Anatomy & Function of the “Core”

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Disclosures

- None
Objectives

• Define core stability
• Review the components of the core
• Discuss the role of coordination vs. strength in achieving a stable core
Functional Spinal Stability

Panjabi, 2003
Osseoligamentous Structures

Lucas & Bresler, 1961
Thoracolumbar Fascia

- Trapezius
- Latissimus dorsi
- Gluteus maximus

Diagram:
- Center pole = Spine
- Guy ropes = Abdominals (Ab)
- Tent = Thoracolumbar fascia (TLF)
Core Musculature

- The abdominals in the front
- The diaphragm as the roof
- Paraspinals and gluteals in the back
- The pelvic floor and hip girdle musculature as the bottom

Hodges 1999
Muscles of the Lumbar Spine

Global
- Rectus abdominus
- External oblique
- Internal oblique (ant)
- Iliocostalis (thoracic)

Local
- Multifidi
- Psoas
- Transversus abdominis
- Quadratus lumborum
- Internal Oblique (post)
- Iliocostalis
- Longisimus

Akuthota & Nadler, 2004
Paraspinals

- Intertransversarii
- Multifidus
- Rotatores
- Transverse process
- Interspinales
- Spinous process

Posterolateral view

Superior View
Quadratus Lumborum
Psoas major
Diaphragm

- “Ceiling” of the Core
- Respiration
  - Reciprocal with pelvic floor
  - Descends with inspiration
- Spine stability
  - Increase IA pressure
  - Pts with LBP and SIJ → abnormal recruitment

O’Sullivan, 2002
Pelvic Floor

- “Floor” of the Core
- Respiration
  - Reciprocal with diaphragm
- Spine Stability
  - Support lumbopelvis and pelvic organs
  - Co-activation with TrA (Sapsford 2001)
- Specialized Functions
  - Sphincteric control
  - Sexual function
Abdominal Wall Musculature

Anterior View of the Abdominal Muscles

- rectus abdominis
- transversus abdominis
- internal oblique
- external oblique
- aponeurosis
EXTERNAL OBL
• Increases IAP
• Trunk rotation
• Side bending
• Controls ant pelvic tilt

INTERNAL OBL
• Increases IAP
• Trunk rotation
• Side bending
Transversus Abdominis (TrA)

1. Increase Intra-abdominal Pressure
   - Symmetric
   - Active in both sagittal flex/ext (Barker 2005)

2. Contributes to control of trunk rotation
   - Asymmetric
   - Ipsilateral > Contralateral (Urquhart 2005)
   - Feed forward/anticipation (Hodges 1996)

3. Different types of activation
   - Tonic during gait
   - Phasically active with breathing and heel strike (Saunders 2004)
“Core” Controversy

HOLLOWING
• “Drawing in”
• Selective recruitment of TrA and multifidi (Urquhart 2004)
• Incr spine stiffness (Hodges 2003)
• Early in rehabilitation

BRACING
• EO > TrA, multifidi, IO (Urquhart 2004)
• Greater spine stiffness than hollowing (Grenier 2007)
• Incr ability to stabilize against trunk perturbations (Vera-Garcia 2006)
• More functional
Stability of Hip Joint

- Bones
- Ligaments
- Muscles
- *Neuromuscular Control
Stability of the hip joint
Stability of Hip Joint

- LIGAMENTS/CAPSULE
Functional Hip Stability

- Maintaining an appropriate femoral head position within the joint capsule and labral complex

Table 1  Range of motion (degrees) in the hip compared to daily activities.

<table>
<thead>
<tr>
<th></th>
<th>Allowable¹</th>
<th>Walking²,³</th>
<th>Tie Shoe⁴</th>
<th>Stairs⁵</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexion/extension</td>
<td>140/30</td>
<td>30/15</td>
<td>129</td>
<td>40</td>
</tr>
<tr>
<td>Internal/external rotation</td>
<td>90/90</td>
<td>4/9</td>
<td>18 abd.</td>
<td></td>
</tr>
<tr>
<td>Abduction/adduction</td>
<td>90/30</td>
<td>7/5</td>
<td>13 ext.</td>
<td></td>
</tr>
</tbody>
</table>

(Stewart, 2006)
Neuromuscular Control

- Stability of hip in normal daily activities are provided almost entirely by the action of muscle forces (Stewart 2006)

- Muscles contribute to 95% of hip joint contact forces during normal walking (Correa 2010)
Stability of the hip joint

- **MUSCLES**
  - Flexors
  - Extensors
  - Abductors
  - Adductors
  - Internal Rotators
  - External Rotators
Hip flexors

- Iliopsoas
- Rectus Femoris*
- Sartorius*
- Tensor fascia latae
- Gracillis
- Adductor longus
- Adductor brevis
- Pectineus

*Anterior thigh; Femoral N
Hip extensors

- Gluteus maximus
- Gluteus medius
- Hamstrings*
  - Semitendinosus
  - Semimembranosus
- Biceps femoris

Posterior thigh; Sciatic Nerve
Hip abductors

- Gluteus maximus
- Gluteus medius*
- Gluteus minimus*
Hip adductors

- Adductor brevis*
- Adductor longus*
- Adductor magnus*
- Pectineus*
- Gracilllis*

Medial thigh; Obturator Nerve
Hip external rotators
# Hip internal rotators

<table>
<thead>
<tr>
<th>Muscle</th>
<th>IR/ER @ 0° Hip Flexion</th>
<th>IR/ER @ 90° Hip Flexion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gluteus Minimus</td>
<td>Primarily ER - Some anterior fibres IR</td>
<td>IR</td>
</tr>
<tr>
<td>Gluteus Medius</td>
<td>Both</td>
<td>IR</td>
</tr>
<tr>
<td>Gluteus Maximus</td>
<td>ER</td>
<td>Primarily IR - Posterior fibres still ER</td>
</tr>
<tr>
<td>Piriformis</td>
<td>ER</td>
<td>IR</td>
</tr>
<tr>
<td>Iliopsoas</td>
<td>Marginal IR</td>
<td>Marginal ER</td>
</tr>
<tr>
<td>Quadratus femoris</td>
<td>IR</td>
<td>IR</td>
</tr>
<tr>
<td>Obturator externus and internus</td>
<td>IR</td>
<td>IR</td>
</tr>
</tbody>
</table>

![Diagram of hip muscles showing internal rotators](image)
Putting it all together functionally

- Driver of the kinetic chain
- Proximal stability $\rightarrow$ distal mobility
- Small contraction = big effect (Cholewicki & McGill 1996)
  - 5% MVC for ADLs
  - 10% MVC for vigorous activity
- Controlled by neural subsystem
  - Constant feedback
  - Continued refinement of movement
- Contribution of each muscle changes based on the demand (Zazulak 2007)
References

• Akuthota V & Nadler S. Core strengthening. *Archives of Physical Medicine and Rehabilitation*. 2004; 85(S1):S86-S92


• Rho, ME et al. Gender Differences on Ultrasound Imaging of Lateral Abdominal Muscle Thickness in Asymptomatic Adults: A Pilot Study. PMR 2013