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The Stiff-Legged Deadlift

P. J. Gardner, CSCS, and Don Cole

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THE MANAGEMENT OF LOW-back pain is a major health and economic concern in the United States. From 60 to 80% of the population will experience low-back pain in their lifetimes (2). From 30 to 40% will have recurrent episodes (2). With low-back pain being so paramount in our society, every safeguard should be taken against it. The stiff-legged deadlift (SLD) is one exercise that—performed incorrectly—could cause severe low-back pain and possibly permanent debilitation.

The SLD is a universal lift used in most high school, university, and professional-sports organizations. It is an excellent lift for lower-body development if performed correctly. However, it can be extremely dangerous if incorrect technique is used. The risk of injury in using this movement is high, but so are the strength gains to be made. Because of the high risk of injury, it is considered a controversial lift and may not be universally suited for every athlete's resistance-training program. There are some requirements as well as contraindications for this lift. It is one of the most misunderstood lifts (3) that many individuals inadvertently perform incorrectly.

This article will examine the spinal mechanics of this lift, disc pressures, ligamentous strains, and muscular requirements of this potentially dangerous resistance-training movement. Also, illustrations will be provided to assist in further understanding the biomechanics of this movement and to show the proper and improper techniques for performing it. Without a doubt, more education and supervision is needed in weight rooms across the country to reduce the number of back injuries incurred from this one particular lift. With such emphasis on the technique of this lift, we must first understand how the spine functions as a complete unit.

Anatomy of the Lumbar Spine

In relation to the SLD, due consideration should be given to the anatomy of the lumbar spine. Structures most involved include the lumbar disc, posterior motor unit (facet joints), and the intervertebral foramen (Figures 1 and 2). The lumbar disc is comprised of a noncompressible, fluid-filled nucleus surrounded by semielastic, ligamentous fibers that are referred to as the annulus (Figure 3). The nucleus is confined by vertebral end plates and circumscribed by the taut annulus fibers (Figure 3). Flexibility of the spine is allowed by shifting of the nuclear fluid with expansion and contraction of the surrounding annulus. The facets are arthrodial joints that function in a gliding fashion. They define the direction of movement of 2 adjacent vertebrae. The lumbar facets are positioned in a vertical and slightly sagittal plane and thus allow a long axis of flexion and extension of the lumbar spine. Because of the plane of the facets, they allow limited lateral movement and rotation.

The intervertebral foramen is the open space between 2 adjacent vertebrae. Its boundaries are defined anteriorly by the disc, su-

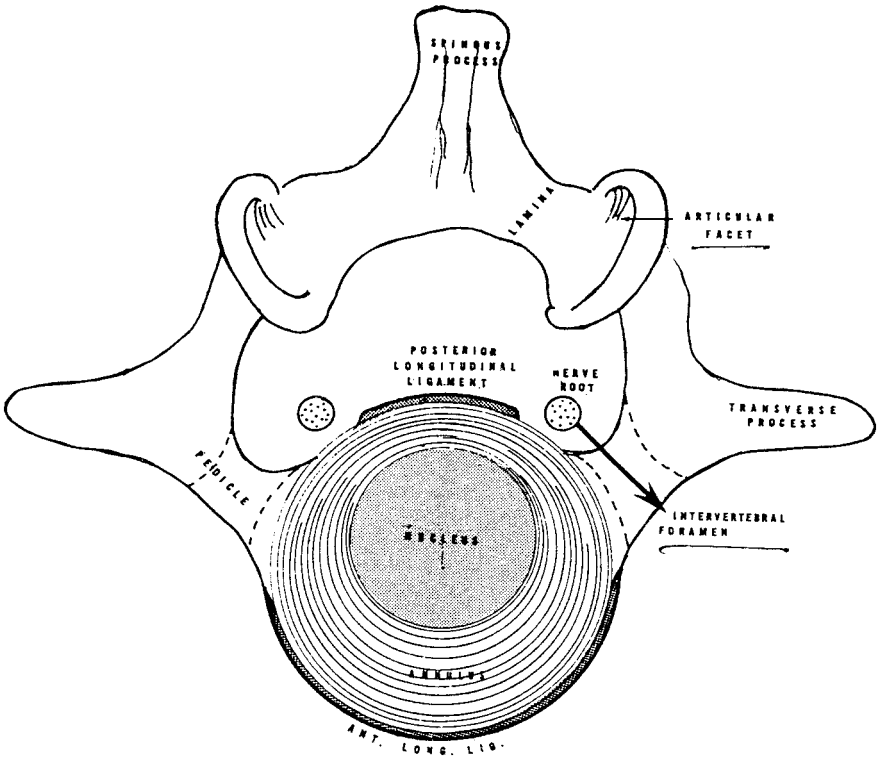


Figure 1. **Vertebral segment. As viewed from above, the vertebral segment is divided into the anterior and posterior segments. The anterior portion is the vertebral body and the disc structures. The posterior portion consists of the lamina, pedicles, facets, and so on. In this segment, the posterior longitudinal ligament is incomplete, placing it at the lower lumbar level. Reprinted with permission (2).**

periorly and inferiorly by the pedicles, and posteriorly by the facets. The anatomical significance of the intervertebral foramen is as an exit point for nerve roots leaving the spinal cord.

The complex structures of the lumbar spine function well if forces are exerted in 1 directional plane at a time. The joints may be loaded and moved in flexion–extension, in rotation, or in lateral motion. However, any combination of these movement planes can exert excess torque and loading. Spinal anatomy needs to be understood before undertaking the SLD.

Prerequisites

Before the SLD is included in any program, certain criteria should be met to reduce the chance of injury. One should have excellent flexibility in the hips and low back before attempting this lift. If the hamstring group and low-back muscles are tight, flexibility in these respective areas need to be improved through specific low-back and hamstring stretches prior to performing the SLD.

In addition, one's grip strength is a secondary factor, and straps should be used if needed. When using heavier weight, the grip is usually the weak link in performing this lift, and using straps is appropriate. Obviously, one would need to do specific gripping exercises to increase grip strength.

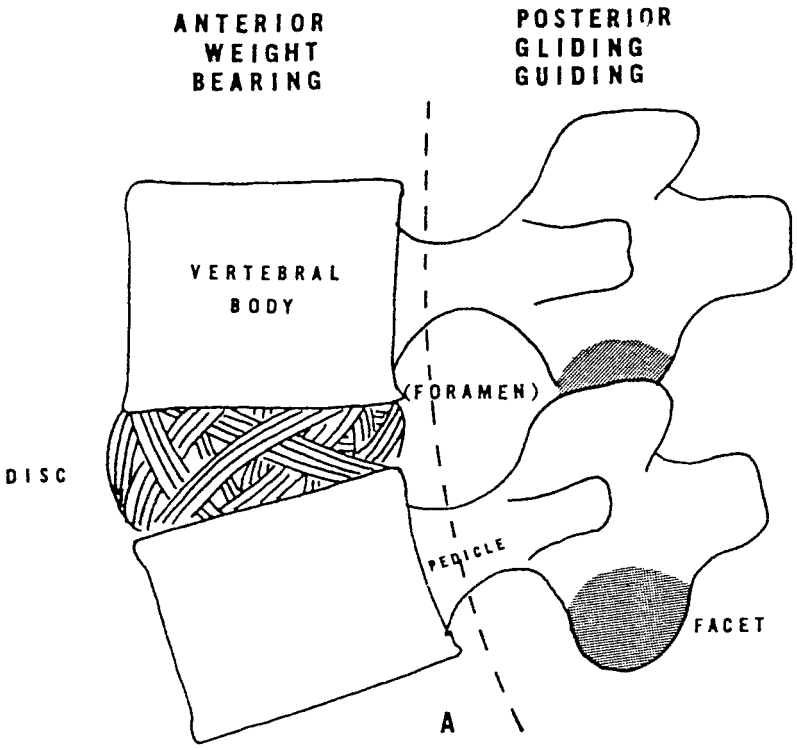
The general overall health of the back—including muscles, ligaments, vertebral bodies, and discs should be unimpaired and asymptomatic. The individual should be released to include this lift in his or her resistance-training program by the appropriate sports-medicine professional—especially if he or she has had any type of back injury in the past (8).

Spinal Mechanics

During the SLD, the spine is put under enormous stress. Once trunk flexion begins, the intervertebral disc pressures increase significantly throughout the range of motion. When one moves from full flexion into extension with the weight supported by the hands, the lumbar discs are under tremendous torque because of the long lever arm between the weight and the low back. This weak mechanical leverage causes the muscles to produce forces in excess of 10 times the amount of weight lifted (5). In full spinal flexion (Figure 4), the lumbar discs are at the most vulnerable position for injury to occur.

This is one reason that you should not bounce or attempt to ballistically explode up with the barbell. The transition from flexion to extension is intended to be slow and deliberate, using submaximal poundage. When coming to the upright position (Figure 5), the individual should not attempt to push the hips forward, thus hyperextending the lumbar spine (Figure 6). To guard against injury, one must adhere to strict form.

Lifting in more than 1 plane of motion may cause severe damage to the lumbar discs. The hydraulic pressure of the nucleus acting upon the unsupported posterior rim of the disc can cause tears in the annulus. If the tear is large enough, the nuclear material will force a bulge or protrusion to form. This is the classic ruptured/herniated disc syndrome. If



Correct Form

The SLD is performed by placing the hands directly under the shoulders. The feet should be a comfortable distance apart, and the toes should be pointed straight ahead. From the bottom position (Figure 7), the knees are slightly bent—not locked—and the lower back should be in a flat or slightly arched position and kept tight throughout the lift (Figure 9). The movement should be initiated in a slow and controlled manner, with the bar kept close to the legs throughout the movement. In fact, the bar should never be allowed to

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Figure 2. **The functional unit of the spine in cross-section (lateral view). Reprinted with permission (2).**

the annular tears are small, the nuclear material will be contained without significant bulging. Although the athlete will not suffer immediate ill effects, the long-term prognosis is accelerated degenerative changes and dehydration of the affected disc, which result in degenerative disc disease. Dehydration of the disc is a major component of chronic disc pain syndromes in middle-aged adults (2).

Low-repetition work with heavy weight is extremely demanding on the lumbar structures and should be used on a very limited basis. Once every week or no more than 3 times in a 2-week period is suggested (7).

The shoulders must be kept tight with the scapulae retracted to stabilize the thoracic spine. This helps maintain proper form and prevents the shoulders from becoming rounded at any point during the lift. This is accomplished through isometric contraction of the rhomboids.

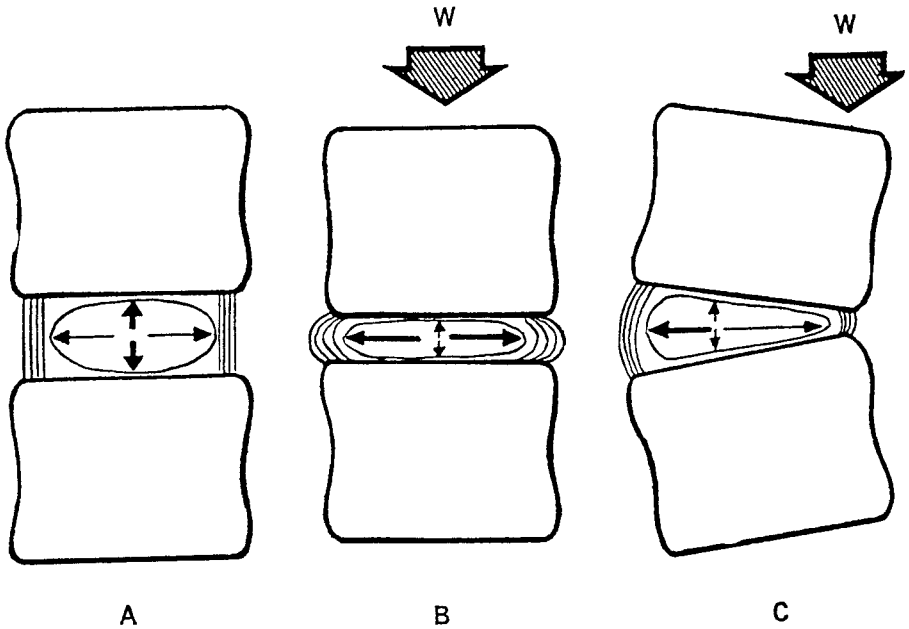

Figure 3. **Hydraulic mechanism of the intervertebral disc. (A) The normal resting disc with the internal pressure indicated by the arrows exerted in all directions. The disc is confined above and below by the vertebral plates and circumferentially by the annulus. The annulus fibers are taut. (B) Compression of the disc is permitted by the noncompressible fluid of the nucleus expanding the annulus. Flexibility is seen to exist in the annulus. (C) Flexion of the spine is permitted by horizontal shift of the nuclear fluid, which maintains its cubic content but causes expansion of the posterior annulus and contraction of the anterior annulus. The intertwining of the annular fibers permits this change in the capsule with no loss of turgor. Reprinted with permission (2).**

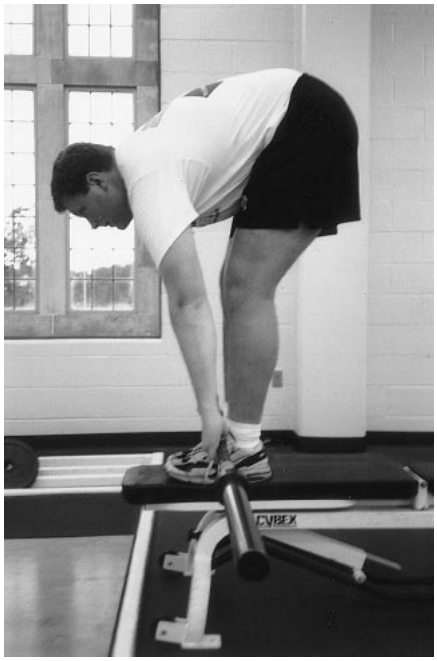

Figure 4. In full spinal flexion, the lumbar discs are at the most vulnerable position for injury.

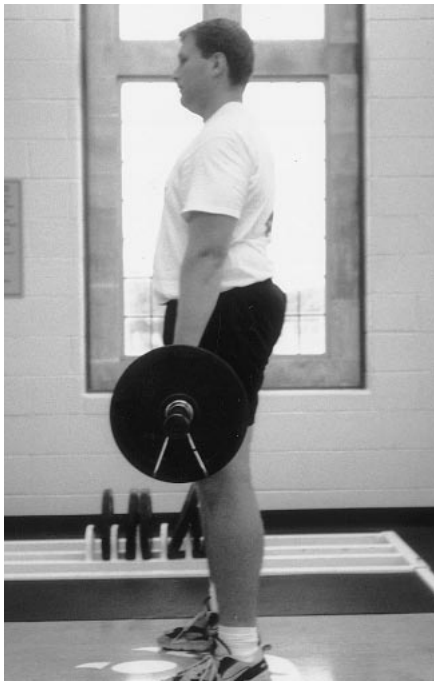

Figure 5. Upright position.

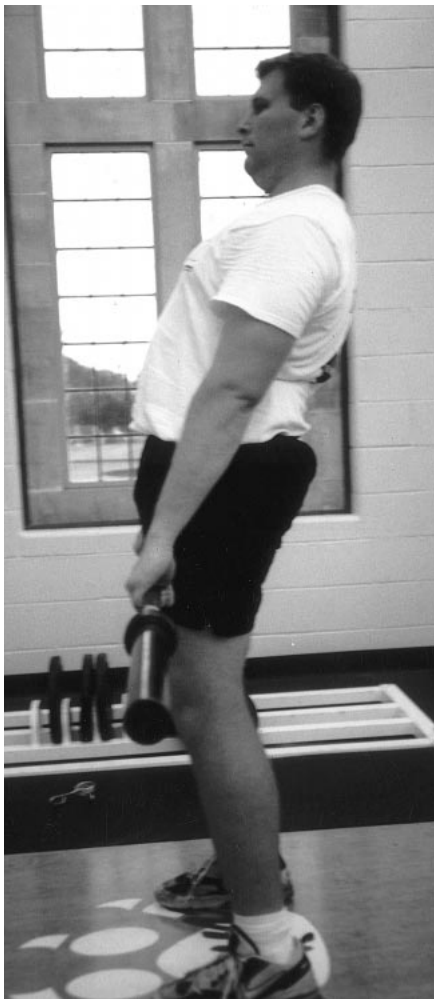

Figure 6. Incorrect form, hyperextending the lumbar spine.

move out away from the legs (Figure 8), and all the movement should occur at the hips—not the knees (3). The arms are kept

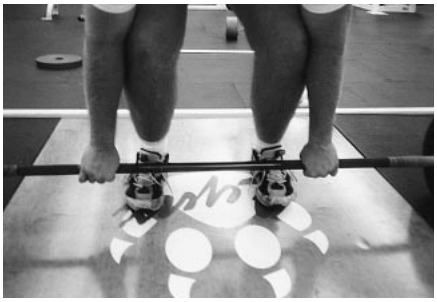

Figure 7. Correct stance, bottom position.

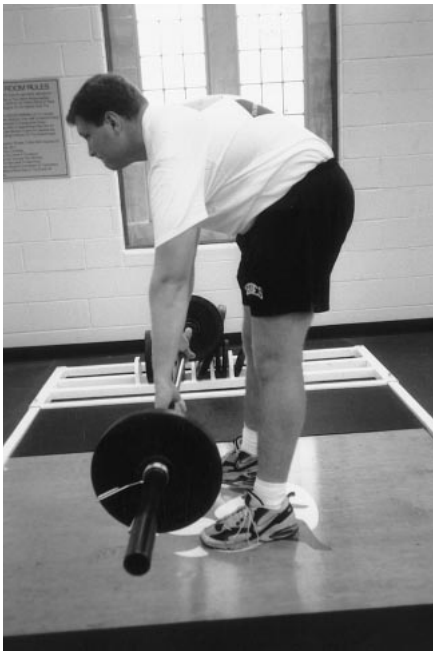

Figure 8. Incorrect form, bar moving away from legs.

straight and should be pulling back throughout the lift without bending the elbows. The back is flat and should not be allowed to become rounded—especially in the

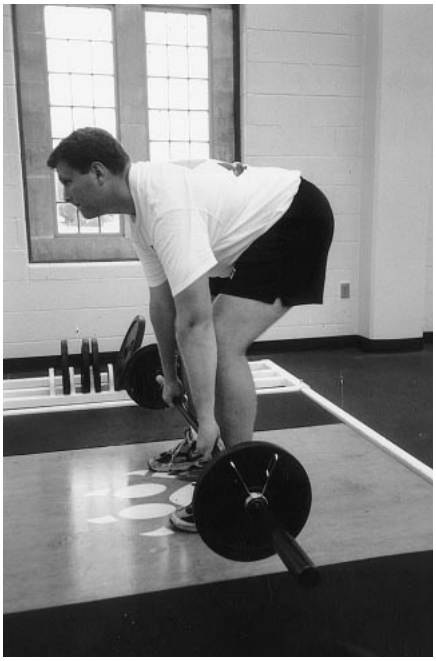

Figure 9. Arms straight and back flat.

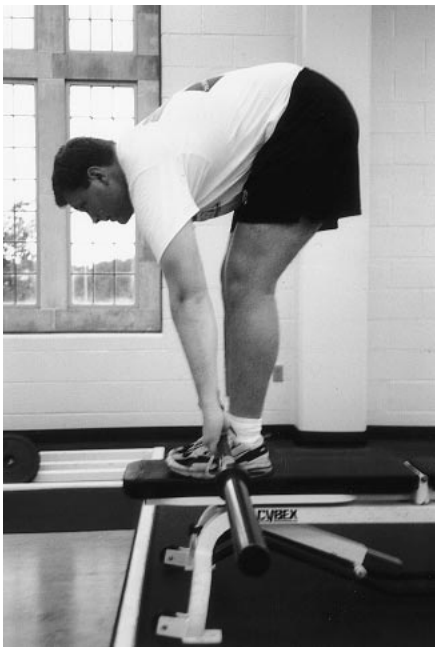

Figure 10. **There is no need to lower the bar further than the tops of the shoes.**

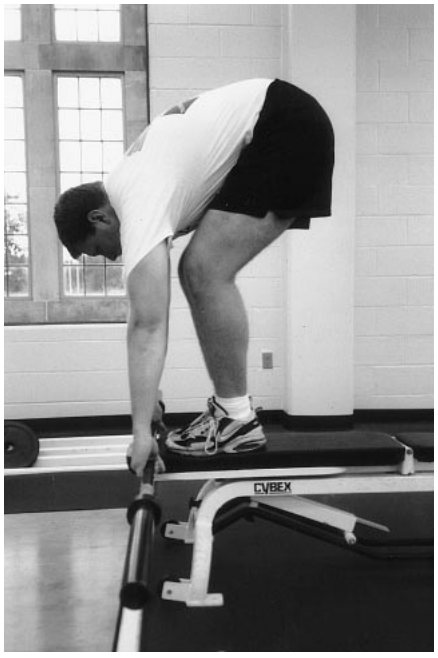

Figure 11. **Standing on a bench to get increased range of motion is a common cause of back injury to athletes and should not be attempted unless you are experienced in this lift.**

Figure 12. **In most cases, an adequate and safe range of motion would be where the bar is approximately 6–8 inches off the ground or midway up the shin.**

lower depths of the movement (Figure 9). However, rounding of the back and shoulders is acceptable when using very light weight to target intervertebral muscles. The spinal erectors, gluteals, and hamstrings are the muscle groups most responsible for the movement in the lower body. The adductors, gastrocs, and abdominals play a major role in stabilization, as do the latissimus dorsi and trapezius muscles in the upper body (3, 7).

The legs can be straightened once the bar has cleared the midthigh position; however, be sure not to hyperextend the back at the top position (Figure 6). Lower the bar in a controlled manner, keeping the back tight and the bar close to the legs until you reach your deliberate end point. There is no need to lower the bar further than the tops of the shoes (Figure 10); therefore, standing on a bench to allow the bar to be lowered below the shoes (Figure 11) is unnecessary (12, 13).

Standing on a bench to get increased range of motion is a common cause of back injury to athletes and should not be attempted unless you are experienced in this lift (12, 13). The excessive range of motion puts the lumbar spine in jeopardy. In most cases, an adequate and safe range of motion would be where the bar is approximately 6–8 inches off the ground or midway up the shin (Figure 12). For most lifters, the barbell with 45-lb or 35-lb plates lifted from the floor would allow adequate range of motion.

In regard to upper-body positioning, the neck should be kept in a neutral position (Figure 12) or slightly extended (Figure 13) as the bar is lowered. Never flex the neck during the lift (Figure 14), which could allow the back to round or cause your balance to shift forward. The scapulae should be retracted as the bar is lifted and lowered.

The shoulders should not be allowed to roll forward (Figure 15) as the bar is moved through the range of motion unless one is targeting the intervertebral muscles. Correct form is the key to a safe lift, and technique is more important than weight!

Your grip is also important because if it is positioned off-center on the barbell by even a small amount, it creates an asymmetrical distribution of forces throughout the lumbar spine—where 85-90% of disc herniations occur (5, 7). A mixed grip (Figure 16), where one hand is pronated and one hand is supinated, is suggested with heavier weight (11). However, once again, be aware of uneven weight distribution that could apply the forces unequally as the lift is initiated and lead to injury.

Improper form in this lift,

Figure 13. Neck slightly extended.

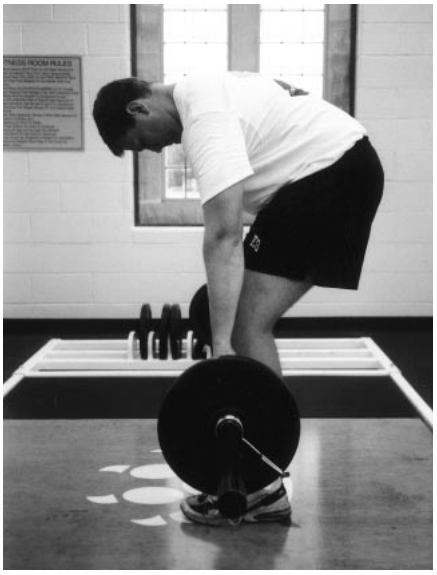

Figure 14. Incorrect form. Flexing the neck during the lift could allow the back to round or cause your balance to shift forward.

Figure 15. Incorrect form. The shoulders should not be allowed to roll forward.

which allows any degree of lumbar rotation in conjunction with the normal flexion–extension movement, can have dire results. Consequences may include tearing of the facet joint capsules with associated swelling (sprain) or hyperextension of the sacral base upon the L5 nerve root as it exits the intervertebral foramen (impingement syndrome) (2).

Range of Motion

Surprisingly enough, it has been advocated in the past by leading authorities in the field of resistance training and bodybuilding that if an individual does not have back or knee problems, he or she can do the SLD with the legs completely straight (4, 7, 10). As late as the 1980s, some bodybuilding literature suggested "full-range" SLDs as the only way to perform the lift (4). Also suggested was that individuals stand on a bench (Figure 11) or on a block of wood to allow the bar to be lowered to a greater range (4, 9, 10); and it was suggested that individuals should lower the bar below the soles of their feet in order to get the maximum benefit from this exercise (4).

Practitioners in the field of resistance training have revised their earlier recommendations and now suggest keeping the knees "soft" or unlocked throughout the range of motion and not to stand on an elevated surface to execute the lift (7, 11). Standing on a bench to gain increased range of motion is a common cause of back injury to athletes and should not be attempted unless the individual is experienced in this lift and understands the inherent risks (12). This is an individual choice. One should use caution and sound judgment when choosing this action.

Most sports do not require the excessive flexibility that is necessary when using full-range SLDs. An ironic point is that this excessive range of motion (when the bar is below the feet) does not increase strength because once the back starts to round, ligaments—not muscles—support most of the load (11). The rounding of the back places undue strain on the ligamentous structures and erector spinae muscles (Figures 8 and 15). The forces on the lumbar spine are tripled when rounding occurs (11).

Lifting with the lumbar spine in a rounded or "unlocked" position allows posterior loading of the disc nucleus, even prior to the lifting movement. An unlocked spine performing a SLD drastically increases the probability of injury to the posterior lateral aspect of the lumbar disc, unless the individual is using very light weight. These facts should underscore the importance of using correct form and of keeping the back flat throughout the range of motion.

A protective mechanism against rounding is to keep the lumbar back in lordosis. This concept is known as "setting the back" (3, 8). It is done by isometrically contracting the muscles in the low and middle back prior to

Figure 16. **A mixed grip.**

lifting the weight. This should lock in the lordotic curve and protect the spine. Keeping the back tight stabilizes the lumbar spine, which protects it from rounding (11; Figure 9).

In the bodybuilding arena, an individual with a very strong and flexible low back may be able to tolerate the disc pressure at the extreme range of motion, but for most other individuals, this maneuver would be inviting injury. The most extreme range of spinal flexion (Figure 11) is a physiological end point that should be approached with extreme caution. Just remember, you may be millimeters away from rupturing a disc—a major, debilitating injury. So why risk the extreme range of motion? Will the strength and flexibility possibly gained be worth the risk of a career-ending injury? Will those few extra centimeters of depth make you a better athlete or lifter? It is not likely. You have to be the judge.

One alternative to the full range of motion is to deliberately tilt the pelvis forward in order to prestretch the hamstring group (3, 7; Figure 13). In this position, the bar should be lowered just below the knees, keeping the back tight (3, 6, 8). This is known as a Romanian deadlift. A more conservative and safer approach to finding the proper range of motion is to always keep the knees slightly bent and to lower the bar to the point of tightness in the upper hamstrings (1).

Range of motion is an individual preference and should be determined by the individual's own subjective comfort zone. Be conservative to avoid injury, and always use submaximal resistances.

Stiff-Legged vs. Bent-Legged Deadlifts

The nomenclature can be confusing. There are no fewer than 7 variations of the deadlift (3). As previously mentioned, the stiff-legged deadlift is actually performed with slightly bent knees. The bent-legged deadlift (conventional style) is performed altogether differently and is intended to work the legs and back together (3); it can be used as a precursor to the stiff-legged deadlift if the individual lacks hamstring and low-back flexibility (12). The bent-legged deadlift (conventional style) is not intended to work the hamstrings and low back as directly as the stiff-legged deadlift. It is beyond the scope of this article to discuss in detail the bent-legged deadlift. For clarification purposes, understand that the stiff-legged and straight-legged deadlift are synonymous and that the bent-legged deadlift is the traditional competition-style deadlift.

Summary

Low-back pain is prevalent in our society today, and every safety measure possible needs to be pursued to decrease its occurrence. Lifting weights incorrectly can cause injury to the low back. The SLD is a common lift in weight-training programs across the country and needs to be examined closely. Performed correctly, it is an excellent exercise to increase lower-body strength and flexibility. Using incorrect form however, can cause devastating injury and chronic low-back problems.

Understanding the lumbar spine and its movements is critical for knowing how the mechanical forces of the SLD affect the spine. Strength and flexibility of the back should be good before attempting SLDs. Before including SLDs in anyone's training program, one should always receive proper medical clearance.

The mechanical form used for the lift is very important. Strict form allows for the proper and safe execution of the movement. Standing on a bench to perform the lift is not necessary and is probably even dangerous. During the lift, the back should be kept tight and not allowed to become rounded. The range of motion should be conservative in order to avoid injury. The spine encounters large forces during this lift and has weak mechanical leverage–therefore, one should not attempt to accelerate up with the weight. The spinal flexion–extension transition is intended to be gradual and to be conducted in 1 plane of motion—never in 2 planes.

Using heavier weights requiring fewer repetitions is demanding on all spinal structures and should be approached with caution. The upper body should be kept stable throughout the entire lift by isometrically contracting the rhomboids and the posterior shoulder girdle muscles. The shoulders should not be allowed to roll forward at any time unless light weight is used, and the cervical spine should be straight or slightly extended during the movement. The knees should be kept slightly flexed through the range of

motion. The low back can be "set" to protect it from injury by stabilizing the lumbar spine.

To insure that the SLD remains a productive lift for individuals attempting to gain greater hamstring strength and flexibility, understand the mechanics of the lift, use good judgment, and make sure that everyone lifts within his or her capacity. ▲

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Gardner

Cole

P.J. Gardner, MS, CSCS is currently employed as an exercise specialist at Physiotherapy, Associates in Memphis, Tennessee and works individually with local high school and college athletes. He holds a Master's degree in fitness and wellness from the University of Memphis and is currently pursuing an athletic training certification through Rhodes College. He is certified by the ACSM, NSCA, and USWF.

Dr. Don E. Cole is a chiropractic physician with post-graduate training in spinal biomechanics and physical rehabilitation. He has extensive experience in the treatment and correction of athletic injuries at the collegiate level. Dr. Cole is a member of the American Chiropractic Association and presently serves as Vice President of the Tennessee Chiropractic Association, and is a guest lecturer at several Chiropractic universities. He is former Chiropractor of the Year for the State of Tennessee.

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