GETTING TO THE CORE OF LOW-BACK PAIN IN GYMNASTICS: TRAINING COUNTERMEASURES

INTRODUCTION

In gymnastics, skill complexity progresses rapidly. With this progression comes increased external loads placed on the gymnast's body, thus heightening the risk of injury. Perhaps the most debilitating injuries are those occurring at the most highly loaded region of the trunk, the low back. Studies among elite gymnasts have reported a 79% rate of low back pain (LBP) (1); 50% of rhythmic gymnasts have experienced LBP (2). A study by Pajek and Pajek (3) reported an increased risk of low back injury for gymnasts who practiced 15 or more hours per week. It is impractical to reduce practice time, so it is important to identify means to lessen the occurrence and reoccurrence of LB injuries. No gymnast's body is the same, so it is difficult to pinpoint a “fail safe” means to prevent injuries to the low back. However, integrating simple training countermeasures may help not only reduce the risk of LBP, but also assist gymnasts who may be recovering from such an injury. This article provides some insight into the where, what and how of LBP as it relates biomechanically to muscles of the core and provides coaches some countermeasures that may help reduce the risk of LBP and injury from a general fitness perspective.

BIOMECHANICS AND CORE

WHERE IS LBP?

LBP occurs in the lumbar region of the spine and includes five vertebrae (L1-L5) and pelvis, also termed the lumbosacral region (4). The low back is the most mobile of spinal regions, accounting for approximately 75% of the back’s flexion and extension (4). Refer to Kruse and Mehta’s 2011 article for an in-depth description of the structure of the lumbar vertebrae (5).

WHAT EXACTLY IS “THE CORE”?

The functionality of the lumbosacral spine is maintained by muscles of the lumbo-pelvic hip complex (LPHC) commonly referred to as “the core.” These muscles include functionality across three spectrums: local, global and movement (6). The local muscles include the transverse abdominus, internal oblique, multifidus, diaphragm, and pelvic floor muscles, which attach directly to the vertebrae. Their job is to increase intra-abdominal pressure, which increases spinal stiffness, limiting extreme compressive, shear, and rotational forces (6) (the twisting, jumping, and landings). The muscles of the global system attach from the pelvis to the spine and include the quadratus lumborum, psoas major, external oblique, portions of the internal oblique, the rectus abdominus, gluteus medius, and the adductor complex (6). Their main job is to stabilize forces between the pelvis and spine and transfer the load between upper and lower extremities of the body; they provide stability during front and back walkovers, back handsprings, etc. The movement spectrum is a much larger group of muscles responsible for force production, which is increased by at least 15%-70%
during dynamic movements [5, 6]. They include: deep longitudinal subsystem (erector spinae, thoracolumbar fascia); posterior oblique subsystem (gluteus maximus, lattisimus dorsi); anterior oblique subsystem (internal and external oblique, hip external rotators); lateral subsystems (gluteus medius, adductor complex, quadratus lumborum) [6]. The erector spinae are the largest, most important muscles in trunk extension and hyperextension. Ligaments and fascia (connective tissue) are also an important part of stability for the LPHC. Two important stabilizers are the iliolumbar ligament and thoracolumbar fascia, both aiding in flexion and extension processes of the spine [5].

HOW DOES THE CORE WORK?

Two purposes of the core are to provide trunk stabilization and create intra-abdominal pressure to reduce compressive forces when executing any gymnastics skill. The transverse abdominus wraps around the trunk like a belt, and works with the internal oblique to create intra-abdominal pressure. The multifidus and erector spinae create LPHC stabilization as the gymnast moves through multidirectional flexion and extension (forward, backward, lateral).

WHAT ARE CONTRIBUTORS TO LBP?

As Kruse and Mehta mention, there are different reasons for LBP in a gymnast [5]. It may be a minor or major postural deviation. Ideally, the spine should follow curvature that is balanced from the cervical region through the pelvis, without excessive exaggeration. However, if a gymnast has severe lordosis (frontal pelvic tilt manifested via an overarched low back) or lateral deviation (scoliosis) then he/she may be susceptible to LBP and injury [4, 5, 9]. Additionally, there are specific conditions of the low back that contribute to LBP to include spondylosis and spondylolisthesis. One study reported out of 3,000 gymnasts, 17% had LBP associated with these two conditions [1, 7]. The most common form of LBP is attributed to general, nonspecific muscle and ligament sprains and strains [1, 8, 10]. Excessive lordosis, leaning forward, or low back rounding causes muscles of the low back and core to work intensely during force production and reduction, compromising their functionality. In this situation, the spinal integrity is diminished and most vulnerable to injury.

HOW DOES LBP DEVELOP?

The three most common ways LBP and injury surfaces:

- Acute injury/trauma (compression and rotation of the joints/vertebrae).
- Chronic overuse/repetitive stress on the LB through:
  - Excessive hyperextension accentuated when performed on one leg such as during a back walkover [1, 5].
  - Landings and dismounts which increase the ground reaction and vertical reaction forces (GRF and VRF). Overall, these forces are reported to contribute to 70% of competition injuries [11], with 52% contributing to LBP during landings, and 36% contributing to LBP injury during dismounting [10, 12]. When a gymnast lands, the ground “pushes back” a force that may be up to 13 times her body weight [10, 13]. (That’s 1,300 pounds on a 100 pound gymnast!)
- Muscle imbalance. When the trunk flexors are under-active and extensors over-active, or vice versa [2, 6]. This occurs if opposing muscle groups are not strengthened equally (i.e. repetitive abdominal strengthening exercises with exclusion of low back exercises). It has been reported that those with LBP show decreased activation of transverse abdominus and multifidus muscles [6, 14, 15, 20].

COUNTERMEASURES TO REDUCE THE RISK

A proper warm-up, including all styles (self-myofascial release [foam roller], dynamic movements [push-ups, lunges, burpees, trunk rotations], movements through range of motion [ROM], cardiovascular, and active stretching) is a great way to try to reduce risk of LBP and injury. Limit static stretching during the warm-up to overactive or tight muscles, rather use static stretches at the end of practice when general muscle lengthening should be the focus [6]. Another countermeasure is consistently varying practice sessions; the monotony of “bars and vault Monday” and “floor and beam Wednesday” is not as conducive to overall physical development as compared to variation. Not only will varying practice sessions have psychological benefits, such as building a gymnast’s adaptation and excitement, but also biomechanically allows for a break in repetitive stress on any single body part [16].

Finally, incorporate cross training into the routine! Other sports disciplines utilize gymnastics for cross training concepts, and gymnasts can benefit from the same cross training concept. Here are some ideas:

1. Pilates. Focused on core stabilization, studies utilizing Pilates as a means of rehabilitation report to have reduced LBP, increased health and sports functioning, and flexibility [3]. This may have application in prevention, as well.
2. Focus on integrating exercises that are isometric and involve co-contraction of the trunk flexors and extensors (transverse abdominus, multifidus and erector spinae) into the warm-up. The most recognizable, effective positions are “hollow-hold” positions, also called the “drawing in” technique. These can be executed in the prone with or without arm and leg elevation, four-point kneeling, and supine. Inclusion of these exercises led to decreased LBP in gymnasts participating in one study [17].
3. Train in unstable environments. Take those jumps (tuck, full, pike, etc.), V-ups and tuck-ups, and transfer them to the Bosu and DynaDisc. Front and back scales? Use a foam
roller for balance! Have your gymnast try a reverse burpee* on a Bosu; this promotes co-contraction of the flexors and extensors. Don’t forget the Wobble Board; testing stability with eyes closed on it works great for the core. Don’t just do plank holds on the floor, use the stability ball for plank rollouts, pikes or knee tucks. These exercises create an unstable external environment requiring heightened neuromuscular activation to elicit maximal proprioceptive responses of the core muscles. Core exercises performed on an unstable surface have been proven to increase engagement of local and global systems when compared to regular core exercises [6, 18, 19].

**CONCLUSION**
The muscles of the core play a major role in the integrity of the spine and the balance of the body. This article articulated some general fitness countermeasures which, when integrated into practice may biomechanically help reduce LBP and injury in a gymnast. Because the nature of gymnastics is so demanding when it comes to rotational, shear, VRF and GRF placed on the spine, it is undoubtedly necessary to focus efforts on strengthening the core as best possible to prepare the body for the external stresses consistently placed upon it.

### REFERENCES


