels nearly touching, if memory serves here (figure 33). This is called a "frog stance", and some lifters can use it effectively. Most cannot, and it serves no good purpose to show them how. Likewise, it serves no good purpose to prevent a kid that is pulling well this way from continuing to do so. As long as the grip width is correct, the stance is probably okay.

The Little Details

While we're on the floor here, breathing should be discussed. Breathe while the bar is on the floor, not while supporting a heavy weight at the top. Remember from our discussion of the squat the role of air and pressure in trunk support. This applies especially to the deadlift. Review this now, please, if you are not familiar with this concept. A set of deadlifts should *start* at the floor, meaning that each rep begins and ends at the bottom, the back getting set and a new breath for each rep while the bar is on the floor between reps. Many people like to pull the first rep off of the floor, breathe at the top at lockout, and finish the set by bouncing the bar off the floor for the remaining reps. This is bad. It is easier to do the set this way, true, but easy and strong are usually opposing concepts. The trainee needs to develop the ability to set the back and control his position each time he pulls the bar, because these are precisely the skills and the muscles we are doing this exercise to develop. The point here, as is so often the case in the weight room, is not simply to *do* the deadlifts, but to *get strong* by doing deadlifts. They have to be done right, not just done. Also, any back position problems that develop during the set cannot be addressed by resetting the back – the only place to do this would be at the top, and the back is under load at the top so the position cannot be corrected there. If the back begins to round during the set, it tends to stay round or get worse unless it is reset, a thing done best at the bottom when the bar is sitting on the floor and the back can move into the correct position unloaded. And one of the key features of the deadlift is that it requires the production of force from a dead stop. Thus, the name. If a bounce is incorporated into all the reps except the first one, much of the value of doing them is lost.



There are a couple of ways to think about setting the back before the pull starts. For some people, it is sufficient to think about arching the lower back. This is, after all, most of what setting the back is about. But really and truly, we "set" the entire torso before we pull, and some may find it helpful to think about it in this way - squeezing low back and abs and chest all at the same time, not as separate muscle groups but as the trunk, taken as a whole unit. A cue for this might be "big breath, and squeeze against it," increasing the effectiveness of the Valsalva and causing all the muscles participating in it, precisely the ones we are concerned with, to contract harder and provide more stability.



Eyeball position is often overlooked when assuming the starting position. If the trainee looks straight down at the floor when deadlifting, the bar will usually swing out away from the legs. It is easier to keep the chest up and the upper back tight if the eyes are focused on a point about half way up the wall facing the platform. It doesn't really matter how far away the wall is, because the angle to that point will stay basically the same, unless the wall is several miles away. And looking up too high is not any better for the deadlift than it is for the squat, as discussed at length in that chapter. Actually, looking straight down is not terribly detrimental to the squat, but it will make the deadlift harder most of the time.

Arms must stay straight during the deadlift. There is no better way to produce a really decent elbow injury than to let 500 lbs. straighten out your elbows for you. The physics of force transmission is not difficult to understand. The force produced by the hips and legs is transmitted up the rigid torso and down the arms to the bar. In the same way the back must stay locked to facilitate force transfer, the elbows must stay straight too. The bent elbow is a thing that can be straightened out, if the weight is heavy enough. Unlike a rounded back, a heavy deadlift can be finished with bent elbows, but there is potential for injury. The elbow is flexed by the muscles of the forearm, the brachialis, and, in the supine arm, the bicep. If the elbows are bent, these muscles are working unnecessarily, since they add nothing to the lift, and in fact bent elbows actually increase the distance the bar has to travel. It is important to teach your trainees that arms are not involved in the deadlift, and that straight elbows are the best way to pull. This will also be important when we learn how to power clean.

Once the bar has completed the trip up the legs, there are several ways to finish the deadlift, only one of them correct. The bar is locked out by lifting the chest, pulling the shoulders back, and bringing the knees, hips, and lumbar spine into extension simultaneously. Many trainees insist on exaggerating some of these things, causing them to perform the movement inefficiently and, if carried to the extreme, unsafely.

For instance, it is unnecessary to roll the shoulders up and back at the top, overemphasizing the shrug. The deadlift is not finished until the shoulders are back and the chest is up, and finishing this part of the movement is important. Trainees need to be encouraged to lift the chest to lock out the shoulders, and occasionally it will be necessary to say "Shoulders back" at the finish. But the traps get sufficient work from heavy deadlifts without the trainee attempting to add additional trap work by exaggerating the shrug, and possibly causing a neck injury in the process. Heavy barbell shrugs are a good assistance exercise for an advanced lifter who knows how to perform them correctly, but novice deadlifters have no business trying to combine deadlifts with incorrectly performed barbell shrugs.

Likewise, it is unnecessary and unwise to exaggerate the hip-extension part of the lockout (figure 34). Since it is virtually impossible to hyperextend the hip joint in an upright position with a loaded bar on the anterior side of the thighs, what actually happens is that the trainee hyperextends the lumbar spine, sometimes as almost a separate movement after the deadlift is actually finished. This is a very dangerous habit to acquire, as uneven loading of the lumbar discs is as harmful from the posterior as it is from the anterior (figure 35). This usually develops in intermediate lifters, guys that the coach has stopped watching closely. Correct it immediately if you see it.

Knees sometimes get forgotten in the rush to lock everything out from the hips up. Many contest deadlifts are red-lighted because of failure to lock out the knees. This always produces a flurry of bad language from the lifter when the lights are explained to him, because anybody who can lock out a 622 lb. deadlift can also straighten out his knees the final 3

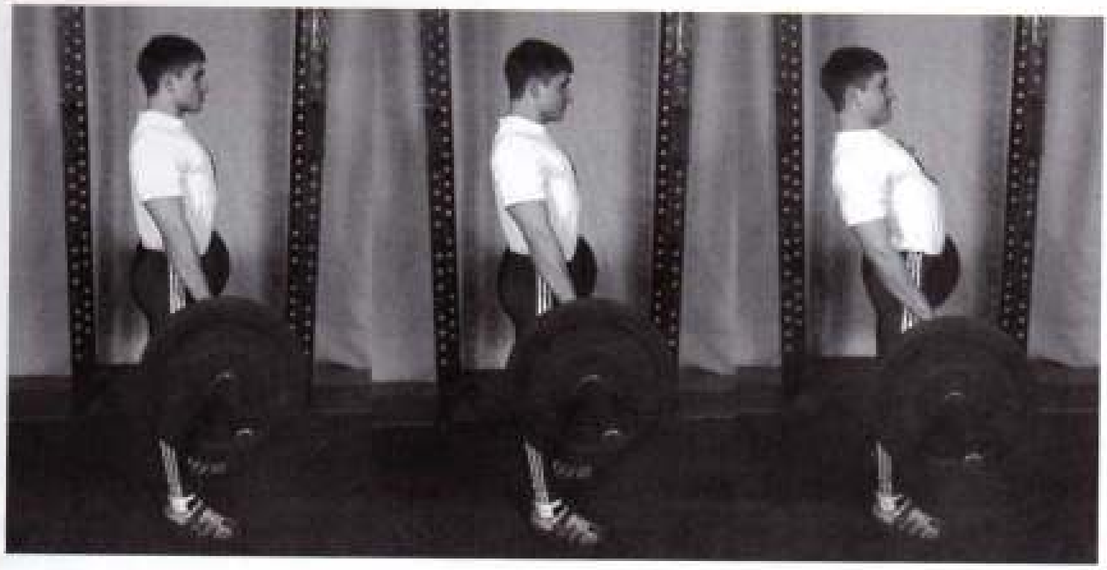


Figure 34. Some trainees will want to over-extend the back to finish the lift (left to right). This is unnecessary and potentially dangerous.

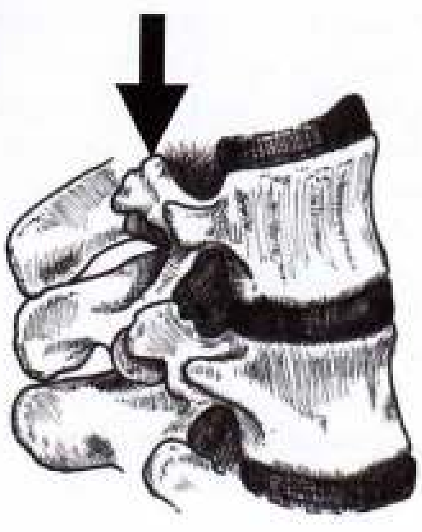
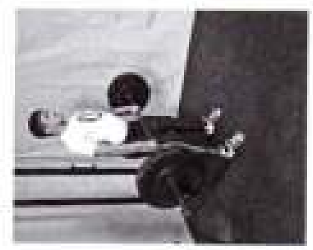


Figure 35. Unnecessary arching as in figure 34 asymmetrically loads the spine to the posterior, setting up conditions that may precipitate intervertebral disk injury. As in almost every exercise-related injury, it is not the exercise that is injurious *per se*, it is the inappropriate execution of the exercise that is the culprit. Our job as coaches is to teach and foster good exercise technique.

degrees (figure 36). Once the deadlift is finished at the top, it requires essentially no work, only remembering to do it, to lock the knees out. Novice trainees should be reminded to lock out the knees early in their deadlift training, even if they are doing it right anyway. That last little movement is an important part of the lift, even if a powerlifting meet is not the goal of training.



Encourage your trainees to hold the bar locked out at the top for just a second before they set it down, so that a stable position has been achieved first. If the kid is in the process of falling backwards as he attempts to lower the bar, there will be a significant wreck. The bar should only be lowered *after* it is locked out and motionless for

Figure 36. Occasionally, with heavy weights, the knees are not locked out. Look at the angle of the thigh to upper calf in the photo above. The fix for this is simple – cue the lifter in a clear, strong voice to "Stand up!" Our friend Phil Anderson suffers here from inexperienced coaching and lax judging.

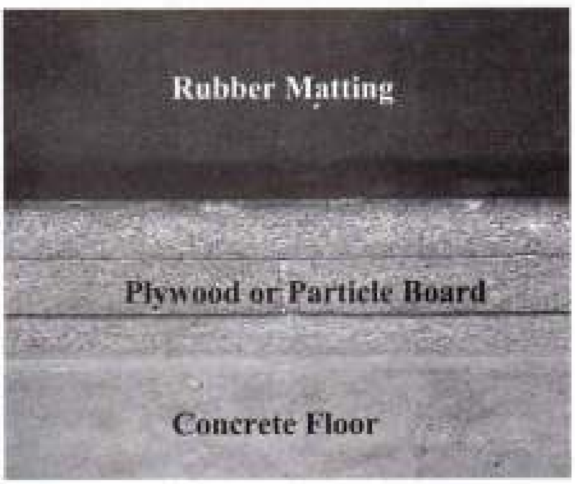


Figure 37. Basic layers of a cheap and durable training platform. Three layers of 4'x8' sheeting (oriented in alternating direction with each layer) covered with a layer of 4'x8' rubber matting. We like this type of platform on top of a simple concrete floor. It is not a pretty platform but it is economical, safe and easy to clean. This particular platform has been in service for 9 years. The trim has been removed in order to see the layers.

just a second, indicating a correctly finished lift.

Setting the bar down fast in the deadlift is actually okay. Since the deadlift starts as a concentric movement, as opposed to the squat, much of the effect of the deadlift is due to the hard initial position and the lack of help from a stretch reflex during the lift. Setting it down slowly will make it harder, and some trainees might benefit from the extra work, but the emphasis in the deadlift is picking up heavy weights. As the weight increases, bar speed will decrease with the difficulty of the set. Setting it down slowly uses up too much gas that could be better used picking up the next rep. As long as a modicum of control is exercised, it can be dropped as fast as the trainee is capable of doing safely, with the back in good position according to our previous analysis. Going down fast with poor control is, of course, hard on the kneecaps and shins. And depending on the type of plates being used and the nature of the platform surface, a poorly controlled bounce can cause problems. But in general, a deadlift can and probably should go down faster than it comes up, with the difference in the up and down speeds increasing as the weight on the bar increases.

Equipment

A platform is a good thing to have in a weight room: multiple layers of plywood or particle board glued and screwed together, with rubber mats under the plates or the whole thing surfaced with rubber (horse trailer mats work just fine and are relatively cheap) (figure 37). Failing that, rubber mats placed under the plates on the floor will work, but the room really needs to be set up correctly to train the pulling movements. Bumper plates, a necessary expense for the clean and the

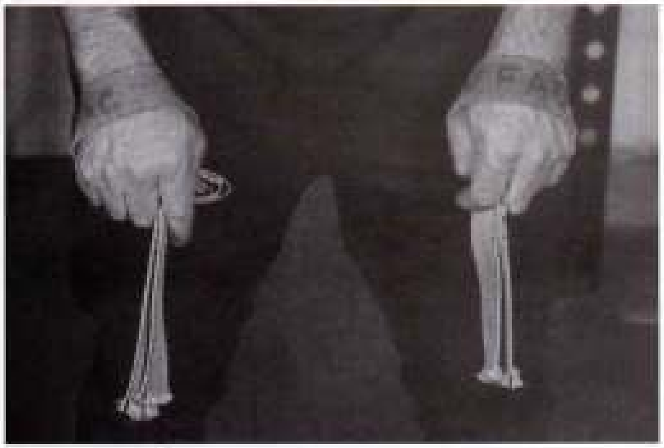


Figure 38. Our favorite straps are simple strips of movers strap or seat belt. Anyone's mom can make these. In fact, any kid who can operate a ruler and a pair of scissors can too. Really skinny luggage webbing is functional but tends to focus the load in too small an area for comfort. Note that the straps are riding on the carpals of the hand, not up on the wrists.

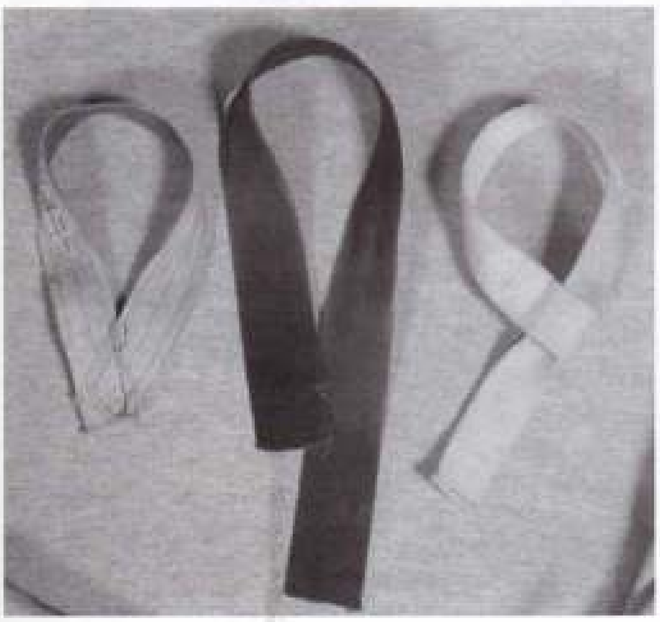


Figure 39. There are different types of straps commonly seen in the weight room. Unfortunately, the most commonly available type for sale in sporting goods stores are poorly designed and wear out rapidly (right). It is common for this type of strap to fail within a few months with a single user. The sewn loop model (left) has been in service for 5 years serving 30 olympic lifters per day. The flat strap model (center) has been in service for 22 years in a commercial gym.

snatch, can be used for the deadlift as well, but the more reasonably priced ones take up so much space on the bar that iron plates will eventually need to be used for stronger trainees. The room should be equipped for this.

Straps will be useful on occasion. Use the kind made from seat belts (it's probably best not to take the ones out of your car for this purpose), or other nylon-type material. Cotton will not work, no matter how thick and strong it looks. They can either be left as simple pieces of strap material, about two feet long, or the ends can be tacked together. Straps go around the hands, not the wrists (figure 38). And do not use the kind with a loop sewed into one end, where the rest of the strap passes through the loop. These will continue to tighten on the wrist during the set. They are never really secure with a heavy weight, tend to wear out quickly and tear during a heavy set, and will never stay in adjustment (figure 39).

A general word now about coaching the deadlift, or anything else in the weight room, or for that matter anything that needs coaching. Don't fail to coach, when you need to coach. One of the worst things that can happen to a kid with bad technique is that nobody tells him he has bad technique. There are two reasons a coach would sit and watch his trainees pulling with a round back: he doesn't recognize the problem, or he chooses not to coach the problem. A coach that doesn't recognize technique problems needs to learn more about lifting technique, and develop a "coaching eye" for spotting form problems. This is a matter of both experience and education, and both should be diligently acquired as a matter of professional growth. A reluctance or inability to voice corrections as necessary is a different type of problem, one sometimes solved

Non-Dominant Hand

Dominant Hand

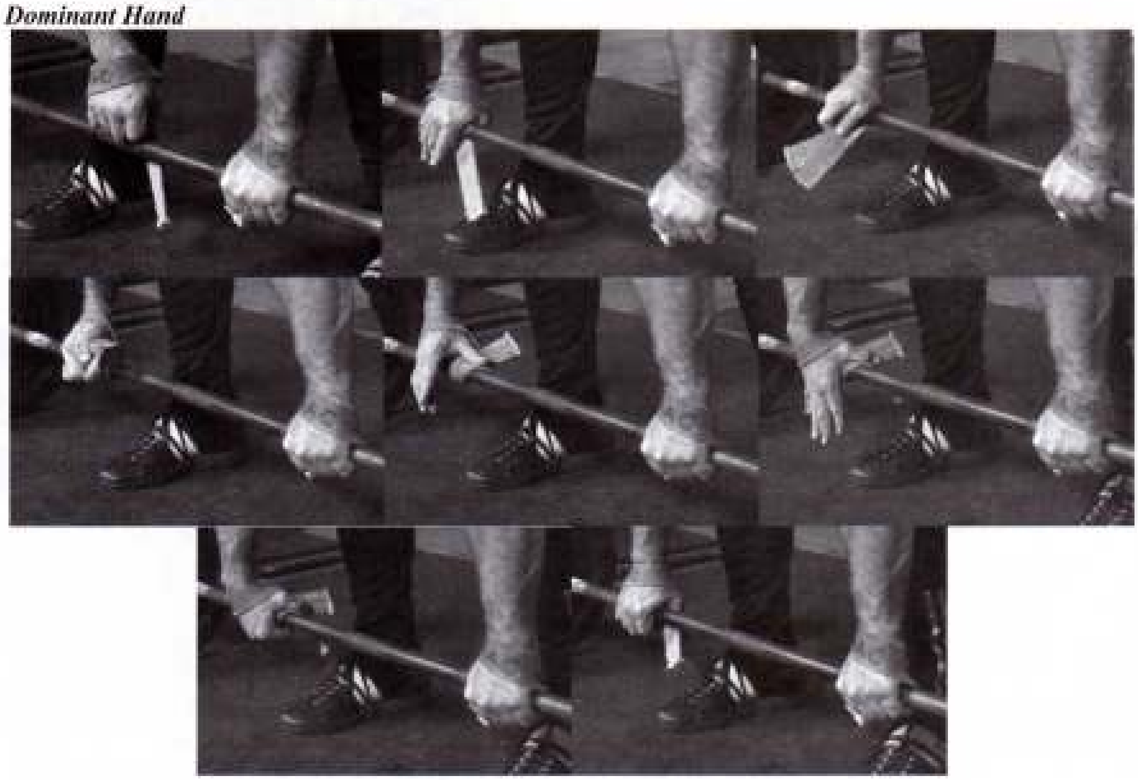


Figure 40. Strapping in is always a challenge for the novice, and here's how you do it.

through experience, but sometimes indicative of the type of personality that might have difficulty with coaching. Don't fail to prepare yourself to coach by learning as much about the sport as possible, and *always* use your knowledge base as effectively as possible to the betterment of those you are charged with coaching. Don't overcoach – let the trainee have a chance to do the things he's learned from you when he's ready to – but don't fail to coach him enough to get him there.

Finally, this method of teaching the deadlift is designed to be used in a sports conditioning program – it is not a powerlifting course. The author was a moderately good deadlifter during his career in the sport, and learned many valuable lessons about strength off the floor during this time. Among them is that not everybody needs to deadlift. Trainees with injured backs, trainees that are prone to re-injury, and trainees that cannot be taught to perform the movement correctly (no matter whose fault this is, yours or his) don't need to deadlift. Back strength can be obtained by other means if necessary. Since we are not powerlifting, and we are not contesting the deadlift, we have the option of not doing them. It's better if we can, since we need to learn to pull off the floor for the clean and the snatch, but these lifts are done with much lighter weights, and are therefore more forgiving (in terms of injury potential, not correct mechanics) than the deadlift. But we don't *have* to deadlift. And since we are not powerlifting, we don't have to do limit singles. From a training standpoint there is little to be gained by doing 1 rep max deadlifts, and 1RM can be inferred from a 5RM if obtaining this information is somehow necessary. Deadlifts are an excellent way to develop a brutally strong pull off the floor, if they can be done correctly.

The Press

The press is the oldest upper body exercise using a barbell. The day the barbell was invented, the guy that invented it figured out a way to pick it up and put it on his shoulders and shove it up over his head. After all, it is a logical thing to do with a weight.

Equipment has changed quite a bit over the past hundred or so years. We now have barbells that load with plates, racks to set our bars in that adjust to various heights so that we don't always have to clean them to our shoulders first, and even plates made out of rubber in case we need to drop the weight. But pressing the barbell overhead is still the most useful upper body exercise in the weight room.

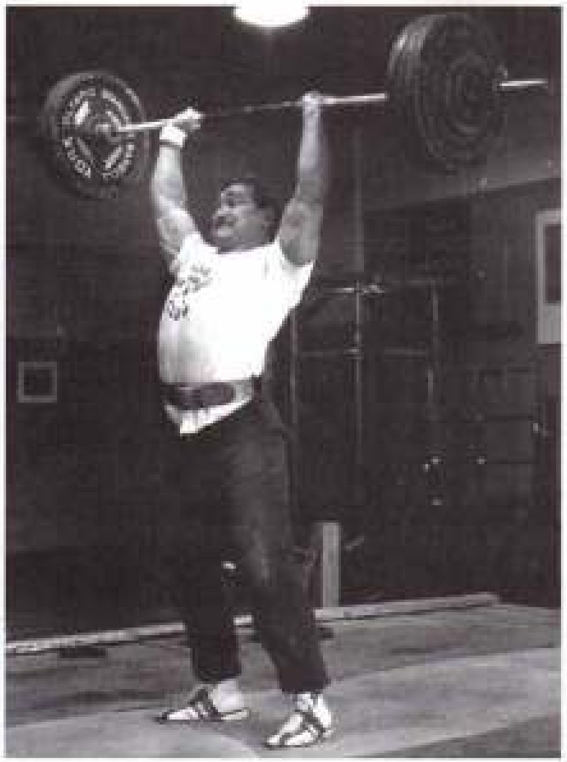
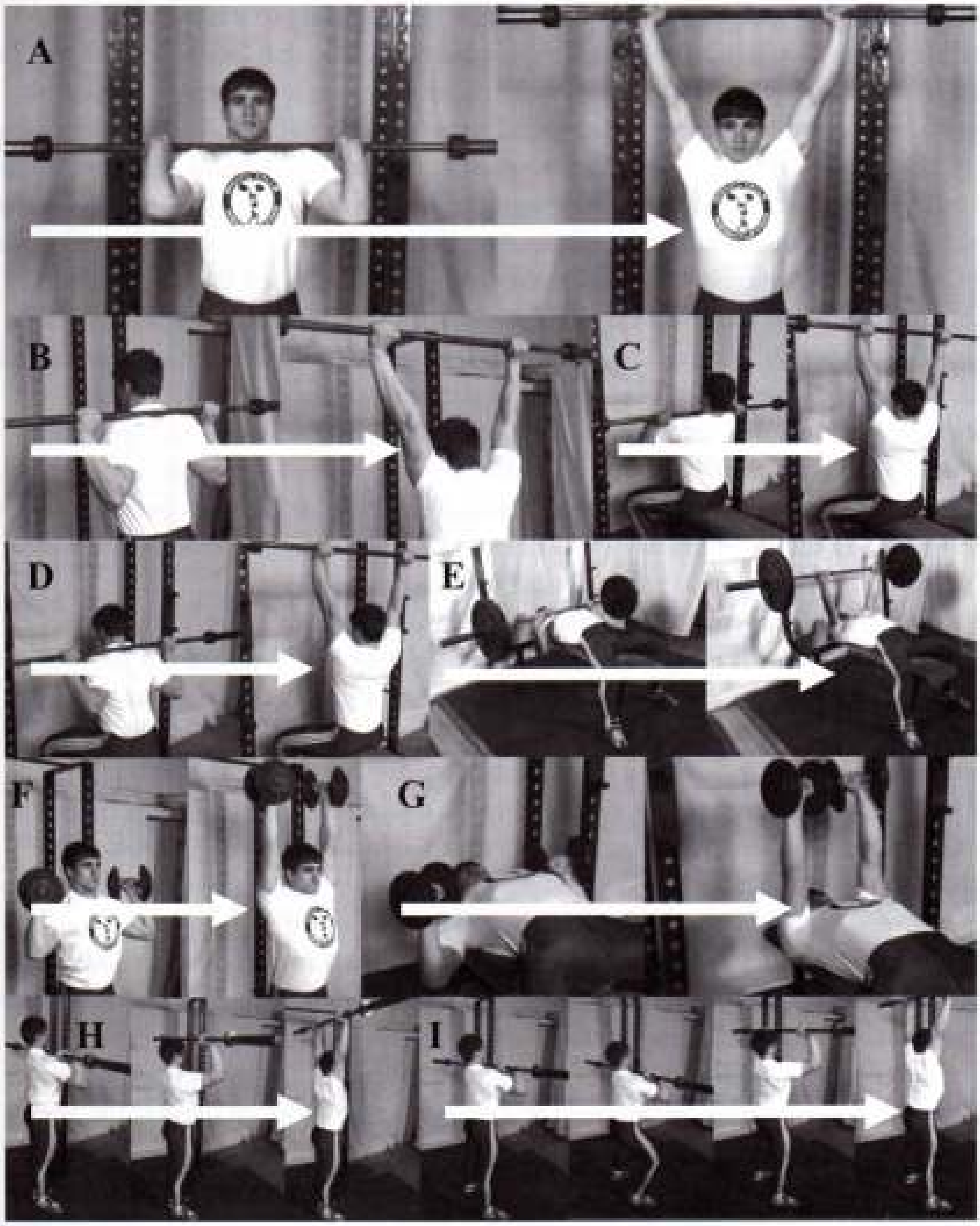


Figure 1. The press was and is a mainstay for upper body strength development. In this photo circa 1969, Bill Starr, now retired NFL and NCAA strength coach, presses 350 in the gym.

Back then, the standard test of upper body strength was the Press, or more correctly, the Two-hands Press. The popularity of the bench press has changed this, to the detriment of athletes and lifters that never obtain the benefits of this more balanced exercise. Bench pressing, a contest lift in powerlifting, actually became popular among bodybuilders first, when large pectorals became the fashion in physique contests starting in the 1950s. Powerlifting incorporated the bench press as a standard contest lift in the mid-1960s, thus diminishing the importance of the overhead version of the press among those training primarily for strength. The final nail in the coffin was the elimination of the Clean and Press from Olympic weightlifting competition in 1972. The exercise has continued its decline in both popularity and familiarity, to the extent that today one is quite likely to hear a seated behind-the-neck press described as a "military press."

Figure 2. Tommy Suggs demonstrates a moderate degree of layback in this 1968 National Championship photo. The press was eliminated from Olympic competition due to difficulties in judging. It was not uncommon to see lifters "lay back" and press. Vasily Alexyev, the noted Soviet Superheavy did a more extreme version, akin to a standing bench press.



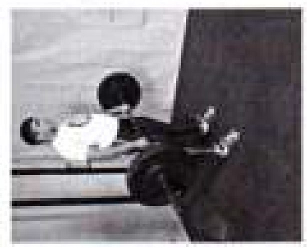
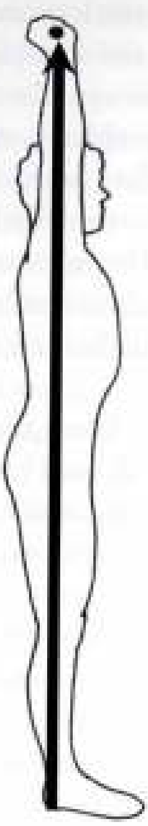


Figure 3. Various pressing exercises: A. Press, B. Press behind the neck, C. Seated Press, D. Seated Press behind the neck, E. Bench Press, F. Dumbbell Press, G. Dumbbell Bench Press, H. Military Press (heels together), and I. the Push Press.

So, a terminology lesson is in order (figure 3). A "press" refers to a movement performed while standing, whereby a weight is extended to arms length overhead with the use of the shoulders and arms only. If a barbell is used in both hands, it is properly a two-hands press, although it is understood that the unqualified term "press" refers to a barbell press using both hands. Any deviation from this description warrants a qualifier. A Seated Press would be a two-hands barbell press done in a seated position, an exercise that requires special equipment to be performed, unless the lifter is capable of cleaning the weight and sitting down with it on his shoulders, and then lowering it to the floor after the set. A Dumbbell Press is a standing two-hands movement, unless the one-hand version is specified. Any press performed supine on a bench is a Bench Press, the barbell being understood as the equipment unless a Dumbbell Bench Press is specified. If the barbell is used behind the neck, this is part of the name. A Behind the Neck Press is a harder movement than a press; still harder is a Seated Behind the Neck Press. "Military Press" refers to the strictest form of the exercise. The use of the legs as an aid in starting the bar off of the shoulders means that a Push Press has been performed, and no actual press uses the knees. A Military Press is very strict, without any bend of the hips or back used to start the weight.

One of the reasons the Press was eliminated from Olympic weightlifting was the difficulty most judges had in bringing themselves to red-light an excessively weird press. Referred to by the term "Olympic Press", the extreme form of this movement was a "Continental Press", started from the shoulders by the use of a combination of a back hyperextension and a whipping of the hips. Some very adept practitioners could lean back to a point almost equivalent to a bench press, rendering the description of the lift as a "press from the shoulders" rather inaccurate (figure 2). An inexperienced or unconditioned lifter attempting this movement ran the risk of a spinal hyperextension injury, although they were not that common. Experienced, conditioned lifters had very strong abs.

The Press, performed in rather strict fashion (although not so strict as a true Military Press) is the most useful upper-body exercise for sports conditioning. This is primarily because it is not *just* an upper-body exercise. Except for powerlifting and swimming, all sports that require the use of upper body strength transmit that strength along a kinetic-chain that starts at the ground. Any time an athlete pushes against an opponent, throws an implement, uses a racquet or club on a ball, or transmits force to an object, that force starts at the ground. The kinetic-chain - the parts of the body involved in the transmission of force from the places where it is generated to the places where it is applied - starts at the ground and ends at the bar in the hands when performing a press (figure 4). The kinetic-chain in a bench press, in contrast, begins at the point on the bench where the upper back interfaces with it, and ends at the bar in the hands (figure 5). Proficient bench pressers involve the legs all the way down to the ground, thereby adding to the length of the kinetic-chain, but can still perform a significant percentage of their best lift with their feet up on the bench, or even up in the air. And even a very proficient bench presser, using the trunk in as efficient a manner possible, is still lying on a bench, not balancing the load *and* using his entire body against only the ground as he presses.



Basic bench press performance is different from the press in that it is primarily an upper body exercise. It is an unusual thing in sport to actually place the back against an immovable object and use it to push against. The press involves the entire body down to the feet against the floor, using all the trunk musculature and the hips and legs to stabilize the body while the shoulders, upper chest, and arms press the bar overhead. Both exercises are closed kinetic-chain movements - where movement begins at the non-fixed end of the chain and stops at the fixed end – but the use of the entire body in the kinetic chain is inherent in the press.

It differs also in that the bench press begins with an eccentric contraction, or "negative," while the press starts from the shoulders with a concentric contraction. The bench press has the advantage of using a stretch reflex out of the bottom to assist the concentric contraction, the up phase of the lift. The press, in contrast, starts the drive up from the shoulders with the bar at rest - the hardest part of the movement is the first part of the movement.

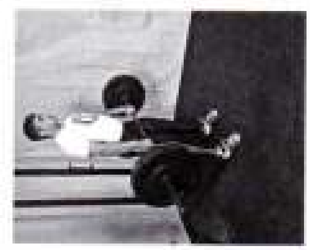


Figure 4. The kinetic chain of the press.

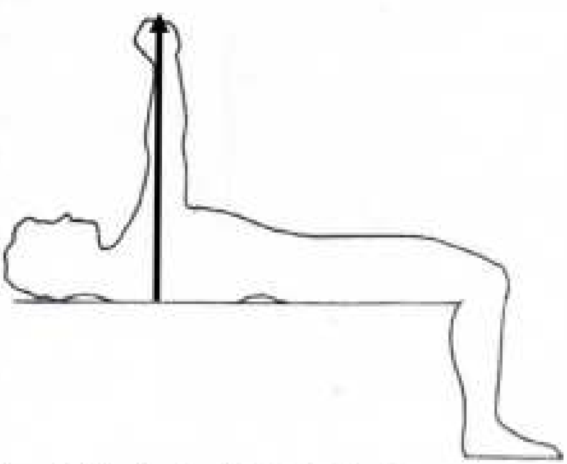


Figure 5. The kinetic chain of the bench press.

For an exercise to be useful as a conditioning tool for a sport, it must utilize the same muscles and the same type of neurological activation pattern as that sport. It need not be an identical copy of the sport movement. (In fact, it has been demonstrated that if the motor pathway of the slower conditioning exercise is too similar to that of the faster sport skill, as in throwing a weighted basketball, interference with correct skill execution can result.) It just needs to incorporate all the muscles involved in the skill in a coordinated way, so that strength is produced in the context of coordination. A sport such as football requires the use of all the muscles in the body, as force is generated against the ground by the hips and legs, transmitted up the trunk, and applied to the opponent through the arms and shoulders. Understand that the force is *not* produced solely and independently by the upper body. Shoulders and arms participate in the production of force, but they are completely dependent on the hips and legs to generate drive, and to react against the ground as they work. In football, the kinetic-chain begins at the ground; in pressing, it begins at the bar. But both movements transfer force along this kinetic-chain through the trunk, and its isometric function is the same in both. The press provides exactly the pattern of kinetic similarity required of a useful, applicable exercise. The bench press does not. We will do them both in this program, but we must realize the strengths and limitations of each.

As a general rule, the more of the body involved in an exercise, the better the exercise. The press produces strength in the trunk muscles – the abs, obliques, costals, and back, as well as the shoulders and arms. It trains the whole body to balance while standing with a heavy weight in the hands. It uses more muscles and more central nervous system activity than the bench press. And it produces force in a more useful direction than the bench press, in which force is directed at about 90 degrees away from the trunk. Most use of the arms in football is at an angle well above 90 degrees. The press, producing force vertically overhead, is not an exact match, but it is much closer to a useful direction than the bench press. If it were not for the fact that football players don't put their backs against solid objects and push against them, the Incline Bench Press would be a pretty good exercise. Some programs have switched to the incline for this reason, but this still ignores the important kinetic-chain element of the press (figure 6).

In fairness to the bench press, it is possible to lift a lot more weight on the bench than standing with the bar in the hands. For simple upper-body strength, the bench is the better exercise. Doing both enables the strength from the bench press to be applied in a more useful

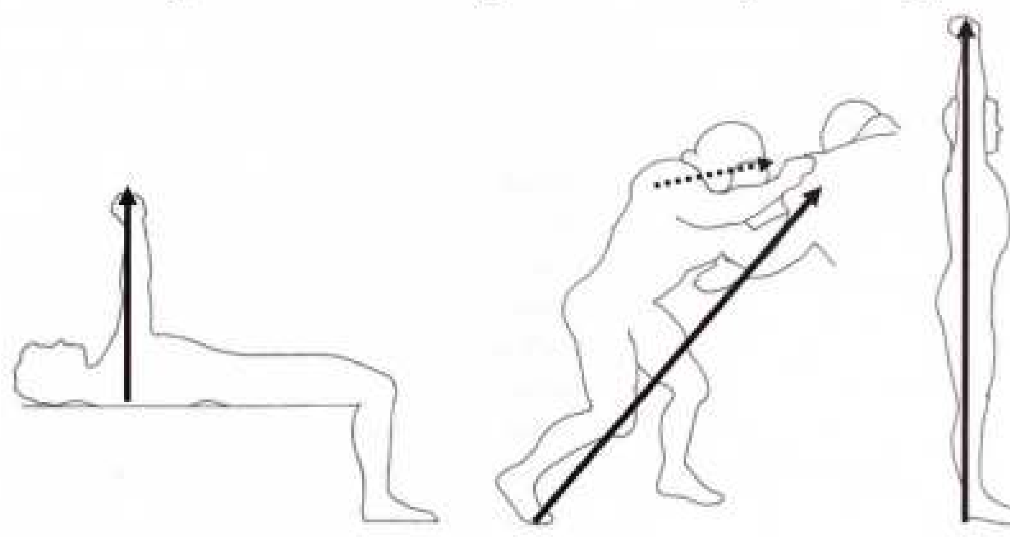
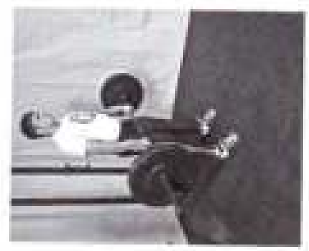


Figure 6. Comparison of kinetic chain vectors of bench press, typical football activity, and the press. Note that in the lineman's effort there are elements of both vertical and horizontal force application. The press strongly develops the trainee's ability to push at or near the vertical while driving from the ground.

way for sports. But athletes that never do anything but bench press tend to have more shoulder problems than those who include overhead training. With all the pressing emphasis directed to the anterior side of the shoulder, the posterior gets relatively weak. Since it is possible to bench very heavy weights with years of training, this strength imbalance can be very pronounced. The posterior shoulder musculature includes the very important rotator cuff group (the external rotators), the muscles responsible for decelerating internal humeral rotation during throwing movements (figure 7).

The rotator cuff basically consists of the muscles on and immediately beneath the shoulder blades, and although they do not work directly in a press, they are used isometrically in the movement and are strengthened. The bench press does not work them much at all, certainly not much in comparison to the loads being handled by the pectorals and anterior deltoids, which function as the main internal rotators of the humerus. If the internal rotators become strong enough to exceed the capacity of the external rotators to decelerate the humerus during a throw, injury can and often does occur. This problem is usually addressed in physical therapy with direct work on the rotator cuff involving very light isolation exercises. It can be addressed in training before the problem ever starts by making sure that bench press work is balanced by an equivalent amount of overhead work. For every bench press workout there should be at least one press workout.

An absolutely wonderful thing about the press is its simplicity. It is a very easy movement to learn and perform correctly. But it is a very hard lift to do with a lot of weight; most people can work productively for many years developing their ability to do it well. A silver lining in every cloud, eh?



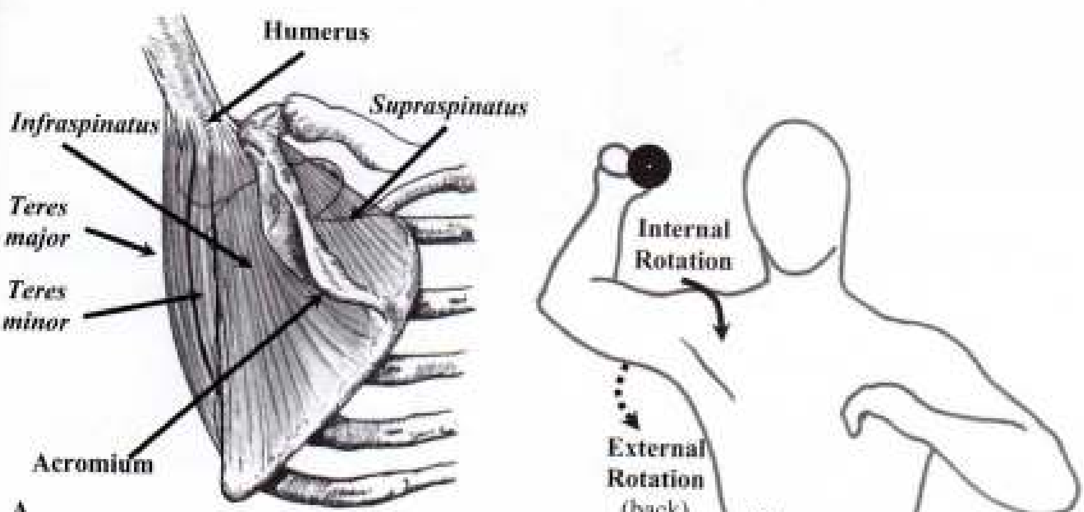


Figure 7. A posterior view of the rotator cuff muscles (A). They decelerate humeral internal rotation during throwing (B). The press helps in developing a stable shoulder girdle due to the rotator cuff's isometric function during the exercise.

Press teaching order

Figure 8. The hands should grip the bar outside the shoulders.

Figure 9. A closer view of the grip position. Note the spacing on the standard bar, and the thumbs-around grip.

1. The press starts at the rack with the empty bar. After a good shoulder warm-up, have the trainee approach the bar. It should be set at the same height as for the squat, at about the middle of the sternum. The grip should be narrower than either the squat or the bench press, not much more than an inch or so wider on each side than the widest part of the shoulder (figure 8). For most people this will put the index finger about an inch and a half into the knurling on a standard Olympic bar (figure 9). The choice of equipment may not be up to the coach here, and most people will need to work with what they have, so make note that a standard Olympic weightlifting bar has a 16 1/2" (42cm) space between the knurls (there is no standard center marking for a powerlifting bar). It might make things easier to mark all your bars to this standard so that everybody can use the same grip width every time. The thumbs should be around the bar with the weight as close to the heel of the hand as wrist, elbow, and shoulder flexibility permits (figure 10). This position may be hard to maintain at first, but flexibility in these joints will improve rapidly.

2. Now have the trainee take the bar out of the rack, the EMPTY BAR. The idea is to have the bar resting on top of the anterior deltoids at the start of the movement (figure 11). Many inflexible trainees will not be able to get the shoulders far enough forward and up to put the bar in this position. Again, flexibility improves quickly, so just point out that this is where it's supposed to be, and that he should try to get it there. The movement can be done from a less than perfect position without any real problem. Now, have him rotate his elbows forward and up so that the elbows are in front of the bar when viewed from the side (figure 12).

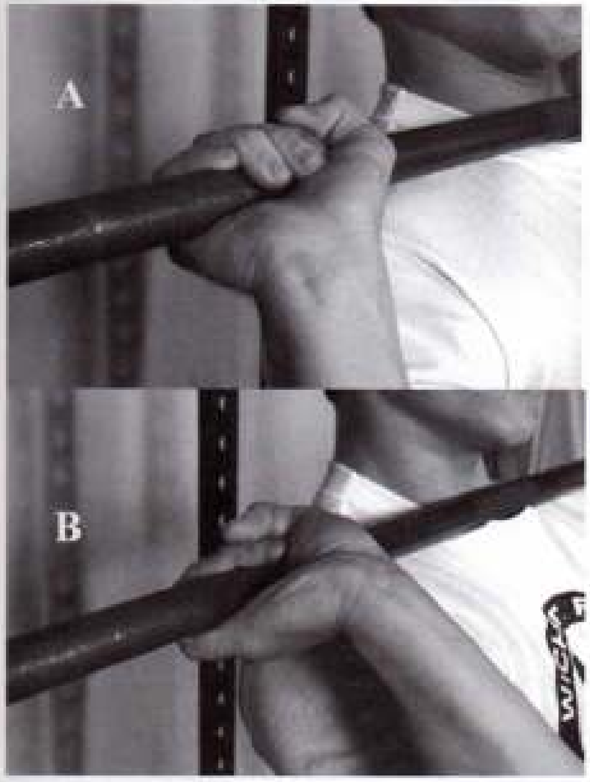
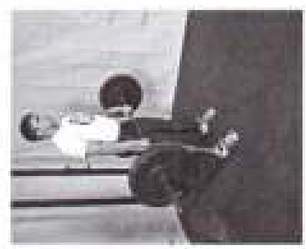


Figure 10. Correct positioning of the bar is as close to the heel of the palm as possible (A) not back on the fingers (B).

Figure 11. The bar rests on the anterior deltoid. Inflexible trainees may have difficulty keeping the bar in contact with the shoulder – as flexibility in the wrists and elbows increases, this position will improve.

Stance in the press is not precisely critical as with the squat. Strict military press form requires that the heels be together, but this is not necessary for our purposes. Tell him to take a comfortable stance, and he will usually end up with something that will work. Heels will be about 10 to12 inches apart. Much closer than this would be a balance problem, and much farther apart just feels weird and is uncommon to see with most trainees.



Many initial position problems will fix themselves with a correct positioning of the eyes. Have him look straight ahead to a point on the wall level with his eyes. (It is assumed that you are in a facility with walls.) Tell him to stare at that point, to not look away from it for the whole set. It may be necessary to give him a point to look at. Do not hesitate to draw a big dot on a sheet of paper and hang it up for your trainees. It will show them that you are serious about this, and give their little brains a new thing to focus on.

3. Tell him to lift his chest. The bar on the shoulders will provide the cue for the direction you mean when you say this, and most trainees will raise the bar up by lifting the sternum up (figure 13). This is actually accomplished by placing the

Figure 12. The elbows are positioned in front of the bar. This helps the bar to be rested on the shoulders, and provides for the correct direction of drive up.

upper part of the erector spinae in contraction. "Chest up" is really a back contraction, and the press and the front squat are the two best exercises for strengthening and developing control of these muscles. Lifting the chest improves the chances that the bar will move in the correct path during the press, and improves stability between reps due to the tightness produced in the upper back.

4. When the elbows are up correctly and the chest has been lifted, the bar is ready to press. We will first show him where the bar is going at the top, so that he knows its position at lockout. Then we will show him how to get it there.

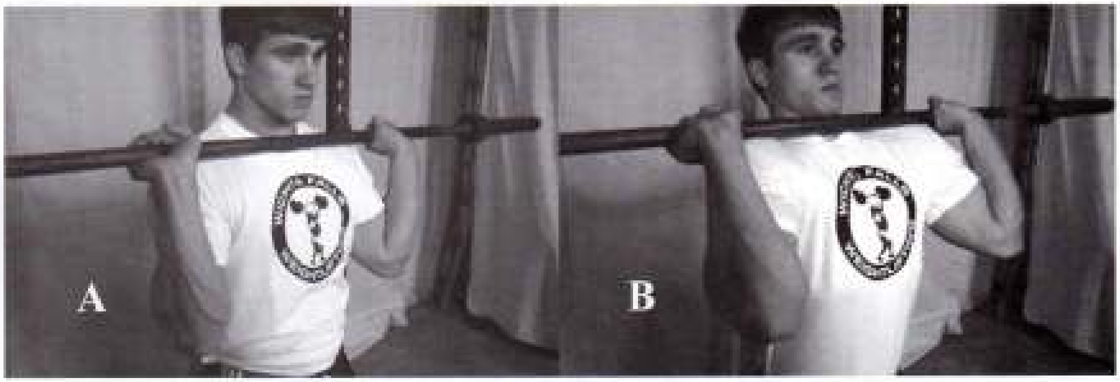


Figure 13. Trainees will be tempted to hold the bar as in A above. In this position the upper back is relaxed and the shoulders have no firm platform for the drive up. Rotating the elbows forward and lifting the chest up as in B above corrects this position.

Tell him to take a big breath, hold it (our friend the Valsalva Maneuver), and "drive the bar up over your head." (The breath should be held until the bar is replaced on the shoulders.) The vast majority of trainees will press the bar up to lockout but in a position just in front of their foreheads. Stand right behind and to the side, and say, "Now, that is NOT over your head." Reach up and touch the bar and gently pull it back to a position directly over his ears, a point that should correspond to the highest point on his skull when he is looking directly ahead with his neck in normal anatomical position. Say, "This is over your head." He should understand (figure 14).

Figure 14. Trainees usually want to leave the bar in front of the head. Use the technique above to get the bar back over the ears. Be careful to move the bar back slowly, without jerking the shoulders.

Figure 15. Gentle pressure on the elbows will help the trainee understand "lock out". Coupled with a gentle upward pressure that encourages a shoulder shrug, the contribution of the traps to the movement can be taught.

Now move to a position directly behind him and look at his elbows. They will usually be almost locked out, but not quite. Grip his elbows gently, and at the same time as you push them together, which will lock them out, pull them up so that his shoulders shrug up from the traps (figure 15). Say, "Lock your elbows all the way out." Then touch his traps and say, "Now shrug up from here, like you're not through pushing." The combination of locking the elbows out and shrugging the traps up at lockout with the bar directly over the ears produces a very firm, stable position at the top. This whole procedure should take only a few seconds. Have him repeat it for a set of five, "breathing at the shoulders" before each rep, then have him lower the bar to the original start position and walk it back into the rack. Have him touch the vertical part of the rack, not the horizontal part of the hook, so that he doesn't miss, and then set it down.

After he does the first set, he is ready to be introduced to the key concept of the press: how to get under the bar. This involves making the bar path correct, and, establishing the proper movement of his body in relation to the bar. Have him take the bar out of the rack and assume the starting position. Then explain that he needs to get under the bar, and that means that the bar has to go from his shoulders, in front, to over his ears, kinda in the back. That represents a lateral movement of a few inches, but bars like to travel in straight lines up and down, especially when heavy.

The way to make up the distance is like this: have him lean back slightly, very slightly, and drive the bar up straight. As soon as it crosses the top of his forehead, tell him to "Get under the bar. Move your body forward under the bar and lock it out. Don't move the bar back. *You* move *your* body *forward* under the bar" (figure 16). When he does this correctly, he will find that it is easier to lock out at the top, because the forward movement of the body straightens out the angle of the shoulder, thus driving up the distal end of the humerus and the attached forearm (figure 17). Have him do this for a set of five, and rack the bar. At this point, the vast majority of trainees will have grasped the concept of getting under the bar, but will have made it very difficult by pushing the bar too far forward, away from their chins, thus increasing the distance back to the lockout position over the ears. Fix this on the third set, still with the empty bar, by saying, "Now, keep the bar close to your face on the way up. Aim for your nose as the bar leaves your shoulders." With a slight backwards lean, he will drive the bar straight up with this cue. At worst, he will only hit himself in the nose once before he figures it out. Have him do a set of five and rack it. Start up in ten or twenty pound jumps until the bar speed begins to slow markedly on the fifth rep of the set, and call it a workout.

Faults and Corrections

There won't be nearly as many problems with the press as there are with the squat, because there are fewer joints actively participating in the movement of the bar. Most problems are either starting position problems, or bar path problems.

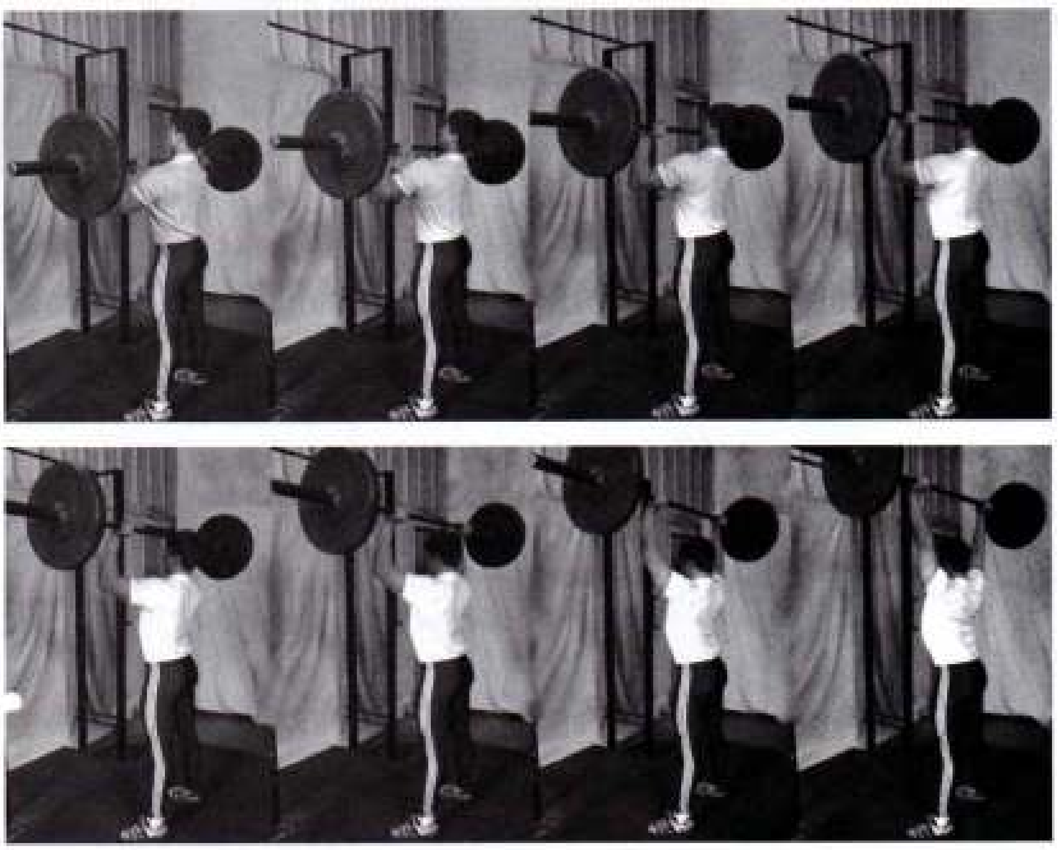


Figure 16. The press. Note that in the initial drive from the shoulders, the trainee is leaning back just a bit. Then, as the bar clears his head, he moves back forward under the bar.

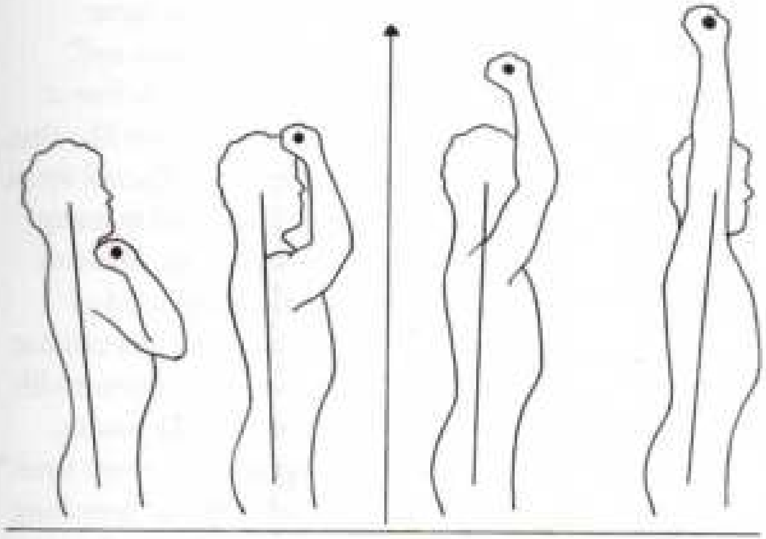


Figure 17. Note that the angle of the torso moves from slightly behind vertical to slightly ahead of vertical between start and finish.

As mentioned earlier, eyeball position is important for good body position. If your trainee is having problems of any kind, always check to make sure his eyes are looking at the right place. This solves lots of problems with all the lifts in this program.

The preferred torso alignment is nearly vertical, especially at first. The stronger and more skilled the trainee becomes, the more trunk movement he can correctly incorporate into the press. Actually, leaning back excessively is seldom a problem at first. It will not occur to most people that they can lean back to start the press until well after they have begun training the movement. If the kid leans back, look at his elbow position. It will usually be too low, with elbows behind the bar. He's trying to lean back to make a flat spot for the bar to be stable, not perform a Norbert Schemansky-style continental press. Have him rotate his elbows up to the right position and usually he will stop leaning back. If he still leans back, point it out to him and tell him to "stand up straighter."

Letting the chest cave in, so that the upper back is loose, is a more common problem. Heavy weight on a military press is an uncomfortable enough thing already, without exacerbating the problem with a lack of good support. Keeping the chest up is the way to keep the thoracic spine in proper anatomical position, and this is accomplished with the upper back muscles (figure 18). When the upper erector spinae contracts, it rotates the ribcage up, holding it in place against the load on the shoulders. A cue to "lift the chest" is usually all that is required, but most trainees will need to hear this with every rep for a while. Most people's attention span is short under a bar, and focus on technique is more

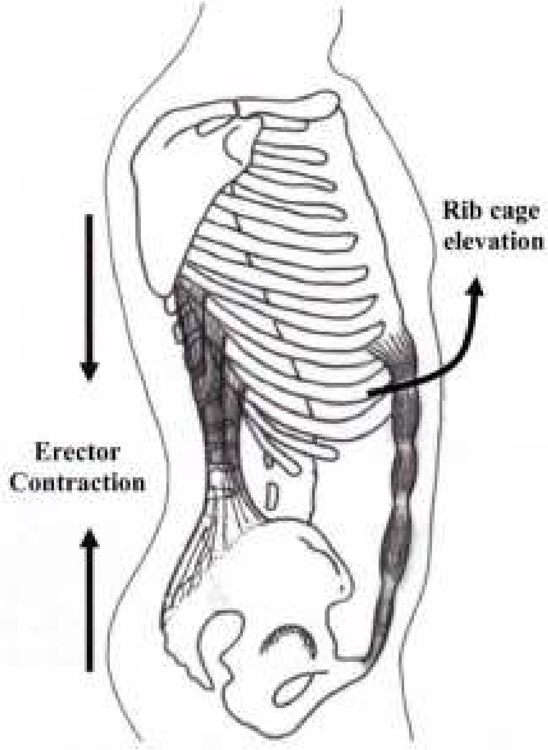


Figure 18. When the spinal erectors contract, the rib cage is elevated to the anterior.

difficult the heavier the weight gets. It is usually necessary to cue these form corrections with a quick "Chest up!" several times over several sets before it soaks in. Many position cues are like this, in that they are perceived and acted upon when they are given, but it takes many reminders to actually alter an incorrect motor pathway. He may get tired of hearing you say the cue, and you can use this too. Say, "This set, I want you to lift your chest without me telling you to. Think about it! Lift the chest every time."

There are two different breathing patterns that can be used during the set. The first, which seems to be more useful for novice trainees using lighter weights (but not always, your call), is to breathe at the top of the press, at lockout. It has to be a quick breath, taken without relaxing anything that is supposed to be tight, and has the advantage of allowing the trainee to rebound the bar quickly off of the shoulders. This use of a stretch reflex is fine at first, but most lifters tend to outgrow this and adopt breathing at the shoulders between reps. This method requires that the lifter stay very tight, with chest up during the breath, a thing learned with experience. Breathing at the top allows the novice to handle heavier weights while he is learning the skills necessary to maintain control during the press. Breathing at the shoulders allows the more experienced lifter the luxury of a second or two of rest between heavy reps. Try both methods and see which works best in each particular situation.

The most common form problem with light weights is the bar out in front too far, away from the face, producing a curved bar path (figure 19). This doesn't happen with heavy weights, because heavy weight can't be pressed like this. If the trainee is allowed to push the bar forward off his shoulders instead of straight up, he will never get strong enough to handle big weights anyway, so this problem only occurs at light weight by default. It is most often the result of allowing the elbows to drop into a lower position that puts the forearms behind the vertical, instead of up where they should be. This is an easy thing to correct, if caught early, he just needs to be told to raise his elbows, and "aim for your chin," or "push the bar toward your nose." He may hit it once, but that will usually be the only time.

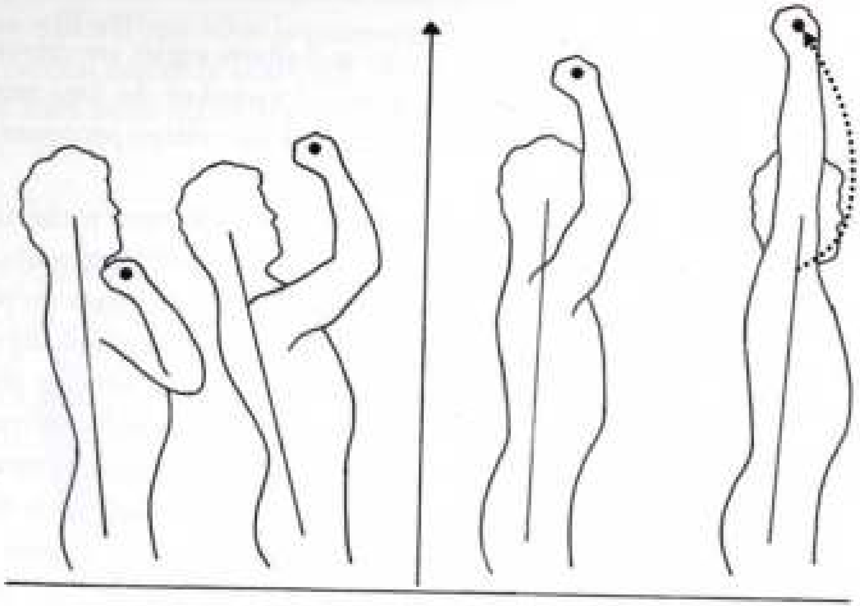


Figure 19. A common error is pushing the bar away, as though the trainee is afraid to get the bar too close to the face. This produces a curved bar path and a very inefficient movement.

Leaving the bar out in front, not "getting under the bar," is a different problem, and most definitely will occur often at heavy weight. This can occur when the bar has been started perfectly straight up, but after the lifter fails to move forward under the bar when it crosses above his head. Heavy weights tend to blur awareness of the fine points of technique, as anyone who has trained heavy knows. We depend on our training, which has embedded the correct motor pathway, and our coach, who can see a problem developing and can cue a correction, to keep our form good. Most often, when a lifter misses a heavy press in front, he won't know why. Most often he didn't get under the bar. As he gets to the point on the way up where he should move forward, in fact just before he gets there, say, "Get under it!" This should trip the trigger, provided he actually knows how to do this.

There is another way to make the body get forward under the bar. As is so often the case in coaching, a thing can be explained many different ways, and occasionally a trainee will require you to use all of them before you find one that elicits the desired response. You as a coach are required to know both the mechanics of the movement and how to explain them well enough to be able to get a trainee to move correctly under the bar. The lockout of the press can be thought of as the shoulders moving forward under the bar, but it can be approached from the opposite direction and thought of as the hips moving *back* as the bar crosses the forehead. These are obviously two different ways to explain the same concept. If the lift starts with a slight back extension, lockout is facilitated when the back is straightened and the shoulder and elbow angles are driven up, as previously illustrated. Either the chest and shoulders moving forward or the hips moving back produces the same net effect relative to the bar; whichever the trainee processes more readily is the one that works best.

An emphasis on getting forward under the bar can result in a balance problem (noticeable as a tendency to be on the ball of the foot during the drive and lockout). A good connection with the ground requires that the weight be evenly distributed over the whole foot. Also, any shifting forward during the press must be done in the context of the entire body staying in balance under the bar. If the forward shift is sufficient to actually alter the center of gravity of the bar/lifter system, the lifter will have to compensate by moving a foot or both feet to avoid losing the bar. Getting under the bar comes from a shift in torso position, not from a shift affecting the body all the way to the ground. This much movement disrupts the kinetic-chain and the lift. It may be necessary to overcorrect the trainee to keep his weight on his heels in order to average him out to the middle of the foot. Say, "Drive from the heels" during the set, and he will usually correct immediately. This is really an easy problem to fix, because it doesn't feel good to be off-balance and he will be receptive to your suggestion.

Leaning back is a problem that gets worse as the weight gets heavy. Virtually every lifter will do this after a few weeks of training as strength improves and he learns that the bar can be started from the shoulders with a hip drive. This movement is an important part of the lift, and is only a problem if excessive. Excessive is bad because it alters the movement sufficiently that the target muscle groups get left out, the desired anterior/posterior balance across the shoulder is lost, and extreme loaded hyperextension of the lumbar spine is

Figure 20. Too much lay-back is to be avoided. If the elbows move forward as the chest and shoulders move back, neither can be in an efficient position for shoulder drive. Lay-back is excessive when it causes a missed press.

dangerous. Furthermore, excessive is really a judgment call on the part of the coach. Experience will tell you what is excessive. If a trainee consistently misses heavy presses out in front at a certain degree of lean-back, that much is excessive if the coach feels that the miss would not have occurred with a better back position (figure 20).

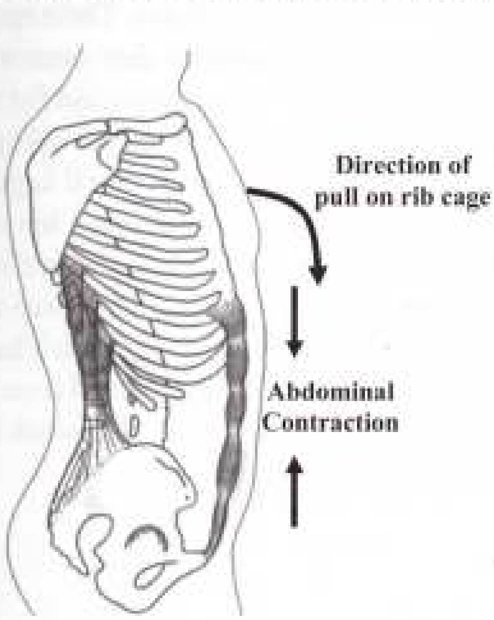


Figure 21. If excessive back arching is noted, it may indicate that the trainee has underdeveloped abdominal musculature. The rectus abdominis supports the trunk and prevents lay-back.

Part of the problem may be weak abs. The rectus abdominis acts directly against lumbar hyperextension by providing tension between the ribcage and the pubis, counteracting lumbar hyperextension and increasing intra-abdominal pressure to reinforce correct lumbar curvature from the anterior side of the trunk (figure 21). Weighted situps, or more specifically weighted Roman chair situps develop a strong set of abs (figure 22). This, along with a coach's reminder, can help with this problem in the press, but it will be something that has to be watched as long as the press is trained heavy.

Another common problem is that when the weight gets heavy, most trainees try to make the press into a push press, by starting the bar up with a push from the knees. This is a logical way to cheat, after all - the hips and legs are much stronger than the shoulders and arms. If a push press is the intended exercise, then it must at least be done correctly, with the bar resting firmly on the deltoids for a firm transfer of power to the bar, and

Figure 22. The Roman Chair Sit-up. A great developer of abdominal strength, this exercise will help the trainee maintain proper pressing form and trunk stability during all types of exercises and sporting activities.

a sharp dip and drive using hips and legs, not a slow push out of the knees. But if we are trying to do a strict press, then it must be done with strict form. If the weight is too heavy to do with strict form, take some off.

Some people are reluctant to admit they have too much weight on the bar, in the same way that they are prone to take too big an increase in weight each workout. Their ego interferes with their thinking, causing them to attempt to handle weights they cannot do with correct form. As with all exercises, correct form is necessary for real progress and for safety. The push press enables heavier weight to be handled, true, but the shoulders are doing less of the work while the triceps are getting better at locking out the bar. This is fine if kept in proper perspective: push presses make a good assistance movement for the press, but they are no substitute for it. Strict work with good form causes strength to be developed in the target muscle groups. More importantly, we need to learn how to bear down on a hard rep and finish it without cheating it, so that we develop the mental discipline to stay with a hard task and finish it correctly. This is one of those indirect benefits that can be obtained from physical education. Our job as coach is to ensure that proper form is used, that work is done correctly, and that everybody leaves better than when they got there.

The Power Clean

The power clean cannot be done slowly. Therefore there is no confusion over the nature of the exercise. The power clean is used in sports conditioning because it increases explosion and done correctly is the best exercise for converting the strength obtained in the other exercises to power. Since the nature of the vast majority of sports is explosive, involving the ability to accelerate the athlete's body or an object, the ability to accelerate is pivotal in sports performance. The power clean is our most important tool in the war against inertia.

In his famous book "The Strongest Shall Survive," Bill Starr included the power clean in his Big Three, with the comment that "If your program only allowed you to do one exercise, this would be the best." The power clean has always been used by weightlifters to train the clean, the more complete and more complicated version of the lift. The term "clean" refers to a way to get the bar clear of the floor "clean" to the shoulders. If this is accomplished in one movement, it is a clean; if in two (if it stops on the way up on the chest or a belt), it is referred to as a "Continental Clean". Heavier weights can be lifted in the Continental style, but a clean requires more power to make the bar complete its trip in a single effort. In the modern usage of the term, the "Clean" refers most commonly to a full squat clean (figure 1). It has not always been this way. The split clean – a style that made use of a forward/back split like that commonly used for the jerk in Olympic weightlifting – was used more commonly until the 1960's (figure 2), when the squat style began to be favored due to the heavier weights that could be lifted with this front squat-based technique. The term "power" as a qualifier in front of an exercise refers to an abbreviated version of a more involved movement, the shorter version being harder to perform at the expense of reduced technique requirements. A "power snatch" is a snatch without a squat or split, the use of which reduces the height the bar must be pulled. The "power jerk" is a version of the last part of the Clean and Jerk where the feet do not move. Likewise, the "power clean" is the version of the clean without a split and without too much squat.

Figure 1. The power clean is a variation of the "Olympic" clean, a movement where the weight is caught in the full front squat position. Bill Starr cleans 435 at the 1969 nationals.

Figure 2. Another variant of the clean used commonly through the 70's was the split style clean. Note the depth of Bill Starr's split.

The clean requires pulling the barbell up fast enough and high enough, using power generated by the hips and legs, to catch it on the shoulders. As such, the faster it comes up, the higher it will go and the higher the bar can be pulled the more weight can be cleaned. As a corollary, the lifter can clean more weight if he can get better at getting under a bar not pulled as high. This is the purpose served by splitting and squatting: it shortens the distance the bar has to be pulled. Since our purpose is sports conditioning and not cleaning heavy weights per se, we will use the power version of the lift.

The term "power" has a very specific meaning in the study of mechanics. Power is defined as the amount of work performed per unit of time, and physicists measure it in joules per second, or watts. As a practical matter – and as we will use it here – power can be best understood as the ability to exert force rapidly.

More terms now: Velocity is the speed of a moving object. Acceleration is the rate of change of that velocity, the *increase* in the speed. For an object to accelerate, force must be applied to it. Strength is the ability to generate force. "Power" is the ability to generate that force rapidly. A more familiar term for this might be "quickness". Just developing an athlete's strength is not enough – we must also develop his ability to rapidly recruit the strength he is building, so that he can accelerate better. A strong man might very well be able to apply enough force to a very heavy weight to get it moving, but a powerful man can get it moving more quickly.

The vertical jump is a valuable diagnostic test for power. It directly measures the athlete's ability to generate force rapidly enough to accelerate his bodyweight off the ground. It is used to predict this aspect of performance. Studies have shown that vertical jump performance is predictive of sports proficiency, that power clean performance is predictive of vertical jump performance, and that power clean performance is predictive of squat strength. Squat performance is predictive of squat jump performance, and squat jump performance is predictive of power clean performance. The power clean, by training the athlete to move a heavy weight quickly, is the glue that cements the strength program to sports performance.

One way to understand the concept of power in this specific situation is by comparing performances in the power clean and the deadlift. As we have already seen, the deadlift is a straight pull off the floor, standing up with the bar and stopping at arms length, whereas the power clean continues the pull on through an explosive phase up to a catch on the shoulders. A deadlift can obviously be done with a heavier weight than a power clean, if for no other reason than that it is a shorter movement. So a power clean can be thought of as being done with a percentage of the deadlift. A very strong powerlifter can deadlift two to three times his power clean. (If he trains it at all. In the early days of powerlifting, most competitors had weightlifting experience or were coached by people who did.) So his power clean might be 40% of his deadlift. But a very powerful Olympic weightlifter might power clean 85% of his deadlift. This is a direct result of training specificity: the powerlifter is good at pulling big weights slowly, and the weightlifter is good at pulling moderate weights faster, and thus higher. But it could be that the weightlifter has not trained with sufficiently heavy weights to develop his deadlifting strength. Or it could be that the powerlifter has neglected to develop his power off the floor (sorry for the awkward sentence, due to the bad choice of name for the sport – it should be "strengthlifting", but I predict that my suggestion will not be adopted soon). Actually, the question is this: why is the higher-velocity weightlifter cleaning a higher percentage of his deadlift than the lower-velocity powerlifter? We shall soon see.

As evidence that strength and power are related, George Hechter incorporated power cleans and clean high-pulls (the partial version of the clean, where the bar is shrugged hard but not racked on the shoulders) into his deadlift training, by warming up his deadlifts with the explosive movements up to about 60% of his max single deadlift, and then deadlifting on up to his work sets. His best deadlift of 825 lbs. at a bodyweight of 242 is testimony to the effectiveness of this approach. The popular Westside method, developed by the amazing Louie Simmons, utilizes the concept of power development by using weights in the range of 50-75% of max in the squat, bench press, and deadlift with an emphasis on maximum acceleration during the reps. His lifters have rewritten the records in all weight classes as a result of his ingenious incorporation of the principles of power/strength production into the training of athletes whose emphasis has historically been training for strength. He has figured out a way to train the squat, bench and deadlift as if they were the Olympic lifts, by training them with weights that can be used at the velocity where maximum power is produced.

This range, 50-75% of 1RM, is where maximum power is produced. The range represents differences in the nature of the various exercises, whether the exercise is primarily an upper-body or lower-body movement, and the skill, strength, and experience of the individual athlete. At weights heavier than this, velocity drops off to the point where power begins to diminish. At very light weights the velocity is so high that maximum recruitment of muscle is not possible. This is due to several factors involving the physiology of skeletal muscle contraction, among them the fact that a very high velocity movement does not allow enough time for the nerves to recruit many of the components that contribute to muscle contraction. Like trying to throw a wiffleball, a very light weight moving very fast does not provide enough resistance to push against effectively. A baseball is pretty good to throw, because it's just about the right weight to throw hard and fast. Power is at a maximum when throwing a 16 lb. shot, due to the combination of weight and velocity. But a great big rock, or "BFR", would be too heavy to allow for the production of much power, because of the very slow velocity even a very strong man could produce. So the load must be optimum for power production. Weights in the range of 50-75% are in the right range for weight training, for the speeds we use for total-body explosion.

As it turns out, the ability to produce force against a weight is dependent on the speed at which the movement is trained. What this means is that if heavy weights are lifted at a slow speed, the lifter gets good at lifting them at *that* speed. He does not get good at lifting them at a faster speed. So slow deadlift training will not make the clean move faster. And if a lifter gets good at pulling a weight fast, as in a power clean, he gets good at generating force at that faster rate of speed. The rate of speed that is trained is the rate of speed to which we adapt. But this rule only works well in one direction: strength developed at a slow rate of speed can only be effectively used slowly, but strength developed at a high rate of speed can be used at that high speed and *at speeds slower than that.* It is incredibly important to understand this. **High speed training, with enough weight to make high power production necessary, makes for useable strength at a wide range of speeds from fast with moderate loads where the training takes place to slow with heavier loads, where the contest squat, bench and deadlift are done.**

This is probably due to the way the central nervous system adapts to exercise, and the way it plugs in to the muscles. The most demanding way to use the muscles and the nerves that run them is explosively, with weights that require the production of maximum power. If muscles are trained to do this efficiently, the slower jobs, even with heavier weights, are a piece of cake.

So the next logical question is this: why do we need to squat at conventional speeds – to develop strength at slow speeds – if we are training for explosive sports? The reason is that there are slow and isometric components to even explosive movements that benefit from the strength developed at slow speeds. A clean has a slow phase off the floor that benefits from the strength it takes to maintain the position until the explosive phase. The explosion at the top does not benefit from the slow strength developed in the squat, but the rest of the lift does, from the floor pull to the catch and support position at the top. Likewise, a hit in football, while it has explosive components from off the ground till the moment of impact, takes on slow strength characteristics after contact is made. In fact, there are few examples in sports of movements that don't have both slow and fast components.

And since strength gained at a given speed translates down to slower speeds, but not up to faster speeds, the squat and deadlift at slow, conventional speeds build strength at speeds slower than that at which they are performed. This speed range goes from the slow, like that with which a clean comes off the ground, down to zero velocity – an isometric action in the position-holding components of the immobile segments of the body in faster movements.

Both types of training are necessary and each contributes to the development of each other. It should be obvious that a man with a 500 lb. deadlift can clean more than a man of the same bodyweight with a 200 lb. deadlift, because of the great difference in the ability to produce force. But between two men that both deadlift 500 lbs., the one moving it faster is producing more force, is therefore stronger, and is training in a way that teaches his muscles and nervous system to produce even more force. Training faster with a given weight requires more force production, because acceleration requires force. The faster a weight is moved, the more force it takes. And when the ability to produce force goes up, heavier weights can be lifted at all speeds, from the fastest speed trained on down. This is why the power clean makes the deadlift go up and the deadlift contributes to the power clean.

The weight that can be used for a heavy power clean, for most athletes, is the correct weight to use to improve force production. It is heavy enough to have to pull hard and by its very nature cannot be done without explosion. Unless it is moving fast at the top, it will not even rack on the shoulders. Its only drawback is that it is a very technique-dependent exercise. And that is why we are here. Let's learn to do it, and coach it.

Teaching the Power Clean

The power clean is best taught from the top down. This means that the mechanics of catching, or "racking" the bar on the shoulders is taught first, and the emphasis in the trainee's mind is on the rack position from the beginning. It is important for him to learn that in the power clean speed becomes important at the top of the pull, not off the floor. The first part of the pull, from the floor to the mid-thigh, serves to get the bar in the correct position for the explosive movement that racks the bar, and it is done *correctly*, not quickly. From the mid-thigh on up the movement must get faster, but it cannot be done correctly if it has not started from the right place. By teaching the top of the power clean first, and only then worrying about getting it down to the floor, the coach assigns the correct priority to the most important part of the pull, as will the athlete. After all, the first part of the power clean is essentially a deadlift, which we already know how to do. When the top of the pull has been learned, we will slide down a little at a time into a deadlift, making the transition from half a movement to the whole thing.

First, the position at the top, with the bar in the hands at arms length, with straight elbows, straight knees, and chest up is referred to as the **Hang Position**. A power clean done from this starting point is referred to as a "hang power clean" (figure 3). This position is

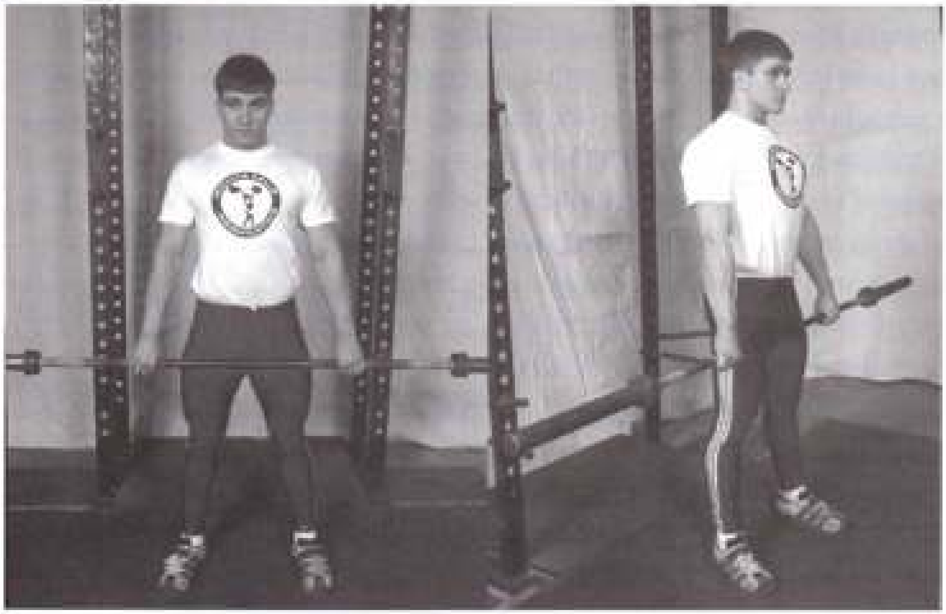


Figure 3. The "hang" position.

assumed by taking the EMPTY bar off the floor with a correct grip and deadlifting it into position. The correct grip will be, for most trainees, about 21 inches between index fingers in a double-overhand grip, just a tiny bit wider than the deadlift grip and an inch or so wider than the press grip. This grip is wide enough to let the elbows rotate up unimpeded into the rack position, to be described shortly, and will obviously vary with the shoulder width of the trainee. Later, we will learn the hook grip, but for now a normal thumbs-around grip will be fine.

Figure 4. The beginners grip.

Figure 5. The basic stance the trainee should assume will be similar to a vertical jump take-off position.

The empty bar will be correct for the vast majority of trainees, but some smaller kids and women may require a lighter bar, a 15 kg women's competition bar, or an even lighter shop-built one to comfortably learn the movement. There is no point in weighting the bar at first, as we are learning the movement only. The empty bar is enough resistance to provide some ballast for the elbows to rotate around. A broomstick is too light to have sufficient inertia to stay in place during the turn, and even light weights on the bar at this point will interfere with focus on what the bar should be doing.

Foot position will be about the same as for the deadlift, 12-15" apart, with toes pointed very slightly out, like the stance for a flat-footed vertical jump. This is the stance that allows most people to apply maximum power to the ground. If this stance does not come naturally to your trainee, have him jump a couple of times to sort this out (figure 5).

From the hang position, have the trainee unlock his knees, shove his hips back, and slide the bar down to the middle of his thigh. This movement should be done with the weight on the heels, and with the shoulders slightly out in front of the bar. The chest should stay up and the back should stay locked in position. The bar slides down the thigh as the knees unlock, the butt goes back, and the shoulders go forward. (figure 6).

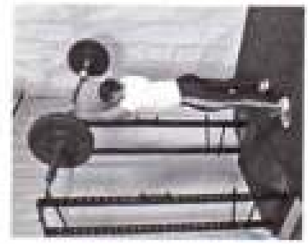


Figure 6. The ready position to begin the "RDL" has the hips back, the knees unlocked, the shoulders over the bar, and the bar on the thigh.

Then have him return to the hang position. During the entire movement, the bar must stay *on* the thigh, touching the actual surface of the leg as it moves down and up. Have him do this short movement until he is familiar with using the hips to move the bar. After he does this short movement a few times, have him lower the bar on down past his knees, and then have him bend his knees to finish the trip to the mid-shin. It should be noted here that *from the point at which the knees unlock they do not move forward as the bar is lowered to the knee, and that from just below the knee on down they do move forward. In other words, hips lower the bar to the knees, and knees lower the bar to the floor.* Coming back up is the exact opposite movement – as he comes back up he will straighten his knees until the bar clears them, and then he will return to the position at the top, dragging the bar up his legs as he extends his hips (see figure x and note the knee position during the movement). Since this is the first part of an exercise called the Romanian Deadlift, or "**RDL**", we will refer to it as such. This movement prepares him to do the full power clean correctly, and integrates the lower part of the pull with the top part of the pull before they can be separated in his mind into two distinct things.

Figure 7. The "rack" position has the bar resting on the deltoids, with the elbows up and the upper arm nearly parallel with the floor.

The next step is the crucial part of the lift: getting the bar on the shoulders. First, the trainee must put the bar in the right place, on top of the deltoids with elbows up, and then secondly he must learn how to get it there correctly. From the hang position, with correct width grip, have him get the bar up onto his shoulders, any way he wants to use right now. It should sit right on top of the frontal deltoids (the meaty part of the front of the shoulder), well off of the sternum and collarbones. The key to this position is the elbows: they must be up very high, pointed straight forward with the humerus as nearly parallel to the floor as

Figure 8. Typically trainees like to feel the weight on their arms instead of their shoulders. Note the incorrect elbow position above. This needs to be corrected immediately as it will lead to discomfort with heavier weights and will ultimately limit performance. Compare this with figure 7.

possible (figure 7). Some trainees will have trouble getting in this position due to flexibility problems. A grip width adjustment usually fixes this. Widen the grip a little at a time until the position is better. If the elbows are up high enough, the bar will clear the bony parts and sit comfortably on the belly of the deltoid muscles. This position is secure and pain-free, to the extent that your trainee will never in his entire life be able to clean a weight that will be too heavy to hold like this. So it is imperative that he understand that *this* is where the bar goes and *not* anywhere else – not sitting on his chest, and not just carried in his hands. He must not stop with his elbows pointing at the floor (figure 8). He will want to do this, and the purpose of this step is to beat into his head the rule that the bar sits on the shoulder muscles with the elbows pointing straight ahead. This position is referred to as the **Rack Position.**

It may take a couple of workouts to stretch his wrists out so that this position is tolerable. Wrist discomfort is the most common complaint among novices learning the power clean. It may help to actively stretch them out between sets, using the free hand to stretch the other wrist.

Have your trainee assume the rack position a few times and watch to see how he does it. If he naturally flips his wrist over as he pulls the bar up and rotates his elbows into position, your next task will be easier. Get him back in the hang position and have him start the RDL again to refresh his memory about keeping the bar on the skin as he slides it down the thigh. Just as he starts down into the RDL, he will have unlocked his hips and knees. This position we will call the **Jumping Position.** His elbows will be straight, his knees and hips will be unlocked, but the bar will not be too far down the thigh (not even halfway down) but on the skin touching the thigh (figure 9). Put him in the jumping position and identify it to him as such.

Now put him in the jumping position and tell him this: "Jump and catch the bar on your shoulders. Catch it in the same place you had it before, with your elbows up. Like this." Demonstrate the rack quickly, just a couple of times with a bar. "Now you try it." He will jump and make some attempt to catch it on his shoulders, most usually with elbows in the wrong place. Before he can put the bar down, grab his elbows and place them correctly pointing forward, and moving the bar into the right position on the shoulders (figure 10).

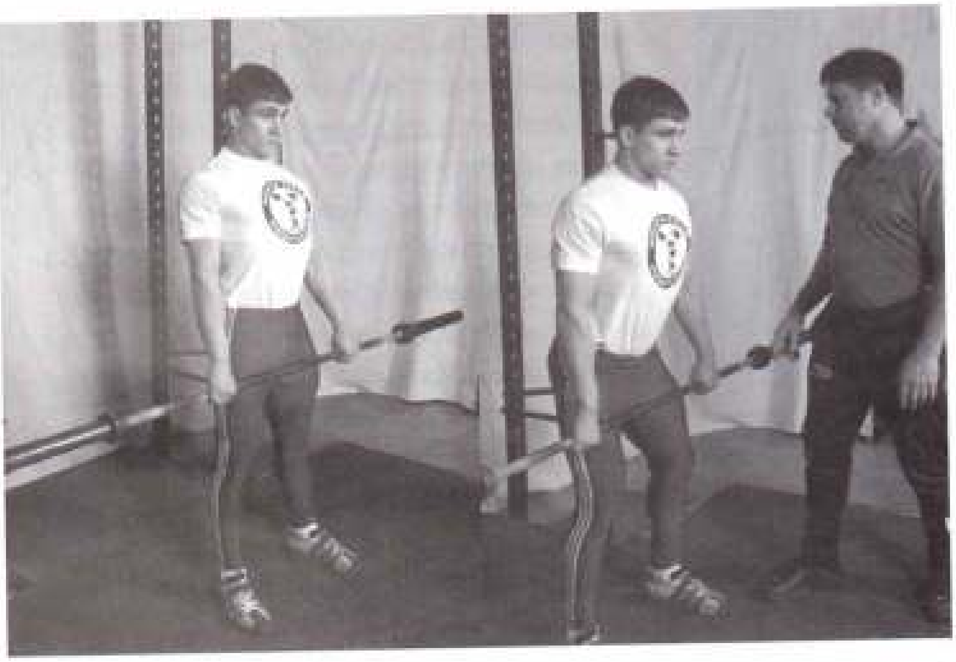


Figure 9. Have the trainee assume the "jumping" position with the bar. The knees and hips are unlocked, the bar is just below the hang position in ***contact*** with the thigh. The trainee "Cleans" when he connects the dots between here and the "rack" position.

Figur 10. When the trainee assumes the incorrect rack position, the coach must be ready to step in and correct the error by physically placing the trainee's elbows in the correct position.

Jumping is the key. The power clean is not an arms movement, and if he first learns that a jump is involved, he will never learn to arm-pull the bar. The jump generates the upward movement of the bar, and later when his form is good the jump will be thought of as an explosion at the top.

Have him put the bar back down to the jumping position and try it several more times. Each time be sure that (1) he starts from the jumping position with the bar *touching* the thigh, (2) he jumps, and (3) he racks the bar with his elbows up high. Observe how close the bar is to his chest as it comes up during the jump. It will usually be out away from his chest several inches. After he jumps and catches the bar in the rack position a few times, tell him to touch his shirt on the way up. Or hold your hand close to his chest and tell him to keep it close enough that he doesn't touch you during the pull.

When he is racking the bar fairly well, tell him to stomp his feet as he catches it. This will be poorly coordinated at first, but will improve very quickly as you encourage him to time the stomp and the catch together. This is a very natural movement, and will add explosion to his jump and quickness to his catch, as he anticipates the faster foot movement required to stomp feet.

Again, be *sure* that each pull starts from the jumping position, *touching the thigh*. This cannot be overemphasized, as the pull will be wrong if the jump starts from any other position (figure 11).

During this process, let him rest as needed. It is not productive to let fatigue interfere with concentration and good form. Take the time necessary to go through this critical process properly.

When he is consistently producing a good jump and rack, with the bar close and elbows in good position, start the next phase of the instruction by having him slide the bar down below the jumping position and then come back up to it to do the jump and catch. He will do this by performing the RDL, as previously shown. As he thinks about this new part of the movement, remind him to touch the thigh as he jumps and to rack the bar with elbows up high. Be sure that he stays in contact with the thigh as he slides the bar down, *that he slides it down by shoving the hips back*, and that he keeps his chest up.

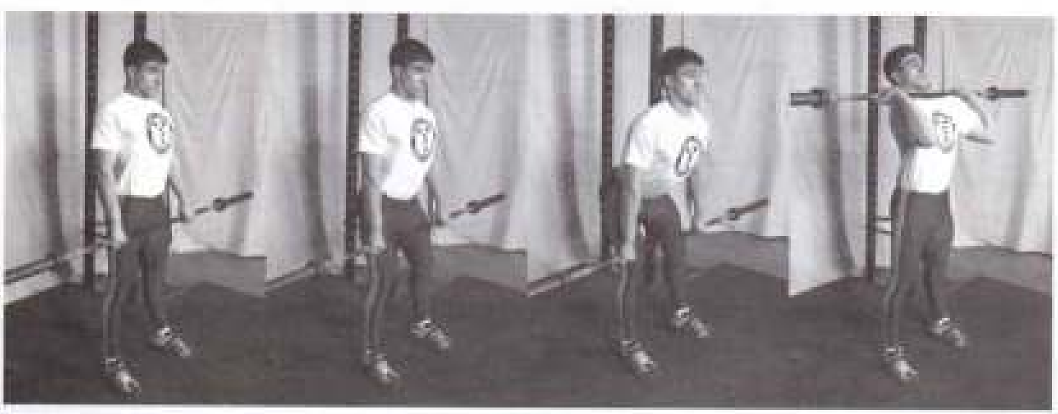


Figure 11. The critical positions to understand are (left to right): The hang position, the jumping position, the Romanian Deadlift position, and the rack position. Until the bar leaves the legs to move to the rack position, it must remain in contact with the thigh.

If his form stays good, have him drop a little lower each time, finally dropping below the knee, and then down the shin and on down to the floor by bending the knees (figure 12). Each time as he gets back to the jumping position the bar *must start the jump from the thigh*, in contact with the thigh. It must stay in contact with the leg all the way down and all the way up, and it is lowered to the knees with the hips, and to the floor with the knees. If his form stays good, have him drop a little lower each time, finally dropping below the knee, and then down the shin and on down to the floor by bending the knees. Each time as he gets back to the jumping position the bar *must start the jump from the thigh*, in contact with the thigh. It must stay in contact with the leg all the way down and all the way up, and it is lowered to the knees with the hips, and to the floor with the knees. By emphasizing this knee/hip relationship during the early phase of learning the pull from the top down, the correct movement order will be in place when he begins to start the clean from the floor (figure 13).

Figure 12. The progression on teaching and learning the power clean is from the top down. As the trainee masters the clean from each position, move the bar lower and lower on the leg until you can use standard height plates from the floor.

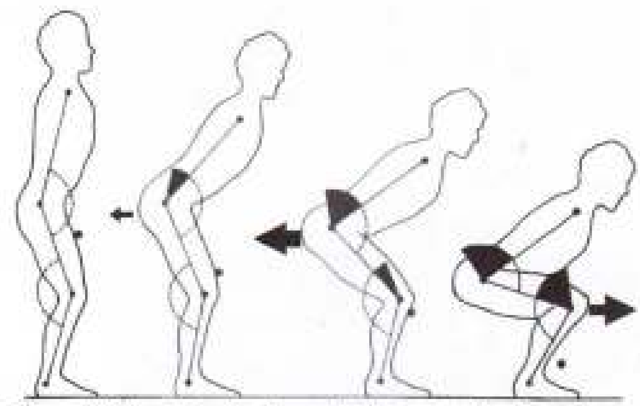


Figure 13. Learning to lower the bar correctly from the beginning will make it easier to pull from the floor correctly later. Note the progression from predominantly hip movement to predominantly knee movement after the bar passes the knee.

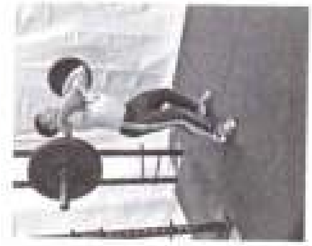
If at any time during this progression the form breaks down, stop. Go back and work it until it is correct. This method works from the top down, and if you leave a mistake in the middle of the power clean, it will cause problems that will have to be fixed later.

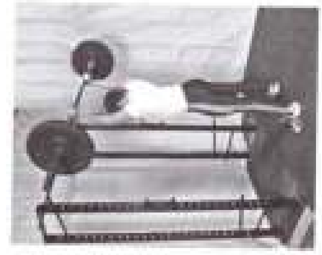
By the time he gets the bar to the floor, he is doing a power clean. It may be necessary to go back to the jumping position if he begins to let the bar drift out away from the legs as it passes the upper thigh or as he pulls the bar past his knees and forgets to slide back up the thighs in a hurry to rack the bar, as is common at first. Do not let him clean without touching the thigh in the jumping position. It may be necessary to return to the jumping position many times while learning the clean, but eventually he will

Figure 14. The hook grip. Note that the fingers are wrapped around the thumb. The force of friction combined with gravity and grip strength provides a robust hold on the bar.

become dependent on the mechanical advantage obtained by doing it this way and in fact become unable *not* to touch the thigh on the way up.

So basically we have a movement that consists of a deadlift that turns into a jump and catch. But even though the two phases are learned separately, it is important to integrate these two movements into one. There should be no break in velocity between the pull from the floor and the jump and catch. In fact, the velocity gradually increases from the floor to the rack. This will need to be explained to him, by saying, "Don't stop to touch your thigh with the bar. If you slow down to touch, when the bar gets heavy you will lose momentum and miss the lift. Just touch your leg on the way up without slowing down to do it."





Within a couple of workouts, when the movement is good enough to worry about peripheral matters, introduce the **hook grip.** The hook grip is critical in enabling heavy weights to be used. It should not be considered optional (figure 14). This is a very important thing to get out of the way early, before much weight is being handled in the lift. If you wait too long to introduce the hook, it will be painful and will be resisted by the trainee. It is accomplished by simply laying the middle finger on top of the thumbnail as the grip wraps around the bar, and letting the bar settle into the

Figure 15. The grip must be on the outside of the shins (left). Having too close a grip (right) puts the hands in front of the shins and creates many bar position and grip problems, as well as skinless thumbs.

bottom of the "hook" made by the fingers, so that the bar rests in the fingers during the pull, not the tight fist. Most trainees will release the hook as they rack the bar, due to wrist flexibility, and this is fine. The hook will need to be reset for each rep.

Once the power clean is complete, from the floor with the hook grip, form problems can be addressed. Olympic weightlifting coaches have spent a lot of time analyzing the clean and all its constituent elements, and even a cursory examination of this material would require more time and patience than the reader and the author combined possess. And it is not necessary for our purposes here. There are just a few important things about the power clean that need to be in place. First and foremost, the bar *must* be close to the body all the way from the floor up until it racks. And since the whole purpose of the exercise is power production, the movement must be done explosively. We will now examine a few specific problems that are commonly encountered, starting at the floor, and address them in as practical and simple a way possible. Just remember that acquiring a good understanding of the theoretical basis of the lift and some experience coaching it to a few people will quickly teach a coach as much as it will the trainee.

Stance

The stance should be the same as that used in the deadlift. Feet should be in the stance used for a flat-footed vertical jump, for the same reason: we are going to rapidly transfer force to the floor and this stance, heels 12-15" apart, is the best for this. Some trainees may develop a taste for a wider stance, and as long as grip is not affected that is fine. Grip and stance are related in that the grip is chosen to maximize racking efficiency and stance is chosen to fit just inside the grip. Since the bar must be close to the shins, the stance must be inside the hands so that the fingers do not keep the bar away (figure 15). The wider the grip, the wider the stance can be, and since no one can use too wide a grip (since it just doesn't work) the range of stances available won't include anything much wider than about 15" between the heels. Some very tall individuals with wide hips and shoulders will need a stance wider than this, but not many and not much wider.

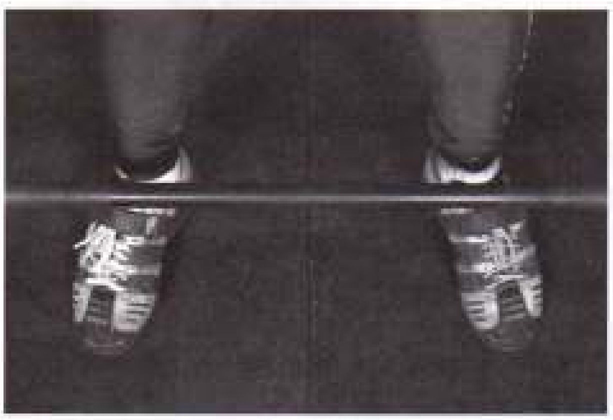


Figure 16. The toes should point slightly outward. Consistent positioning is crucial to repeatable technique. Have the trainee memorize the angle of the foot to the bar and how many shoelace eyelets are in front of the bar as seen from above.

Toes should point very slightly out (figure 16). Most trainees will not have problems with an incorrect toe position, as it is uncomfortable to do it terribly wrong. The slight angle out allows the knees to assume the correct angle, since feet and knees need to line up straight to prevent patellar tracking problems. Just make sure that toes do not point dead-straight ahead, or out too much.

Off the floor

We have discussed the mechanics of the pull off the floor in great detail in the deadlift section of this book. All of that material applies to the power clean and it is suggested that the analysis developed for the deadlift be applied here as well. It is important to be as efficient off the floor as possible, as any problems that develop at the top part of the pull can usually be traced to an incorrect starting position off the floor.

The path the bar makes through space from starting position to racking position is a major factor in the efficiency of the lift. The bar path is observed by looking at the end of the bar from a position just off the platform and looking at the lifter from the side. Imagine that the end of the bar traces a line in the air during the lift. This line is the bar path, and it is very important to develop your ability to form an image of this line. More information about what happened during the pull can be obtained using this visual skill than any other when coaching the clean. There are several advanced movement analysis instruments that record and interpret bar path information, but none is as immediately useful in real time as the experienced eye of the coach.

An ideal bar path is illustrated in figure 17, and will vary only slightly among individual lifters due to anthropometry. The bar comes off the floor and heads back very slightly as the knees straighten out. It continues up in an essentially straight line, curving very slightly away as the elbows begin to rotate under the bar. At the top, the bar path will inscribe a little hook as the bar comes back and down onto the shoulders in the rack position.

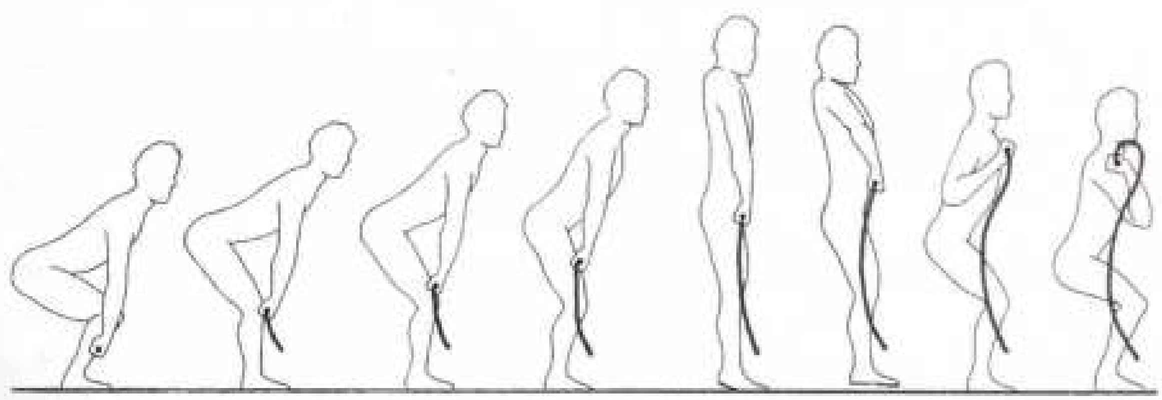


Figure 17. The bar trajectory will look somewhat like a very narrow, skewed, and backwards "s". From a strictly mechanical standpoint, a straight line is the most efficient way to move a load, but the anthropometry of the body dictates otherwise.

Let's review the angles involved in the pull and see what varying them does to the bar path (figure 18). The knee angle, hip angle, and back angle are the same for the power clean pull off the floor as for the deadlift. The correct starting position facilitates an efficient pull. For example, if the trainee's knees are too far forward, as when the knee angle is too acute, the hip angle is too open, and the trunk is nearly perpendicular to the floor, the bar cannot come up in a straight line, but rather must move forward to get around the knees. You will notice that his thighs are approaching parallel with the floor. When this happens, the bar is already way too far out in front and must be pulled back in as it approaches the jumping position. This initial error is magnified as the bar ascends toward the rack position. Since the weight is too far out in front and the lifter is forward on his toes, it is difficult to get the weight and the knees back far enough to correctly finish the clean in the jumping position. The bar stays forward, causing him to jump forward to catch it, directing the jump forward instead of up (figure 19). This very common error is fixed by having the trainee lift his hips and pull the bar back in to his shins. Another approach is to have him think about keeping his weight back on his heels as the bar comes off the floor. Right before he pulls, tell him to "lift your toes" or "find your heels" (figure 20).

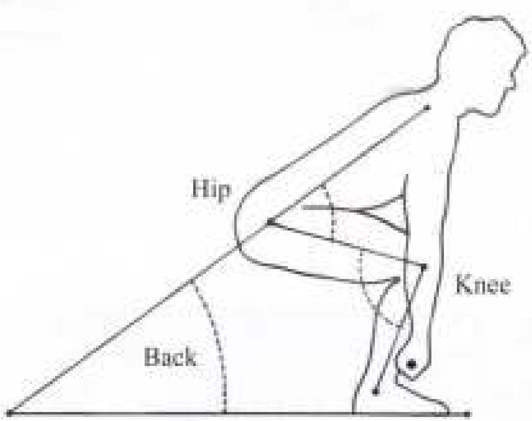


Figure 18. The important angles in the clean are the same as in the deadlift: the hip, knee, and back.

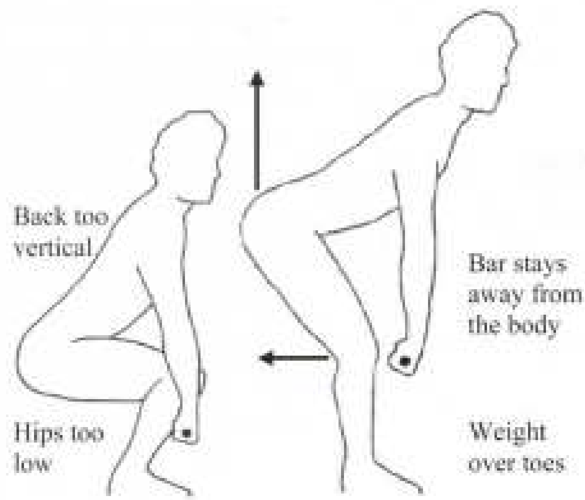


Figure 19. Starting with the hips too low leaves the bar too far away from the body throughout the pull. This requires the athlete to jump forward to rack the bar. Diagnose this by observing start position, watching the bar path, and asking the trainee if he felt the weight on his toes.

The other extreme, with the hips up too high, where the knee angle is too open, the hip angle is too acute, and the back angle is nearly parallel to the floor, presents a different problem. Notice that the trainee's butt is up in the air and his chest is facing the floor. He may also be looking down. Here the quadriceps muscles of the thigh have essentially been removed from the lift, since their job of extending the knee has already been done before the bar leaves the floor. Thus, they contribute nothing to the first part of the lift. Again a starting

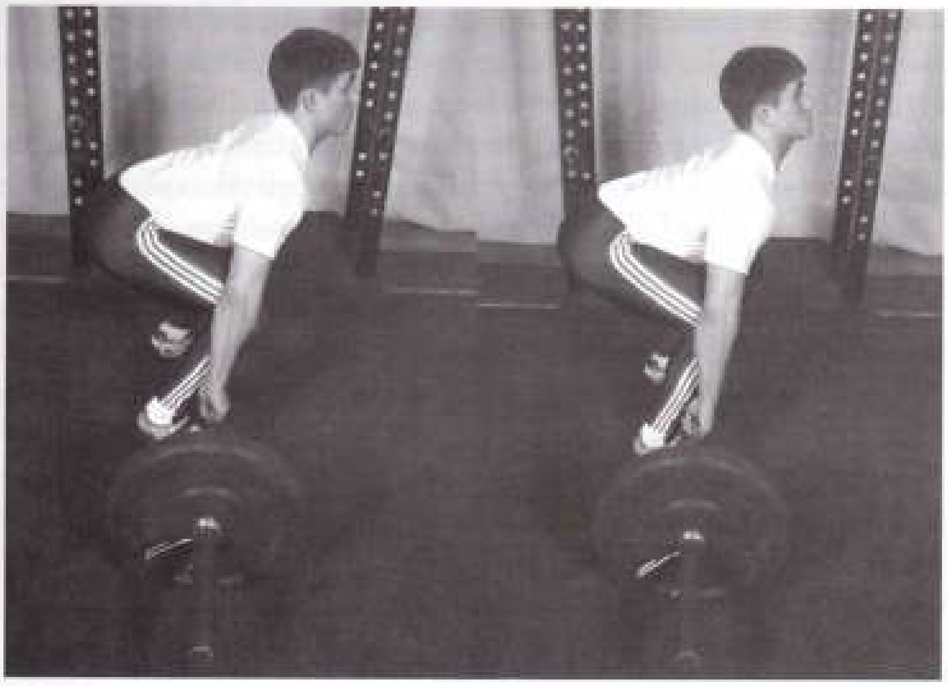


Figure 20. A simple cue to correct a trainee who is starting with his weight over his toes (left): tell him to lift his toes (right). This will bring his weight back over his "whole foot".

position problem contributes to problems higher in the pull. Since the back is nearly parallel to the floor, the pull from the floor leaves the knee angle open and the hip angle acute when the bar gets to the jumping position. The knees are too straight to jump efficiently, and the bar swings away from the body as the hip angle opens, in a "loop", a classic error in the clean where the bar goes out instead of up. This is also easily fixed by adjusting the lifter's starting position, by telling him to "look ahead, lower your hips and use more 'squat'" (figure 21).

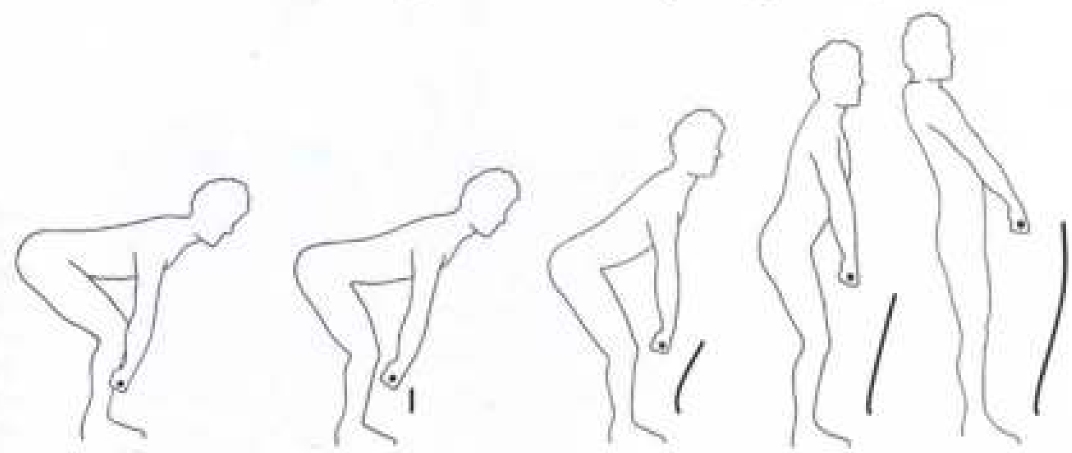


Figure 21. Starting with the hips too high will cause the bar to move away from the body. The resulting non-vertical bar path causes lots of power to be wasted in an attempt to compensate. This problem is similar to the problem illustrated in figure 18, in that the bar ends up too far forward. This can be diagnosed by the hips-high start position and the trainee's jump forward to rack the bar.

These examples represent the extreme variations in starting errors, and define a gradient that will be observed throughout the range of trainees of differing anthropometry, skill, and talent. It is up to the coach to develop his eye for angle and bar path, an understanding of the relationship between them, and the ability to use these to analyze errors and suggest corrections. This is a skill that can only be developed through the experience gained by many hours in the weight room, analyzing faults, making corrections, and seeing if they worked.

Now, these next comments are possibly the most important to understand in the whole discussion of the pull from the floor. Remember from our initial instructions that the bar accelerates from the bottom to the top, getting faster as it gets higher. This means that the bar starts slow and gets fast. The *entire purpose* of the lower half of the pull, the deadlift part, is to get the bar into the jumping position, so that the bar can be accelerated on up to the racking position. As such, it is far more important for the pull from the floor to be *correct* than it is for it to be *fast*. Remember this: the bar must be pulled correctly at the bottom and fast at the top. **Pull the bar slow and correct off the floor – fast and close at the top.** The off-the-floor errors mentioned above usually occur when the lifter gets in a hurry and jerks the bar off the floor. If he jerks the bar off the floor, he jerks himself out of position. If he's out of position he can't hit the jump.

Any position error that is established by being in a hurry off the floor will be magnified on the way up, as described above, and since the movement is so fast there is no time to correct the error. But if the bar comes off the floor slowly, the lifter's proprioceptive skills have time to make the small corrections that might be needed to put the bar back in the right place before it begins moving so fast that a correction is impossible. Control of the bar

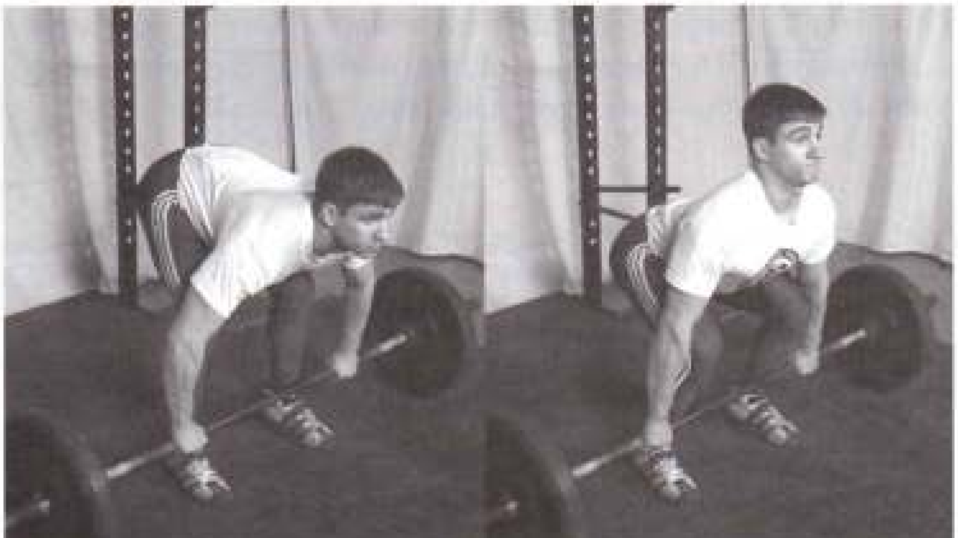


Figure 22. Preparing to jerk the bar off the floor (left) versus preparing to squeeze the bar off the floor (right). Jerking the bar off the floor ruins all aspects of correct position. Note the slack in the arms and the horrible start position in the photo to the left.

position is the whole point of coming up slowly, so that the jumping position can be hit correctly every time.

Jerking the bar off the floor is the most common problem you will encounter after the transition to the full power clean from the hang. From the starting position, the trainee will bend his elbows a little and then jerk the slack out of his arms in an attempt to get the bar moving rapidly as it leaves the floor (figure 22). This jerk will usually be accompanied by his shoving his butt up in the air, as discussed above. This must be dealt with the first time you see it. Several things work to fix this. Try telling him to get in the starting position, and then "squeeze the bar off the floor." Or tell him "long straight arms and keep the chest up off the floor." Or just "slow off the floor." Also make sure that his eyes are looking forward and not down, since eyes-down is often associated with hips-up. The idea is to get him to maintain correct position while accelerating on up through the jump.

At the top

After the bar has been pulled up from the correct starting position, it will assume a nearly vertical path until it reaches the jumping position. This middle part of the pull is rather uneventful, or at least it should be. The bar needs to be on or very close to the legs, touching or nearly touching the skin all the way up. The path is vertical because the knees and hips extend in a coordinated way that results in the load moving up in the most efficient trajectory possible – a straight line with as little forward or backward deviation (seen as lateral movement in the bar path) as possible. Any non-vertical bar movement will require the lifter to do extra things at the top to catch it. The bar should be starting to accelerate through this phase, gaining velocity in anticipation of the jump that is about to occur (figure 23).

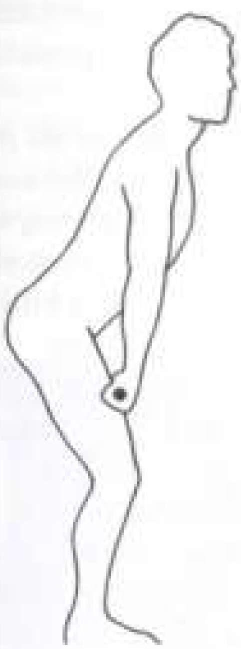


Figure 23. It is important that the bar be in contact with the legs after it passes the knee. It is here that peak power is being developed during the jump, and if the bar is not on the thigh the jump cannot be vertical.

During this section of the pull, forward movement of the bar is usually due to an incorrect start, as previously discussed. Starting errors are magnified as the bar goes up. If your trainee is throwing the bar out away from him, check his starting position again. He may need to be reminded to keep the bar against his legs on the way up. He may even need to be told to use his lats to actively push the bar back into his legs on the way up. This will usually correct the fundamental position problem, since he can't actually use his lats to do this if he is in the wrong position (figure 24).

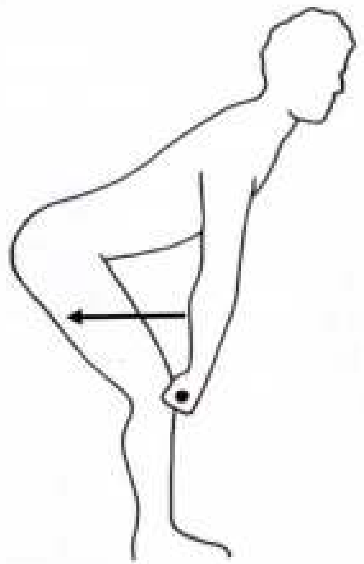


Figure 24. Some trainees will need to be reminded that contracting the lats will help keep the bar close to the legs.

As the bar approaches the jumping position, the most important part of the movement occurs. If the lifter is correctly pulling the bar, it is accelerating as it moves up the thigh, sliding up the skin or the sweats. As it gets to the jumping position, about 2/3 of the way up the thigh, the lifter should actually try to jump off the ground with the bar. The reaction with the ground during this explosion is the impulse that imparts momentum to the bar. The knees, hips, and ankles extend simultaneously. The bar accelerates on up in response to the burst of force generated by this extension and is transmitted up the back and down the arms to the bar. As the bar comes up high enough that the elbows must unlock, they begin to rotate up into the rack position. The clean is finished as the elbows complete their rotation by coming to a position pointing forward.

An interesting thing to note about this phase of the pull is the movement of the knees. As the knees extend in the initial pull from the floor, the shins have become vertical, placing the knees back enough to allow the bar to come up in its vertical path. After the bar clears the knees and as it slides up the thighs, the knees will come a little forward back under the bar as the hips extend. This puts the back in a vertical or nearly vertical position to facilitate the jump with the bar hanging from the arms. Then the jump occurs, and the knees and hips extend explosively. So the knees actually extend twice – once off the floor and again at the top during the jump – allowing the quadriceps to contribute twice to the upward journey of the bar. Olympic weightlifting coaches refer to this as the "second pull", although second *push* (against the floor) might be more descriptive. This movement will occur as a natural physical consequence of getting into the jumping position and the bar touching the thighs as the jump occurs (figure 25). That is why you should ensure that this position is learned early and thoroughly.

One way to ensure that the jumping position is used correctly every time is to establish a marker for its successful execution. If the lifter actively tries to touch the bar each rep at the same place high on the thigh – and develop the ability to feel the contact point and control it, he will gain a large measure of conscious control over the finish of the power clean. Bar contact on the thigh is necessary for correctly meeting the jumping position, and if that contact is used as a cue, the jump is much more likely to be correctly performed. The coach can use this bar contact as a cue, by telling him "hit the bar with your thigh on the way up," or "make sure you brush the thigh with the bar." This cue can be used to increase the speed of the clean by telling him to "hit it harder." It can also be used as a diagnostic tool, clothing

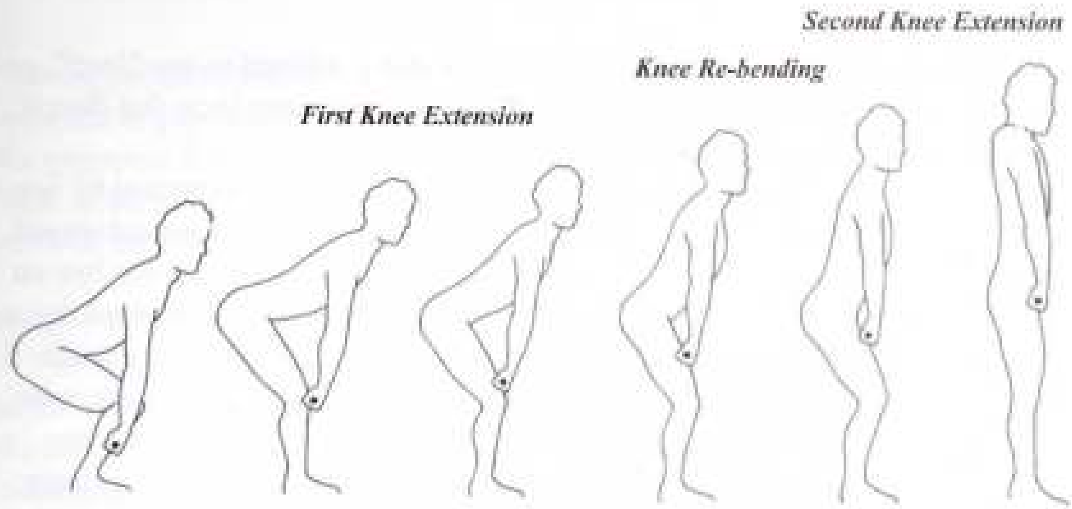


Figure 25. The pull can be divided into two components: the first pull to the knees then the second pull at the top.

permitting, by looking at the thigh to see where the red mark from the bar contact is. Both you and your trainee can diagnose pulling errors by seeing where the mark is on the thigh in relation to where it should be for the most efficient jump (figure 26).

After the bar leaves the jumping position, it is important that it stay close to the chest, so that it doesn't have to travel very far to get back into the rack position. If the bar heads away from the body between the jump and the rack, the distance between the bar and the shoulders has to be closed. This is done by

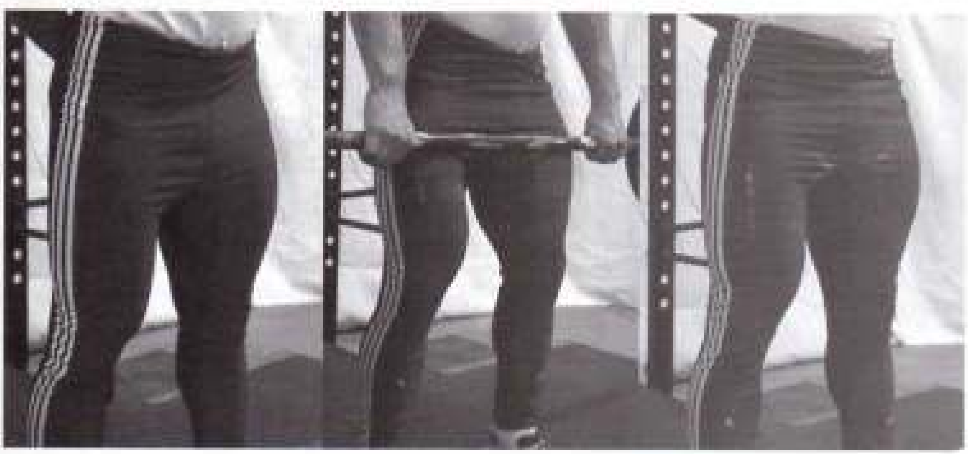


Figure 26. Chalk is a handy tool for many purposes. You can determine if the trainee is getting the bar close enough to the thighs by simply looking for chalk marks where once there were none. In the photos above, the trainee began with clean training tights (left), chalk was applied to the bar, the subject then did a single power clean (center). From inspection of the training tights, you can see where the bar made contact with the legs.

either pulling the bar back in to the shoulders in a trajectory that is referred to as a "loop", or by jumping forward to meet the bar. Neither of these is efficient, since any force that directs the bar anywhere other than straight to the shoulders is wasted.

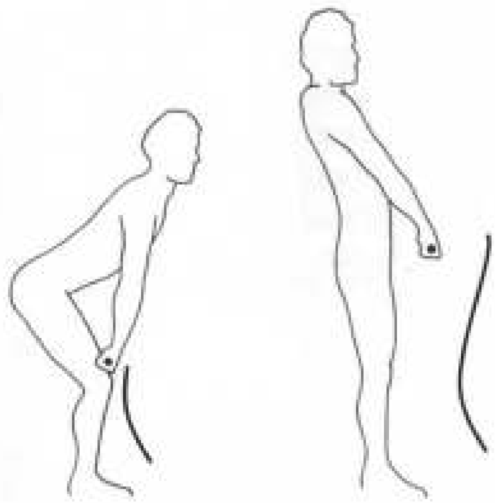


Figure 27. When the trainee starts the second pull too low, the bar tends to swing away from the body. This happens when he fails to wait until the bar comes up high enough on the thigh – and thus until the torso is sufficiently vertical – so that the bar can be shrugged straight up when he jumps.

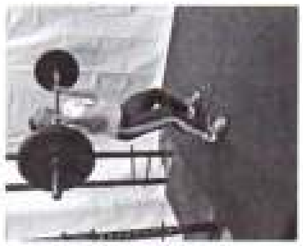
Figure 28. A cue that can cure many ills of the pull is to have the trainee attempt touch his shirt on the way up.

A loop should be corrected by first determining how the bar is going forward. If the jump is started early, i.e. too low on the thighs, the bar will loop forward due to a trunk angle that is not vertical enough. If the bar is to go straight up, the back must be vertical enough that most of the hip extension is already over before the jump takes place, or the remaining hip extension will swing the bar away (figure 27). This fault is determined by observing where on the thigh the bar is when the jump occurs. If your trainee has a jumping position that is consistently too low on the thigh, tell him to "wait longer before you jump", or to "touch higher on the thigh as you jump".

If the loop occurs because he is forward on his toes during the lower pull, you will see air under his heels and his knees in a too-forward position as the bar passes them. In this case, he loops it because the bar is headed forward from the ground on up. Set him back on his heels to start the pull, and make sure he keeps his heels down until the jump occurs with the bar well up on the thigh. Yell at him about keeping the bar back against his thighs while you're at it.

If he manages to loop the bar from the correct jumping position, tell him to make the bar touch his shirt on the way up. Tell him to "keep the bar close enough to you that you feel it on the way past your chest" (figure 28). Actually, if he tries to touch the shirt on the way up, this will usually correct the errors made at the bottom. This is an excellent example of "correction displacement", where sufficient attention focused on correcting an error later in a sequence of movements unconsciously causes the correction of the initial problem earlier in the sequence. If he is told to touch the shirt with the bar before he racks it, he will have to get back on his heels to do it, since the shirt is more "back" toward the heels than forward towards the toes.

Arms



A common error during the jumping phase of the power clean is the use of the arms. There is a bodybuilding exercise known as the Upright Row, where the bar is raised to the chin with a narrow double-overhand grip. It is a slow movement that uses the arms and deltoids, and though it bears a superficial resemblance, it has absolutely nothing to do with our explosive power clean. After the bar leaves the jumping position, no thought whatsoever should be given to the arms. None. The arms should be thought of as pieces of rope that attach the shoulders to the bar, and the bar gets to the shoulders through the action of the jump, and the jamming forward of the elbows.

Most people have, deep in their brains, a little bundle of brain material that tells them that all things must be lifted with the arms, especially if these things are going to be lifted above the waist. And embedded in most of your trainees' minds is a picture of a bodybuilder doing an upright row. These two factors contribute to the difficulty of convincing them to stop doing an arm pull. Arms will be a problem that you will definitely see. Arms will get used both at the top and off the floor, so let's back up and address both situations now.

The bending of the elbows as the bar leaves the floor is a habit that must be addressed as early as possible in the process of learning the power clean. The trainee should know not to bend the arms, since he has learned this in the deadlift. To refresh everyone's memory, the function of the arms is to transmit the pulling power generated by the hips and legs to the bar.

Power is transmitted most efficiently down a non-elastic medium, like a chain, as opposed to a medium that stretches, like a spring. A chain transmits all the power from one end to the other, while a spring absorbs some of the energy as it deforms. When the bar is pulled from the floor with bent arms, the bent elbow is essentially a deformable component, a thing that can straighten out, thus preventing some of the pulling force from being transmitted to the bar. The little variances in the degree of elbow bend result in an unpredictable amount of force transfer to the bar, and thus in an unpredictable bar path. If the bar path varies with each clean, bent elbows are often the problem. And once elbows are bent, they cannot be straightened out during the pull; that would require the forearm, bicep and brachialis to relax, a thing they will be reluctant to do even if there was time to think about it and do it (figure 29).

At the top, the elbows bend because the trainee is trying to curl or upright row the bar with the arms. Elbows can rotate very fast, blindingly fast in fact, if the muscles of the arms are relaxed and providing no resistance to the rotation. The second the lifter tightens the forearms, biceps and triceps as he attempts to use these muscles to move the bar, he slows the movement down. He also causes the elbows to stop at the point where these muscles reach the end of their range of motion in contraction, which leaves his elbows pointing down and the bar sitting on his sternum. (This is another good reason to use the hook grip. The hook makes for a secure grip without the need to squeeze the bar with the fingers, thus contracting the forearm muscles.)

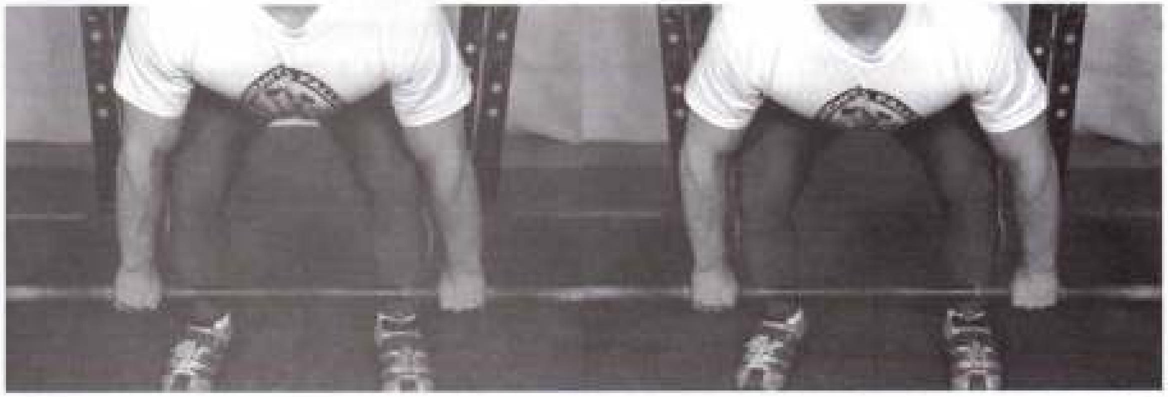


Figure 29. It is crucial that the trainee pulls with straight arms starting at the floor (left). Lots of trainees picture themselves as having massive arms (or at least *wanting* massive arms) and as a result they think their arms can help them clean big weights. They will usually start pulling from the floor with arms bent to some degree (right). This is a difficult habit to break once it becomes established. Fix it quickly.

Rack position

After the elbows rotate and jam up into position, pointing forward, the bar is said to be in the **rack position**, or **"racked"**. The upward rotation of the elbows causes the deltoids to come into a contracted position that puts them at a higher level than the sternum, permitting the bar to sit comfortably clear of the chest. At this point, most lifters will have relaxed the grip somewhat, and some will have released the hook. It is okay to release the hook, or even to let the little finger drop off the bar if it facilitates a good rack position. It is not okay to completely let go of the bar, although this does occur in some very inflexible trainees. The most important factor in the rack position is the elbow position and its effect on the deltoids, making a place for the bar to sit (figure 30).

Figure 30. The rack position. The hook grip can be released here. The bar should rest across the deltoids.

This is actually the position the bar is in for a correct Front Squat – an exercise used

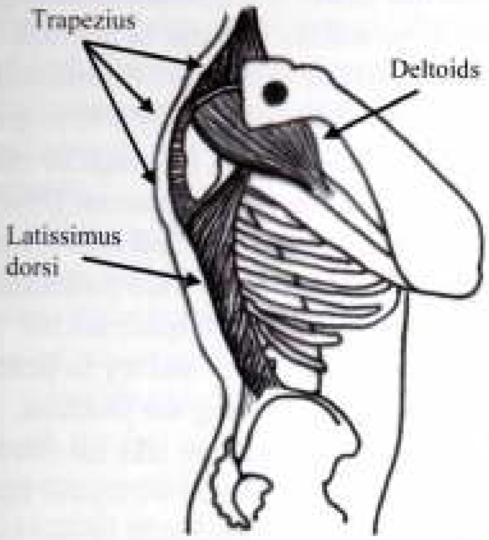


Figure 31. In the rack position the contracted deltoids support the bar, while the trapezius, lats, and other back muscles stabilize the position.

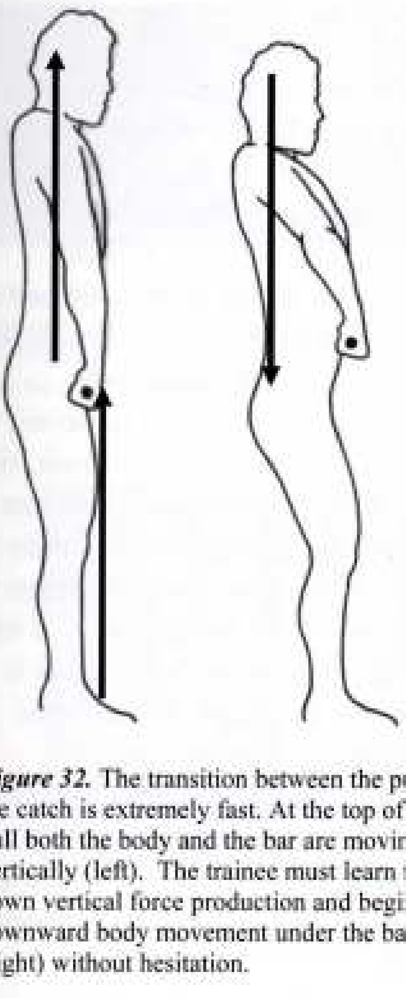


Figure 32. The transition between the pull and the catch is extremely fast. At the top of the pull both the body and the bar are moving vertically (left). The trainee must learn to shut down vertical force production and begin downward body movement under the bar (right) without hesitation.

by Olympic weightlifters to assist the full-squat clean. The correct rack position is the one that allows the most weight to be supported on the deltoids. In the correct position, the bar sits on the contracted deltoids. The delts hold the humerus up parallel with the floor, keeping the weight off the sternum. The ribcage is held up by tension in the upper back musculature, and the entire trunk is rigid in isometric contraction and further supported by a Valsalva maneuver. In this position, as much weight as he can ever clean can easily be supported (figure 31).

The pull stops during the racking phase. "Stops" means that the muscular force generated during the pull ceases being applied to the ground. As soon as the feet move out of the pulling stance and begin the stomp, the force has stopped pushing the floor. If it hadn't, the feet could not move. When force stops being applied to the bar, it stops accelerating, and Mean Old Mr. Gravity causes its velocity to drop to zero and start back down almost instantly. It is during this reversal in acceleration that the racking position is assumed. The movement is a shrug of the shoulders instantly followed by jamming the elbows up and forward to catch the bar on the deltoids. The movement is fast, as it must be if the bar is to be caught before it falls too far (figure 32).

It will be unusual not to see most of your trainees catch the bar with their elbows pointing at the

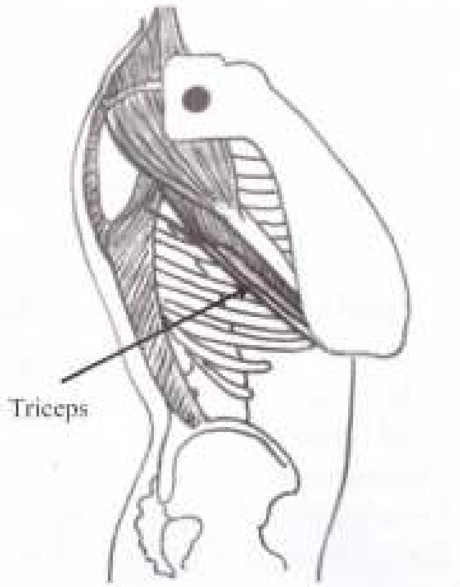


Figure 33. Tight triceps may be the culprit in a trainee's inability to rack the bar correctly. The triceps can limit the ability to push the elbows forward and up.

Figure 34. A broom stick placed under power rack pins can be used to work racking-specific flexibility.

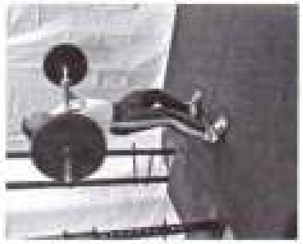
floor. This is due either to a misunderstanding of your instructions and the concept of the rack position, or to a lack of flexibility. A sufficiently flexible trainee should be physically able to get his elbows in the correct position, although he may be reluctant to do so for various reasons. If he racks the bar wrong a few times and feels it bump his sternum because his elbows were down and the deltoids were not up enough to space the bar away, he may become gun-shy and try to hold it up with his hands, exacerbating the problem. Have him rack the bar, and then take his elbows and move them up into position with your hands, so that he can see where they should be and feel why.

Once he has been shown where the bar sits on his shoulders and has been told why, he needs to learn how to get the bar there quickly in one single elbow rotation.

The grip can limit the ability to make a quick rotation. Many times, a lack of wrist and triceps flexibility prevents this complete rotation. Wrist flexibility is the more obvious of the two, but tight triceps prevent the elbow from coming up high enough to permit a good deltoid contraction (figure 33). Both can be stretched and worked on for an extended range of motion, using the bar or a stick in the rack (figure 34).

If flexibility is not sufficient to permit the full rotation of the elbows into a good rack, the fingers must go. They are the expendable part of the chain, and after the pull has stopped their function as the last element of force transfer to the bar is over. This concept is sometimes the source of the confusion – the hands do not hold up the bar, and they stop being critical to the clean after the elbow rotation starts. So the fingers can do what they want to as the bar is racked. They can hang on if they want to, or they can release to the extent that only the index, .niddle, and ring fingers are in contact with the bar (figure 35).

If flexibility is sufficient and the trainee is simply reluctant to let go of the bar enough to permit the elbows to come up, yell at him about it. All that is necessary is a little relaxation of the hand, and a willingness to rotate all the way up into position a couple of times to see how it feels to do it right. You might stand in front of him and tell him to "hit my hands with your elbows" as you hold them up in front of him, palms facing his elbows (figure 36). Sometimes it helps to tell him to "aim your shoulder at the bar," or to "hit the bar with your shoulders, like you're trying to strike a blow." (Make sure he knows what a "blow" is.) The crucial concept to communicate to your trainee is that the bar is not racked until the elbows point forward, and that stopping the elbow rotation before it reaches this position is not acceptable.



Once again, this is a good reason to use a hook grip. The hook permits the fingers, and thus the forearm, to stay looser without compromising grip security. If the hand and forearm are already loose, they don't have to be loosened to permit the elbows to rotate.

Just after the shrug and at the same time as the elbows begin to jam forward, the feet stomp the floor. This foot movement causes everything happening around it to time out better. It feels better when the feet stomp and the bar racks at exactly the same time, and the body will time the rack to coincide with the stomp. Then, if the stomp is fast, it pulls the rack along faster with it. The simultaneity of the two events is fairly automatic, and not too many trainees will stomp out of phase with the rack because it just feels too weird. So the stomp actually sharpens the timing of the racking movement. A certain

Figure 35. The best grip for racking the bar is with all fingers in contact with the bar (left), although flexibility limitations may require beginners to adopt grips with one finger (center) or two fingers released (right) in order to get the elbows into proper position. Actively trying to maintain contact with the bar with the hand and working to increase flexibility after each training session will fix this over time.

Figure 36. An elementary drill to get the trainee to get his elbows up. Give him a target to hit with his elbows.

amount of knee bend will accompany the stomp, necessary to cushion the catching of the weight. Catching the weight with perfectly straight knees is not desirable, and actually doesn't occur very often since it also feels too weird. The stomp thus makes the movement quicker, while at the same time cushioning the catch.

Figure 37. Beginners will frequently split their feet to the side and to the front and rear instead of stomping the feet into the floor. Frequently they will also sway their hips forward and their shoulders back. Enforce the stomp, having them aim for their own pulling position footprints.

The feet will stomp into their same footprints or just a little wider. Just a little means a couple of inches per side wider. You will see some trainees shift their feet out to a position wider than a squat stance. This "spider in heat" position is used in an attempt to drop lower under the bar, in lieu of pulling it high enough. They don't get a good stomp going this wide because the angle is not conducive to stomping and the distance covered is so far that it takes too long. Stomping is quick, lateral splitting is not. Fix this when you see it by making them stomp into their starting position footprints several times without the bar. And make them focus on this foot position during the clean with a lighter weight that can be racked properly. A lateral split is a bad thing to choose as a habit: it is dangerous, hard to control, and ineffective. The purpose of the power clean is pulling the bar high – we don't want to make it easier to get under the bar, we want to pull the bar higher. And if we *were* going to make it easier to get under the bar we would use the standard squat version of the clean, not a weird bastardized mutation thereof (figure 37).

After the rack

After the rack, your trainee should recover back to a fully upright stance with elbows still in the racking position. Discourage the habit of putting the bar down before a full recovery is achieved. If your trainee is in a big hurry to put it down after he racks it, he might soon get in a big hurry to rack it and start racking it wrong. Disaster follows close on the heels of such things. Make him finish each clean correctly.

All Olympic weightlifters have heard the words, "Finish the pull!" This cue is used when the bar gets heavy and understanding it is crucial to completing any type of clean. If the racking movement starts before the jump has put all available force into accelerating the bar that critical last bit, the bar fails to travel to its full height and the rack must be accomplished at a lower position than it would be if the pull had been finished. This usually means that the bar is caught in a position more forward than up, or not racked at all. An unfinished pull indicates that the last part of the pull, the jump and shrug, has been done inefficiently or incompletely. Explain what you mean by "finishing the pull" and use this cue when you see your lifter miss it at the top (figure 38). This cue will be used a lot when the bar is heavy and the difference between making and missing the clean is the finish.

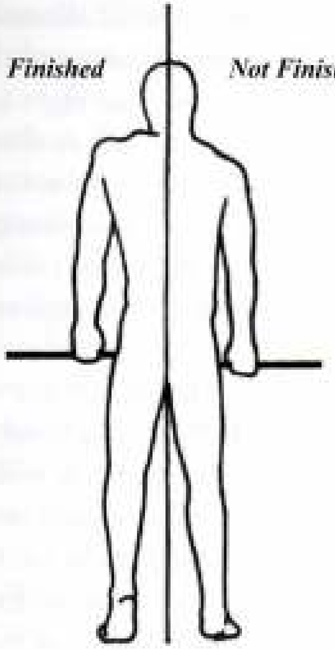
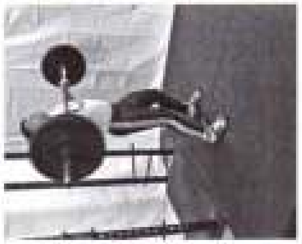


Figure 38. Finishing the pull (left) means extending the ankles, knees, and hips while also shrugging the shoulders. Not finishing the pull (right) is easy to detect, especially by observing trap shrug.

Power cleans are not like squats or deadlifts, movements that can be ground out to a bone-on-bone finish if only one has the stones. A deadlift can be locked out even if it is a little out of position by just pulling harder. The movement is slower and there is time to fix minor form problems with more strength before the pull is over. The clean takes less than a second to do, and if it is not right, it doesn't rack. Cleans can be racked only if all the contributing factors are there: strength, power, and technique. Since the clean is a much more mechanically complicated movement, it is more sensitive to each contributing factor than the slow movements are. This is evidenced by the experience common to all lifters, where 100 kg. is good for many attempts but 105 *just will not rack*. Finishing the pull collates all the factors involved in the pull, and causes them all to come together at the right time to contribute to racking the weight.



After the clean is racked and recovered, the bar must be dropped without anybody getting killed. The method used here will depend on the equipment. If a platform and bumper plates are available, as they should be, the bar can be dropped from the rack position in a controlled manner. Care should be taken to keep the bar from bouncing anywhere but right where it is dropped, by keeping it level on the way down. The hands should not leave the bar while it is dropped until just before it gets to the floor: bars that are released at the top and allowed to free-fall are much more likely to bounce unevenly than bars that are tended as they drop (figure 39).

Figure 39. Bumper plates are there for two basic purposes: to allow the dropping of weights without causing damage to the facility, AND to allow weightlifting exercises to be safer. Dropping the weight to the floor in a controlled and symmetrical manner eliminates the potential for injury caused by bad positioning while lowering or decelerating big weights.

If bumper plates are not available, the task becomes harder. The bar must be released from the rack and caught at the hang, and then lowered to the floor, to prevent damage to the barbell and the floor. This can be tricky, since it really hurts to actually drop the bar right on the thighs. The bar has to be released from the rack with enough grip on it to be able to slow it down before it hits the thighs. It is decelerated with the traps using a movement that is the opposite of the shrug, used during the jump. It needs to stop here under control before being lowered on down to the floor. And if metal plates are used, it would be prudent to use rubber mats to protect the floor. But really, get some bumper plates. They are important enough to consider necessary.

As with almost everything we do in the weight room, eye position is important for balance and stability. Eyes should be focused straight forward or very slightly up on a fixed object on the wall facing the lifter. Failure to consistently focus the eyes on a fixed spot will usually result in a wandering bar path, due to the resultant slight variations in back angle in the starting position. This will not be a problem until the bar gets heavy, but if the trainee starts to miss heavy cleans, check his eye position. This will be one of the easier things to fix.

Cues

Cues are the way a coach communicates with an athlete just before and during the execution of an athletic movement. They are signals that remind the athlete to change some part of the movement he is about to do, as previously discussed with the coach. They focus the athlete's attention on a thing that he should be thinking about at that time, instead of the thing he probably is thinking about. As such, a cue is not a long, expository explanation that introduces a brand new concept just before the lifter performs a PR attempt. It is a word or two, maybe three, seldom four, that reminds but does not explain. A cue should not have to be processed much by the mind that receives it; it should be heard by the ear and sent on down to the place that was waiting for it to trigger the action to which it refers.

An example of a cue would be "chest up." In contrast, "lift the chest so that your back gets flat" is not a cue. The former can be used after the lifter has assumed the starting position, right before he starts the pull. The latter must be used well before he assumes the starting position, when he can give some thought to what he is about to do.

Cues are worked out between the athlete and coach during training. They evolve naturally as the two people communicate with each other about the movement. A coach will develop his favorite ways of explaining key concepts to his athletes over his coaching career. He will tailor these explanations to fit the needs of the individuals he is working with and cues will develop. Some cues, like "chest up", are almost universal due to their usefulness, brevity, and sound. It almost barks the correct position at the athlete. Other cues, like "Now!", that appear to be so non-specific as to be useless, are in fact specific to a thing decided upon between coach and lifter, and are extremely individual to that particular situation.

As such, cues must be given in the right circumstances and at exactly the right time, or they are useless and do not cue anything. If your trainee is having bad starting position problems, these are not corrected with a cue, but with coaching before the position is assumed. Then, if his chest is not up quite enough, say the magic words. "Chest up" will work for that one problem, but if his entire starting position is a mess, a cue is not the answer.

For instance, if he is not touching his thigh with the bar as he passes the jumping position, right before he leaves the floor with the bar say "touch your leg!" or whatever term you have used before to refer to the jumping position. He will hear this, and by the time the bar gets to the thigh the reminder will have done its job.

This is the nature of the timing problem in giving cues. The power clean takes about a second to execute, and anything you say during the movement will never be processed through the ears, brain, and nervous system of the recipient in time to be used effectively. And if it is given too early it interrupts the mental things that the lifter must do himself before the movement reaches the phase where the cue applies. Both lifter and coach have a job to do during the correction of a problem: the lifter must get his body into the correct position to execute the movement, and then do it as well as he can, while the coach must cue the necessary correction. If the coach interferes with the correct part of the lifter's execution by timing the cue wrong, *he* screws up the lift. As in the previous example, if the cue to "touch your leg" is given while the lifter is assuming the starting position, the early cue might interrupt the process. He should be cued either before (for a more advanced lifter who can process it this way), or just after (a better choice for most novice trainees) he gets into his starting position.

Lifters, being people after all, are highly individual in the ways they respond to coaching and cueing. When working with the power clean, a more coaching-intensive lift than the slower movements, the coach will be challenged in dealing with the complexity of an exercise that works all the joints of the body in a precisely coordinated manner. You will find that there are two basic types of cues – body cues and bar cues – and that individual trainees will respond to them differently. Body cues are references to the body of the lifter, like "chest up", "look forward", or "long, straight arms". They draw awareness to the thing doing the moving, the muscles or bodyparts that need correction.

In contrast, bar cues refer to the object being moved. Examples are "keep it close", "touch your shirt", or "rattle the plates", all referring to the barbell. A particularly helpful way to use a bar cue is to refer to the speed of the bar as it passes through a certain section of the lift. For instance, if the problem is the trainee jerking himself out of position coming off the floor by getting in a hurry to get the bar moving fast, tell him "pull it slow" and then as he breaks it off the floor tell him "slam it!" Both cues refer to the bar, and if he does these things to the bar correctly his body will have responded correctly.

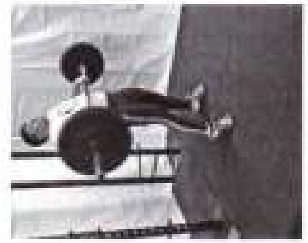
He might need to be helped to make the bar move faster at the top by coaching him about increasing the bar speed after the jump. Tell him to think about making the bar move faster as it passes his shirt. This is descriptive of the section of the lift, but refers to the bar speed. Then before he starts the pull, the cue would be "past the shirt fast!" or even "fast shirt!" as an abbreviation for the longer cue. The correction has been discussed before the set, the cue refers to this correction, and the bar speed is the focus of both.

If the racking speed is emphasized by using the cue "rattle the plates" (referring to the sound the barbell makes at the top if it is moving fast during the last part of the movement), problems that began occurring earlier in the pull can be fixed. If the bar is to be accelerated so that the plates can be rattled, the jumping part of the pull will have to be correct and explosive. For this to happen, the bottom part of the pull will have put the bar in the right place for the jump and the bar will have come off the floor correctly. (This is another way to use "correction displacement", by focusing on correctly executing a thing happening at the top, which then fixes a problem that actually started lower.)

Some trainees process bar cues better than body cues, and what works for one exercise might not work for another. Deciding which to use is just one part of a skill that coaches must develop through experience. Knowing that a cue is necessary, when it is not, when to give it, and how to give it are the stuff of coaching. Some are good at this, some can be taught to be good at it, and some never learn to do it effectively. A coach cannot optimally affect the performance of his athletes if he cannot help them at the right time, when they need the help. Cues are that help, and coaches must learn for themselves and from themselves the most effective ways to use them.

There will be many other problems to solve and the better the coach is at solving them, the more valuable he will be to the strength and conditioning program, and to his athletes.

Programming



It is May 15, and you decide that this year you are going to get a suntan – a glorious, beautiful, tropical suntan. So you decide to go out in the back yard (to spare the neighbors and innocent passers-by) to lay out at lunchtime and catch a ray or two. You lie on your back for 15 minutes and flip over to lie on your belly for 15 minutes. Then you get up, come in and eat lunch, and go back to work. That night, your skin is a little pink, so the next day you just eat lunch, but the following day you're back outside for your 15 minutes per side sunbath. You are faithful to your schedule, spending 30 minutes outside every day that week, because that's the kind of disciplined, determined person you are. At the end of the week, you have turned a more pleasant shade of brown, and, heartened by your results, resolve to maintain your schedule for the rest of the month. So, here is the critical question: what color is your skin at the end of the month?

It is exactly the same color as it was at the end of the first week. Why would it be any darker? Your skin adapts to the stress of the sun exposure by becoming dark enough to prevent itself from burning again, and it adapts to the stress that burned it. Your skin does not "know" that you want it to get darker; it only "knows" what the sun tells it, and the sun only talked to it for 15 minutes. It can't get any darker than the 15 minutes makes it get, because the 15 minutes is what it is adapting to. If you just got darker every time you were exposed to the sun, we'd all be really, really dark, especially those of us who live in a sunny area, since we all get out of the car and walk into the house or work several times a day. The skin does not adapt to total accumulated exposure, but to the longest exposure. If you want to get darker, you have to stay out longer, in order to give the skin more sun exposure than it has already adapted to.

Exercise is the same thing – a stress imposed on the body that it can adapt to, but only if the exercise is designed properly. Lots and lots of people come in to the gym and bench 225 x 5 x 3 every Monday and Friday for years, never even attempting to increase the weight, sets, reps, speed, or pace between sets. Some don't care, but some are genuinely puzzled that their bench doesn't go up, even though they have not asked it to. Your bench strength doesn't adapt to the total number of times you've been to the gym to bench, or your sincerest hope that it will get stronger. It adapts to the stress imposed on it by the work done with the barbell. Furthermore, it adapts to *exactly* the kind of stress imposed on it. If you do sets of 20, you get good at doing 20s. If you do heavy singles, you get better at doing those. But singles and 20s are very different, and you don't get better at doing one by practicing the other. The muscles and nervous system function differently when they do these two things, and they require two different sets of skills and abilities, and thus cause the body to adapt differently. The adaptation occurs in response to the stress, and *specifically* to that stress, because the stress is what causes the adaptation. This is why calluses form on the hand where the bar rubs, and not on the other parts of the hand, or on the back of the hand, or on the face. It can obviously be no other way.

An awareness of this central organizing principle of exercise physiology is essential to program design. If a strength program is not designed to get your trainees stronger, you don't get to call it a strength program. It is just an activity. To get stronger, you must do something that requires that you be stronger to do it, and this must be built into the training program.

Many millions of words have been written on the subject of program design, and it is perhaps the major topic of discussion in exercise science circles. This book will take a very simple approach to the problem of programming for novices, and then leave it to the individual coach, other sources, and the coach's experience with athletes to provide programs that challenge and improve those athletes.

The less experienced the athlete, the simpler the program should be. The stronger an athlete becomes, the more susceptible he becomes to **overtraining**, a condition produced by the body's inability to adapt to the stress level applied. Rank novices are not strong enough to tax themselves beyond their ability to recover, and can be trained to the limit of their ability nearly every time they train. As the athlete progresses through his training experience, the program will get more and more complicated as a result of the changing nature of his adaptive response. Intermediate trainees are capable of training hard enough that some allowances for active recovery must be incorporated into the training program, but progress still comes faster for these athletes when they are challenged often by maximum efforts. As an athlete becomes more advanced, more care should be taken to ensure enough variability in the intensity and amount of exercise that overtraining does not become a problem. These principles are illustrated in Figure 1.

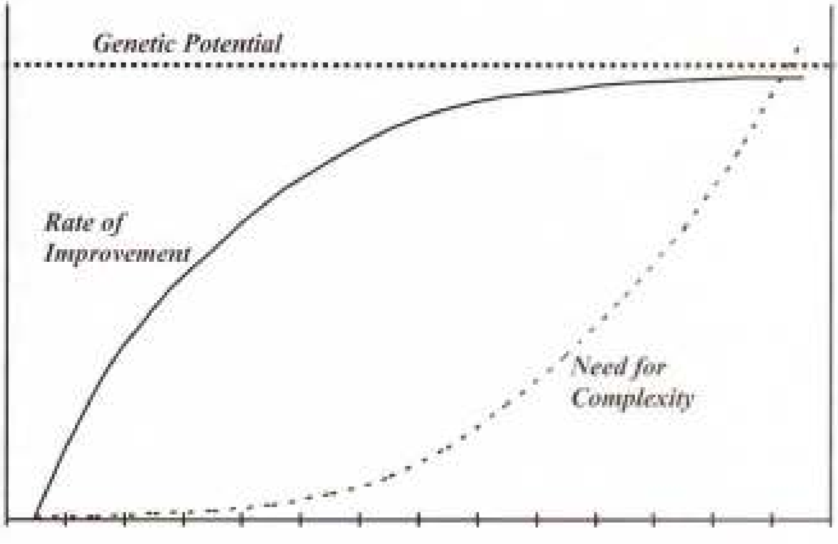


Figure 1. The complexity of programming required for improvement increases over the training career. Novice trainees require little more than the simple linear progressive resistance paradigm.

So, as a general rule, your novice trainees need to try to add weight to the work sets of the exercise every time they train, until they can't do this anymore. **This is the basic tenet of "progressive resistance training".** All of them can do this for a while, and some of them can do it for longer than others, depending on individual genetic capability, diet, and rest. If they are challenged, they will adapt, and if they are not, they won't. For as long as possible, make sure that they lift more weight each time.

Before an athlete even gets through the door of the weight room, he should already know every thing he will do while he is there, the order in which it will be done, how much weight it will be done with, and how to determine the next workout based on what he does today. No athlete should ever arrive to train not knowing what he is going to do. Wandering around the gym, deciding what looks fun, doing that thing until the fun stops, and then doing something else **is not training**. Each training session must have a definite achievable goal, usually an increase over the previous workout in the amount of weight lifted, or another definable objective based on the previous workout.

Strength in each exercise will progress differently, due to differences in the amount of muscle mass involved, and the sensitivity of the movement to technique problems. The deadlift, for instance, improves rather quickly for most trainees, faster than any of the other lifts, due to its limited range of motion around the hips and knees, and the fact that so many muscles are involved in the lift. In contrast, the press goes up rather slowly due to the smaller muscles of the shoulder girdle. The more muscle mass involved in an exercise, the faster the exercise can get strong and the stronger it has the potential to be.

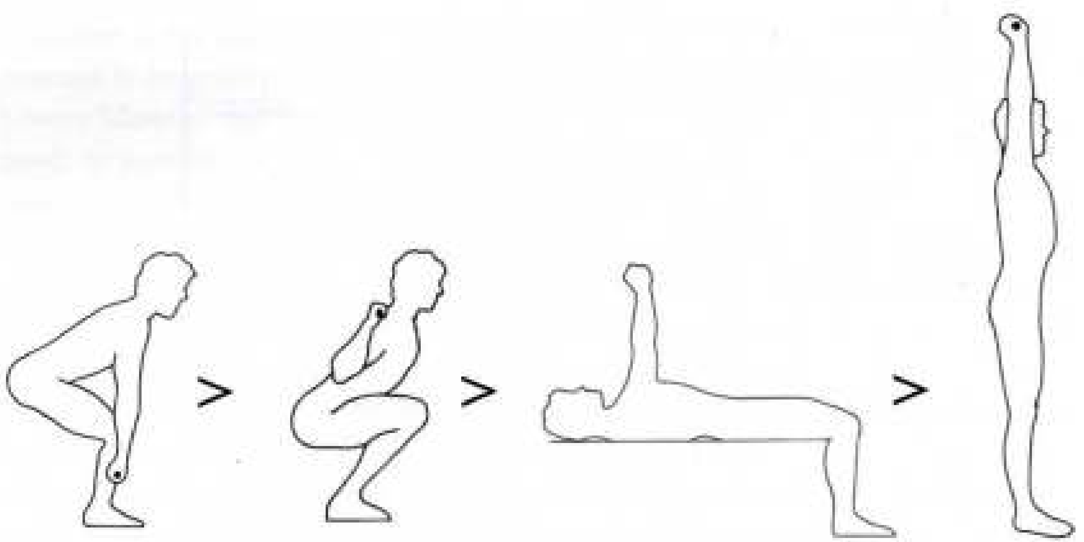


Figure 2. The continuum of potential strength gains, and ultimately performance, for the exercises in this book is primarily a function of the amount of muscle mass involved in an exercise. Other factors affect the power clean: although it involves a large muscle mass, the technical and speed of movement requirements of the lift place it somewhere between the bench press and press for potential gains and rate of increase in performance.

In a trained athlete, the deadlift will be stronger than the squat, the squat stronger than the bench press, the bench press and the power clean close with the bench usually a little stronger, and the press lighter than the other four. This distribution holds for the majority of athletes, and is predictive of what should happen. For example, if your trainee benches more than he deadlifts, something is out of whack. He may have a grip problem, an injury, or a motivational discontinuity, e.g. a strong dislike for the deadlift. In any case, this situation should be addressed lest a strength imbalance cause problems on the field or for other lifts (figure 2).

The differences in the nature of the lifts must be considered in all aspects of their use in the weight room.

Teaching the lifts

The squat should be taught first, since it is the most important exercise in the program and its skills are critical to all the other movements. The squat should be your trainees' introduction to the training program. When you first get a new trainee, it is likely that he will have either been taught the movement wrong, in which case he will need to be de-programmed (the worst-case scenario) or that he will never have been shown it at all (the best case scenario since no incorrect motor pathways exist that need to be fixed.) It is much harder to correct a movement than to teach one, as any sport coach will attest. The problem is particularly evident in the weight room, where correct technique is the essence of everything we do, and a stubborn form problem resulting from prior incorrect instruction can be costly in terms of time and slowed progress. The squat serves to get his attention, alerting him to the fact that in your weight room, things must be done correctly (figure 3).

Assuming that we have time to teach more than one exercise the first day (and we should arrange things so that we do), the next exercise to teach would be the bench press. The squat has fatigued the lower body, and the bench press allows it an opportunity to rest while another skill is introduced. The bench is usually easy to teach, especially in the absence of preconceived notions acquired from pictures in the muscle magazines or helpful buddies. Fewer problems will be encountered while teaching the bench press, since fewer muscles and joints are involved in the primary aspect of the exercise and there is less that can go wrong.

The deadlift will be the last thing to learn the first day. The mechanics of the correct pull from the floor are crucial to the clean, and for that matter to hauling hay and other manual labor-type skills that some of your trainees may find themselves doing from time to time. The deadlift is where your trainees learn to set the lower back, and doing this at the conclusion of the first day, after the squat, will solidify the concept of back position and make it more understandable to the body and to the mind. If the squat that first day has been difficult or has taken a long time, or if your trainee is older or very deconditioned, the first deadlift instruction might just be an introduction to good form with light weight. This prevents excessive soreness after the first session, which would definitely compromise the

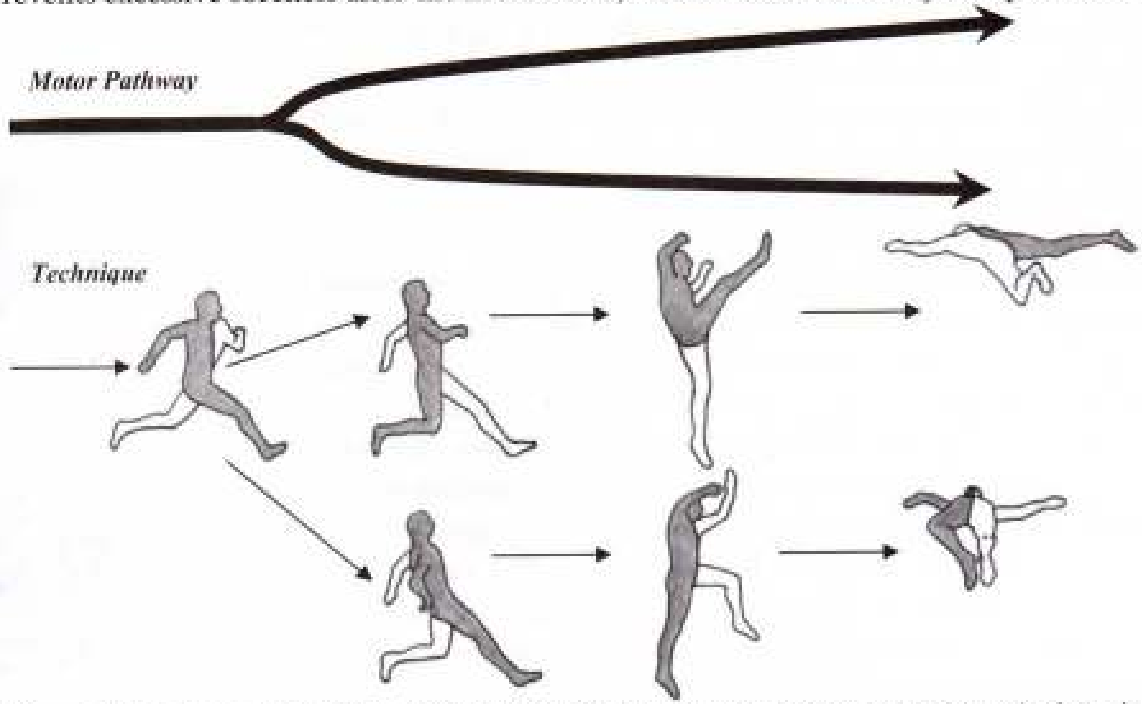


Figure 3. The relationship between similar techniques and their motor pathways. In the example above, both motor pathways (techniques) end in a successful high jump, however the motor pathway involved in performing the Western Roll high jump technique (top) is less efficient than the Fosbury Flop technique (bottom). You can jump higher with the Flop. The motor pathways of the two techniques diverge before the takeoff stride and become increasingly dissimilar thereafter. Early in the approach the motor pathways are very similar, and it is this phase that overlap and interference between the two would become a problem. The more similarity between the two techniques, the greater chance of motor pathway confusion, and the more difficulty a trainee will have in keeping them separate. The more divergent the motor pathways become, the less likely they are to overlap and interfere. It is therefore essential to learn complicated movements correctly early, since correct and incorrect movements often have similar motor pathways.

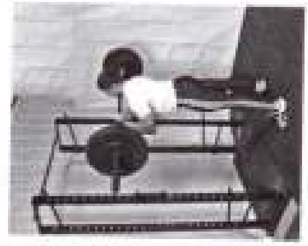
second one. The next deadlift workout can be heavier, and the target weight more easily and accurately determined after recovery from the first squat workout has occurred.

The other two lifts are learned at the next workout, provided there were no major problems encountered. Start the second workout with the squat, and then teach the press. The bench press may have produced a little soreness in the pecs, but not usually in the triceps, and pec soreness will not interfere with the press. Pressing provides the same break for the lower body between exercises that the bench press does, since we will be power cleaning next. The press is more complicated than the bench press, and introducing it after the bench serves to allow a graduated increase in complexity.

The power clean, being the most mechanically challenging of the exercises, should be introduced last, and only after the deadlift is correct off the floor. If that occurs the first workout, the clean can be taught the second time. If more time is needed to correct the deadlift, take it. Introducing the power clean too early will produce problems for the clean, since the initial part of the movement depends on the deadlift's being fairly automatic. Better athletes can learn the power clean earlier, but take your time with the others.

Workout order

For novices, and in fact for many more advanced trainees, a very simple approach to training should be taken. Effective workouts need not be long, complicated affairs. Many people are under the impression that progress in the weight room means learning more ways to curl, the basic one or two not being sufficiently numerous. Progress means more strength, not more exercises. It is not necessary to do many different exercises to get strong – it *is* necessary to get strong on a very few important exercises, movements that train the whole body as a system, not as a collection of separate body parts. So, in keeping with this philosophy, the following novice workout is offered in Figure 4.



Workout #1		Workout #2	
1	Squat	*1*	Squat
2	Bench Press	*2*	Press
3	Deadlift	*3*	Power Clean

Figure 4. Teaching order of the first two workouts. This series is repeated.

Essentially, we squat every workout and alternate the bench press and press, and the deadlift and power clean. This schedule is for three days per week, allowing a two-day rest at the end of the week. It will mean that one week we press and power clean twice, and the next week we bench and deadlift twice. The workout should be done in the listed order, squatting first, the upper body movement second, and the pulling movement third. This allows the squat to get everything warm for the next exercise (a thing it will do well), then the upper-body exercise allows the legs and back to rest and recover for the pulling movement to be done next, with any assistance exercises to be done saved for last.

Most Olympic weightlifting coaches will use a workout order that places faster movements before slower movements, so that the explosive lifts, the snatch, clean and jerk, and their variations, are performed before the strength exercises like the squat and the pressing movements. This makes perfect sense if the competitive lifts are the emphasis of the program. This program uses the power clean as the explosive movement, but since none of the exercises in the program are herein approached as competitive lifts, doing the power clean as the last exercise in the workout is just as productive for our purposes. If the coach wishes to emphasize the clean for some particularly needy trainees, that is fine, provided sufficient warmup is done first. A major advantage to doing the squat first is the superior warmup it provides to all the subsequent movements, and if cleans are done first, some squats should probably be incorporated into their warmup.

For most people, and for quite some time, this schedule will work well. Any supplemental exercises added to this should be chosen very carefully so as not to interfere with progress on these five crucial movements. Remember: if progress is being made on these exercises, your trainee is getting stronger and your objective is being accomplished.

After your trainee progresses beyond the novice phase, this workout, with very few additions, can still be used. The variety is introduced into the programming of each lift, and variations are made in the workload. Even for more advanced trainees, it is still unnecessary to add lots of different exercises to the workout, as the purpose is always served when the strength level increases on the basic lifts. Any assistance exercises that are added must be kept in their proper perspective; they are there to help make the basic lifts get stronger, not as an end in themselves. The press will always be more important than tricep work, and if tricep exercises interfere with pressing or benching, they are being misused.

Warmup sets

Warmups serve two very important purposes. First, warmups actually *warm up* the soft tissue – the muscles and tendons, and the ligaments that comprise the joints – that we are going to use in the exercise. General warmup exercises, like walking fast or jogging, or riding an exercise bike (the preferred method, due to the greater range of motion the knee is exposed to during the exercise, better preparing it for the squat), serve to increase the temperature in the tissue and mobilize the synovial fluid in the joints. Specific warmups, like the unweighted and empty bar sets of the barbell exercise itself, also serve to warm, mobilize, and stretch the specific tissues involved in that particular movement. This is important for injury prevention, since it is more difficult to injure a warm body than a cold one.

The elevation of tissue temperature is very important, and requires that several variables be kept in mind. The temperature of the training facility should be considered as a factor in this phase of warmup. A cold room interferes with effective warmup, while a hot room aids it. Winter months and summer months produce different warmup requirements for most athletes, since they usually arrive at training feeling different in August than in January. An athlete with a healing injury needs extra warmup specific to the tissues affected by the injury. And the age of the trainee affects warmup requirements as well. Younger trainees (damn them!) are less sensitive to a lack of warmup than adults, and the older the adult the more time he needs to devote to pre-workout preparation.

The second function of warmup is especially important in barbell training: it allows the athlete to practice the movement before the weight gets heavy. Light warmup sets, done first with the empty bar and then progressively heavier until the work sets are loaded, serve to prepare the movement pattern itself, so that when the weight gets heavy attention can be focused on pushing hard instead of how to push. The motor pathway - the neuromuscular adaptation to a complicated movement pattern - must be prepared every time it is used, whether throwing a baseball or doing a squat. The warmup sets prepare the motor pathway at the same time as they prepare the tissue for the upcoming heavier work. While the first sets are being done, form errors can be addressed and fixed, and good form can be practiced, so that when the work set is done the athlete's conscious attention can be more focused on driving the load and less on form.

Both of these aspects of warmup are neglected at peril of injury and lifting inefficiency. Many school programs, in a jam for time, omit most of this crucial part of the workout. The strength coach, by abbreviating warmup sets for his trainees, commits *malpractice* when he does this. Please heed the following rather strong statement: **if your schedule does not allow time for proper warmup, it does not allow time for training at all.** If the schedule is such that 50 kids have to try to squat, bench, and deadlift on 5 stations in 50 minutes, it is better to omit strength training from the program than to risk the probable injuries that will result from lack of warmup. Yes, warmups are *that* critical.

Warmups will vary with the lift being warmed up. The squat, being the first lift of the workout and by its nature a total-body movement, should be carefully and thoroughly prepared with a couple of empty bar sets, and then as many as five sets between those and the work sets. This ensures that the initially cold body is warm before any heavy work is done. The next upper-body movement will have the benefit of some advance preparation, and, in the absence of an injury, can be warmed up adequately with only three or four sets. The deadlift, being a simple movement, requires mainly tissue preparation, and this has occurred during the squat, provided that the pressing hasn't taken so long that the trainee has gotten cold. The power clean, being a more complex movement, will require more warmup for technique purposes. Assistance exercises, if they are done, will be done last with already-warm muscles and joints, and will require only one or two warmup sets.

Any area that is injured will require additional warmup. If the injured area does not respond to the warmup sets by starting to feel *much* better after two or three sets with the empty bar, a decision will have to be made about whether to continue with light sets or to wait until the area has healed better.

First, some terminology clarification. A **work set** or sets is the heaviest weight or weights to be done in a given workout. **Warmups** are the lighter sets previous to the work sets. **Sets across** refers to multiple work sets done with the same weight. The work sets are the ones that provide the training effect – they are the sets that make strength go up, since they are the heaviest. The warmup sets serve only to prepare the lifter for the work sets; they should never interfere with the work sets. As such, they must be planned with this in mind. The last warmup before the work set should never be so heavy that it interferes with the work set, but heavy enough that allows the lifter to feel a heavier weight before he does the work sets. It might consist of only one or two reps even though the work sets are five or more reps. For instance, if the work sets are to be 225 x 5 x 3 (weight x sets x reps), then 215 x 5 would not be an efficient choice for a last warmup. A better choice would be 205 x 2, or even 195 x 1, depending on the lifter's preference, skill, and experience. Since the focus is on completing all the reps of the work sets, the warmups must be chosen to save gas for the heavier sets.

As an example of the importance of proper warmup, let's examine the effects of a bad warmup carried to an extreme. There is an old workout "method" still floating around weight rooms and gyms all over the world, known as the Pyramid. For the bench press, it would go something like 135 x 10, 155 x 8, 175 x 6, 185 x 5, 195 x 4, 205 x 3, 215 x 2, and 225 x 1. By the time the last set is finished, the trainee feels as though he has had a pretty good workout. The problem is that it is exactly the same workout he did last time, and that by the time he has done 6390 lbs. of work before the last set at 225, the chances of his ever increasing this last set are slim. By the time he reaches what should be a work set, he is destroyed, since all of his warmup sets have essentially been work sets too. His warmups didn't prepare him to increase his work sets, so he never lifts any more weight than he did the previous workout, and he is quite thoroughly stuck. If the warmup sets fatigue instead of prepare, they are not warmups and strength cannot increase.

As a general rule, it is best to start with an empty bar (45 lbs.), determine the work set or sets, and then divide the difference between them into even increments. Some examples are provided in Figure 5.

Most trainees will need to select three to five warmup weights, using each of them for one set. If additional warmup is desirable (as with a cold room, older trainees, or injured lifters) multiple sets can be done with the empty bar and the lighter sets. This provides the benefits of the warmup without the fatigue of too much work at heavier weight before the work sets.

As the warmups progress from the empty bar up through heavier weights, the time between the sets should increase a little.

Exercise Squat	**Weight**	**Repetitions**	**Sets**
	45	5	2
	95	5	1
	135	3	1
	185	2	1
Work sets	225	5	3

Bench Press	**Weight**	**Repetitions**	**Sets**
	45	5	2
	85	5	1
	125	3	1
	155	2	1
Work sets	175	5	3

Deadlift	**Weight**	**Repetitions**	**Sets**
	135	5	2
	185	5	1
	225	3	1
	275	2	1
Work sets	315	5	1

Press	**Weight**	**Repetitions**	**Sets**
	45	5	2
	75	5	1
	95	3	1
	115	2	1
Work sets	135	5	3

Power Clean	**Weight**	**Repetitions**	**Sets**
	45	5	2
	75	5	1
	95	3	1
	115	2	1
Work sets	135	5	3

Figure 5. Example warmup set distributions.

As a general rule, the time between sets should be sufficient to recover from the previous set, so that fatigue from the prior set does not limit the one about to be done. The heavier the set, the longer the break should be. This type of training requires that all of the reps of each set be completed, since the program is based on lifting more weight each workout, not completing each workout faster. A strength program is designed to make people stronger, i.e. able to exert more force and lift more weight. Some training programs used in bodybuilding rely on the fatigue (figure 6) produced by short breaks between sets, and these programs specifically increase muscular endurance. Although endurance increases as a function of increased strength, it is not a parameter specifically targeted by this program at the novice level. More benefit can be obtained by lifting heavier weights, through efficient timing of sets to allow for recovery, than by trying to decrease the time between the sets and allowing fatigue to limit the ability to exert maximum force.

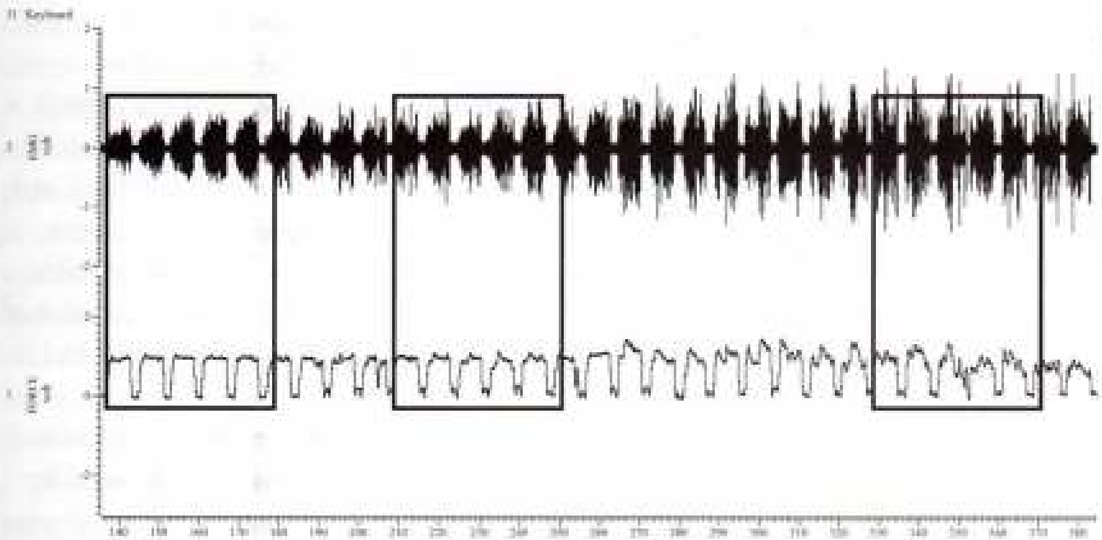


Figure 6. Sets of 5 reps seem to be optimal for teaching purposes. It is apparent from EMG (top) and force (bottom) data that there is a progressive loss of motor coordination with higher repetitions. In reps 1-5 the muscle is firing in a very coordinated manner (tight uniform EMG waves and consistent force production), by reps 10-14 there is a significant loss of motor coordination (erratic EMG waves and force continuity during the rep), and by 25-29 repetitions motor neuron activity is greatly randomized and force generation is lower and less uniform. Although we as coaches need to see multiple repetitions to detect errors and determine movement patterns, using more than 5 repetitions will likely make teaching correct technique more difficult. Note that the peak level of force production on rep 20 is essentially the same as on rep 1 although control of the force has degraded. A 20-rep set is not really heavy, but it sure is long.

The time between sets will vary with the conditioning level of the athlete, in a couple of different ways. Rank novices are not typically strong enough to fatigue themselves very much, and these people can go fairly quickly, just a minute or two, between sets, since they are not lifting much weight anyway. The first two or three sets can be done as fast as the bar can be loaded, especially if two or more are training together. More advanced trainees need more time between the last warmups and the work sets, perhaps five minutes. If doing sets across, very strong lifters may need 10 minutes or more between work sets.

Work sets

The number of work sets to be done after the warmups will vary with the exercise and the individual. The squat benefits from sets across, usually three sets, as does the bench press and the press. The deadlift is hard enough, and is usually done after a lot of squatting, such that one heavy set is usually sufficient. The power clean can be done with more sets across, since the weight is lighter relative to the squat and deadlift, and the limiting factor is usually technique, not absolute strength.

Multiple work sets cause the body to adapt to a larger volume of work, a thing that comes in handy when training for sports performance. One school of thought holds that one work set, if done at a high enough intensity, is sufficient to stimulate muscular growth. For novices, several problems with this approach immediately present themselves. First, we are dealing with inexperienced trainees who do not yet know how to produce maximum intensity under the bar, and will not know how for quite some time. Second, if they don't know how to work at a very high intensity, more than one set will be necessary to provide sufficient stress to cause an adaptation to occur - one set will not provide enough. Third and most importantly, one intense set adapts the body to work hard for one intense set, since exercise, as we know, is extremely specific. Except for Sumo, sports do not usually involve one relatively brief intense effort, but generally involve repeated bouts of a higher volume of work. A sets-across routine more closely mimics the effort usually involved in sports, and is therefore more useful as a conditioning tool.

In fact, one of the most effective strategies for the squat, bench, and press is five sets across of five reps, done once a week as one of the workouts, increasing the weight used by very small amounts, less than 5 pounds, each week.

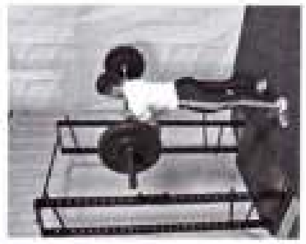
How many reps should a work set consist of? It depends on the adaptation desired. Five reps is a good number for most purposes, but an understanding of the reasons for this is essential, so that special circumstances can be accommodated correctly.

When trying to understand the nature of any given set of variables, it is often helpful to start with the extremes, the limits of which can reveal things about the stuff in the middle. In this case, let's compare a one rep max squat, or 1RM, to a 20RM squat, and look at the different physiologic requirements for doing each (figure 7).

The single most important contributing factor to the successful heavy one rep attempt is the ability of the muscles involved to produce force. The heavier a weight, the more force the moving of it requires, as should be obvious. The one-rep set doesn't take very long to do, so muscular endurance is not a factor, and neither is cardiovascular capacity, for the same reason. The only thing the muscles must do is produce sufficient force to overcome the pull of Mean Old Mr. Gravity on the bar. So, in response to 1RM training, the body adapts by getting better at producing high amounts of force, one rep at a time. It does this by adjusting the components of the system that produce the force: the nervous system, the "neuromuscular" system - the way the nerves make the muscles work, and the muscles themselves, especially the components of the muscle that actually produce the contraction.

There are other adaptations that are secondary to the main ones, but they all involve helping the body perform a brief, intense effort. Psychological adaptations enable the fear of the heavy weight to be overcome. The heart adapts by getting better at working with a huge load on the back, and the blood vessels adapt by becoming capable of responding to the demands of increased peak blood pressure. The skin under the bar gets thicker, the eyeballs get used to bugging out, and new words are learned that express the emotions of success with a new PR squat. But the primary adaptation is increased force production.

On the other hand, a heavy set of 20 reps is an entirely different experience, one of the most demanding in sports conditioning. A set of 20 can usually be done with a weight previously assumed to be a 10RM, given the correct mental preparation and a certain suicidal desire to grow or die. The demands of a 20 RM, and therefore the adaptation to it, are completely different. A 20 RM is done with about 80% of the weight of a 1RM, and even the last rep is not really heavy, in terms of the amount of force necessary to squat it. The hard part of a set of 20 is that the last 5 reps are done in a state that approaches death, or at least a hellish nightmare. The hard part is making yourself squat another rep with the pain from the accumulating lactate, an inability to catch your breath, and the inability of your heart to beat any faster that it already is. The demands of a 20 RM involve continued muscle contraction under circumstances of increasing oxygen debt and falling muscle pH, as lactic acid accumulates faster than it can be removed by the bloodstream.



In response to this type of stress, the body gets better at carrying lactate away from and supplying oxygen to the muscles. These adaptations are primarily cardiovascular in nature, since the main source of stress involves insufficient blood flow. The heart gets better at pumping blood under a load, the vessels expand and become more numerous, and the lungs get better at oxygenating the blood - although not in the same way that a runner's do. The main muscular adaptation is also essentially vascular, in that a denser bed of capillaries is produced, to provide oxygen and carry away lactic acid. The contractile part of the muscle tissue gets better at working under the acidic conditions produced by lactic acid accumulation. Psychologically, 20 RM work is very hard, due to the pain, and people who are good at it develop the ability to displace themselves from the situation during the set. Or they just get very tough.

It is essential to understand that the 1RM work does not produce the lactate stress that the 20 RM work does, and that the long set of 20 reps is not heavy in the same way that the 1RM is. They are both hard, but for different reasons. Because they are so completely different, they cause the body to adapt in two completely different ways. These extremes represent a continuum, with a heavy set of 3 more closely resembling 1RM in its adaptation, and a set of 10 sharing more of the characteristics of a 20 RM. Sets of five are a very effective compromise for the novice, and in fact for the advanced lifter more interested in strength than muscular endurance. They allow enough weight to be used that force production must increase, but they are not so heavy that the cardiovascular component is completely absent from the exercise.

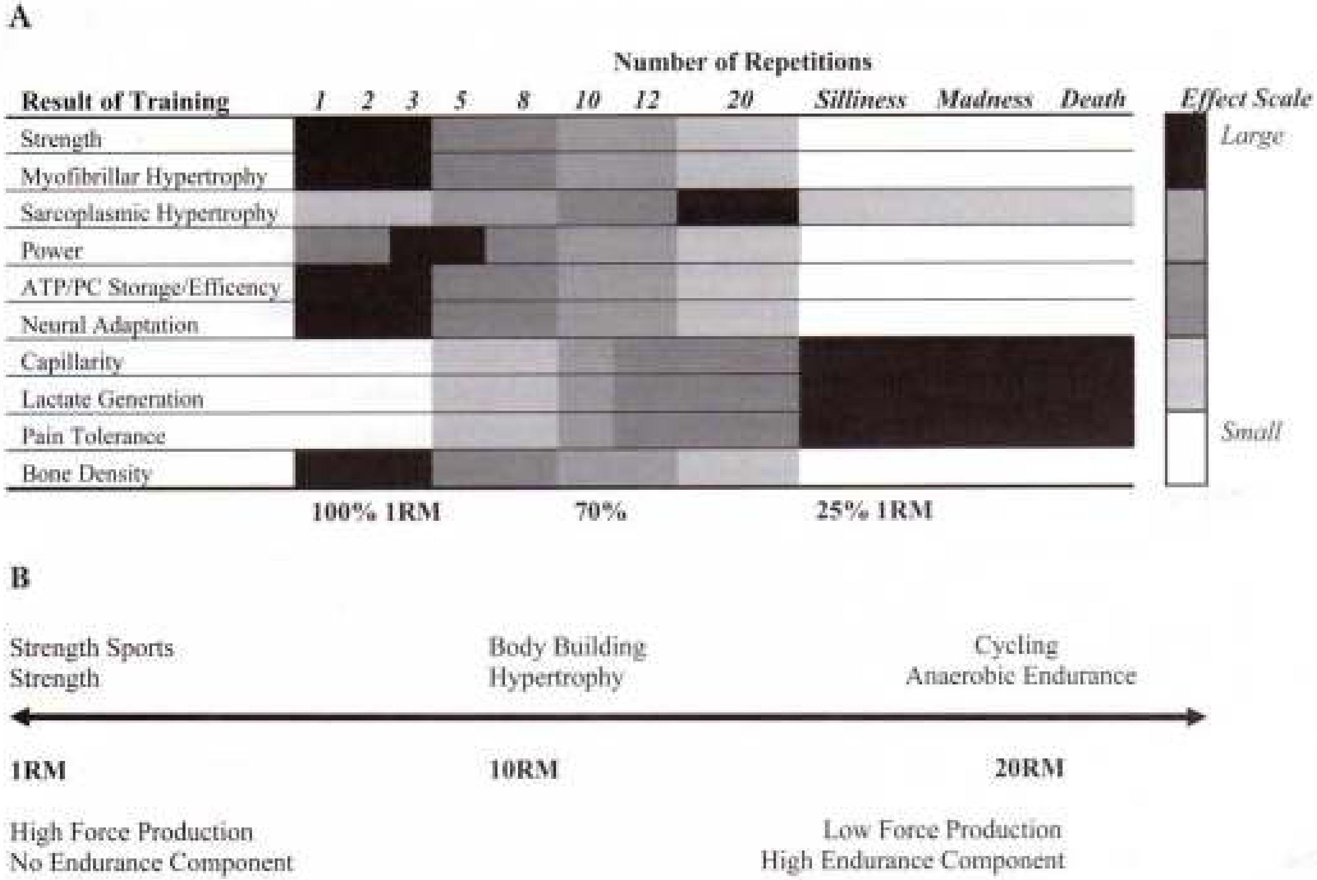


Figure 7. (A) Just as in running, different volumes of training (repetition schemes) produce different results. For example, in the continuum above, the largest gains in strength result from low repetition work, in the range of 1-3 repetition maximum. Conversely, the largest adaptation in lactic acid tolerance occurs at the very high end of the repetition spectrum. Coaches and trainers must be very explicit in what their training goal is and select specific repetition schemes to meet those goals. (B) The strength continuum, in more general terms.

Back-off sets

It is occasionally useful to increase work volume by doing additional sets after the work sets are completed. These sets are done with a lighter weight, and are referred to as **back-off sets.** They can be done with the same number of reps, or a higher number, depending on the reason for doing them or the effect desired. If there were technique problems with work sets, a couple of back-off sets with 80% of the work set weight and 150%

of the work set reps is a useful way to practice form. The weight is light enough to permit the trainee to focus just on the technique without worrying about actually completing the last reps, and the higher number of reps allows for lots of practice with the movement. Back-off sets must be coached very tightly, with feedback to the lifter on every rep. If the technique situation warrants doing back-off sets, it also warrants the coach's attention during them. Otherwise, the trainee is just practicing bad form with lighter weight and higher reps, and the problem gets worse.

Sometimes it is desirable to just get some more work with heavier weight. If the work sets were doubles or triples (sets of 2 or 3 reps), it might be necessary - depending on where the lifter is in his training cycle - to use back-off sets to increase the work volume. Or it might be that heavy singles were being done, either for testing purposes or for work volume as sets across, and heavy back-off sets would then be used to make up the actual training volume that day.

Training volume is calculated by multiplying the weight on the bar times the reps. 315 x 5 = 1575 lbs., the volume, or tonnage, for the set. Heavy singles, even though they're heavy, don't add up to very much volume. Sets of 10 do. Five sets of 5 do too. Compare singles across, 225 x 1 x 5 = 1125 lbs., with the corresponding set-of-5 capacity of the same trainee, 195 x 5 x 5 = 4875 lbs., and you can see the situation clearly.

Progression

The effective training of novices takes advantage of the fact that untrained people get strong very quickly at first, and this effect tapers off over time until advanced trainees gain strength only through careful manipulation of all training variables. Novices can, and should, increase the weight of the work sets every workout until this is no longer possible. In fact, novices get strong as fast as the workout makes them, and what was hard last time is not hard today. They can adapt so quickly that the concept of "maximum intensity" is hard to define. If a kid gets strong as fast as his work sets increase, a 10 lb. jump is not really heavier relative to his improved strength. The key to maintaining this rate of improvement is the careful selection of the amount of weight that we increase each time.

Work set increases will vary with the exercise, the age and sex of the trainee, the experience of the trainee, and the consistency with which the trainee adheres to the program. Close observation by the coach will provide all the information needed to determine the increments of increase. A little practice within the following general guidelines will produce good results.

For most male trainees with good technique, the squat can be increased 10 lbs. per workout, assuming 3 workouts per week, for three or four weeks. When he misses the last rep or two of his last work set, the easy gains are beginning to slow down and 5 lb. jumps can be taken for a while. For very young kids, older trainees, and most women, 5 lb. jumps are sufficient to start with, and then smaller jumps will be required, as will the lighter barbell plates (lighter than the standard 2 ½ lb plates) that make smaller jumps possible. If it is important for your female and pre-pubescent athletes to make progress, it is important to obtain the right equipment to enable them to train correctly. It may be necessary to make the plates, or to have some 2 ½'s milled down, but it is necessary, so get it done. It will be useful at some point for all athletes to have access to light plates, since progress on the lifts will eventually slow to the point where they will be useful for even your advanced men. Don't be afraid to take small jumps – *be afraid to stop improving.*

Some very talented, heavier trainees can take bigger jumps of 15 or 20 lbs. Anything more than this is usually excessive, even for the most gifted athlete, since an increase of 60 lbs. per week in the squat is not going to be realistically sustainable for very long. Don't be in a big hurry to find a trainee's sticking point in his early training progression. **It is always preferable to take smaller jumps and sustain the progress, than to take bigger jumps and get stuck early. Getting stuck means missing any of the reps of the prescribed work sets, since the weight cannot be increased until all of the reps have been done as prescribed.** This is an important thing to keep in mind when training novices. It is easier to not get stuck that it is to get unstuck.

In the bench press, the muscles are smaller, so the increases will be smaller. If the first workout has properly determined the initial strength level, 5 lb. jumps for most male trainees are possible for a while, assuming we are alternating bench presses and presses. Some talented, heavier trainees can make a few 10 lb. jumps, but not many. Older trainees, the very young, and women will need to start with small jumps, and the special light plates are particularly important for these trainees to keep making progress on the bench. Do not be afraid to slow the increases down to very small jumps on the bench; remember that an increase of even 2 lbs. per week means a 104 lb. increase in a year, not a shabby thing, especially for a lighter, older trainee.

The press will behave similarly to the bench press, since the muscles involved in moving the bar are small relative to the squatting and deadlifting muscles. The press uses lots of muscles, true, but you can only press what the triceps can lock out, and no chain is stronger than its weakest link, trite as that might be. The same jumps used for the bench can usually be used for the press, although the press will start off at somewhere between 60% and 80% of the weight used in bench press. Since we are alternating the two exercises, they will stay about the same weight apart as they increase.

The deadlift will progress faster than any of the other lifts, since the start position, basically a half-squat, is very efficient mechanically, and since virtually every muscle in the body is involved in the movement. Most trainees can add 15-20 lbs. to the deadlift each workout for a few weeks, with the very young, women, and older trainees taking a more conservative approach. With this being the case, the deadlift will use heavier weights than the other lifts, and should be stronger and get stronger faster than the other lifts. A trainee who benches more than he deadlifts needs to quit skipping his deadlifts. But since the deadlift involves more muscles and more weight than the other lifts, it is easier to overtrain and should not be trained using sets across. It is really easy to get really beat-up doing a lot of heavy deadlifts. One work set is usually quite sufficient to maintain improvement.

It is interesting that the power clean behaves more like the bench press than the squat or deadlift, in terms of the way it increases over time. The reason for this involves the biomechanical nature of the movement, and the factors limiting its progress. The power clean is explosive and technical, and involves more than just absolute strength. It is limited at the top of the movement by the ability to get the bar on the shoulders, and the higher the bar goes, the smaller the muscles involved in making it rack, and the more dependent it is on good technique having generated enough momentum to get it high enough to rack. It is sensitive to fatigue and the amount of work done prior to it. With this in mind (after a proper first workout assessment), the power clean will move up maybe 5 lbs. per workout for most trainees. Women, young and older trainees, and those with technique problems might only make 5 lbs. every other workout, or might need to introduce smaller plates earlier in the progression.

Assistance exercises, which are by their nature inefficient isolation-type exercises, make very slow progress. Any trainee claiming rapid gains on tricep extensions or barbell curls is not utilizing particularly strict form, and should be criticized for such foolishness.

When these smaller jumps can no longer be sustained, the trainee can be considered an intermediate, and the fun begins with more complicated manipulation of his training load. This variation in training load and intensity for purposes of ensuring continued progress is referred to as **periodization**. It is unnecessary for rank beginners, since they get strong as fast as the weight can be increased every workout, and it is indispensable for advanced lifters, who cannot continue to make progress without it. Intermediates are, like the name says, somewhere in between, with some degree of training parameter manipulation necessary to allow for recovery on some lifts, and with other lifts still progressing in a more or less linear fashion. When it becomes necessary, some **offloading**, i.e. lighter work, must be built into the program to allow the body and the mind to catch up with the increased weight and workload. Skill and care must be utilized in designing programs for these more advanced lifters so that just enough work is balanced with just enough rest. Many periodization models have been developed, and the literature is filled with interesting ways to use them, some valid, some not so valid. The strength coach must rely on common sense and experience when applying them to his trainees, as their continued success is dependent on his good judgement in this very important matter.

And all these guidelines apply only to trainees who do not miss workouts. Failure to train as scheduled is failure to follow the program, and if the program is not followed, progress cannot predictably occur. If a good trainee has to miss a couple of workouts due to severe illness, or possibly the death of a parent, spouse, or good dog, allowances can be made, and the last workout completed should just be repeated set for set. But if a trainee continually misses workouts, he is not actually training, and your valuable time should be spent more productively elsewhere.

Likewise, trying to increase the weight faster than prescribed by the program and by common sense is also failure to follow the program. If you as a coach either encourage or permit unrealistic increases between workouts, it is your fault when progress does not occur. Greed is useful when controlled, as most of human history and the science of economics demonstrates. But greed is an ugly thing when uncontrolled, and will result in your program's progress coming to an ass-grinding halt. The exercises must increase in weight in order for progress to occur, by definition. But if you allow your trainees or yourself to succumb to the temptation of 10 lb. jumps on the bench press, or 50 lb. increases on the squat, just because the plates were handy (or the right plates were inconvenient), you are going to get stuck. Too much weight on the bar is just as bad as no increase in weight at all, or for that matter, missing workouts. Take the time and care necessary to ensure that the right plates are available, that everybody knows what weight should be on the bar and why this is so.

You may find yourself in the position of working with so many athletes at one time that it is just physically impossible to coach them all enough to ensure their technique on every work set. This is certainly a less-than-optimal situation, but the realities of the program sometimes dictate such things. Try to work with a manageable number of athletes whenever possible, and make those changes that are feasible within the constraints of the program that will improve the coach/athlete ratio. And be conservative about increasing work set weight until you are sure that their technique is good enough to justify the increase.

It is understandable that, as a coach, you want your program to show results, and results means stronger athletes. But please understand this, if you miss everything else in this entire book: **stronger does not necessarily mean more weight on the bar**. Resist the temptation to add weight at the expense of correct technique – you are doing no one any favors when you sacrifice form for weight on the bar. Progress stops, trainees learn many, many incorrect things about training, themselves, and you, and no one benefits in the long run.

Nutrition and bodyweight

A program of this nature tends to produce the correct bodyweight in an athlete. That is, if a trainee needs to be bigger, he will grow, and if he needs to lose bodyfat, that happens too. It is possible, and quite likely, that skinny kids on this program will gain 10-15 lbs. of non-fat bodyweight in the first 2 weeks of a good barbell training program, provided they eat well. "Well" means 4 or so meals per day, based on meat and egg protein sources, with lots of fruit and vegetables, and lots of milk. Lots. Most sources within the heavy training community agree that a good starting place is one gram of protein per pound of bodyweight per day, with the rest of the diet making up 2500 – 5000 calories, depending on training requirements and body composition. Although these numbers produce much eyebrow-raising and cautionary statement-issuing from the registered dietetics people, it is a fact that these numbers work well for the vast majority of trainees, and have done so for decades.

One of the best ways to move in the direction of these numbers is to drink a gallon of milk a day, most especially if weight-gain is a primary concern. A gallon of milk per day, added to the regular diet at intervals throughout the day, will put weight on any skinny kid. Really. The problem is getting them to do it. It is currently a fad, as this is written in 2005, for boys to think they need a "six pack", although most of them don't have an ice chest to put it in. The psychology of this particular historical phenomenon is best left to others to investigate and explain, but the coach must cope with objections among his trainees to the obvious necessity of weight gain for skinny athletes. Aesthetics aside, *heavier* is necessary if *stronger* is to occur, and once they see that weight gain actually makes them look better (amazingly enough), they become less resistant to the idea. Milk works because it is easy, it is available, it doesn't need any preparation, and it has all the components necessary for growing mammals, which your trainees most definitely are. This time-proven method works for everybody that can digest milk – the lactose intolerant will need to make up the difference with more food.

Weight gain occurs the same way strength gains occur – fast at first, then more slowly as training progresses. It is possible for genetically favored individuals, for example a broad-shouldered, motivated kid 5'10" weighing 140 lbs., to gain as much as 60 lbs. in a year of good steady training, good diet, and milk. This is actually not that unusual a result for this type of trainee. What is unusual is *finding* this type of trainee. It is far more common to see 20 lb. increases in bodyweight over a 4-month period for lots of kids, with only a very few diligent ones doing much better. But most kids that will eat even a little better than they did before will gains several pounds the first few weeks.

Fat kids (not used here disparagingly) see a different result entirely, as their bodyweight doesn't change much for the first few months. What they will notice is looser pants in the waist, legs and hips staying about the same, shirts that are much tighter in the chest, arms, and neck, and faster strength increases than their skinny buddies. Their body composition changes while their bodyweight stays close to the same, the result of a loss in bodyfat due to their increasing muscle mass.

Both kinds of kids show improvement, and as their coach you can take pride in the results they obtain under your guidance, and enjoy their progress with them as they improve both their strength and their appearance.

Equipment

A lot of money has been wasted on weight rooms and gyms since the 1970s. Machines, as a general rule, are expensive, single purpose devices, delivering one exercise per footprint on the floor at a high price per square foot of training space. Barbells, on the other hand, are cheap. They can be used for lots of different exercises. The bench press, a single purpose device, is not an absolutely necessary piece of equipment, since the exercise we use it for can be done with a flat bench and a power rack. All of the exercises in this program can be done with a minimum of equipment, which allows for the better use of resources. Instead of $100,000 spent on an average 15-station circuit of machines, half that amount could be spent on the best barbell room in the world, with bumper plates, good bars, and platform space to accommodate lots of lifters, all in the same space.

Each station should be organized around the power rack, and each power rack should have a platform attached to it, such that the inside floor of the rack is perfectly flush with the surface of the platform. An 8'x 8' platform works well, providing plenty of room for every purpose it will serve. The room should be equipped with as many of these as possible, within the constraints of space and funding. These rack/platform units will use about 96 square feet, and in this space all the exercises in this program can be performed. If space permits, the same number of bench presses allow for the best use of training time by lots of athletes. The bench press/bar assembly uses about 36 square feet. Six of each of these units, both platform and bench press, would total 792 square feet. The layout of the room around this equipment must take into consideration the amount of space necessary to load and spot the bars used on the stations. Given enough space to move around and spot safely, an 1100 square foot room can be used as a perfectly serviceable training room for 20 athletes at a time. The general floor plan will obviously depend on the room, but this facility could be laid out in a 25' x 45' room, not a terribly big space. Twice that much space could accommodate a decent number of athletes, and at that number coaching efficiency becomes the main problem to solve.

Figure 8. A simple and multi-functional platform/rack/flat bench assembly. Every exercise presented in this text can be done with this set-up.

The power rack is the most important piece of equipment in the room, after the barbell itself. All our exercises can be done with a good rack, barbell, and flat bench (figure 8). It should be wide enough between the uprights to just safely accommodate the bar without a lot of extra room between the sleeves and the uprights (about 48"). The wider the rack, within safe limits, the more easily it can be safely used by taller, bigger lifters. The total height of the rack should be such that the crossbar at the top can be used for chin-ups and pull-ups by tall trainees; a 7 ½' to 8' tall rack would be fine for most everyone. The depth of the rack may need to accommodate a trainee squatting inside it occasionally, and for most people an inside dimension of 28" is comfortable. The base depth should be greater (about 48"), for tipping stability. It should be fitted with a heavy plywood floor, reinforced with a welded crossmember or two. The floor will extend all the way to the edge of the rack base, so that it can be made flush and continuous with the platform surface (figure 9). Each power rack should have a hook assembly for the bar to hang from outside the rack. It should have four heavy 1" thick pins that cross the depth of the rack from front to back with 4" or so extra on each side. These pins and hooks will adjust in height using holes drilled in the channel iron that forms the uprights of the rack. The closer together the holes are, the finer the adjustments can be for lifter height; 3" center to center is good, 2 ½" is better, 4" does not work well. The holes should extend from top to bottom. The entire rack should be correctly welded together, with no bolted components to loosen in a busy weight room.

Plywood is the least expensive and most convenient material for the platform. It is relatively cheap, very tough, and six sheets make a perfect 8' x 8' platform. The layers are alternated so that the seams do not penetrate the whole platform, and the unit is made very strong when the layers are glued and screwed together. Rubber horse trailer mats finish the surface, making it virtually indestructible. The thickness of this assembly is about 3", assuming ¾" plywood and ¾" rubber (figure 10). The rack and the platform surface need to be flush to eliminate the trip hazard, and invariably the rack will need to be shimmed, since racks and platforms usually won't match. Shim the floor under the rack with rubber, plywood, or some other dense, flat stuff to make the dimensions agree. Custom platforms are available from several sources; these are usually designed for the Olympic lifts and will be expensive but good-looking. They are unnecessary, but nice if the budget permits.

Figure 9. The platform must extend into the racks, with both surfaces flush for safety when racking or un-racking weights.

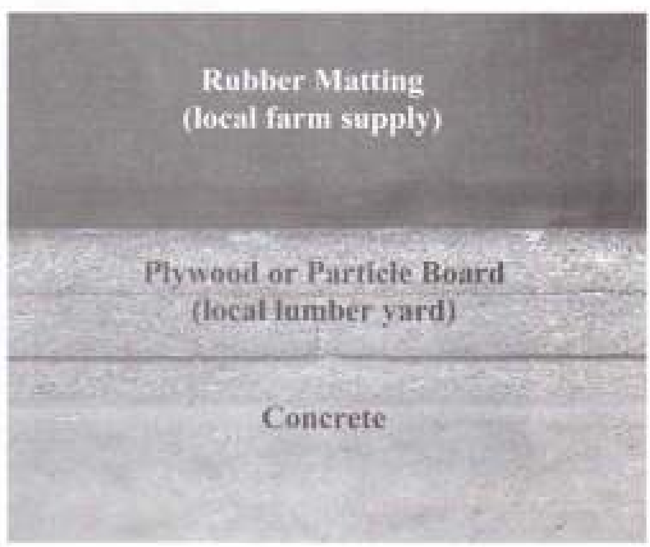


Figure 10. The layers of an inexpensive and durable platform.

An upright support bench for the bench press should be sturdy as hell, fully welded with no bolted joints to loosen, and may or may not have adjustable hooks. If the hooks are not adjustable, the fixed hook should be about 19" above the surface of the bench. It should always have wide uprights, about 48" apart, to minimize the risk of loading problems by inattentive trainees. The surface of the bench, with the padding compressed, will be 17", the width will be 12", and the length 48". The feet of the bench should not interfere with the lifter's foot placement. It should be built in such a way that it does not tip back when heavy weights are racked hard. There should be no obstruction for a center spotter standing at the bencher's head (figure 11). Some benches are equipped with safety hooks, to allow a stuck solo bencher a way to get the bar off him without having to dump the bar on the floor or wait till Search And Rescue arrives. If these are present, they should be right above chest height, about 9" – 10" above the bench.

Most weight rooms will want bench press benches, since having them frees up the power racks for other exercises, but again, they are not actually necessary since the power rack and a flat bench can be used for bench presses. If this is to be done, a flat bench should be the same dimensions as the support bench (figure 12). Too much padding will increase the effective height of the bench, not good for shorter lifters and annoying to taller ones that have used proper equipment before. Too wide a bench is a bad problem at the bottom of the movement, where it interferes with the shoulders and arms as the bar touches the chest.

Most benches are upholstered with vinyl for ease of cleaning. This material wipes off well, but fabric upholstery lasts many times longer, especially auto upholstery fabric. Fabric also provides better traction for the back during lifting. It can be cleaned with a shop vac, and stains can be removed with mineral spirits and a rag.

Figure 11. A standard bench press bench. Note the safety hooks at the lower position on the uprights.

Figure 12. A flat bench can be used with power racks to satisfy training needs. It needs to be as sturdy as a bench press bench.

Bars are the place to spend money, if you have it. If you don't, raise it somehow, because cheap bars are dangerous, unpleasant to use, and a bad investment. Cheap bars will bend. Even expensive bars can bend under the wrong circumstances, if they are dropped loaded across a bench, for instance. But cheap bars will always bend, even under normal use. A good bar should be properly knurled and marked, should be put together with roller pins and not with bolts or screws, and should require little maintenance beyond wiping it off occasionally. It should be made to international competitive specs, so that it will accommodate the different brands of plates that all weight rooms eventually accumulate. Above all, a good bar is made of excellent steel, which will not deform with normal use. Expect to pay $250 or more for a good bar. There are lots of cheap imported bars available for less than $100. They are junk. Do not buy them. And do not hesitate to send back a good bar that bends under normal use, since they are not supposed to do that. A reputable company will replace a bar that fails, since their manufacturer will stand behind them in this event. If they don't, tell all your friends.

All real weight rooms are equipped with standard barbell plates with a 2" center hole (figure 13). The little plates with a 1" hole are referred to as "exercise plates", and are not useful since no good bar is commercially produced for them. Standard barbell plates come in 2.5, 5, 10, 25, 35, and 45 lb. sizes. Of these, all are necessary except the 35s. Any loading that involves a 35 can be done with a 25 and a 10, and the space saved on the plate racks can be used for additional, more useful plates. Metric plates are 1.25, 2.5, 5, 10, 15, 20, 25, and occasionally 45 kilos. Good plates are milled to be close to the weight named on the casting, and should be well within a half pound, or .25 kilo. Metric bumper plates go up to 25

Figure 13. Standard Olympic plates are the best choice. They come in a wide variety of denominations and construction. Metal plates as small as ¼ pound are very useful and bumper plates up to 25 kilograms (55 pounds) allow heavy bar loads with fewer plates.

kilos, and bumper plates are available from a few sources in pounds. Bumpers are useful for power cleans, and save a lot of wear and tear on bars and platforms. All plates bigger than 25 lbs., or bumper plates 10 kilos or bigger, should be 17.5" (45cm) in diameter.

Plate racks are available in two main styles, an A-frame tree and a tray (figure 14). If the A-frame is used, it should have two pins on each side so that 45's or other full-diameter plates can be loaded on the bottom and smaller plates loaded on the top pins. Such a rack can accommodate more than 650 lbs. of standard barbell plates. The pins themselves should be made from at least 8 inches of 1" rod, so that the 2" hole in the plate fits over it with an inch of slop. This is very important for ease of racking the plates – if the pins are made from 2" pipe, both hands will have to be used every time a plate is racked. This can get to be annoying. Tray-style racks are easy to use since there is no center pin, but usually do not hold as many plates as a A-frame rack. They work well for bumper plates, and can be made longer for them since the load of rubber plates is less dense and heavy in the middle of the frame.

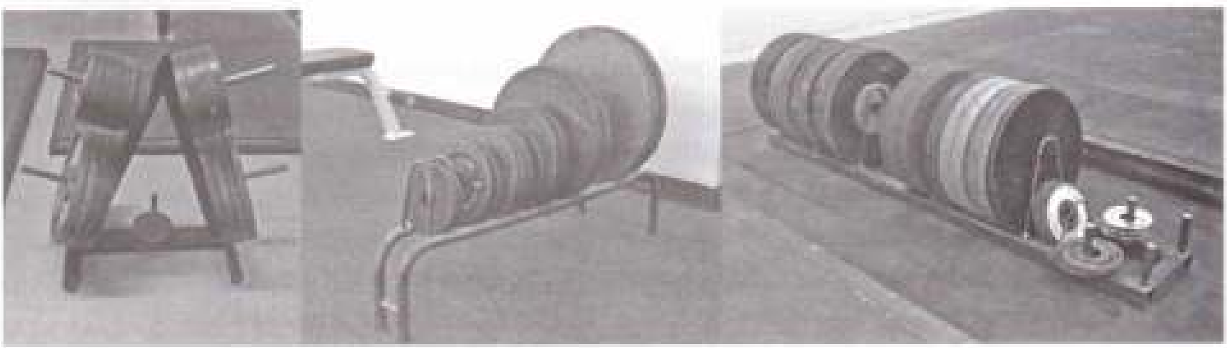


Figure 14. An A-frame plate rack (left) and two models of tray racks (center and right). These can either be purchased or constructed by a coach with some welding skill.

Collars are usually thought of as necessary safety equipment in the weight room (figure 15). While collars are important on occasion, it is much more useful to learn to keep the bar level so that plates don't slide off the bar. Plate slide is often a problem when squatting, since walking a bar out of the rack unavoidably involves some side-to-side movement when stepping back. Collars are useful when squatting, but are less important when benching and pressing, since the bar theoretically stays level during the movement and only one step out of the rack is used in the press. In the event of an uneven extension, collars are quite handy. If it becomes apparent that the trainee may lock one side out before the other it would be prudent to use them. It would also be good to correct this error

Figure 15. Four different types of collars.

if possible. Collars are useful in the deadlift, since they help keep sloppy plates from "walking" down the bar during the set down/pick up cycle. The same holds true for the clean, although bumper plates aren't as bad about this as standard plates unless they are old and worn out.

Collars come in many designs, from inexpensive spring clips (which are very serviceable and reliable unless worn out or sprung), to expensive, very sturdy plastic types, to set-screw sleeve types, to adjustable competition collars. Springs work fine for most training purposes. If security is a problem, 2 can be used on each side.

Chalk should be provided in the weight room. It increases traction between the bar and the hand, reducing the likelihood of lost bars and grip accidents. It reduces callus formation, since stress against the skin of the palm and fingers is a function of the movement of the bar against it, and callus forms in response to this stress. It should be kept in a chalk box in a strategic location in the weight room (figure 16). If the room does not provide the chalk, for whatever misguided reason, the trainees should be required to provide their own. It can be purchased at most sporting goods stores, or ordered over the internet. If the room does provide the chalk and trainees insist on bathing in it, dropping chunks on the floor, putting clouds of it in the air, or otherwise wasting it, insufficient screaming at them is the problem. But training should not take place without chalk.

Each trainee should have proper clothing, i.e. a t-shirt, stretchy sweats or shorts, and a pair of shoes suitable for squatting and pulling. Some facilities provide belts, but if these are not available the trainee needs to get his own. One of the wonderful things about strength training is that minimal personal equipment is actually necessary, especially compared with other sports. The money spent on shoes is about the only significant expenditure the trainee has to make, belts being cheap and quite share-able between buddies.

Figure 16. Chalk stands are available from any supplier of gym equipment or gymnastics equipment. Chalk is a necessary safety supply. Would any gymnast approach the high bar without it during training? Weight training is no less dependent on grip security and hand safety. A gym without chalk is a health spa.

Another thing each trainee should have is a training log, a journal to record each workout (figure 17). No one can remember

Figure 17. All trainees should write down their workouts in a training log. Many fancy forms have been produced for this purpose over the years but an inexpensive school composition book works well. The trainee should never show up for a workout without it, it is part of his workout gear and is a necessary tool for progress.

all the numbers involved in all the exercises in a program. It might be that the numbers for a couple of weeks of workouts can be remembered just fine, but a person's entire training history contains valuable data that should be recorded for future use. This is information that will be used each workout and over the course of the athlete's training history to determine the nature of problems and to analyze productive training periods. Training information should be written in a format that can be easily read by both athlete and coach, since both will have to consult it on a regular basis. A composition book works just fine, and the price is certainly right. A spiral tears up too easily with use. The best training book would be a bound ledger, with enough pages for years' worth of training notes. All people who are serious about their training write down their workouts. Encourage this for your trainees.

Soreness and injuries

There are two more things that everyone who trains with weights will have: soreness and injuries. They are as inevitable as the progress they accompany. If your trainees work hard enough to improve, they will work hard enough to get sore, and eventually they will work hard enough to get hurt. As coach, it is your responsibility to make sure that they are using proper technique, appropriate progression, and safe weight room procedure. They will still get hurt, but it won't be your fault – when people lift heavy they are risking injury. It is an inherent part of training hard, and it must be prepared for and dealt with properly when it happens.

Soreness is a widely recognized and studied phenomenon. Despite the fact that humans have experienced muscle soreness since literally the Dawn Of Time, its cause remains poorly understood. It is thought to be the result of inflammation in the basic contractile unit of the muscle fiber, and the fact that it responds well to anti-inflammatory therapy tends to support this theory. Since muscular soreness has been experienced by so many people for so long, many misconceptions about it are bound to develop. They have. What is certain is that lactic acid (a transient by-product of muscle contraction) has nothing to do with it.

Soreness is usually produced when the body does something to which it is not adapted. An example of this would be the athlete's first workout, if not properly managed. Another example would be an athlete's first workout after a layoff, a thing that, if handled incorrectly, can produce some of the most exquisite soreness a human can experience. More on this later. Any time a workout program is changed, either by increasing volume or intensity or by changing exercises, soreness normally results.

The onset of the perception of soreness is normally delayed, anywhere from 12 to 48 hours, depending on the age and conditioning level of the athlete, the nature of the exercise being done, and the volume and intensity of the exercise. For this reason, it is referred to in the exercise literature as DOMS, or delayed-onset muscle soreness. It has been many people's observation that certain muscle groups get sore faster and more acutely than others, and that certain exercises tend to produce soreness while others, even when done at a high level of exertion, produce none at all.

The part of the rep that causes soreness is the eccentric, or "negative" phase of the contraction, where the muscle is lengthening under the load rather than shortening. This is thought to be due to the way the components of the contractile mechanism in the muscle fibers are stressed as they stretch apart under a load. And this explains why some exercises produce more soreness than others. Exercises without a significant eccentric component, like the power clean, in which the weight is dropped rather than actively lowered, will not produce nearly the soreness the deadlift will. Deadlifts, like squats, benches, presses, and many assistance exercises, have both an eccentric and concentric component, where the muscles involved both shorten and lengthen under load. Some sports activities, like cycling, are almost entirely concentric, since all aspects of correct pedaling involve the shortening of the muscles involved and completely lack any lowering or resistive component. Cycling, and resistance training assistance exercises like sled pulling, are therefore capable of being trained very hard without resulting in much soreness. Since soreness is inflammatory, it is likely that the harder an athlete can train without producing high amounts of muscle inflammation – and the attendant unfriendly hormonal responses - the better for recovery. But that is best left for another book.

Soreness, unless it is extreme, is no impediment to training. In fact, many records have been set by sore athletes. If your athletes are not training hard enough to produce occasional soreness, and therefore having to train through it, they are not training very hard. Waiting until soreness subsides before doing the next workout is a good way to guarantee that soreness will be produced every time, since the athlete never gets adapted to sufficient workload frequency to stop getting sore. Extreme soreness that interferes with the normal range of motion must be dealt with on a case-by-case basis, and a decision made about whether or not to train through it after it has been warmed up carefully and thoroughly. But in general, if the warmup returns the movement to the normal range of motion, the workout can be done. Some allowances might have to be made if it is determined that the soreness is the result of a lack of recovery from the preceding several workouts; if the athlete is not getting recovered, there is another problem to solve.

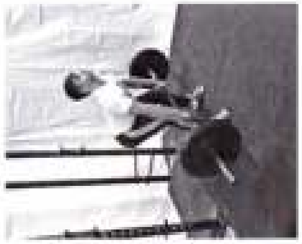
In contrast to normal soreness, which by its nature is delayed for hours after the workout, injury could be defined as something that happens to the body that is immediately perceived as pain, and that persists after the movement has stopped. If pain occurs immediately in response to a movement done during training, it should be assumed to be an injury and should be treated as such. It is extremely important to develop the ability to distinguish between injury pain and normal soreness, since your athlete's safety and long-term progress depends on this being done correctly.

When athletes return to training after some time off, their de-trained condition must be considered when reintroducing them to the program. Depending on the duration of the layoff, different approaches are taken. If it has been just a few (fewer than 5 or 6) workouts missed, have them repeat the last workout they did before the layoff. They should be able to do this, maybe with difficulty but, hey, you didn't ask them to miss the training. This will result in less progress lost than if significant backing-up is done, and the following workout can usually be done in the order it would have been had the layoff not occurred.

If the layoff has been a long one, a couple of months or more, care should be taken when planning the first workout back. If an athlete has been training with weights for long enough to get very strong, adaptations have occurred in more than just his muscles. The nervous system and its relationship to the muscles, the "neuromuscular system", has changed too, and it remembers very well how to lift weights even if the muscles are out of condition. This neuromuscular efficiency is quite useful when the athlete is in shape, but when detrained it allows him to lift more than he is actually in condition to do without incurring adverse effects. Spectacular soreness, as mentioned earlier, will result unless restraint is used in determining volume and intensity. Heroism is not demonstrated when a guy comes back after a year's layoff and tries to repeat his PRs. Unless you have absolutely nothing else important to do for several days afterward, exercise good judgement when doing the first workout back in the gym.

Misconceptions About Training Youth

Knowledge to share with parents and administrators · *Lon Kilgore, PhD*



There has been considerable debate among the public, educators, coaches, physicians, and scientists as to when it is appropriate to begin weight training in children and adolescents. A variety of apparently sound reasons have been provided as grounds for not training youth or training them only with the use of machines with pre-determined movement pathways. Presented here are some common criticisms leveled at the training of youths by the biased, misinformed, and inexperienced. Each of these common claims is followed by an objective examination of the scientific and medical literature. Although this book is most relevant to students just beginning high school, the wide array of maturation rates in children makes these issues relevant to the coach. Every coach should be versed in the literature and theory surrounding his profession and be able to defend his methods of training. Lack of knowledge can be mistaken for lack of competency.

Criticisms of Youth Weight Training

(1) Weight training has been portrayed as ineffectual in improving strength in younger children, as hormonal response is largely absent in preadolescents.

Although most students benefiting from this text will be pubescent, a significant number will not. As such this information can be quite valuable for the coach. Studies that demonstrated a lack of strength increase were inadequate in magnitude of training load, training volume, duration, or did not use the simple principle of progression (Ainsworth, 1970; Docherty, 1987; Hettinger, 1958; Kirsten, 1963; Siegel, 1989; Vrijens, 1978). Research points to the loads, volumes, and durations similar to those commonly used in the training of competitive weightlifters to be effective in increasing strength in children. A program's ability to increase strength appears to be more closely related to the intensity of training than on volume (duration) of training. High intensity programs have been shown to increase strength in preadolescents in 6 weeks or less (Mersch, 1989; Nielsen, 1980; Ozmun, 1991, Wescott, 1979). If the conventional wisdom that weight training is ineffective in children, simply because they do not produce significant amounts of testosterone, were correct, females of all ages would be unable to get strong as they produce only a tenth of the amount secreted by an adult male.

Figure 1. Curt White, 12 years old in this national championship photo, began training with weights several years earlier and developed into one of the strongest men in US history, the holder of the American record Clean & Jerk of 440 pounds in the 181 lb class. Kids can get very strong using sound exercise principles that progressively challenge them physically.

Within the clinical community there is a general recommendation that all physical activity be prescribed at moderate levels. With respect to weight training, this recommendation excludes powerlifting, weightlifting, bodybuilding, and general training with maximal weights until the completion of puberty. The utility of this recommendation points to inexperience, and a lack of understanding of the activity by the clinical community. By specifically naming these types of training on their condraindicated list, they propose to eliminate high volume – low intensity weight training (body building), low volume – high intensity weight training (powerlifting), and moderate volume – moderate to high intensity training (weightlifting) from youth training. Any coach that attempts to use these overly restrictive guidelines will be ineffective in making a stronger, healthier young athlete. An analogy demonstrating the lack of reason within the clinical community's recommendation would be to argue against sprinting (high speed – low volume training), against distance running (low speed – high volume training), and against middle distance running (moderate to high speed – moderate volume training) in the young trainee. To produce a track athlete within these guidelines would be virtually impossible. It is revealing that they fail to see this inconsistency.

Another problem with these guidelines is the clinical community's position on the use of progression (recommended use of progressive resistance training). The premise of progression is to make the body work harder than it has worked previously, then repeatedly apply that load over the following days and weeks until the body adapts to it by becoming stronger. Inherent in this concept is that the athlete must be pushed beyond his current work capacity in order to make gains. Another term for pushing beyond their current work capacity is "maximal" or "near maximal" work, something the clinical community recommends against (i.e., the stated inconsistency). An efficient and effective method of progressive resistance training that can be safely employed is detailed in the programming chapter of this book.

(2) Injury rates with weight training are a continual source of concern and have been proposed as one of the major rationale for precluding children's training with weights.

One of the strongest supporting documentations of this claim is a report from the US Consumer Product Safety Commission (1987) in which it is stated that weightlifting can cause injury to children. The report claims that 8543 weightlifting-related injuries occurred in children younger than 14 years of age. Strains and sprains were the least severe injuries (and most commonly reported) and fractures were the most severe (and least commonly reported) injuries noted in the study. This study did not examine any conditions that may have predisposed the subjects to injury, nor did it examine the training history and program of the subjects. It was noted, however, that a large percentage of the injuries occurred in unsupervised training in the home. In adults, weight training is often recommended as a means to reduce the frequency of injury and is also used to re-establish normal function after joint and soft tissue injury. Data from adolescent male football players point to this as a potential use in young athletes as well. Cahill (1978) noted that the number and severity of knee injuries was reduced in athletes who trained with weights. Further evidence of the safety of weight training relative to other sports and exercise activities can be seen in the injury rates of other youth sports (Hamill, 1994). Weight training's injury rate of 0.0012 injuries per 100 participant hours pales to the 6.2 injuries per 100 participant hours in youth soccer and 1.02 injuries per 100 participant hours in basketball. Time in the weight room carries even less risk of injury than a traditional physical education class where there is an injury rate of 0.18 injuries per 100 participant hours. In fact, weight training, unlike many other sporting activities is an accepted and recommended therapeutic modality following injury. If weight training can damage injured tissues, why would any responsible clinical professional recommend them for rehabilitation or prevention? The idea that healthy juvenile muscle, bone, and tendon is more fragile than injured adult tissue is baseless.

Epiphyseal plate (growth plate) fractures may be the key concern in this controversy. Damage to these plates induced by weight training is frequently cited as a reason for avoiding weight training in children. The existing medical and scientific data do not support this as a valid contraindication. One instance of epiphyseal fracture attributed to weightlifting has been reported in preadolescents (Gumbs, 1982). In pubescent athletes, five publications have reported instances of fractures related to weight training (Benton, 1983; Brady, 1982; Gumbs, 1982; Rowe, 1979; Ryan, 1976). The overwhelming majority of these injuries were attributed to improper technique in the execution of the exercises and excessive loading. Each report failed to consider that the injury may actually have occurred as a result of contact with the floor or other object subsequent to loss of balance and falling, and not be attributable to the actual weight training movement. Further, proper diagnosis and treatment of this rare injury resulted in no detrimental effect on growth (Caine, 1990).

It has also been noted that weight training does not interfere with growth by other means (Ramsey, 1990; Sailors, 1987; Seigel, 1989; Weltman, 1986). Research reviewed by Theintz (1994) seems to suggest that sport training for less than 15 hours per week was not disruptive to hormonal status, growth or puberty.

Training programs in which training loads are prescribed and monitored and in which training activities are supervised have proven to be remarkably safe in terms of the frequency of injury occurrence. Several studies have followed the rate of injury during training programs of several weeks to a year in duration (Pierce, 2000; Ramsay, 1990; Rians, 1987; Servidio, 1985; Sewall, 1986). Rians' 14-week long study (1987) reported only one minor shoulder strain which resolved itself by the end of the study. One study of importance to the competitive weightlifting community, or any other group using higher percentages of maximum, is the one-year study of a USA Weightlifting Regional Development Center program that included more than 70 pediatric athletes in which no reports of injury were noted (Pierce, 1999). The bottom line is that it seems to be the level of supervision, not the practice of weight training that is problematic. Qualified coaches need to be in the weight room any time a youth is training.

Weight Training Benefits for Youth

The benefits of strength training are unquestionable. It is considered an essential element in preparing for competition in virtually every sport. The American College of Sports Medicine recommends that nearly everyone train with weights for the health benefits associated with resistance training. It is consistently one of the top three recreational exercise activities in the US, according to the Sporting Goods Manufacturers Association. An understanding of these benefits by parents, school personnel, and medical staff is important for acceptance of the use of weight training in school-age populations.

(1) Strength and power increases with proper training in children.

An indication of this relationship can be seen simply by comparing strength norms for the US youth population and performances of weightlifters competing at USA Weightlifting events, high school powerlifting events, and from scientific data demonstrating increases in vertical jump (a measure of power output) following weight training in children (Nielsen, 1980; Weltman, 1986).

(2) Neuromuscular coordination improvement in children has been linked to repetitive practice of the specific skill (regardless of the skill investigated).

Figure 2. While weight training for kids can develop sport related fitness, good coaches consider how accessory training combined with on-the-field practice affects the child.

The ages that appear to be optimal for learning movement patterns are between 9 and 12 years of age (Singer, 1970). The average age of incoming freshman will be 14 years, not too far from the optimal motor development ages. The preponderance of data suggests that there are no valid reasons to assume that these children cannot effectively learn and correctly execute weightlifting skills repeatedly if taught and supervised properly. Free weight exercises develop balance and coordination that cannot be developed using machine weights.

Figure 3. Every kid can smile in the weight room. No other training activity lets everyone experience the joy of success regardless of physical capacity.

(3) Weight training is inclusive.

Many sports select directly or indirectly for very specific physical attributes (Duquet, 1978; Keogh, 1999) or involve competition against other youth regardless of body mass. Powerlifting and weightlifting, with their multitude of weight classes and age groups, allow for athletes who traditionally have few competitive outlets the opportunity for competition in a controlled, equitable environment. Even in a non-competitive weight room, any student or athlete can experience success since any participant can improve his performance. As such the activity may be more suitable for child participation than sports where success is measured simply by victory or defeat.

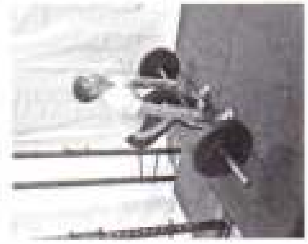
Recommendations

Based on the available medical and scientific data we strongly recommend:

1. Weight training programs for youth should be conducted by well-trained adults. Ideally, the supervising staff should be certified to coach and certified in first-aid. The American Academy of Pediatricians proposes that it is essential that all staff working with children should be trained in supervising strength training through completion of programs from universities or professional organizations. Few universities possess faculty that are both experientially and academically prepared to teach coaches proper coaching methods pertaining to weight training. USA Weightlifting, in particular, and the National Strength and Conditioning Association both have strong coaching education programs for developing and certifying coaches that are easily accessible. Ensure that the certifying authority you choose is backed by an organization with professional membership and that the certification examination is rigorous. Obtaining a certification from an organization in business only to sell them is rarely of value. Professional workshops, when conducted by trained professionals, are also appropriate methods for gaining expertise.

2. Weight training should take place in facilities equipped to support safe training practices. Use of quality free weights in supervised weight training sessions, as presented in this book, can be done inexpensively.

3. Skill-based weightlifting programs that include a wide variety of general athletic preparation are appropriate for children and can commence between the ages of 9 and 12 years of age.



4. Total exercise training time should not exceed 15 hours per week. Coaches must consider the cumulative effect of all the trainee's physical activities. We recommend a holistic approach to training, an approach that requires the coach to be cognizant of the trainee's exercise/activity behaviors on and off campus.

Figure 4. Weight training is for everyone regardless of age, gender, and sport.

5. Utilization of maximal weights, although no data currently establishes a clear-cut relationship, has been opposed as a practice that places the child athlete at risk of injury. We do not discourage use of maximal and near-maximal loads (see Chapter 7 for clarification). These loads should be used cautiously and applied only as part of a regimented training program for technically proficient trainees. Each attempt and set must be supervised and safety measures must be in place. Excellence in technique should be emphasized rather than the amount of weight lifted.

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Mark Rippetoe CSCS is the owner and general manager of Wichita Falls Athletic Club. He has 25 years experience in the fitness industry and 10 years personal experience as a competitive powerlifter. He has coached athletes in barbell and strength sports since 1980. He was in the very first group to sit for the NSCA's Certified Strength and Conditioning Specialist exam in 1985, and has been continuously certified since then. He was certified by USA Weightlifting as a Level III Coach in 1988, and currently holds the Senior Coach certification. He has coached numerous national level competitors, and many thousands of people interested in improving their health and strength.

Lon Kilgore, Ph.D. is a professor of kinesiology at Midwestern State University (USA) where he teaches exercise physiology and anatomy. He also holds a senior faculty appointment in Exercise Science at Warnborough University (UK). His career as an Olympic-style weightlifter began in 1972 as a means to improve his wrestling performance. His wrestling career ended after high school, but weightlifting continued and he has had many national event podium appearances over his 30 plus years of competitive experience. His coaching efforts began in 1974 when he took five athletes to the AAU Junior Olympic Nationals and since those early days he has remained active in coaching national and international caliber weightlifters. He also did a three year stint as a NCAA DII strength coach. He has worked with athletes from the beginning ranks to professional and Olympic athletes. He is currently Chair of the Sports Science Committee and a coaching course instructor for USA Weightlifting and a member of the Board of Certification for the American Society of Exercise Physiologists.

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