Tensional Integrity of the Cervical Spine

Tensegrity Model
PAIN & Structural Reorganization
Rehabilitation Strategies
Support & Stabilization
Why has healthcare adopted fitness trends as rehab?

- Isolation
- Single plane
- Static Platform
The Spine is Dynamic NOT Static

The curves of the spine provide resiliency and a dynamic response to gravity.

- **Movement**
- **Power**
- **Support**

ALL manifest directly from the spine!
Meeting the Challenge

• Structure is the key to understanding Function.
• Structure supports weight by reacting to gravity.
• When muscle supports weight rather than structure the result is increase in muscular fatigue.
• This disrupts the balance and the skeletal muscles ability to move bones, thus compromising the bodies ability to meet the demands of its environment
Tensegrity

• Tensegrity: "A tensegrity system is a system in a stable self-equilibrated state comprising a discontinuous set of compressed components inside a continuum of tensioned components."

• Training isolated muscle groups will never create "self-equilibrium", it will destroy it!
Four Primary Layers of Fascia

• Pannicular Fascia: Derived from Somatic Mesenchyme, Surrounds the Entire Body Except Orifices, Muscles of the face are imbedded into it.

• Axial Fascia: Surrounds the Hypaxial and Epaxial Muscles. Forms the primitive Matrix that skeletal muscles, tendons, ligaments, aponeuroses, and joints develop. Also, Epimysium of Skeletal Muscle, Periostium of Bone, the peritendon of tendons, and the investing layer surrounding the joint capsules.
Four Primary Layers of Fascia

• Meningeal Fascia: Includes the Dura as well as the leptomeninges.

• Visceral Fascia: Most complex of the four layers. Surrounds the body cavities- Pleural, pericardial, and peritoneal.
Physical medicine and rehabilitation, also referred to as physiatry or rehabilitation medicine, is a branch of medicine concerned with evaluation and treatment of, and coordination of care for, persons with musculoskeletal injuries, pain syndromes, and/or other physical or cognitive impairments or disabilities. The primary focus is on maximal restoration of physical and psychological function, and on alleviation of pain.

(U.S. National Library of Medicine)
Diagnostic Testing & Data Collection for Physical Rehabilitation

- Pain Scale (1-10)
- Range of Motion (ROM)
- Muscle Strength (1-5)
- Joint Tests
- Muscle Testing* (See Post Activation Potentiation)
Goals of Physical Rehabilitation

- Decrease Pain
- Improve Range of Motion (ROM)
- Improve Muscle Strength (1-5)
- Improve Joint Tests
- Muscle Testing*
PAIN

• Nociceptive Pain

• Neuropathic Pain

( A neuropathic pain component is common in acute whiplash and associated with a more complex clinical presentation. Sterling M, Pedler A.)

• Pain Matrix Dysfunction

( Chronic Whiplash Associated Disorder )
Nociceptive Pain vs Neuropathic Pain

- Caused by Damage to body tissues
- Sharp
- Aching
- Throbbing
- Benign Pathology
- Sports Injury
- Arthritis (Although Chronic it is still from a noxious stimuli)
- WARNING!!!!

- Paresthesia: Painless abnormal sensation in the absence of nociceptor stimulation.
- Dysesthesia: Unpleasant and abnormal, whether evoked or spontaneous. (Shooting, Burning, Electric) “funny bone”
- Allodynia: Pain from stimulus that would not normally be painful.
- Secondary Hyperalgesia: Excessive Sensitivity to stimuli.
Normal

Nociceptor Input → Brief pain, proportionate to input

Touch Receptor Input → Touch
## Types of Neuropathic Chronic Pain

<table>
<thead>
<tr>
<th>Ectopic Foci</th>
<th>Ephaptic Trans</th>
<th>Central Sensitization / Structural Reorganization</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Damage to Myelin</td>
<td>• AKA: Cross Talk</td>
<td>• Excessive responsiveness by central neurons</td>
</tr>
<tr>
<td>• Alters gene activity in cell</td>
<td>• Occurs in Demyelinated regions due to lack of insulation between neurons.</td>
<td>• Reduced inhibition</td>
</tr>
<tr>
<td>• Stimulates mechanosensitive and Chemosensitive ion channels</td>
<td>• Action Potential in one neuron may induce an action potential in another.</td>
<td>• Central Neural Activity outlasts tissue injury</td>
</tr>
<tr>
<td>• Takes on new pathologic role</td>
<td></td>
<td>• Affects Neurons throughout the nociceptive pathways: Dorsal Horn, Brainstem, Thalamus, and Cerebral Cortex</td>
</tr>
<tr>
<td>• Generates Action Potentials as well as Conducting Action Potentials</td>
<td></td>
<td>• Prolonged Central Sensitization alters Structure and function of the CNS</td>
</tr>
</tbody>
</table>
Normal Response to Injury

Increased Pain

Nociceptor Input

Touch Receptor Input

Central Sensitization
Neuropathic Chronic Pain

Nociceptor Input

Touch Receptor Input

Central Sensitization Despite Lack of Input

Persistent Pain
Nociceptive Chronic Pain

Inflammatory Chemicals → To Brain
Neuropathic Chronic Pain

No Stimulus → Ectopic Foci → To Brain
Neuropathic Chronic Pain

No Stimulus

Touch

Ephaptic Transmission

To Brain
Neuropathic Chronic Pain

Mild Stimulus → Increased Excitatory Transmitters and Excitatory Receptors → To Brain
Prolonged central sensitization leads to rewriting of connections in the CNS. In the Dorsal Horn, Structural changes include withdrawal of C-Fiber axons terminals from the dorsal horn and growth of Ab-fiber axons into regions of the spinal cord that normally receive only C-fiber endings, with formation of Novel synapses between Ab fibers and central nociceptive neurons.
Pain Matrix Dysfunction

No Stimulus → No antinociceptive Signals → Pronociceptive Signals → To Brain
DN4 - QUESTIONNAIRE

To estimate the probability of neuropathic pain, please answer yes or no for each item of the following four questions.

INTERVIEW OF THE PATIENT

QUESTION 1:
Does the pain have one or more of the following characteristics?  YES  NO
Burning .................................................................
Dull ...........................................................................
Painful cold ..............................................................
Electric shocks .........................................................

QUESTION 2:
Is the pain associated with one or more of the following symptoms in the same area?  YES  NO
Tingling ......................................................................
Pins and needles ......................................................
Numbness ..................................................................
Itching ......................................................................

EXAMINATION OF THE PATIENT

QUESTION 3:
Is the pain located in an area where the physical examination may reveal one or more of the following characteristics?  YES  NO
Hypoesthesia to touch ..............................................
Hypoesthesia to pinprick .........................................

QUESTION 4:
In the painful area, can the pain be caused or increased by:  YES  NO
Brushing? ..................................................................

YES = 1 point
NO = 0 points

Patient’s Score:  / 10

Sensitivity 83%
Specificity 90%
The 5-LANSS Pain Score

1. In the area where you have pain, do you also have “pins and needles”, tingling or prickling sensations?
   - NO - I don’t get these sensations: 0
   - YES - I get these sensations: 5

2. Does the painful area change colour (perhaps look mottled or more red) when the pain is particularly bad?
   - NO - The pain does not affect the colour of my skin: 0
   - YES - I have noticed that the pain does make my skin look different from normal: 5

3. Does your pain make the affected skin abnormally sensitive to touch? Getting unpleasant sensations or pain when lightly stroking the skin might describe this.
   - NO - The pain does not make my skin abnormally sensitive to touch: 0
   - YES - My skin in that area is particularly sensitive to touch: 3

4. Does your pain come on suddenly and in bursts for no apparent reason when you are completely still? Words like “electric shocks”; “jumping and bursting” might describe this.
   - NO - My pain doesn’t really feel like this: 0
   - YES - I get these sensations often: 2

5. In the area where you have pain, does your skin feel unusually hot like a burning pain?
   - NO - I don’t have burning pain: 0
   - YES - I get burning pain often: 1

6. Gently rub the painful area with your index finger and then rub a non-painful area (for example, an area of skin further away or on the opposite side from the painful area). How does this rubbing feel in the painful area?
   - The painful area feels no different from the non-painful area: 0
   - I feel discomfort, like pins and needles, tingling or burning in the painful area that is different from the non-painful area: 5

7. Gently press on the painful area with your finger tip and then gently press in the same way onto a non-painful area (the same non-painful area that you chose in the last question). How does this feel in the painful area?
   - The painful area does not feel different from the non-painful area: 0
   - I feel numbness or tenderness in the painful area that is different from the non-painful area: 3

Total score:

Scoring a score of 12 or more suggests pain of predominantly neuropathic origin

“Functional rehabilitation is an extension of the traditional elements of physical therapy, the purpose of which is to return the athlete to highly complex movement patterns such as athletics. As well as the traditional elements of physical therapy such as strength and flexibility, the functional rehabilitation program incorporates agility and proprioceptive/kinesthetic training, which enables the athlete to participate at preinjury levels of activity while reducing the risk of recurrent injury.”

Data Collection for Functional Rehabilitation & Movement

- Functional Movement Screen (FMS)
- Movement Dynamics
- The Performance Matrix
- X-ray Analysis (WHAT!!! We will come back to this)
When is it appropriate to analyze movement?

- 1.) Physical Exam
- 2.) Movement Assessment (Must be pain free)
- 3.) Performance (Strength, endurance, etc)
- 4.) Skill (Throwing, Running, swing, etc)

If the client/patient is not pain free upon movement assessment, they will not move well. If they do not move properly, performance will suffer. This deficit in performance CAN NOT be overcome with more performance training.
An endurance-strength training regime is effective in reducing myoelectric manifestations of cervical flexor muscle fatigue in females with chronic neck pain.


CONCLUSIONS:

An endurance-strength exercise regime for the cervical flexor muscles is effective in reducing myoelectric manifestations of superficial cervical flexor muscle fatigue as well as increasing cervical flexion strength in a group of patients with chronic non-severe neck pain.

SIGNIFICANCE:
Provision of load to challenge the neck flexor muscles is required to reduce the fatigability of the SCM and AS muscles in people with neck pain. Improvements in cervical muscle strength and reduced fatigability may be responsible for the reported efficacy with this type of exercise program.
Active neck muscle training in the treatment of chronic neck pain in women: a randomized controlled trial.

JAMA. 2003 May 21;289(19):2509-16

Both strength and endurance training for 12 months were effective methods for decreasing pain and disability in women with chronic, nonspecific neck pain. Stretching and fitness training are commonly advised for patients with chronic neck pain, but stretching and aerobic exercising alone proved to be a much less effective form of training than strength training.
Training the cervical muscles with prescribed motor tasks does not change muscle activation during a functional activity.

Falla D, Jull G, Hodges P.

The results demonstrate that training the cervical muscles with a prescribed motor task may not automatically result in improved muscle activation during a functional activity, despite a reduction in neck pain.
Structural vs Functional
“Considering the relationship between spinal function and structure, it is probable that functional rehab and structural rehab are attempts to treat the same patient dysfunction; albeit with different approaches.”

Electromyographic analysis of neck muscle fatigue in patients with osteoarthritis of the cervical spine.


The results showed that at moderate and high forces (i.e., 50%, 80%, and 100% MVC) the anterior neck muscles in patients with osteoarthritis of the cervical spine fatigued faster than those of normal subjects. The posterior neck muscles in patients fatigued faster compared to normal subjects at high force levels (i.e., 80% and 100% MVC). This indicates a higher fatigue of the anterior and posterior neck muscles associated with arthritic changes of the cervical spine.

*MVC= Maximum Voluntary Contraction
Deep Cervical Flexors
Three Types of Muscle Contractions

**Isometric contraction:** muscle contraction without appreciable shortening or change in distance between its origin and insertion.

**Concentric contraction:** Contraction resulting in shortening of a muscle, used to perform positive work or to accelerate a body part.

**Eccentric contraction:** Contraction in the presence of a resistive force that results in elongation of a muscle, used to perform negative work or to decelerate a body part.
Upper Crossed Syndrome

- Chronic Shortened Position Causes Loss of Sarcomeres (Shortening of Muscle) Coutinho EL: Journal of Medical Biology Research 2004

- Chronic Lengthened Position Causes Sarcomerogenesis (Lengthening of Muscle) Caiozzo VJ: Clinical Orthopedic Research 2002
Hands on Exercise
Tool What’s Short & Tape What’s Long

Nitto
Feedforward activity of the cervical flexor muscles during voluntary arm movements is delayed in chronic neck pain.


Abstract
The objective of this study was to compare onset of deep and superficial cervical flexor muscle activity during rapid, unilateral arm movements between ten patients with chronic neck pain and 12 control subjects. Deep cervical flexor (DCF) electromyographic activity (EMG) was recorded with custom electrodes inserted via the nose and fixed by suction to the posterior mucosa of the oropharynx. Surface electrodes were placed over the sternocleidomastoid (SCM) and anterior scalene (AS) muscles. While standing, subjects flexed and extended the right arm in response to a visual stimulus. For the control group, activation of DCF, SCM and AS muscles occurred less than 50 ms after the onset of deltoid activity, which is consistent with feedforward control of the neck during arm flexion and extension. When subjects with a history of neck pain flexed the arm, the onsets of DCF and contralateral SCM and AS muscles were significantly delayed (p<0.05). It is concluded that the delay in neck muscle activity associated with movement of the arm in patients with neck pain indicates a significant deficit in the automatic feedforward control of the cervical spine. As the deep cervical muscles are fundamentally important for support of the cervical lordosis and the cervical joints, change in the feedforward response may leave the cervical spine vulnerable to reactive forces from arm movement.
Flexion Relaxation Phenomenon (FRP)

• The flexion-relaxation phenomenon (FRP) is defined by reduced lumbar erector spinae (ES) muscle myoelectric activity during full trunk flexion.

• It is believed to reflect the load-sharing interaction of the active and passive components of lumbopelvic stability. During progressive trunk flexion, tension in the posterior ligaments and zygapophysial joints increases to a level where the active extension moment generated by the posterior muscles of the spine is no longer needed.
The biomechanical and clinical significance of the lumbar erector spinae flexion-relaxation phenomenon: a review of literature.


CONCLUSIONS:
The myoelectric silencing of the erector spinae muscles in the trunk flexion posture is indicative of increased load sharing on passive structures, which tissues have been found to fail under excessive loading conditions and shown to be a source of low back pain. The studies that show differences in the presence of the FRP among patients and control subjects are encouraging for this type of clinical assessment and suggest that assessment of the FRP is a valuable objective clinical tool to aid in the diagnosis and treatment of patients with low back pain.
FRP During Sitting

- Slumped sitting posture yields flexion relaxation of the thoracic erector spinae muscles.
- Lumbar erector spinae muscle group remain relatively constant activation levels regardless of seated posture.
- Thoracic erector spinae silence occurred at a smaller angle of lumbar flexion during sitting than the flexion relaxation angle observed during standing flexion relaxation.

T1/2 6.2° (-1.0°) 720.0%
T2/3 -3.1° (4.0°) 177.5%
T3/4 3.8° (5.0°) 24.0%
T4/5 -8.9° (6.0°) 248.3%
T5/6 5.2° (5.0°) 4.0%
T6/7 -5° (6.0°) 108.3%
T7/8 -1.9° (6.0°) 131.7%
T8/9 -4.8° (4.0°) 220.0%
T9/10 3.7° (3.0°) 23.3%
T10/11 10.8° (3.0°) 260.0%
T11/12 21.3° (3.0°) 610.0%
T12/L1 14.0° (-1.0°) 1500.0%
L1/2 1.7° (-5.0°) 134.0%
L2/3 -15.0° (-6.0°) 150.0%
L3/4 -15.2° (-9.0°) 68.9%
L4/5 -12.7° (-19.0°) 33.2%
L5/S1 -60.9° (-33.0°) 54.2%
SB: 32.6° (40.0°) 18.5%
PI: 31.3° (56.0°) 44.1%
PTPIA: 67.4° (67.0°) 6%
Altered Flexion Relaxation Phenomenon from Slumped Sitting (FRP)

- Thoracolumbar “Hinging”
- Lumbar ES are Active
- Thoracic ES or Inactive
- Obvious Answer: Strengthen/Activate Thoracic ES
- What’s the Not So Obvious Answer?
Latissimus Dorsi

- Innervation: 6th, 7th, and 8th cervical nerves via the Thoracodorsal (long scapular) nerve.
- Origin: Spinous Processes of T7-L5 (Part of the Thoracolumbar Fascia), 9th-12th Ribs.
- Insertion: Intertubercular Groove of the Humerus.
- Actions: Extension, Adduction, Transverse Extension or “Horizontal Abduction”, Flexion from an extended position, and (medial) Internal Rotation of the Humerus.
Latissimus Dorsi

• Functionally Coupled with the Contralateral Gluteus Maximus
• Synergist in Lumbar Lateral Bending
• Enhances Trunk Extension Under High Demands
• Prevents Thoracolumbar Hinging
• Acts as a Physiological “Back Belt”
Different parts of erector spinae muscle fatigability in subjects with and without low back pain.


BACKGROUND CONTEXT:
There is conflicting evidence regarding erector spinae muscle fatigability because previous studies have not considered the thoracic and lumbar components separately. These muscles have very different mechanical responses and, therefore, would be recruited differentially for the chosen task.

PURPOSE:
The present study was conducted to compare whether fatigability differences exist in the thoracic and lumbar parts of the erector spinae muscles in subjects with and without low back pain (LBP).

STUDY DESIGN:
This cross-sectional study was conducted in the Motion Analysis Lab at Cleveland State University.

PATIENT SAMPLE:
The study sample included 40 subjects with LBP and 40 subjects without LBP.

OUTCOME MEASURES:
The fatigability of the erector spinae muscles was compared based on median frequency of electromyography (EMG) versus time. The level of pain of each subject was also compared using the Oswestry Disability Index.

METHODS:
Fatigue measurements were evaluated between groups based on the assessed sides as well as the thoracic and lumbar parts of the erector spinae muscles using surface EMG. A modified version of the isometric fatigue test as introduced by Sorensen was used to test the endurance of the erector spinae muscles.

RESULTS:
There were significant median EMG frequency (F((1, 78))=28.82, p=.001) differences in the thoracic and lumbar parts of the erector spinae muscles between subjects with and without LBP. The thoracic part had a significantly lower median EMG frequency than the lumbar part in subjects with LBP. The thoracic and lumbar parts of the erector spinae muscles had interactions with group (F((1, 78))=47.88, p=.01] and age (F((1, 78))=16.51, p=.01).

CONCLUSIONS:
The results of this study suggested that subjects with LBP demonstrated higher fatigability of the erector spinae muscles at the thoracic part than at the lumbar part. The increased fatigability of the thoracic part needs to be emphasized in rehabilitation strategies for subjects with LBP. In addition, as age increased, the median frequency of the lumbar part of the erector spinae muscles significantly decreased. Understanding the anatomical and biomechanical characteristics of the erector spinae muscle may enhance clinical outcomes and rehabilitation strategies for subjects with LBP.
Back and hip extensor activities during trunk flexion/extension: effects of low back pain and rehabilitation.


OBJECTIVE:
To compare lumbar paraspinal, gluteus maximus, and biceps femoris muscle function during sagittal trunk flexion and extension in patients with chronic low back pain and healthy control subjects, and to assess the influence of rehabilitation in the back pain patients.

DESIGN:
A cross-sectional study comparing chronic low back pain patients and healthy controls, and a prospective follow-up in back pain patients during rehabilitation.

SUBJECTS:
Nineteen women with chronic low back pain, and 19 women without pain (controls).

INTERVENTION:
Five-week active outpatient rehabilitation (1 hour three times a week) guided by a physiotherapist, followed by 5-week self-motivated exercise at home.

OUTCOME MEASURES:
Subjects performed sagittal trunk flexion and extension while surface electromyogram was bilaterally recorded of paraspinal (L1-L2 level), gluteus maximus, and biceps femoris muscles. The muscle activity was assessed from the average electromyogram and the relative muscle activation onsets and their duration were calculated.

RESULTS:
During early flexion, lumbar paraspinal and biceps femoris were activated simultaneously before gluteus maximus. At the end of flexion and during extension all investigated muscles were activated and relaxed in order. Lumbar paraspinal and biceps femoris muscles were activated in a similar order in low back pain patients and healthy controls during flexion and extension. However, the duration of gluteus maximus activity was shorter in the back pain patients than in controls during the trunk flexion (p<.05), and it ended earlier during extension. Active rehabilitation did not change the muscle activities of lumbar paraspinal and biceps femoris in the back pain patients, but in the measurements after rehabilitation the onset of gluteus maximus activity occurred later in flexion and earlier in extension.

CONCLUSIONS:
The activity of the gluteus maximus muscle during the flexion-extension cycle was reduced in patients with chronic low back pain. The gluteal muscles should be taken into consideration in the rehabilitation of these patients.
Back muscle fatigability is associated with knee extensor inhibition in subjects with low back pain

Suter E, Lindsay D.

CONCLUSIONS:
In golfers with chronic low back pain reduced back endurance was associated with significant inhibition of the knee extensors, indicating that this muscle group cannot be activated to a full extent. These findings suggest a possible association between back extensor fatigability and knee extensor dysfunction in male golfers with chronic low back pain.
Back and hip extensor activities during trunk flexion/extension: effects of low back pain and rehabilitation.


CONCLUSIONS:

The activity of the gluteus maximus muscle during the flexion-extension cycle was reduced in patients with chronic low back pain. The gluteal muscles should be taken into consideration in the rehabilitation of these patients.
Back and hip extensor fatigability in chronic low back pain patients and controls.


CONCLUSIONS:
The chronic low back pain patients were weaker and fatigued faster than the healthy controls. The EMG fatigue analysis results suggest that the gluteus maximus muscles are more fatigable in chronic low back pain patients than in healthy control subjects during a sustained back extension endurance test.
Inervation: Inferior Gluteal Nerve arises from posterior branches of L5, S1, and S2. It also passes from the pelvis below the piriformis.

During a posterior approach to the hip during hip replacement, injury to this nerve can occur. This can lead to Gluteus Maximus "Lurch". Not to be confused with Trendelenburg Gait.
Thoracolumbar Fascia

Anterior layer – Attaching to the anterior aspect of the lumbar transverse processes and the anterior surface of the **Quadratus Lumborum**.

Middle layer – Attaching to the medial tip of the transverse processes and giving rise to the **Transverse Abdominus**

Posterior layer – Covering all of the muscles from the lumbosacral region through the thoracic region as far up as the splenii attachments. This layer also attaches to both the erector spinae and **Gluteus Maximus** aponeurosis. It is this layer that the gluteus maximus and contralateral **Latissimus Dorsi** attach with each other and coordinate together to allow for pendulum like movements between the upper and lower extremity that make walking and running possible.
Reduced thoracolumbar fascia shear strain in human chronic low back pain

Helene M Langevin,1,2 James R Fox,1 Cathryn Koptluch,1 Gary J Badger,3 Ann C Greenan-Naumann,4 Nicole A Bouffard,1 Elisa E Konofagou,5 Wei-Ning Lee,5 John J Triano,6 and Sharon M Henry7

Abstract

Background

The role played by the thoracolumbar fascia in chronic low back pain (LBP) is poorly understood. The thoracolumbar fascia is composed of dense connective tissue layers separated by layers of loose connective tissue that normally allow the dense layers to glide past one another during trunk motion. The goal of this study was to quantify shear plane motion within the thoracolumbar fascia using ultrasound elasticity imaging in human subjects with and without chronic low back pain (LBP).
Transverse Abdominis
(TA or TVA)

Origin & Insertion

• Lower 6 ribs,
  Thoracolumbar Fascia,
  Anterior 3/4 of the Iliac Crest,
  Lateral 1/3 of Inguinal Ligament
• Linea Alba, Pubic Crest and Pecten of the Pubis
Transverse Abdominis (TA or TVA)

Palpation & Proper Activation

• Contact Anterior 3/4 of the Iliac Crest
• Instruct the Patient to “Shrink Their Waist Symmetrically”
• TVA Should Have a Firm “Membrane” Like Feel
• Outward Expansion is the Oblique's Activating, NOT the TVA.

Can be done Supine or Quadruped
Transverse Abdominis
(TA or TVA)

Palpation & Proper Activation

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Can be done Supine or Quadruped
Transverse Abdominis
(TA or TVA)

**Abdominal Hollowing**
- Activates TVA & Multifidi
- Useful in Acute Phase
- **Inhibitory Effects on ES**
- Prevents Anterior Pelvic Tilt During Hip Extension
- Creates Significantly Less Trunk Stability Than Bracing

**Abdominal Bracing**
- Draw Waist In
- Activates TVA, Multifidi, as Well as Internal & External Oblique's
- **Increases Spinal Compression**
- Better Resistance to Lumbar Displacement Than Abdominal Hollowing

Neither of These Conscious Efforts Contribute to Functional Stability. You Must Have Balance Between Mobility and Stability to Meet the Demands of Your Multiplaner, Multivector, Dynamic Environment.
Transverse Abdominis
(TA or TVA)

Inhale using diaphragm
Exhale firmly using TVA
Transverse Abdominis (TA or TVA)

Adding Perturbation to TVA Exercises Increases Activation and Recruitment. Specifically The Multifidi
“It is likely that exercise programs are of insufficient duration and frequency to induce adaptive changes in muscle-tendon length.”