Pressurization As Applied To Spinal Stability

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Abstract

There is a positive correlation between spinal stiffness and spinal stability. It is the intent of this author to present what is known as the integrated system of the thoracolumbar fascia. Thus, a comprehensive view of internal muscles of the back, deep contractile tissue of the abdominal wall, and musculature of the lower limb must be analyzed. It is essential to note that extrinsic factors, based on motor command, may be the indispensable key to spinal stability. Complex studies representing motor learning and recruitment patterns of successful lifters, as contrasted to those with back pain, will be assessed. Moreover, that assessment will lead to corrective and optimizing patterns for the benefit of each reader. Further intricacies discussed include: proprioception of the lumbar spine, mechanics of the nucleus pulposes, annulus fibrosis, and the multisegmental system, which comprises the vertebral column.

Introduction

What is stability? Webster's defines it as ”1**.** the quality, state, or degree of being stable: as **a**: the strength to stand or endure: FIRMNESS **b**: the property of a body that causes it when disturbed from a condition of equilibrium or steady motion to develop forces or moments that restore the original condition c: resistance to chemical change or to physical disintegration. Jesus compares and contrasts stability vs. instability as follows: ”Whosoever cometh to me, and heareth my sayings, and doeth them, I will shew you to whom he is like: He is like a man which built an house, and digged deep, and laid the foundation on a rock: and when the flood arose, the stream beat vehemently upon that house, and could not shake it: for it was founded upon a rock. But he that heareth, and doeth not, is like a man that without a foundation built an house upon the earth; against which the stream did beat vehemently, and immediately it fell; and the ruin of that house was great (Luke 6 47-49).”

Thus, we can think of stability as a concept which encompasses a system's ability to resist that which interferes with equilibrium, be it static (none moving) or dynamic (you are unmoved from your path of motion). When we analyze the trunk’s resistance to outside forces, our focus should be on its central axis, that is, the spine or vertebral column. The joints created by humeral-forearm (elbow) interactions can be thought of as stable hinge joints, in which segmental motion occurs (occurring at a single segment). However, the spine is comprised of numerous adjacent (stacked one on top of the other) vertebrae, capable of an equally numerous amount of movements, much like an accordion. Therefore, a more complex system dependent on both intrinsic (ligament us and muscular) and extrinsic (neurological) support must be in place.

Purpose Outlined

Why focus on this subject? To be frank, if your spine snaps, you snap. Consider it as the rock that one must build their foundation on. It is almost impossible to work through back pain, and dehabilitating to drudge through a serious spinal injury. We are not dealing with a light paper here, but rather one that is fundamental to your career, and your ability to train and function with 100 percent intensity. It must be clearly understood that spinal stability is directly correlated to how stiff the vertebral column actually is. When measuring this aspect, Cholewicki et al. states that, "The determination of lumbar spine stability is accomplished by measuring the instantaneous trunk stiffness in response to a sudden load release (4)." This again goes back to the mobility principle discussed above. It also corresponds with the spine's ability to deform and return to its original shape, a concept known as elasticity. We begin by narrowing in on the latter.

Spinal Mechanics

The vertebral column is a multi-segmental system. The vastly moveable aspect (pre-sacral) of the spine is composed of 24 unfused
vertebrae. Two curves can be noted above, which are classified as Lordotic (bulged out to the front) and Kyphotic (bulged out to the rear). The former can be viewed in the Cervical (neck), and lumbar (lower back) regions, while the latter is seen in the thoracic (portion of the column associated with the ribs), sacral, and coccygeal region (see notes). Such curvatures serve to dampen compressive forces, via shock absorption mechanisms. Take a second to feel how your neck and lower back curve in similar directions. Note also the transition zones which are displayed in the above picture. Transition zones can be defined as those areas in which joints are formed from the final vertebrae in one region, and the first vertebrae of the next. I call these "hot spots" due to the fact that they are prime targets for injuries to occur.

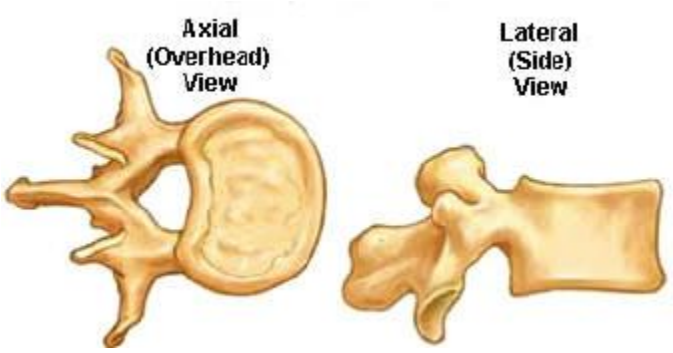
The transition between the lumbar and sacral region will be of primary focus within the paragraphs to follow.

Note Above How the Moveable Lumbar Region Forms a junction with the Sacrum Inferior to it. This is known as the Hot spot of the column.

Our main concern herein will be to review those moveable structures which bear the greatest loads during most compound movements. These are the thoracic and lumbar regions. The former has a built in protective zone, due to its association with the ribs. These act like powerful splints, stiffening and limiting the motion of this region.

Notes: The sacrum are composed of fused, immobile vertebrae. Several important muscles of the gluteal region find their attachments on the sacrum; additionally, it serves as a strong base which takes forces sustained by the column and transfers them to the hip laterally, due to the joint it forms with the Ileum (this is what your belt rests on). The coccygeal region is also of vital importance, as several muscles of great importance find their attachment points here.

Lumbar Vertebrae

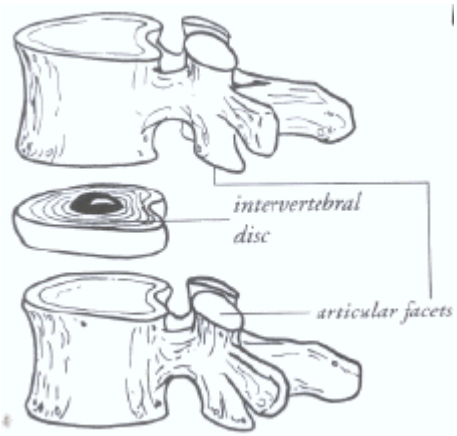


As you realize from my articles on back anatomy, each vertebrae is composed of a flat body anteriorly, which articulates with the body of adjacent vertebrae above and below it (or rather the intervertebral disk between them). The vertebrae in this region have an interlocking design, which limits a good portion of motion (11, 22). Compare and contrast the mobility of the cervical and lumbar regions to see just how

effective this is. However, there is still considerable freedom. Another mechanism to guard against compressive forces comes in the actual shape found within the bones. Pressure is defined as ”force per unit area (40).”

P = F / A

Note that A is inversely proportional to P. That is, the larger the area, the lower P becomes. Realize that the lower you travel down your spine, the larger the load the bones must bear. To compensate for the increase in F, the body increases A, meaning the bodies of the lumbar region increase in circumference from L-1 to L-5. Two joints are found posteriorly, via the articular processes, as can be viewed below.



According to Porterfield and DeRosa, the joints formed between the vertebrae and the vertebral disk, combined with the joints formed by the facets, create an ”Articular Tripod (26).” This tripod effect, along with several other functions, acts to increase the area to which compressive forces are applied. In fact, when standing, these posterior facets shoulder approximately 20 percent of the compressive load (1).

Elasticity is defined as the ability of a tissue to deform, and return to its original shape. The ”elastic limit” can be thought of as the point in which the tissue can no longer return to its original shape, or rather it reaches a point of “plasticity (40).” Vertebrae are lined on the outside with cortical bone (the denser type of bone), and filled in with cancellous, spongy, or trabecular bone. This type of arrangement, combined with other mechanisms discussed shortly, provides a witty shock-absorption system. For example, in the scientific journal, “Bone,” it was shown that even after a vertebra was crushed, it regained 94 percent of its original form!

“Specimens of human vertebral cancellous bone were compressed to well past mechanical failure (15% strain) in the infero-superior direction...With removal of the load, all specimens recovered at least 94% of their original height (9).”

Such a result also shows the vertebra's ability to store potential energy when compressed. Additionally, the cancellous bone is filled with a tremendous blood supply. If fracture were to occur, near original form would be retained, and a quick healing could take place in light of the ample supply of nutrients within the area. Between two adjacent vertebrae lie the IVC.

The intervertebral disk is a fascinating and wonderfully made contraption. It consists of an outer, less hydrated region known as the annulus fibrosis, and progresses into a central and highly hydrated region known as the nucleus pulposes.

Collagen fibers have a tensile strength comparable to steel (39). It is the organization of these fibers, however, that astounds scientists. First, the disk is composed of fibro-cartilage. This type of tissue is A-Vascular, or without blood vessels. The vertebral disks sustain far too great a load to be a bloody tissue. That is, if they relied on blood vessels to supply their nutrient needs, the compressive forces would hinder blood flow and ultimately lead to localized tissue anemia.

The collagen fibers of the cartilage are constructed much like plywood in an up to 20 layer fashion (34). Additionally studies show this region to contain several elastic fibers, which actually provide it the ability to store energy when compressed and, due to its architecture, the cartilage acts as a stupendous shock-absorber.

Another vital aspect which we will discuss further into the article is the concept of proprioception. The annulus fibrosis contains numerous mechanoreceptors, which greatly enhance this essential sense! Roberts et al., in the journal, "Spine," states that, "Mechanoreceptors *were found in the outer 2-3 lamellae of the human intervertebral disc and anterior longitudinal ligament. Physiologic studies in other tissues indicate that these provide the individual with sensation of posture and movement, and in the case of Golgi tendon organs, of nociception. In addition to providing proprioception, mechanoreceptors are thought to have roles in maintaining muscle tone and reflexes. Their presence in the intervertebral disc and longitudinal ligament can have physiologic and clinical implications (28).*"

The nucleus pulposus is perhaps even more astounding. It is composed mainly of water, with a mixture of elastic fibers, and a gelatinous forming substance made of proteins and carbohydrates (22). Such a structure provides your disks with what is known as a hydraulic load bearing system. Blaise Pascal (1623-1662), a brilliant philosopher and scientist, discovered what is now rightfully known as the Pascal principle. It can be defined as follows: Pressure applied to a confined fluid is distributed equally in all directions (10).

1. A compressive (crushing) force is applied to a vertebral disk.
2. As the force is transmitted to the nucleus pulposus, Pascal's principle takes over. That is, water cannot be compressed in this confined space, and the force is therefore distributed equally in all directions, meaning it is not concentrated in one area, but borne by several!
3. The annulus fibrosis handles the stress by the stiffening of its fortified, steel-like collagen fibers.
4. To further distribute the stress, the nucleus pulposus is able to transmit it to inferior and superior vertebrae.
5. The elasticity of the overall system is able to rebound after it releases the energy it is capable of storing when faced with tension.

With such a load-bearing system, your spine can bear colossal loads!

Your next question may concern the avascular state of the cartilage. After all, this tissue is composed of living cells known as chondroblasts and chondrocytes. The answer is contained in the nucleus's ability to bind water. This structure has a high

osmolarity, meaning it can actually draw fluid into its direction. As it does so, it hydrates the annulus fibrosis. Upon compression, fluid also is distributed to the AF. A remarkable system indeed.

The Ligaments Role In The Creation of a Protective Reflex Arc

The vertebral column is enforced with numerous ligaments. For example, on the ventral surface (frontal) of the vertebral column lies the anterior longitudal ligament. It enforces the anterior portion of the vertebral bodies and anchors hard on the sacrum (11). It resists forces from separating adjacent vertebrae, and resists overextension of the spine. The posterior longitudal ligament also resists separation of the vertebral bodies, along with several other supporting structures (there are five other ligaments which will be discussed in future articles). Thus, there is a primary role in keeping the vertebral column together.

However, their function in supporting the spine from ”buckling” takes on what Mr. Knowlden emphasizes as an irreducibly complex system (19). That is, all the factors at work within the spine are either simultaneously in place or the column will fail. According to Lucas et al., without support from surrounding muscle groups, the spine would buckle under as little as five pounds (21)! The problem, however, is that such support must be highly coordinated, with uncanny precision and flawless instruction from the nervous system. How is this accomplished? A closer look at the ligaments of the spine can shed light on the subject.

Dr. Rhalmi and colleagues in the journal, “Spine,” examined the ligaments of the lumbar spine and found numerous “neural elements (29).” A summary is as follows (29):

- “Histologically, neural elements were abundant in all ligaments examined.”
- “Bundles of nerve fibers were seen in all ligaments specimens except those from the ligamentum flavum.”
- “Supraspinous ligaments and lumbodorsal fascia show also individual axons and free nerve endings.”

Solomonow et al. found a critical reason for this enriched supply of neural elements; they call it the “*ligamento-muscular stabilizing system of the spine (33).”* That is, the mechanoreceptors (receptors sensitive to movement) so thoroughly innervate the ligaments, due to their vital importance in forming a reflex arc, sensitive to specific movements. To clarify further, specified movements call for specified stability. Reflex arcs are designed to accommodate and adjust to these movements immediately! Here is a summary of their paper (33):

Emphasis

- “ligaments have a mechanical role in maintaining spine stability, and that muscular co-contraction of anterior and posterior muscles is the major stabilizing mechanism of the spine."

- “literature also points out that various sensory receptors are present in spinal ligaments, and that the ligaments are innervated by spinal and autonomic nerves.“

Experiment To Confirm Emphasis

- These scientists placed various forces on a ligament known as the supraspinous L.

- They found that, "loading of the ligament resulted in electromyographic discharge in the muscles of the same level and at least one level above and/or below."

Conclusions

- "Deformation or stress in the supraspinous ligament, and possibly in other spinal ligaments, recruits multifidus muscle force to stiffen one to three lumbar motion segments and prevent instability."

In summary

1. The ligaments of the spine provide structural support directly by resisting separation of the vertebrae, as well as other hyper movements.
2. Ultimately, however, the spine relies on muscular stability, as minuscule loads would cause it to buckle. This calls for extreme levels of communication with the nervous system, as well as immediate action so as to recruit the appropriate muscles for the force applied.
3. To confirm the second role, I have shown you that the ligaments are richly innervated and that deformation of those ligaments elicits an immediate response in spinal musculature to cause a stabilizing effect of the vertebral column.

The Thoracolumbar Fascia and Its Vital Component In Lumbar Stabilization

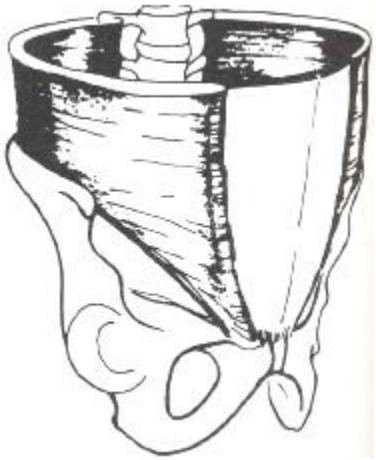
The Thoracolumbar fascia is perhaps the focal point of this article. Anytime you see a term that appears new to you when studying anatomy, simply realize that the name normally indicates much about it. You can deduce from the name that this is a thick sheet of dense connective tissue (fascia), and that it spans the thoracic and lumbar regions of the body. This connective tissue is composed of three layers. The first two are known as the anterior and middle aspects. These layers attach to the transverse processes of the lumbar vertebrae, then the fascia moves out laterally and blends with the fascia of the transversus abdominis and internal obliques.

To clarify, let's examine what transverse processes actually are. When a thin person bends their back, you can see their spine. In anatomical terms, the bumps you see poking out of the back are known as the spinous processes of the vertebrae.


The pictures above are two dorsal (rear) views of the spine; here you can clearly see the spinous processes. If you look on the sides, or laterally on each vertebra, you will notice a process which sticks out on the left and right of the vertebrae. These are the transverse processes.
They are named so due to the fact that they reside in a transverse, side-to-side, or horizontal plane.

Secondly, I stated that after its attachment to the transverse processes, the fascia moves out laterally and blends with the fascia of the transversus abdominus and internal obliques. Why is this important, you ask? Because through this interaction, the spine is able to interact, not only with deep muscles of the back, but also with the abdominal wall. Thus, a 360 degree functional complex is formed, capable of producing spinal stabilization mechanisms that will blow your mind!

Briefly, the transversus abdominis originates on the thoracolumbar fascia, the iliac crest, and the inferior six ribs, and inserts on a connective tissue band known as the linea alba (11, 22). This band of tissue runs from the xyphoid process (the bottom of your sternum), to the symphysis pubis (the groin area).

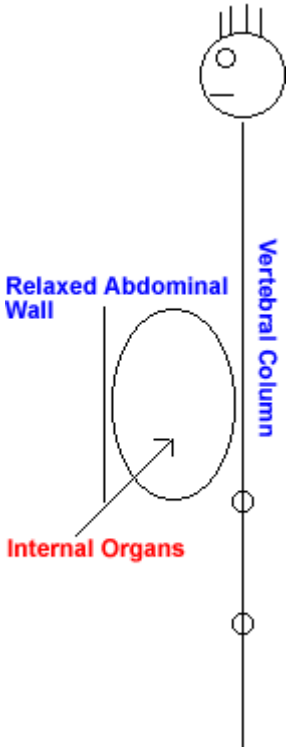


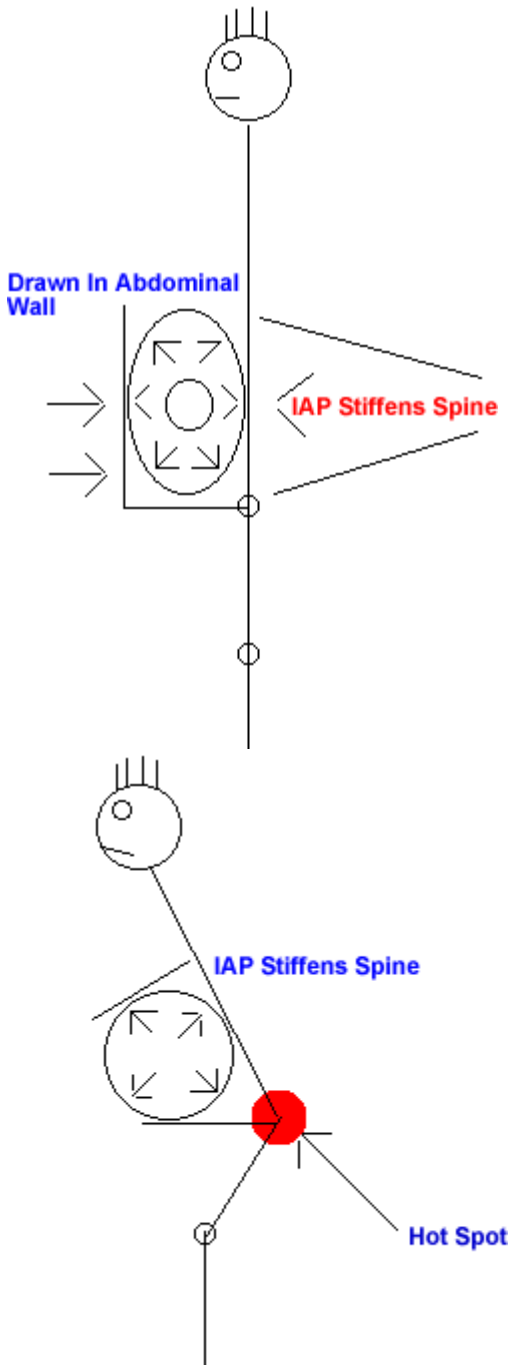
As the picture above indicates, the transversus abdominis and the thoracolumbar form a hoop structure around the lumbar region of the body, which has great significance. The internal oblique also has origin attachments on the thoracolumbar

fascia, and the lower 4 ribs, and inserts on the linea alba (11, 22). Both of these muscles function to draw the abdominal wall inward, which leads us to our next subject, namely intra-abdominal pressure via the co-contractile method of recruitment.

Intra Abdominal Pressure Defined

1n 1987, one of the world's most brilliant scientists conducted what can only be considered as both an innovative and ingenious experiment. He inserted balloons in the abdominal cavities of cadavers, and noted a 23 percent increase in trunk stiffness when inflated to 60 mm hg, and a 43 percent increase in trunk stiffness when inflated to 120 mm hg (35). The balloon effectively increased intra abdominal pressure. The experiment also demonstrated that the firmness of the spine is directly proportional to intra abdominal pressure. That is, the higher the pressure, the greater the stiffness. It will help to see a diagrammatical rendition, based on Tesh's experiment.





Note above that the oval object represents the abdominal cavity, and namely the viscera (internal organs) and the spine is the vertical line. When the abdominal cavity is compressed during hip flexion, the pressure in the cavity increases and it exerts a force against the diaphragm upward, the pelvis downward, and the spine posteriorly. In doing so, as you come back up, this pressure assists in extension. Additionally, like a balloon, the intra abdominal pressure resists flexion of the spine (note how it is pushing against the spine in the opposite direction of flexion), and also resists hip flexion.

This is not the only way to increase abdominal pressure, however; as you have seen above, contraction of the transveris abdominis and internal oblique also accomplishes this.

In the above diagram, the length of the arrows represent the magnitude of force produced against the surrounding structures. Note that as the abdominal wall is pulled in, the magnitude increases. One method of finding if a muscle group is vital to spinal stability is to analyze how the nervous system recruits it. It is interesting to note that this sophisticated supercomputer realizes this, and will increase abdominal activity under high fatigue movements. Essendrop et al., in the "European Journal of Applied Physiology," tested what the nervous system would naturally do when the spinal erectors were extremely fatigued, using various back extension resistance exercises. It was found that as the spinal erectors fatigued and could not contract as efficiently or as strongly, the muscles of the abdominal wall increased in activity, and with them intra abdominal pressure (8). This provides great evidence for the abdominal wall to enhance stability of the spine.

Cholewicki et al., in the "Journal of Biomechanics," constructed a model to see if contraction of the abdominals, and/or intra abdominal pressure, were responsible for increased spinal stability. They tested both mechanisms separately and together. It is stated in their dissertation that:
"The critical load and therefore the stability of the spine model increased with either increased antagonistic muscle co activation forces or increased IAP along with increased abdominal spring force. Both mechanisms were also effective in providing mechanical stability to the spine model when activated simultaneously (3)." To further isolate intra abdominals effects without abdominal co-contraction (abdominal contraction activates further mechanisms of spinal stabilization; I am showing you this in isolation so as to relay the vitality of IAP regardless of these further mechanisms), Hodges and colleagues artificially elevated intra abdominal pressure without activation of the spinal erectors or abdominals! The purpose was to see if IAP could produce an extensor moment (recall that moment is synonymous with torque; to clarify, read an introductory to biomechanics or elbow flexors two). Results were as follows (12):

> When IAP was increased artificially to approximately 15% of the maximum IAP amplitude that could be generated voluntarily with the trunk positioned in flexion, a trunk extensor moment (approximately 6 Nm) was recorded. Although the net effect of this extensor torque in functional tasks would be dependent on the muscles used to increase the IAP and their associated flexion torque, the data does provide evidence that IAP contributes, at least in part, to spinal stability.

In 2003 Daggfeldt et al. devised a "biomechanical model of lumbar back extension over a wide range of positions for the lumbar spine, incorporating the latest information on muscle geometry and intra-abdominal pressure (IAP)." It was found that "IAP (measured during torque exertions) contributes about 10% of the total maximal voluntary back-extensor torque and that it can unload the spine from compression (5)." To test how the body guards against sudden loads, Essendrop and colleagues tested how elevated levels could counteract such forces. In summary of their results, "EMG, IAP, and movement of the trunk were measured. It was found that IAP of a size likely to appear in work situations, and the concomitant increase in muscle co-activation, increased the spine stiffness. This increase in stiffness

decreased the movement caused by the sudden load (7)."

Further Hardcore Support!

When the transversus abdominus, internal obliques, and multifidus muscles (discussed shortly) co-contract, the spine is supported by 360 degrees of tension.



Artificial examples of such support include the neck brace, the elbow brace, and any body part wrapped with an ace bandage, such as the wrist or knee. In the first example, the neck brace stiffens the cervical region, and at the same time protects it from injury. The transversus abdominus acts to literally draw the abdominal wall inward. Wilson et al., in the "Journal of Strength and Conditioning," states that, *"This can be obtained by performing the 'drawing in' maneuver...This technique involves having the athlete 'suck in their gut' by pulling their umbilicus posterior and superior from their beltline. It is important that the athlete continues to breathe during this exercise...(6)."* The umbilicus is the bellybutton.

What needs to be understood, however, is that it is not just the process of contraction of the internal abdominal wall that is crucial to spinal stability, but also how the nervous system recruits these muscles during training protocols reliant on this form of stability. That is, if the NS activates muscles in an improper order, injury can and most likely will follow. Two greatly respected scientists, Hodges and Richardson, confirmed this with a startling protocol. They began by stating that, "Few studies have evaluated the motor control of trunk muscles or the potential for dysfunction of this system in patients with low back pain." It was determined to test if the immediate motor coordination indeed had a profound effect on this subject.

Summary of Study (13):

1. Fifteen patients with and without back pain entered the experiment.
2. Each performed various shoulder movements, such as flexion, abduction, and extension.
3. Electrical activity of both the abdominals, and the deep muscle of the back known as the multifidus, was recorded. Again, the plan was to see in what order these were recruited, and if it was different between the group which had pain and the group which did not.
4. They found that in participants without back pain, the nervous system activated the muscles of the trunk before the muscles of the shoulder.
Interestingly enough, they also found that the transversus abdominus was activated before any other muscle, which they felt confirmed its role in spinal stability.
5. However, they also noted that, *"Contraction of transversus abdominis was significantly delayed in patients with low back pain with all movements."*

6. Their conclusion is as follows: *"The delayed onset of contraction of transversus abdominis indicates a deficit of motor control and is hypothesized to result in inefficient muscular stabilization of the spine."*

As extreme as these results were, I wanted to confirm them with other studies, and what I found was an extremely unified and positive correlation between results (14, 30, 15). For example, Hodges and Richardson teamed up again in the "Journal of AP Medical Rehabilitation." This time, they examined whether sub-optimal recruitment patters could be found at three differing speeds of movement. It was discovered that the majority of participants without lower back pain again activated the transversus abdominus and internal obliques early. However, they note that, "In contrast, subjects with low back pain failed to recruit TrA or OI in advance of limb movement with fast movement, and no activity of the abdominal muscles was recorded in the majority of intermediate speed trials (14)." From this, Hodges and Richardson conclude that, "the results indicate that the mechanism of preparatory spinal control is altered in people with lower back pain for movement at a variety of speeds (14)." Thus, we realize that it is essential for the transversus abdominus to be activated immediately upon any exercise requiring trunk stabilization (16, 17).

We see a motor recruitment problem, but the question is can such innervation be altered? Evidence points to an extremely positive answer here! O'Sullivan, Twomey, and Allison performed varying "conscious" recruitment techniques of the abdominal muscles in 42 subjects and found that all the subjects could notably change motor recruitment patterns--both the conscious and the autonomic patterns. To quote directly:

> "The study findings provide evidence that the conscious and **automatic patterns** of abdominal muscle activation can be altered by specific exercise interventions (25)."

These same scientists have also teamed up, with the addition of Dr. Phyty, for an even more precise study. Here is a summary of what was found (38):

1. Forty-four subjects with back pain were studied for 3, 6, and 33 months in response to various abdominal training protocols.
2. The program had participants specifically train the "deep" abdominal wall muscles. "The activation of these muscles was incorporated into previously aggravating static postures and functional tasks."
3. During this procedure, they had a control group go to their normal back pain practitioner so as to have a valid reference frame to compare to.
4. It was found that, "After intervention, the specific exercise group showed a statistically significant reduction in pain intensity and functional disability levels, which was maintained at a 30-month follow-up. The control group showed no significant change in these parameters after intervention or at follow-up."
5. In conclusion, they noted, "A 'specific exercise' treatment approach appears more effective than other commonly prescribed conservative treatment programs."

Such results are of paramount importance to the bodybuilder, and I submit to you that optimal programming of your motor system will enhance all your lifts in more ways than one!

Re-Programming The System

In order to sufficiently program the system, each component must be reduced. The thoracolumbar fascia is the center of what can be classified as an "integrated" system. What does this mean? It means that several muscles have attachment points to this connective tissue. The lattissimus dorsi attaches the upper extremity to this region, and the gluteus maximus is also associated with it. To clarify, the lats actually insert onto the humerus, furthering the connection, and the gluteus maximus inserts on the femur, or thigh bone.

The system is nothing short of genius. Any movement which requires the lower body incorporates gluteal contraction, which automatically increases spinal stability! Vleeming and colleagues did much to conform this integrated system. They tested how much tension was measured in the TLF with a number of muscles. It was found that, "Traction to a variety of muscles caused displacement of the posterior layer. This implies that in vivo, the superficial lamina will be tensed by contraction of various muscles, such as the latissimus dorsi, gluteus maximus and erector muscle, and the deep lamina by contraction of the biceps femoris." From these results, the following conclusions were drawn (38): "Anatomic structures normally described as hip, pelvic, and leg muscles interact with so-called arm and spinal muscles via the thoracolumbar fascia. This allows for effective load transfer between spine, pelvis, legs, and arms--an integrated system." They postulate that, "the combined action of these muscles assists in rotating the trunk, while simultaneously stabilizing the lower lumbar spine and sacroiliac joints." The author mentioned above by the name of Eric Wilson, also concurs with their results by stating that, "The TLF is connected to the upper extremities by the latissimus dorsi and to the fascia lata by the gluteus maximus muscles. Targeting the latissimus dorsi and gluteus maximus is also important because of their contralateral coactivation capability, thus strengthening the latissimus dorsi assists the gluteus maximus in generating force and vice versa (6)."

The significance of this cannot be overstated, especially when programming the nervous system. What I have done is further research the importance of when an athlete should contract the gluteus maximus, in relation to a lift. I found that Dr. Noe and colleagues had performed a magnificent study on the subject (24). They wanted to test hardcore, experienced weightlifters who have sustained incredible loads with minimal back disturbance. I believe Mr. Blood Stained Shins Powell would approve of the study, as it incorporated deadlifts!

Josh "Blood Stained Shins" Powel's Logo

Muscles tested included the "gluteus maximus, quadriceps, latissimus dorsi, and erector spinae in 4 weight lifters and 11 asymptomatic control subjects." That is to say, that the hardcore, experienced lifters' recruitment patterns were directly compared to non-effective lifters to find what exactly was the difference in their recruitment patterns. It was found that "the weight lifters achieved maximal force at

50% of maximal lift height, whereas the control subjects achieved it at 67%." This is a tremendous difference. The authors noted a significant correlation between early gluteal contraction and maximal force generation. That is, the experienced lifters contracted this region much quicker than their counterparts. It was also noted that "This process would stabilize the pelvis and permit the erector spinae to extend the trunk more efficiently."

Recall that the TLF is composed of three parts. The first two attach to the transverse processes of the lumbar region. The third section, however, attaches to the spinous processes of the thoracic, lumbar, and sacral region. Thus, when the internal abdominal unit contracts laterally, or when complete circular tension is used like a neck brace to stabilize the spine. However, the gluteus maximus is associated with the aspect of the TLF, which finds its attachments on the spinous. Once again, the Lord spared no expense here, as this muscle group has a direct line of pull to the specified region.

Summarizing with a demonstration

1. Stand up, and imagine that your shirt is the thoracolumbar fascia.
2. Now, cross your arms and reach behind you so that your right arm grasps the left side of the posterior aspect of your shirt, while your left hand does the opposite.
3. Now pull on your shirt while uncrossing your arms. Note the tension and increased support that the shirt gives you, as it tightens around the lumbar region. Such a demonstration is comparable to the transversus abdominus and internal obliques drawing the abdominal wall inward and tensing the TLF.
4. Now release your shirt. Reach behind your back and grasp in the middle of your back a section of your shirt.
5. Then pull or tug straight downward. This is similar to the line of pull created by gluteal contraction.

Achieving Peak Spinal Stability

1. Studies show that endurance of the trunk musculature is an extremely vital component. You must be able to both recruit and maintain strong recruition throughout a set. For example, during a set of squats, if you lose your ability to co-contract the muscles which draw in the abdominal wall, your spine will no longer have sufficient support and injury is likely to occur. Such a concept is especially vital to the bodybuilder, who is no stranger to long and hardcore sets.

In order to accomplish this, your abdominal drawing exercises will emphasize both endurance and timing. I will construct a program which will allow this shortly.

2. We will want to train the NT to recruit musculature properly while training. This will call for varying tasks which ask the user to voluntarily contract the TVA, followed by the gluteus maximums primarily.

3. Once you are confident in your ability to use this stabilization system, you will coordinate it into Compound lifts.

Exercises To Incorporate

1. Abs At Work - While at your desk at work, you will want to practice drawing in the abdominal wall while seated in a correct posture. That is, with a normal spinal curvature. Simply draw in the belly button toward your spine and hold it in tight. The goal is to hold it as long as possible while still breathing. I suggest a progressive application like so:

Day One: Draw in abdominal wall and hold for 20 seconds. Now relax. Wait 10 seconds and repeat. Now relax. Wait 10 seconds and repeat.

That is one set. Perform 4 more identical to it.

Day Two: Rest

Day Three: Draw in abdominal wall and hold for 30 seconds. Now relax. Wait 10 seconds and repeat. Now relax.

Perform 4 more identical to it.

Day Four: Rest

Day Five: Rest

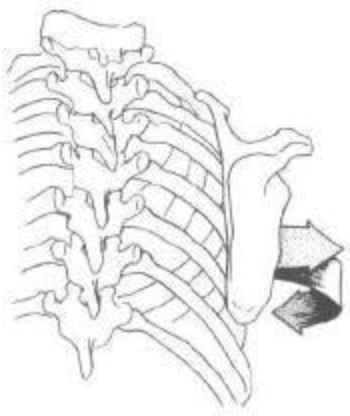
Day Six: Attempt to perform 4 sets at 60 seconds.

2. Variation - This can also be performed at home, on your hands and knees, which is the traditional method of utilizing the drawing in maneuver.

Once you have mastered the above, you will be ready for more specific exercises. Once again, Eric Wilson's strong commitment to research has enhanced our area of understanding in this subject, and many of these are based on his insight (6).

3. Straight Arm Pulldowns WIth Stabilization - Straight arm pulldowns are a "straightforward" exercise. Simply attach a short bar to the high pulley extension, and place your hands on the bar (palms down). Normally you would simply pull the bar straight down towards your legs, with your elbows extended the whole time. Such an exercise targets the lats, for example, and other extensors of the humerus. However, this is not simply a lat exercise, but a re-programming sequence. The weight should be relatively light to begin. No more than 50 percent of your max. Again, begin with your hand on the attachment. Before lowering the weight, draw in your belly button, followed immediately by a contraction of the gluteus maximus. Now pull the weight down. Following this, you will go back to the beginning aspect of the exercise (i.e. let the weight come back up while resisting it), and as you reach the starting position, release the contraction of the gluteus maximus, and then release the drawing in of your abdominal wall. You will repeat for 30-60 repetitions. This develops motor learning, as well as endurance in the target musculature.

4. Internal Oblique blast - Lie flat on your back with your arms at your sides. You are not allowed to protract the scapula or flex the neck.



Shoulder (scapular) protraction - Used when spreading the lats.

Thus, mobility is indeed limited. Begin by sucking the gut in as described above. Now attempt to touch your left foot with your left hand and simultaneously turn your upper body toward the left. However, you will stop as soon as your shoulder blade is off the floor. Once this occurs, hold for a second, and lower. Finish set when exhaustion is reached.

5. Dumbbell Pullovers With Stabilization - Here we work on proprioception and targeted stabilization. These are performed on the floor with the knees slightly bent. Utilize straight arm pullovers. Begin with the dumbbell overhead. Suck in the gut, and then flex the gluteal muscles, followed by a lowering of the weight. Wilson suggests that you actually "predict (6)" when the weight will touch the ground behind you, thus developing the proprioceptive effect. Bring the weight back up, and release the gluteal contraction, followed by releasing the drawing in action. Now repeat. Again, light weight should be used, and reps should range from 15-30.

Program Defined

Week One - Perform as instructed: i.e. 4-5 sets, three times during the week, until you work your way up to 60 seconds utilizing a basic drawing in technique.

Week Two:

Day one of the Week

A. Begin by performing two sets of 60 second drawing in maneuvers while on your hands and knees.

B. Perform two sets of straight arm pulldowns at 50, and 30 repetitions, respectively

C. Finish it off with one set of pullovers at 20 and 15 repetitions.

Day Five of The Week

Week Three:

Repeat

Week Four:

You will be extremely confident in your ability to coordinate the above movements, and significant motor learning will have occurred. At this stage, we take it to a game situation! Your goal is to focus on activating the drawing in technique with all activities which call for stabilization. For example, before performing a lunge, draw in your TVA, before lunging. You will now keep it drawn in the entire set. On a military press, focus on drawing in the TVA first before unracking the weight. After consistently performing this, your motor system will have learned to recruit in this amazing sequence, and your stability will sky rocket! I have also shown convincing studies which demonstrate that lifts will also be tremendously more effective(31)!

Proprioception

Studies show that aerobic conditioning, as well as aerobic work, decrease lower back pain (23). One of the reasons is that aerobic locomotive exercise stimulates activation of important stabilizer muscles of the spine (18).

However, I felt that there was a further mechanism which was correlated with these results, which led me to research studies on proprioception as related to spinal stabilization, namely under conditions of fatigue. It was my view that such studies would show a positive correlation between fatigue and this sense.

Interestingly enough, it was at the turn of last century that one field of motor research was blessed with one of the most Brilliant scientists the world has ever known. Sherrington's theories are still used today. It was he who ultimately coined the term proprioception, which literally means the sense of the body's place in space (18). Kavounoudias et al. states that, "the central processing of proprioceptive inputs that arise from numerous muscles contributes to both awareness and control of body posture." They also state its role in "balance control and body orientation." Numerous receptors detect degrees of stretch (muscle spindles), and intensities of contraction (golgi tendons) (20). The more sensitive you are to joint movements and the intricacies of contracting muscle groups, the greater your form will actually be. It is a known fact that the disruption of kinesetic perception (similarly to PC) will cause drastic miscalculations in our movements (32,37,18). Tamella, Kankaanpaa, and Luoto, each experts on spine mechanics, states that, "Protection against spinal injury requires proper anticipation of events, appropriate sensation of body position, and reasonable muscular responses (36)."

As a consequence, they tested the proprioceptive abilities of 57 people with back pain, vs. 49 without such hindrances. "Their ability to sense a change in lumbar position while seated on a special trunk rotation unit was assessed. A motor rotated the seat with an angular velocity of 1 degree per second. The task in the test involved reacting to the perception of lumbar movement (rotation) by releasing a button with a finger movement." It was found that those with back pain notably had lower proprioceptive abilities than those who were healthy. However, both groups' sense of their place in space lowered considerably while fatigued. They conclude that, "Lumbar fatigue impairs the ability to sense a change in lumbar position. This feature was found in patients and control subjects, but patients with low back trouble had poorer ability to sense a change in lumbar position than control subjects even when they were not fatigued. There seems to be a period after a fatiguing task during which the available information on lumbar position and its changes is inaccurate."

We can therefore conclude the importance of a strong cardiovascular base if one is to take on this brutal sport. Those without sufficient endurance will have lower kinesthetic perception when compared to athletes who do take their overall conditioning seriously. This calls for three things.

1. Cardio should be a part of a bodybuilding regimen for overall conditioning.
2. High repetition work for each body part should be included for localized endurance.
3. Posing must be taken seriously, as a keen relationship must be developed between each muscle group.

Conclusion

We often refer to those without strength as "spineless" or "without a backbone." It was my sincere hope to show you the truth of these sayings today. Do not expect to succeed with as glaring a weak point as a weak back. Conversely, expect to clarify the path toward your athletic endeavors by strengthening this region and all aspects which are intimately associated with it.

Yours In Sport,

Jacob Wilson
President Abcbodybuilding / The Journal of HYPERplasia Research

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