CORE STABILIZATION AND NEUTRAL SPINAL POSTURE

Functional movement, or the ability to move and respond without restriction, as well as to move and respond effectively and with intention, begins with an understanding of core stabilization and neutral spinal posture.

core stabilization and its importance to functional movement

Obviously, the ability to position the spine and activate the muscles necessary to do so is a key skill as it relates to all movement. Equally important, is training the core with the understanding that it links upper and lower body movement. Putting the importance of alignment skill and integrated movement capability in perspective requires a brief discussion of 1) the "serape effect," 2) the impact of load, 3) abdominal bracing, as well as, 4) the development of a definition for core training that aligns with functional training.

the serape effect

The serape effect, first described by Logan and McKinney (1970) helps one to visualize what the core musculature is anatomically suited to accomplish, especially as it relates to rotational power development. The serape is a scarf-like blanket worn by natives in some areas of Mexico and South America. It drapes around the neck and shoulders and crosses near the waist, tucking into the belt area. Visualizing how the serape is worn captures the functional design of the torso muscles' crisscrossing nature. In essence, how the serape is worn reflects fiber direction of the torso muscles, which in turn determines muscle function and movement capability. Most of the muscles of the core/torso and their associated fiber directions are oriented in horizontal or diagonal directions. This anatomical design lends itself well to rotational force production between the hip and opposite shoulder, especially when coupled with ankle, knee and hip extension movement. The so-called serape effect *(Logan and McKinney, 1970)* is specifically the result of interaction between the rhomboids, serratus anterior, and the external and internal obliques. See above.

the serape effect

Based on this functional model, it becomes obvious that useful core/torso training must be more involved than, for example, training the rectus abdominis with isolated trunk flexion and the torso with barbell chest presses. Note that Logan and McKinney made this observation in 1970, yet integrated core and torso training has not been universally received or implemented, though understanding and use of functional-integrated training is gaining momentum. All of the BOSU® Programs incorporate this concept of integrated movement into exercise progression and include the BOSU Integrated Balance Training, BOSU Pro Fitness Training Series, BOSU Sport Training Series and the BOSU Balance Trainer Complete Workout System programs.

The serape effect and this diagonal patterning of muscle synergy can best be observed in rotational movements when the core is loaded or pre-stretched, and prepared to assist a throwing or other rotary motion like a golf or baseball swing. The serape effect represents the most favorable length-tension (best pre-stretch) for a muscle that results in optimal, not necessarily maximal, force production.

This understanding of how the core and torso function together (the serape effect), and how the core links the upper to lower body, establishes a base of knowledge behind the belief that the body should be trained in an integrated fashion, from head-to-toe. In light of this information, the importance of linked power development is evident, but does not exclude traditional approaches to training.

the impact of load

As is true of any form of training, sometimes good intentions can be carried too far. In an attempt to make an activity “sport specific” or “look like a sport skill,” some functional training enthusiasts train certain motions or positions without considering load application. This mistake has caused confusion in the area of functional training and has led many experts to question its relevance.

To follow are a few examples that can get a well-intentioned professional in trouble, in terms of putting an athlete or fitness enthusiast at risk for injury. Though it is necessary for a pro road cyclist to generally assume a flexed, and rounded spinal posture while riding, that does not justify doing dead-lifts or bent over rowing movements with a rounded spine. The risk outweighs the benefit and is not specific to the sport. No cyclist that we know has ever ridden a bike with a weight hanging from his or her neck or arms! Baseball or softball players may field a ground ball with a flexed spine, but that does not justify training the spine in a flexed position with heavy loads. Additionally, trying to replicate a golf swing or pitcher's throwing motion against load (i.e., elastic cable) by tethering elastic resistance to a ball or part of a club handle is ludicrous, especially if the speed of these movements that occur while playing either sport are replicated.

Creating exercises that use high risk postures and/or attempt to replicate the same speed of movement against inappropriate load for a given movement found in a sport, not only can put the spine at risk for injury, but can include other joints like the shoulder and knee. Many sports and daily occupations require positions that constitute poor posture or can place a number of joints, not only the spine, in vulnerable positions that represent the end range-of-motion of joint capsule tolerance. This reality should not justify training with heavy load in these compromised positions. In fact, the body can tolerate many of these positions without load, and a well designed training program can help to counter any negative effects by using exercises to counter any harmful consequence. In sport, it must be exact, not close, in terms of skill replication to be called sport specific.

abdominal bracing and neutral posture application

Being able to establish a braced spine and maintain a braced core is essential to effective and safe movement. This is accomplished by maintaining a mild contraction or tension in the abdominal wall. However, abdominal bracing is very different than abdominal hollowing, which generally refers to a pulling or drawing in of the abdominal wall. When the bracing is performed correctly no change occurs in the abdominal wall. McGill (2002) refers to this as muscle stiffening and terms it “abdominal bracing.”

Much of the confusion and controversy between abdominal hollowing and bracing may stem from previous research (Richardson et al. 1999). Richardson's group observed increased muscle activation of the transversus abdominis with abdominal hollowing. In contrast, McGill has shown that an isometric abdominal brace coactivates the transversus abdominis with the external and internal obliques to ensure stability in virtually all modes of instability (Juker et al. 1998; McGill 2002, pg. 210). When the abdominal wall is braced, it is neither hollowed nor pushed out.

With this background in mind, Richardson and colleagues also observed that transversus abdominis recruitment is impaired after injury. Therefore, Richardson's group developed a reeducation program of exercise to activate this muscle group in low back patients. However, McGill (2002) points out that this is misguided because hollowing as a reeducation exercise for this particular muscle does not ensure stability. Therefore, to encourage back patients or athletes to use hollowing over abdominal bracing if the goal is to enhance stability when performing daily activities and sport is mistaken. Abdominal bracing activates three layers of the abdominal wall (transversus abdominis, internal oblique, external oblique) with no added motion of drawing in, and is much more effective at improving spinal stability (McGill 2001; McGill 2002).

teaching abdominal bracing

Teaching abdominal bracing, as is true for teaching neutral posture, is challenging. An instructor is simply asking the participant to stiffen the abdominal wall with a mild isometric contraction, where no movement occurs in the spine or pelvis. If a participant can already establish neutral posture and can differentiate hip flexion from spinal flexion and extension, he/she will be ready to combine these skills with abdominal bracing. A trainer or instructor should teach that abdominal bracing occurs when the abdominal wall is neither sucked in nor pushed out.

McGill (2002) suggests communicating this idea of bracing by having the person stiffen one joint, such as the elbow, by simultaneously contracting the flexors and extensors. The person stiffens the joint without any movement occurring at the joint and palpates the joint to feel what is happening. This can be practiced at other joints like the knee. Then, the drill is moved to focus on the core/torso region and the person uses the same technique to achieve the bracing effect. Finally, an instructor can teach the participant to maintain the abdominal brace during functional movement situations that include picking up a child, moving in and out of a chair, or during an explosive athletic movement. We often refer to this involved bracing concept as “setting” the core. Realize that stiffness of the core might be sustained for a period of time or only needed on and off for brief moments during performance. But, to set the core correctly, regardless of the situation, one must understand all of the ingredients that contribute to effectively creating optimal core stability.

core training

Training the abdominals and back musculature has been referred to as core, trunk, torso, abdominal and back training to name a few, and in addition has been referenced as the body's power or control center. No matter what one calls this type of conditioning, the breadth of meaning with regard to a functional and complete training of the core should be reflected by what one actually does in a training program.

Bottom line requirements with regard to training the core include a need for 1) stability and 2) a strong, integrated link between the upper and lower body (the serape effect). This coupling link between the upper and lower body must be able to provide stabilization of the core and serve as a springboard for linked power development that can occur during a variety of movement situations, and can include skillful tasks like striking, throwing, lifting, bending or jumping.

Complete core training must involve all of the muscles of the midsection, and include training of these muscles simultaneously with motion that should involve the hip flexor, hip rotator, gluteal and hamstring muscle groups (refer to the BOSU Sport Conditioning Series). Being able to create stability and motion in the core region allows for a smooth transition of power between the upper and lower body which equates to applied – or functional-power development. This powerful link cannot be developed by only training the trunk musculature in isolation. Instead, stabilization, bracing, and rotation are key elements to train in the core region if a functional, performance oriented carry-over is a desired training outcome.

defining neutral spinal posture

Neutral posture can be defined as avoiding the extremes of sustained spinal flexion (rounded spine) or extension (arched spine), or positioning the spinal column and pelvis in a manner that reflects a mid-position between the extremes of these two joint actions. A total approach to abdominal and back strengthening, back wellness and functional balance training must include the concept and teaching of neutral posture. Avoiding the extremes of sustained flexion and extension, when appropriate, should be taught for both the cervical (neck) and lumbar (lower back) areas of the spine. Likewise, intentional movement that causes a shift from neutral posture is not an issue of right or wrong, but one of appropriateness as related to movement demands.

Being able to "set" or establish neutral posture when desired helps to conserve the integrity of spinal discs, ligaments and joints, as well as enhancing movement capability. Awareness of neutral posture encourages a return to, or maintenance of, proper spinal positioning during daily tasks or sport movement.

Neutral spinal posture can, in an even more simplified manner, be defined as an absence of tension in the cervical and lumbar spine. The strongest position of the spine and the position least likely to contribute to increased risk of injury or chronic degenerative spinal disease is represented by neutral posture. Neutral spinal posture refers to the maintenance of "normal" spinal curves that are inherent to a healthy, strong and properly aligned spine. See FIG. A.

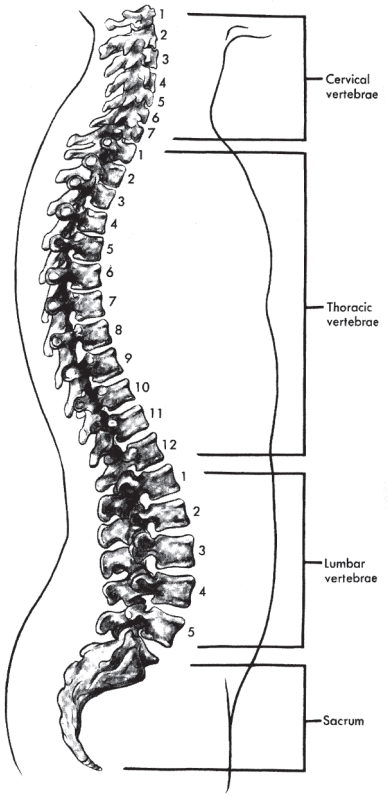

FIG. A
Vertebral column exhibiting the normal curvatures inherent to a healthy and properly aligned spine.

When performing any exercise, sport movement or daily task, whether seated, prone, supine, side-lying, standing and/or during movement, proper alignment in the cervical, thoracic and lumbar regions should be considered. Decisions need to be made with regard to whether or not neutral spinal posture should be maintained (i.e., during a dynamic sporting activity or when performing trunk stability exercises), or if intentionally, the exerciser should choose to move out of neutral (i.e., performing trunk flexion which is typically referred to as a trunk curl or crunch exercise).

It is critical to all physical movement training and back health to have mastered the skill of freely and intentionally moving from and returning to neutral spinal posture. Participants must also have the ability to maintain spinal neutral throughout an exercise or movement when appropriate.

Neutral spinal posture can be illustrated by the maintenance of proper cervical, thoracic and lumbar curvatures. See FIG. B.

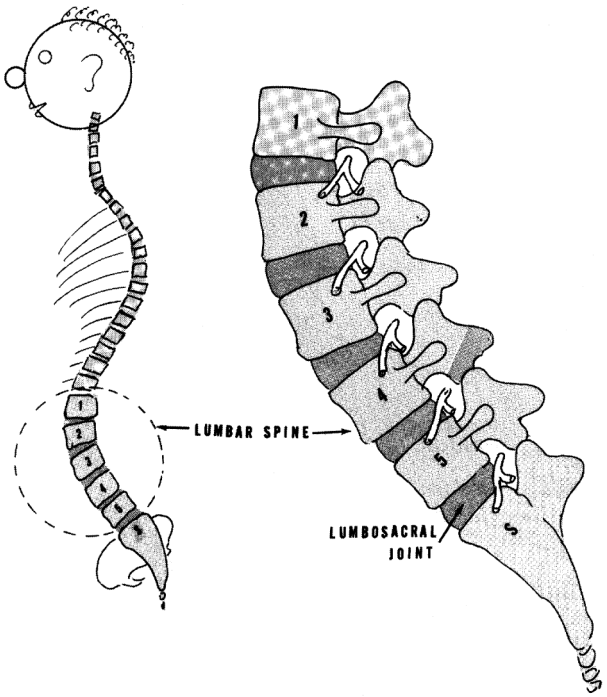

FIG. B
Vertebrae positioning in a neutral lumbar spine.

Illustration adapted from Low Back Pain Syndrome, Rene Cailliet, M.D., F.A. Davis, 4th printing, 1991, pg. 4.

When observing the natural spinal curves, note that the vertebrae are not stacked vertically upon one another. Yet, through the preservation of the desired or normal curvatures of the spine, this positioning protects the integrity of the spinal ligaments, joints and intervertebral discs. When the spine is neutral, the weight of the spine, gravity and other forces are equally distributed across the weight bearing surface of the discs and spinal joints, and are less likely to stress the functional units (the dynamic joints and supportive soft tissue structures) of the spine. Neutral posture minimizes compressive, shear and rotary torque forces.

methods to identify neutral lumbar posture

In order to work with each individual's unique physical traits, it is helpful to teach the individual how to identify his/her neutral or natural (current) lumbar spinal position. Note, "natural" or "normal" is not always ideal.

One of the easiest ways to identify this starting point in the lumbar region is to stand with the heels close to or touching a wall. The protrusion of the buttocks and shoulder blades (scapulae) should lightly touch the wall. Attempt to slide one hand, palm facing the wall, between the small of the back and the wall surface. Many participants who have self-administered this evaluation find there is no space. Some find that two or three fingers may fit in nicely. Others, who have a significantly arched back (lordosis) report that they can "drive a truck" through the existing space!

Regardless of curvature, or lack thereof, as measured by how the hand or fingers fit into the lumbar space, this becomes the reference point for returning to neutral. It should be noted that external observance by a fitness professional should be just that, an observation. Diagnostic tools provided by a medical professional should be suggested if excessive curvature or lack of curvature give cause for concern. There is no "perfect" amount of curvature, nor is it within the scope-of-practice of most fitness professionals to try and attempt to ascertain whether a specific spinal curvature is desired, or represents an unhealthy situation.

Another method that can be used to identify neutral posture is to slowly rotate the pelvis into an anterior tilt (arching the low back) and then slowly rotate the pelvis into a posterior tilt (flattening the low back). Find a neutral point that represents a position between the two extremes. This method can effectively be used by placing the individual in a hands and knees position on the floor, a standing position with a slight bend in the knees and hips, or by positioning him/her in a seated position on a stability ball.

trunk flexion and extension

Early anatomy books illustrate that either excessive extension or flexion of the lumbar spine result in disproportionate and unequal stress on the discs located between the vertebrae. Over time such stress could result in herniated discs, and resultant swelling, nerve root irritation or impingement, and/or degeneration of the vertebrae. Sustaining a misalignment like this during dynamic movement or throughout the day (sitting with a rounded back), may cause irreparable and cumulative damage that can lead to pain, injury and a loss of pain-free mobility in the low back region.

Vertebral or spinal flexion is characterized by compression to the anterior aspect of the disc. Spinal flexion occurs when performing traditional abdominal "curls" where the rib is drawn toward the pelvis, or when a person sits with a rounded low back at his desk. Posterior ligaments, the muscle sheath, and other soft tissue limit excessive flexion. See FIG. C. Spinal extension is restricted by mechanical impact of the facet joints and by the anterior longitudinal ligament. See FIG. D.

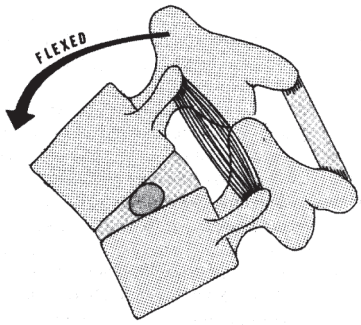

FIG. C
Trunk Flexion

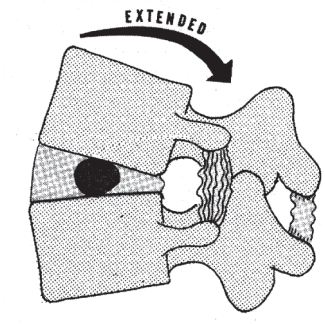

FIG. D
Trunk Extension

Illustrations adapted from Low Back Pain Syndrome, Rene Cailliet, M.D., F.A. Davis, 4th printing, 1991, pg. 90.

When neutral alignment of the lumbar spine is maintained, the forces on the discs between the vertebrae are greatly reduced, as well as stretch forces to stabilizing spinal ligaments. Neutral posture more evenly spreads compression, shear or torque forces over the load bearing surfaces of the intervertebral discs. This helps avoid a concentration of high stress forces in small areas of the discs.

neutral posture summary

In an extensive review, Plowman (1992) highlights the importance of neutral spinal posture in the lumbar region. Greater posterior tilt (toward flat back position) increases low back muscle and ligament tension and, as a result, compressive forces on the spine and discs. It is reasonable to conclude that a sustained flexed or flat back position inherits many of the same risks that a sustained extended or excessively arched back does. Specifically, the ligaments, muscles, fascia and discs that make up the spinal column are put at risk for chronic, degenerative processes to occur.

It must be emphasized that the back was meant to flex as well as extend, and was meant to laterally flex and rotate. Keep in mind that one cannot perform effective, full range mover-type (or isolation) trunk exercises without flexing or extending the spine. Nor can a person effectively participate in all athletic or daily movement requirements unless he/she can move into, and out of, neutral posture. On the other hand, an individual should know how, for example, to establish and preserve neutral posture if he/she is sitting at a desk, driving a car, riding a stationary bike or walking.

Flexion and extension are well tolerated by the spine and its associated soft tissues, including the spinal discs. In fact, this type of movement is necessary, for example, to achieve disc nutrition. Dynamic movement would not be possible if the spine did not tolerate this type of movement. However, excessive and uncontrolled (ballistic) movement of the spine, as well as rotation that is combined with a poorly aligned spine can be detrimental. Remember that the devastating nature of back pain is not associated with a "lightening strike." Instead, a habit that is characterized as seemingly innocuous, such as sustaining poor seated posture over long periods of time, is a leading contributor to low back pain and the associated discomfort or disability.

Material in this chapter adapted from Douglas S. Brooks' live workshop presentations and The Complete Book of Balance Training (in press), by Gregory Anderson, Douglas Brooks and Peter Twist, Effective Strength Training by Douglas S. Brooks, 2001 and BOSU Integrated Balance Training, Brooks and Brooks, 2002.