COMPENSATORY STABILIZATION—THE EXTENSION/COMPRESSION STABILIZING STRATEGY—PART 2

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In the previous article, proper stabilization of the spine and trunk was discussed. The anatomy, mechanics and process by which one should stabilize for sports and lifting were covered. Having a sound understanding of the mechanics and anatomy of trunk stabilization is paramount for effective programming, cuing and training. The following is a review of what was covered in Part 1.

REVIEW OF PROPER STABILIZATION:

- Proper stabilization of the spine involves co-activation of the entire abdominal wall (11,17).
- Such activation is produced by coordination of the diaphragm, abdominal wall and pelvic floor, which work together to control intra-abdominal (IAP) for improved spinal rigidity (2,4,5,6,11,17).
- In most daily activities, this coordinated co-contraction is involuntary (5).
- During a focused, conscious stabilizing event, like seen in weightlifting, the diaphragm will act concentrically, which pushes the contents of the abdomen into the abdominal wall and pelvic floor, resulting in eccentric activation (11,17).
- In most instances, one should breathe between repetitions to make sure that blood pressure is not excessive and sufficient oxygen circulation is maintained.

In sports and strength training, effective spinal stabilization is crucial. It not only protects the athlete from potential injury, but due to improved stability of the trunk, it may help with performance as well (1). Stabilizing with proper strategies, therefore, is pivotal for both performance and injury avoidance. Due to the fact that the nature of sports is performing to the best of one's ability, athletes often push themselves to the limit, making it difficult to stabilize properly if not prepared to do so.

DEFINING THE EXTENSION/COMPRESSION STABILIZING STRATEGY

There is a common compensatory stabilizing strategy seen in both the athletic and sedentary populations. This article will refer to this strategy or "postural syndrome" as the extension/compression stabilizing strategy (ECSS). As the name purposefully implies, this pattern utilizes extension and compression of spine (predominantly the lumbar spine) to stabilize the trunk for locomotion, function, and movement (11). With the ECSS hyperactivity of the lumbar erectors and hip flexors is seen, which can pull the spine into hyperlordosis and the pelvis into an anterior tilt. Similar patterns have been previously identified (e.g., Vladimir Janda with the "Lower Crossed Syndrome," Pavel Kolar with "Open Scissors Position," and Ron Hruska with "Posterior Extensor Chain") (7,8,11). The commonality between these postural syndromes is hyperactivity of the spinal erectors and weakness/inhibition of the abdominal wall producing hyperlordosis and the anterior pelvic tilt that comes with it.

While it is tempting to view the body purely as a mechanical machine, it is not entirely accurate; the body is a complex neuro-mechanical machine that utilizes movements that involve both the central nervous system (CNS) and the musculoskeletal system. Many of the discoveries of Janda can help to explain why the ECSS is so prevalent in sports. Janda observed that at birth humans only have a small percentage of muscles activated. Janda classified these active muscles as "tonic muscles" and include, for example, the lumbar erectors, hip flexors, adductors, levator

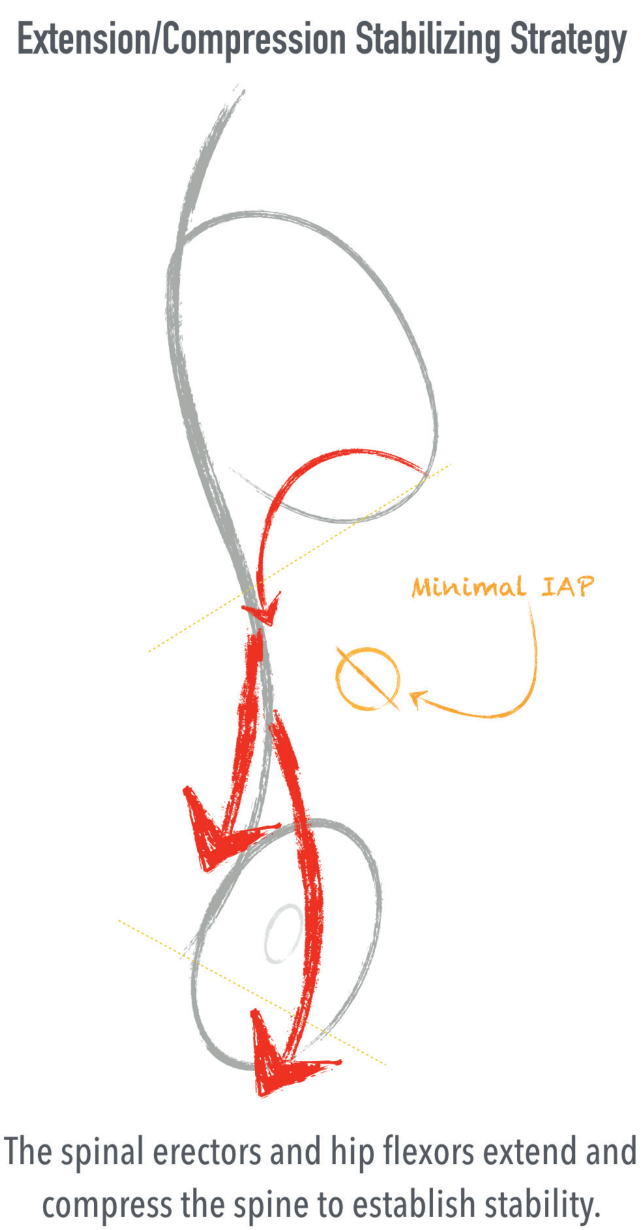

FIGURE 1. ECSS DIAGRAM

scapulae and the pectoral group (8,14). Throughout the first year of life (roughly), the CNS goes through a massive amount of maturation. During this process, muscles previously inactive become activated. These muscles activated in early development make up the "phasic muscle" group and involve such structures as the serratus anterior, abdominal wall, gluteals, and the deep neck flexors. Janda believed that the primary function of tonic muscles was stability whereas the phasic muscles were responsible for movement. Building upon the work by Janda, Kolar realized that the tonic and phasic muscle groups actually work together to both maintain posture and create smooth efficient movement (11).

Maintaining function of the phasic muscles tends to be more difficult than maintaining function of the tonic muscles. This is likely because they are activated later in development. Janda discovered that the tonic muscles tend to become hypertonic while the phasic muscles tend to be inhibited. The posture that results from this pattern is lower crossed syndrome. As mentioned previously, this is a common "postural syndrome" that is described by Dynamic Neuromuscular Stabilization (DNS) and the Postural Restoration Institute (PRI).

NEUROLOGICAL THRESHOLDS & THE ECSS

In my studying the writings of Vladimir Janda and my work with Pavel Kolar, combined with my experience treating and training athletes, I have identified three different thresholds over which an athlete will resort to the ECSS: speed, force and fatigue. Whenever one of these thresholds is exceeded, ideal function and movement is not possible. A coach can ask an athlete to move very quickly to challenge their "speed threshold" (e.g., plyometrics or the second pull of a snatch). A coach can have an athlete generate an incredible amount of force to challenge their "force threshold" (e.g., maximal effort back squat or bench press). Also, a coach can put the athlete in an environment where they have to generate force for an extended period of time to challenge the athlete's "fatigue threshold" (e.g., 100 kettlebell swings with a 16 kg kettlebell). In each of these cases, the nervous system has a threshold over which it cannot maintain activation of the phasic muscles (the ones that activate later in development and tend to become inhibited when "challenged"). Based on this observation, this understanding these different thresholds can potentially enable the coaches to more specifically and efficiently train athletes for their respective sports.

One common example of an athlete exceeding one of these thresholds is when an athlete's knees collapse inward (into a valgus position) coming out of the bottom position in a heavy squat. This is an example of a situation where an athlete has exceeded his "force threshold." In this position (bottom of the squat), under this load (maximal), the athlete is unable to maintain full, balanced muscular activation of the muscles needed to get him out of the bottom of the squat properly. This is caused by his abductors/external rotators (phasic muscles) becoming inhibited due to the fact that they are unable to maintain full activation under these conditions and the adductors (tonic muscles) taking over the load, becoming hypertonic. Without the opposing activation of the abductors/external rotators, the adductors pull the knees inward into adduction.

As often seen in the weight room, once an athlete rises 4-6" above parallel, he is typically able to restore proper knee position. The athlete is able to re-correct the knee position for the simple reason that as he rises out the bottom of the squat his mechanical leverage over the load improves. The better the athlete's

FIGURE 2. VALGUS COLLAPSE

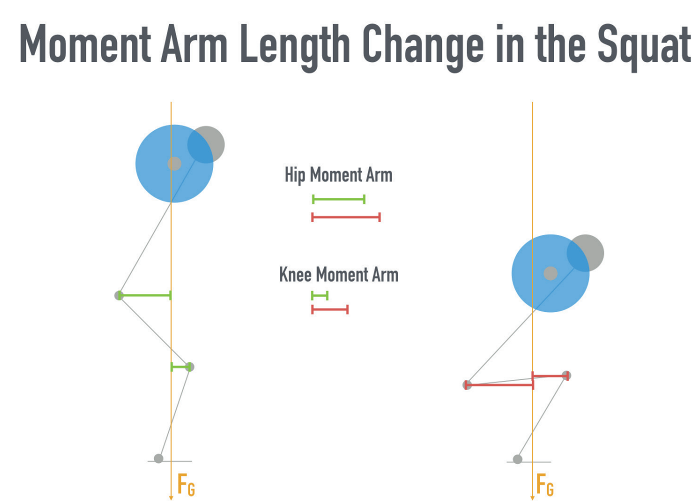

FIGURE 3. MOMENT ARM IN THE SQUAT

mechanical leverage, the less internal muscular effort is necessary to maintain or overcome a joint position (torque = moment arm x force) (3). Once the internal effort required to overcome the position is below "threshold" the athlete is once again able to utilize co-activation of both the tonic and phasic muscles.

What is important to note here is that neither the contractile strength of the glutes or insufficient adenosine triphosphate (ATP) stores is the problem. Instead, it is the inability of the CNS to maintain activation of the glutes (phasic muscles). The force output requirements of this situation exceed the ability of the CNS to maintain balanced co-activation of the tonic and phasic muscle groups (in this case, it exceeds the force threshold of the CNS). It is neurological inhibition, not physical, contractile weakness or a lack of sufficient ATP.

The knees can also collapse inward because of the excessive speed at which a joint is asked to move. The best example of this is a non-contact ACL injury commonly seen in basketball. Typically what happens is the athlete jumps up to get a rebound and upon landing, is unable to control the knee, which results in the knee crashing inward, damaging the ligaments. In this case, the "speed" required to control the knee exceeds threshold and the knee crashes inward. This is because the CNS was unable to coordinate and fire the appropriate muscles to control the knee position. This is an example of an athlete exceeding a "speed threshold."

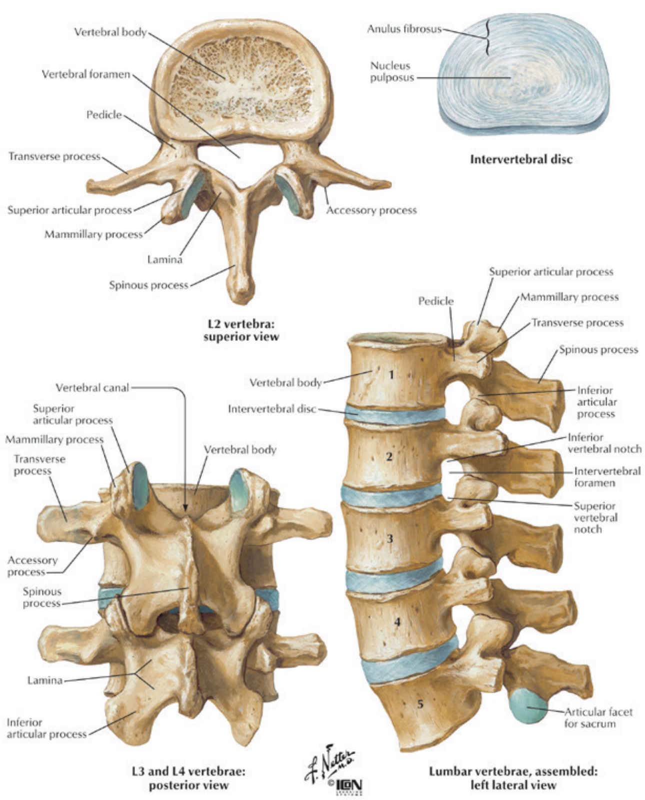

FIGURE 4. LUMBAR SPINE

In the case of the trunk, whether it is speed, force or duration, when a threshold is exceeded, the spinal erectors and hip flexors will become hyperactive and the abdominal wall and hip abductor/external rotators will become inhibited. This results in the focus of this article, the ECSS. When the athlete resorts to the ECSS, the hyperactivity of the lumbar erectors and hip flexors is secondary to inhibition of the abdominals and glutes. This pulls the pelvis into anterior tilt, resulting in hyperextension of the lumbar spine. Due to the lack of trunk muscle co-activation, which acts to maintain more even joint loading, the brain will generate stability of the spine and pelvis by hyper-loading the posterior aspect of the spine (facet joints) (11).

CONSEQUENCES OF THE ECSS

In sports, athletes encounter and exceed these thresholds all the time. This is unavoidable. However, consistently training above threshold without any effort applied to improving an athlete's threshold may result in decreased performance and/or injury. The following is a list of some of the potential consequences of moving and stabilizing with an ECSS.

- **First, the ECSS is a reduction in balanced, co-activation of the trunk muscles, which results in trunk instability.** The lack of co-contraction of the trunk muscles prohibits the athlete's ability to generate stability, which potentially has a detrimental impact on performance as their force-output into the extremities and ability to transfer force through the trunk is compromised (4,5,6,17).

- **Second, when the athlete is no longer using all of the muscles available for stability (including the smaller ones such as the multifidus lumborum), the larger, more superficial muscles such as the erector spinae become overactive to compensate for the lack of stability** (8,11). These muscles typically have longer moment arms acting on the body (enabling them to generate more force) and have a poor ability to regulate the force they are generating and control joint positions (due to the massive motor unit to muscle fiber ratio). This all results in poor joint loading and increased internal forces acting on the body, which potentially accelerates the injury process.

- **Third, overusing a muscle results in a higher risk of injury to that muscle due to increased fatigue.** Because of the lack of co-activation of the muscles participating in stabilization, the muscles actually working to stabilize have to work extra hard, which increases the likelihood of overuse injury to these muscles.

- **Fourth, with the posture distorted, the athlete's joint range of motion (ROM) is affected, which impacts performance.** This is most obvious impact is seen with the hips. When the pelvis is pulled into excessive anterior tilt, the orientation of the hip socket (acetabulum) changes, affecting hip ROM.

Anterior pelvic tilt is typically associated with increased lordosis (extension) of the lumbar spine. What is often overlooked is the fact that anterior pelvic tilt results from closed-chain hip flexion (assuming the athlete is standing). Take an athlete with a pelvis tilted forward (say 40˚) in standing posture; if this athlete wants to execute a squat, before he even starts the motion he has 40˚ less hip flexion due to the position of his pelvis and he has not even started the movement yet. If this athlete only has 110˚ of hip flexion ROM (normal range is 110 – 120˚) and he starts the motion with 40˚ less because of his ECSS, then he is starting the motion with only 70˚ of available hip flexion available (15). About 100 – 110˚ of hip flexion is needed to achieve a full depth squat (defined as anterior superior iliac spine of the pelvis [ASIS] level with the knee) without loss of neutral spine position. So, if an athlete is going to get his hips slightly below parallel, he is going to have to flex his lumbar spine to do so. This is all because he lacks the sufficient hip ROM to squat to the full depth secondary to the starting position of his pelvis, all because he is using an ECSS.

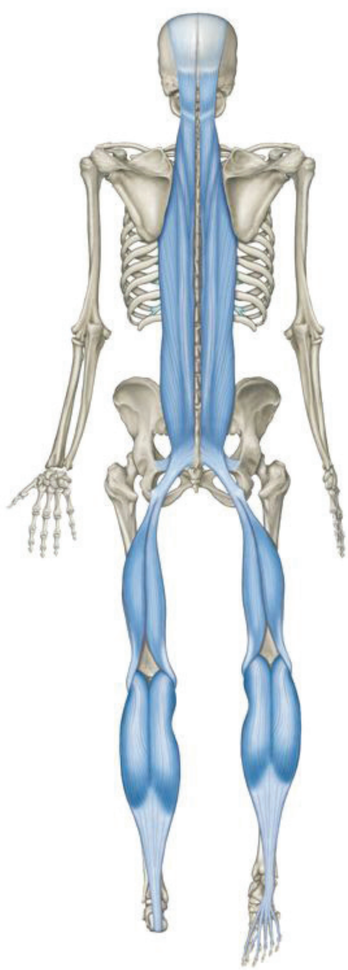

FIGURE 5. POSTERIOR CHAIN

THE ECSS IN TRAINING AND OVEREMPHASIS

Another contributing factor in the prevalence of the ECSS in sports is overemphasis on developing the posterior chain. The term posterior chain is tossed around a lot and has many definitions. However, perhaps the best definition is found in a book by Thomas Myers, "Anatomy Trains," in which he defines the "posterior chain" as a fascial chain that runs from the plantar fascia, up the calves, into the hamstrings, through the sacrotuberous ligament, into the erector spinae and all the way up to the occipital frontalis muscle on the top of the head (Figure 5) (16). Often, overemphasis of the posterior chain is seen in training, which can produce muscular imbalance resulting in the ECSS and functional limitations such as decreased hip flexion due to pelvis position or limited lumbar rotation due to both lumbar position and hyperactivity of the spinal erectors.

One such example of our overemphasizing the posterior is when coaches use wall squats to teach squatting. Even with optimal morphology, it is impossible to squat against a wall without excessive arching of the lower back (Figure 6). In other cases, coaches are using well intended cues that, when over-emphasized, result in the athlete using the ECSS. Cues like "look up," "sit back on your heels," or "chest up" during the ascent of a squat might be appropriate sometimes, but often perpetuate the ECSS because they may result in the athlete arching their lower backs and elevating their rib cages. When an athlete is consistently cued to lift with such a strategy, that pattern may become more and more difficult to change, at some point even becoming pathological resulting in injury or decreased performance.

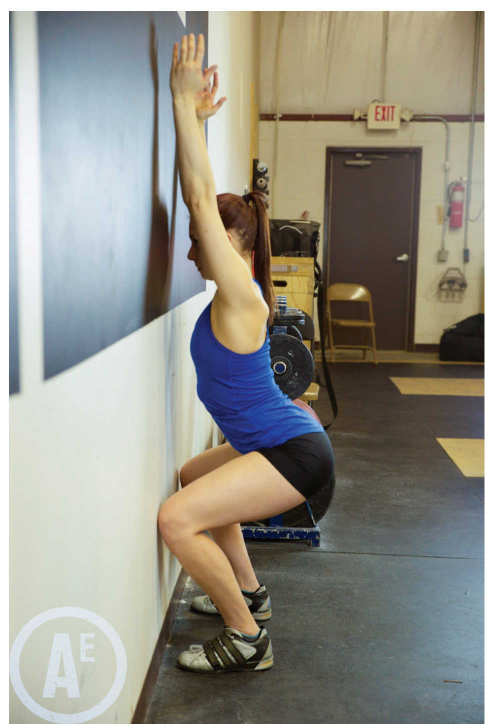

FIGURE 6. WALL SQUAT

Exercise selection is another example of overemphasis on the posterior chain. Many of the commonly utilized exercises for the lower body are predominantly bilateral posterior chain exercises that force the athlete to move in the sagittal plane and block motion in the coronal or transverse planes. Because of the lack of freedom to move in all three planes, athletes often compensate excessively in the sagittal plane resulting in a more pronounced ECSS. Back squat, deadlift, Romanian deadlift (RDL), hyperextensions, good mornings, cleans, hang cleans, snatches, hang snatches and thrusters are just a few examples of exercises commonly used to train the posterior chain.

Another strong example of overemphasis on the posterior chain is the way in which athletes perform lifts. Take for example, the clean. Observe the Figure 7 depicting an athlete in a hang clean position (the position in which the athlete has the least mechanical advantage over the weight). In this Figure, the chest of the athlete is elevated and the pelvis is anteriorly tilted (Figure 7). This is the "Open Scissor" position described previously by Pavel Kolar in which the diaphragm and pelvic floor are oblique to each other. In such a posture, the athlete has no alternative but to stabilize with the ECSS. This athlete may have been told: "keep your chest up," "sit back on your heels," or "find your hamstrings." In any case, the cueing causes the athlete to resort to an ECSS to execute the movement. Instead, the ribs should be held down towards the pelvis (via strong activity of the internal and external obliques), the posterior abdominal wall should expand (demonstrating eccentric activation of the dorsal muscles of the trunk such as the quadratus lumborum and the erector spinae) and the pelvis and spine should be held neutral. An example of this posture can be seen in Figure 8. In this position, the athlete is better able to stabilize the pelvis and spine to generate more force into the floor through the legs, torso, and arms due to increased IAP (4,17).

While it seems evident that the posterior chain is often overemphasized, this does not mean that it is unimportant in sports or that these exercises should be avoided in at all costs in training or even that they always perpetuate the ECSS. Proper cueing mixed with some other ECSS-breaking exercises can help to teach the athlete to stabilize properly.

FIGURE 7. CLEAN ECSS - BAD POSITION

FIGURE 8. CLEAN ECSS - GOOD POSITION

CONCLUSION

Another significant contributing factor, driving athletes into the ECSS is the fact that specific, focused exercise to strengthen the ideal stabilization strategy must be utilized if an athlete is going to be able to maintain proper stabilization at higher and higher thresholds. Lifting more weight, more often, will not accomplish this goal; it will not increase an athlete's thresholds as discussed above. What is necessary to improve these thresholds is proper threshold training (which involves training an athlete right at the threshold in which they will collapse into the compensatory pattern of the ECSS) and auxiliary exercises specifically tailored to train proper stabilization. Coaches that temper their posterior chain exercises with some threshold training and specific trunk exercises designed to break the ECSS to restore proper stabilizing strategies may find their athletes will move better, get injured less, and actually perform better. Training is not just about lifting heavy weight. Proper strength and conditioning training involves identifying specific weaknesses in an athlete based on the needs of the sport and addressing them with specific, targeting exercises and programs. This will be the topic of Part 3.

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