The Importance of Developing a Primary Core Stability Protocol

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NMR Research Shown Beneficial to Reduce Pain and Disability

- "In America alone, the treatment cost of back pain is estimated to be $86 billion per year or 9% of the country's total health expenditure. The search for new ways to manage this old problem is critical in order to improve the health and quality of life of individuals who struggle with this condition."

- According to researchers not only do patients feel less pain, but patients performing these types of exercises are able to be more physically active and experience positive effects over a longer period of time than those who receive other treatments.

Primary Core

Transverse Abdominis (TrA)

Multifidus
Transverse Abdominis Anatomy

- **Origin:** inner surface of cartilages of lower 6 ribs, interdigititation with diaphragm, thoracolumbar fascia, anterior 3/4 of internal lip of iliac crest, and lateral 1/3 of inguinal ligament
- **Insertion:** linea alba (broad aponeurosis), pubic crest, and pecten pubis
- **Nerve Innervation:** T7-T12, L1 (iliohypogastric and ilioinguinal)

Kendall et al.
Actions of TrA

- Flattens abdominal wall and compress the abdominal viscera
- Decrease infrasternal angle of ribs in expiration (upper portion of TrA)
- **No Action** in lateral trunk flexion, except to compress the viscera and to stabilize linea alba (= better action of anterolateral trunk muscles)

Kendall et. al.
Weakness in TrA (observations)

- **Standing position:** Permits bulging of anterior abdominal wall (= increases lordosis)
- **Supine position:** during flexion a lateral bulge tends to occur
- **Prone position:** hyperextension of trunk with lateral bulge tends to occur

Kendall et al.
Multifidus Anatomy

- **Origin**: Sacral region: posterior surface of sacrum, medial surface of posterior iliac spine & posterosacroiliac ligaments. Lumbar, thoracic, & cervical regions: transverse processes of L5-C4

- **Insertion**: Spanning two to four vertebrae, inserting onto spinous process of one of vertebra above from last lumbar to axis (second cervical vertebra)

- **Nerve Innervation**: Spinal

Kendall et al.
Actions of Multifidis

- Extends vertebral column and rotation toward opposite side.

Kendall et al.
Functions of TrA & Deep Multifidus

- Deep Multifidus and TrA provide intersegmental spinal stability
  - Deep fibers of Multifidus control intervertebral motion
  - Superficial fibers of Multifidus control spine orientation

TrA Muscle Activation Patterns

- **TrA may be controlled independently of the motor command for limb movement in contrast to the other abdominal muscles.**

- **Feedforward TrA activation pattern with Lower extremity movement**

- **Feedforward activation TrA activation pattern with upper extremity movement**

- **Preparatory trunk movement precedes upper extremity movement**
Core Dysfunction: Anatomy

Transverse Abdominis:

- Isometric Knee extension/flexion tasks identified subjects with LBP had smaller increase in TrA thickness and less EMG activity

Core Dysfunction: Anatomy

Multifidus:
- Atrophy of multifidus has been used as a rationale for spine stabilizing exercises.
- Barker et al, found selective ipsilateral atrophy of multifidus in patients with unilateral LBP (low back pain).
- MRI analysis of the CSA of Multifidus
  - At level of pain: 21.7% decrease
  - Above level of pain: 15.8% decrease
  - Below level of pain: 16.8% decrease
  - Decreased CSA at level of pain was positively correlating with duration of pain.

Core Dysfunction: Activation Patterns

- Subjects with chronic LBP do not pre-activate TrA prior to rapid upper and lower limb tasks.
  
  

- Onset of internal obliques, **multifidus**, & gluteus maximus was delayed on the symptomatic side (>20ms)= no feed-forward activation in subjects with sacroiliac joint pain
  
TrA Muscle Activation

- Three different techniques used in clinical practice:
  - Drawing-in Maneuver
  - Abdominal Bracing
  - Posterior Pelvic Tilt

- **Drawing-in Maneuver** is more selective in coactivating the TrA and multifidus than the other 2 techniques.

Drawing-In Manuever

- Recommended for stabilization training
- Functions to ↑ intra-abdominal pressure by inwardly displacing the abdominal wall.
- Increases CSA (cross sectional area) of TrA on MRI (TrA contracts bilaterally to form a musculofascial band that appears to tighten like a corset and most likely improves stability of lumbopelvic region.

Drawling-in Maneuver:

- Patient starts in hook-lying position and assumes a neutral spine position & attempts to maintain it while drawing in and hollowing the abdominal muscles.


- Subtle posterior pelvic tilt & flattening of lumbar spine.

- No flaring of lower ribs, bulging out of abdominal wall or ↑ pressure through feet.

- Instructions: draw the “belly button” up and in toward the spine while exhaling.
Feedback Techniques

- If patient is having difficulty activating the Transverse Abdominis, the following has been used to assist with learning:
  - **Pressure transducer for clinical testing and visual feedback** (Pressure Bio-Feedback Chattanooga Pacific)
  - **Biofeedback with surface electrodes**

Visual Feedback- hook-lying

- Place small inflatable bladder with pressure sensor (similar to BP cuff) under lumbar spine and inflate it to 40-mm Hg.
- **Correct Activation:** 10-mm Hg increase in pressure
- Large increase occurs if activating rectus abdominis and/or increased lumbar flexion (posterior pelvic tilt).
- No change in pressure = no activation of TrA
Visual Feedback - hook-lying
Biofeedback with surface electrodes

- Electrodes placed over rectus abdominis & external obliques (near attachment on the 8th rib).

- **Correct activation:** minimal to No activation of these muscles

- Can be used in conjunction with inflatable cuff.
Abdominal Bracing

- Occurs by setting the abdominals and actively flaring out laterally around the waist.
- Technique has been taught years.
- It has been shown to activate the oblique abdominal muscles.

Posterior Pelvic Tilt

- Activates **Rectus Abdominis**: it is **NOT** a core spinal stabilization muscle.
- Only useful for teaching awareness of the movement of the pelvis and lumbar spine.
- Activated when patient explores lumbar ROM with pelvic tilts to find neutral spine position.

Lower Abdominal Progression

- Levels developed by Shirley A. Sahrmann

- Purposes:
  - To improve the performance of abdominal muscles (external obliques, rectus abdominis, transverse abdominis)
  - To learn to prevent lumbar spine motions associated with leg motion
Starting Position - Sahrmann

- Supine with hips and knees flexed and feet on the floor. Contract abdominal muscles by flattening the abdomen and reducing the arch in the lumbar spine. Patient is instructed to place fingers on abdominal muscles and "pull the navel in toward the spine."
Level 0.3 (E1)-Sahrmann

- Lift one foot with alternate foot on floor
- Method:
  - Flex one hip while keeping knee flexed.
  - Return the LE to starting position and repeat with opposite LE.
Level 0.4 (E2) - Sahrmann

- Hold one knee to chest & lift the alternate foot

- Method:
  - Flex one hip and use hands to hold knee to chest.
  - While maintaining contraction of abdominal muscles, flex the other hip. Hold for a count of 3 and return the LE to starting position.
  - Perform with opposite extremity.
  - Repeat 5-6 times
Level 0.5- Sahrmann

- LIGHTLY hold one knee toward the chest and lift the alternate foot

- Methods:
  - Flex one hip and use one hand to hold knee to chest, but hold it less firmly than level E2 (0.4).
  - While maintaining contraction of abdominal muscles, flex other hip.
  - Hold for a count of 3 and return the LE to starting position
  - Perform with the opposite extremity.
  - Repeat 5-6 times
Level 1A - Sahrmann

- Flex the hip to > 90° and lift the alternate foot

**Methods:**

- Contract the abdominal muscles; flex one hip to > 90 degrees by lifting the foot from the table.
- Contract the abdominal muscles and flex the other hip by lifting the foot off the table.
- Maintain the contraction of abdominal muscles and lower the legs, one at a time, to starting position.
- Repeat by starting the sequence with opposite leg.
Level 1B - Sahrmann

- Flex the hip to $90^\circ$ and lift the other foot.

- Methods:
  - Contract abdominal muscles and flex one hip to 90 degrees.
  - Contract abdominal muscles and lift other leg to same position. Maintain contraction of abdominal muscles, lower the legs one at a time to starting position.
  - Repeat by starting the sequence with the opposite LE.
  - Repeat, alternating legs, correctly 10 times to progress to Level 2.
Level 2-Sahrmann

- Flex one hip to 90° and lift & slide the other foot to extend the hip and knee.

Methods:
- Contract abdominal muscles and flex hip to 90 degrees, lifting foot off the table.
- Maintain contraction of abdominal muscles; lift other leg up to same position.
- Maintain one leg at 90 degrees, place other heel on table and slowly slide heel along table until hip and knee are extended.
- Return leg to starting position by sliding heel along table.
- Repeat extension motion with other LE and return it to starting position.
- Repeat, alternating legs, correctly 10 times to progress to Level 3.
Level 3-Sahrmann

- Flex one hip to 90 degrees, and lift the foot and extend the leg without touching the support surface.

Methods:
- Flex hip to 90 degrees, lifting foot from the table.
- Maintain contraction of abdominal muscles and lift other leg up to same position.
- Maintain one hip at 90 degrees, extend the other hip and knee while holding the foot off the table until hip and knee are resting in an extended position on the table.
- Return leg to the hip and knee flexed position.
- Maintain contraction of abdominal muscles, extend and lower the other leg and return it to the 90 degree position.
- Repeat, alternating legs, correctly 10 times to progress to Level 4.
Level 4-Sahrmann

- Slide both feet along the supporting surface into extension and return to flexion

**Methods:**

- **Begin in supine position with both legs in extension.** Contract abdominal muscles and slide heels along table, flexing both hips and knees while bringing them toward the chest.

- Once hips and knees are flexed, pause and reinforce abdominal contraction.

- Slide both legs back into extension.

- Repeat correctly 10 times to progress to Level 5
Level 5-Sahrmann

- Lift both feet off the supporting surface, flex the hips to 90 degrees, extend the knees, and lower both extremities to supporting surface.

- Methods:
  - Begin with LE extended position.
  - Contract abdominal muscles while simultaneously flex hips and knees, lifting both feet off the table to bring the hips to 90 degrees.
  - Reinforce the contraction of abdominal muscles, extend the knees and lower LEs to table.
Primary Core Protocols

- Transverse Abdominis (Levels I-V)
- Multifidus (Levels I-III)

http://lowerabexercises.blogspot.com/
The TrA Level Progression

- These **proposed** levels were designed from the research and are clinically applied to strengthen the Transverse Abdominis in isolation.

- **Purpose:**
  - To have a common terminology among practicing clinicians in the same physical therapy setting.
  - To improve the performance of TrA muscle.
  - To prevent lumbar spine motion (neutral spine) during functional activity.
Starting Position: TrA Level I

- **Method:**
  - Supine with hips & knees flexed and feet on the floor.
  - Patient is instructed to keep a **Neutral lumbar spine** using the **‘Drawing-in Maneuver’** and place two fingers on transverse abdominis and one hand on superficial abdominal muscles.
  - Next, patient is asked to **“pull the navel in toward the spine”** without tightening superficial abdominal muscles and only the **TrA.**
TrA Level I

- Level I will be the starting position for all levels I-V.
TrA Level II

- Lift one foot to 90 degrees with alternate foot on table

- **Method:**
  - Contract TrA and flex one hip to 90 degrees while keeping knee flexed.
  - Return the LE to starting position and repeat with opposite LE.
**TrA Level III**

- **Flex the hip to 90° and lift the other foot.**

- **Methods:**
  - Contract TrA and flex one hip to 90 degrees.
  - Lift other leg to same position. While maintaining contraction of TrA, lower the legs one at a time to starting position.
  - Repeat by starting the sequence with the opposite LE.
  - Repeat, alternating legs, correctly 10 times to progress to Level 4.
TrA Level III
TrA Level IV

- Flex one hip to 90 degrees, and lift the other foot. Extend the one leg without touching the support surface.

- Methods:
  - Flex hip to 90 degrees, lifting foot from the table.
  - Maintain contraction of TrA and lift other leg up to same position.
  - Maintain one hip at 90 degrees, extend the other hip and knee while holding the foot off the table.
  - Return leg to the hip and knee flexed position.
  - Maintain contraction of abdominal muscles, extend other leg and return it to the 90 degree position.
  - Repeat, alternating legs, correctly 10 times to progress to Level 5.
TrA Level IV
TrA Level V

- Flex the hips to 90 degrees and extend the knees without touching the support surface.

- Methods:
  - Flex hip to 90 degrees, lifting foot from the table.
  - Maintain contraction of TrA and lift other leg up to same position.
  - Extend both hips and knees while holding the feet off the table.
  - Return legs to the hip and knee flexed position.
  - Repeat correctly 10 times.
TrA Level V
Multifidus Level Progression (I-III)

- These *proposed* levels were designed from the research and are clinically applied to strengthen the Multifidus in isolation.

**Purpose:**

- To have a common terminology among practicing clinicians in the same physical therapy setting.
- To improve the performance of Multifidus muscle.
- To prevent lumbar spine motion (neutral spine) during functional activity.
Multifidus Level Ia

- Start position: Quadripped
- Neutral lumbar spine
- Have patient lift one lower extremity (LE) (knee) ~ 1 inch from table
- Hold position ~ 5 seconds
- Alternate with the other LE.
Multifidus Level Ib

- Start position: Quadriped
- Neutral lumbar spine
- Have patient lift one LE (knee) and the contralateral upper extremity (UE) (hand) ~ 1 inch from table
- Hold ~ 5 seconds
- Alternate with the other LE and contralateral UE
Multifidus Level II

- Starting position: Prone
- Maintain neutral lumbar spine (i.e. placement of pillow)
- Lift one UE and contralateral LE from the table
- Alternate with other UE and contralateral LE.
Multifidus Level III

- **Starting position:** standing on stool facing wall
- **Extend one UE and contralateral LE**
- **Alternate with other UE and contralateral LE**
Clinical Biomechanics: Intervention Skill Sets

NMR (97112)

Longus Colli Isolation
Text References