Trunk Stabilization Strategies

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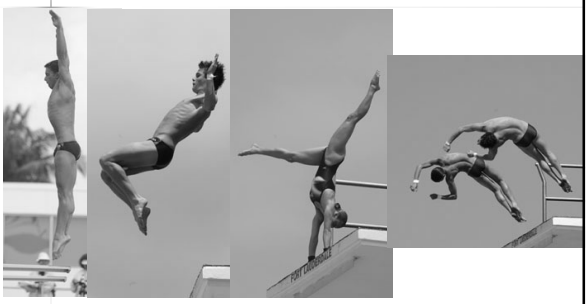
What are the roles of trunk muscles?



USA Diving

Osteoligamentous lumbar spine is inherently unstable!!!!

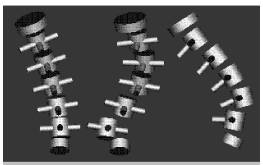


Figure 2: Examples of predicted buckling modes of the lumbar spine (1st 3 Eigenvectors).

Lucas and Bresler, 1961
Crisco et al., 1992
Stokes et al., 2000

Muscles designed for spinal segmental support

- **Global**
  - **Rectus Abdominis**
  - **Internal & External Abdominal Oblique**
  - **Quadratus Lumborum**
  - **Iliocostalis lumborum, pars thoracis**
  - **Longissimus thoracic, pars thoracis**
- **Local**
  - **Transversus Abdominis*****
  - **Internal Abdominal Oblique (fibers attached to thoracolumbar fascia)**
  - **Multifidus**
  - **Quadratus Lumborum (medial fiber)**
  - **Iliocostalis Lumborum, pars lumborum**
  - **Longissimus thoracis, pars lumborum**
  - **Interspinales**
  - **Intertransversarii**

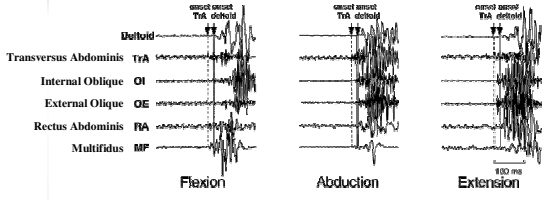
Bergmark A, Acta Ortho Scand, 1989

Functional Significance

- **Global**
  - **Moving the spine segments**
  - **Transferring load directly between thoracic cage and pelvis[1]**
- **Local**
  - **Closer to the center of rotation[2]**
  - **Providing propriocetive[3]**
  - **Overlapping muti-segmental muscles linking adjacent lumbar vertebrae[4]**

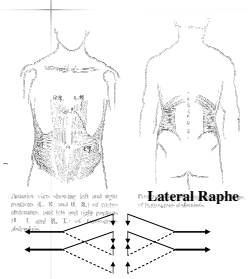
1. Bergmark A, Acta Ortho Scand, 1989
2. Panjabi et al., Spine, 1989
3. Bogduk N, 1997
4. Crisco & Panjabi, Spine, 1991

Feedforward Characteristics of Transversus Abdominis (TrA)



Cresswell et al., 1989
Hodges & Richardson, Exp Brain Res, 1997

Arrangement of TrA converts the trunk into a rigid cylinder[1]

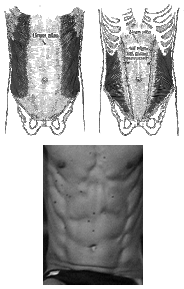


Kendall et al., 2005

- TrA activation is correlated with an increase in intra-abdominal pressure[2,3] without generating flexor moment about the lumbar spine[1]
- Activation of the TrA is independent of directions of arm and leg movements[3]
- Delayed onset of TrA during arm and leg movements observed in LBP[3]
- **No segmental motion measured!!!!**

[1]McIntosh, 1987
[2]Cresswell et al., 1989; 1992; 1993; 1994
[3]Hodges & Richardson, 1995; 1996; 1997; 1998

Multiple global muscles can also stabilize the trunk



Kendall et al., 2005, USA Diving

- Activation of the IO is, to certain extent, similar to the TrA[1]
- More direction specific of the EO is observed[1,2]
- Cocontraction of IO and EO also found to reduce flexion and lateral rotation moments[3]
- Stiffness of the Rectus femoris allows the EO and IO to work more efficiently[4]

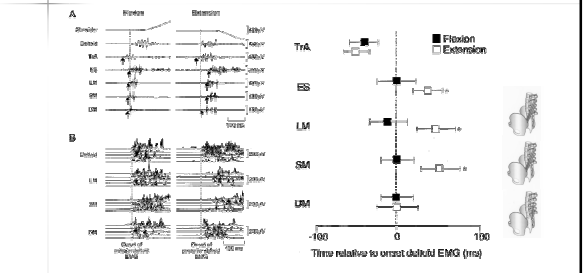
[1]Cresswell et al., 1989; 1992; 1993; 1994
[2]Hodges & Richardson, 1995; 1996; 1997; 1998
[3]Gardner-Morse & Stokes, 1998
[4]McGill SM, 2004

Local muscles of the back stabilize the trunk

- Mutifidus and iliocostalis shown to reduce monosegmental flexion, extension, and neutral zone[1]
- Multisegmental arrangement of the lumbopelvic muscles, similar to the superficial layer of the Multifidus, increase efficiency of stabilization[2]
- When compared to iliocostalis, longissimus, and psoas muscles, activation of the multifidus has a greater effect on reduction of the ROM and NZ of L5-S1 in flexion/extension and lateral bending but not in rotation[3]

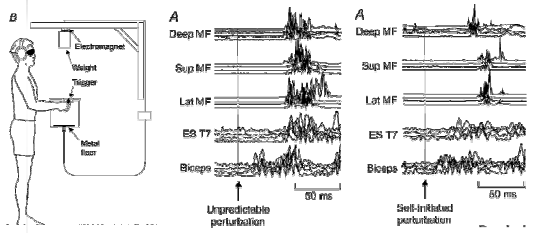
[1]Panjabi, 1989
[2]Crisco and Panjabi, 1991
[3]Wilke, 1995

Different activation patterns between deep and superficial fibers of the multifidus



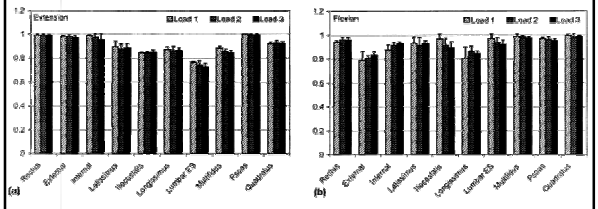
Moseley, Hodges & Gandevia, Spine, 27, 2002

Selective activation of the multifidus is dependent upon mechanical demand



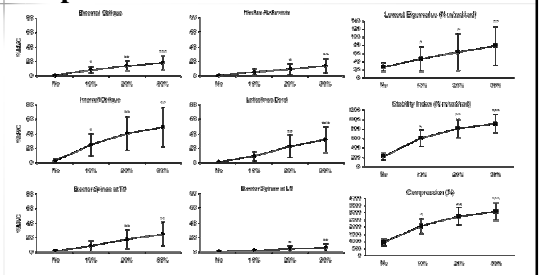
Moseley, Hodges & Gandevia, J Physiol, 2003

Co-contraction of trunk muscles increases spinal stability and compression



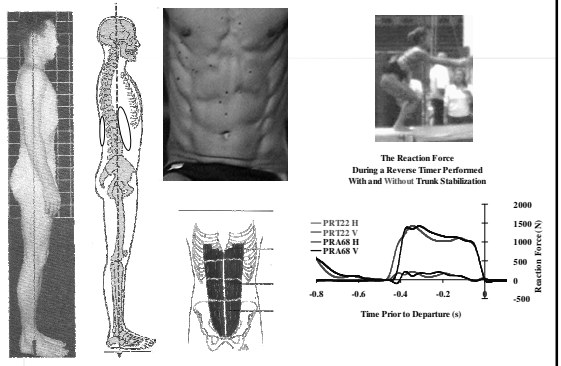
Cholewicki & VanVliet, Clin Biomech, 2002

Co-contraction of trunk muscles increases spinal stability and compression



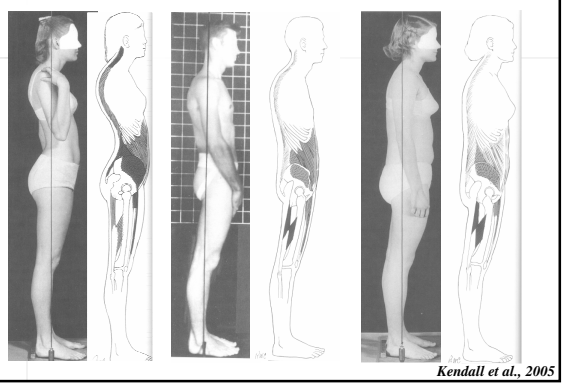
Vera-Garcia, Brown, Gray, McGill, 2006

Balance between trunk muscles counteracts the torques generated during arm and leg movements



Pictures from Kendall F. et al., 1993.

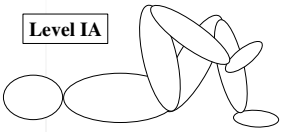
Poor Postures Alter Length of Multiple Muscles



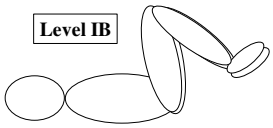
Kendall et al., 2005

Exercises for The Lower Abdominal Muscles

Level IA



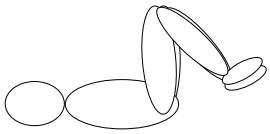
Level IB

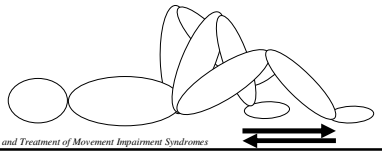


Sahrmann S, Diagnosis and Treatment of Movement Impairment Syndromes

Exercises for The Lower Abdominal Muscles

Level II





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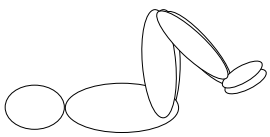
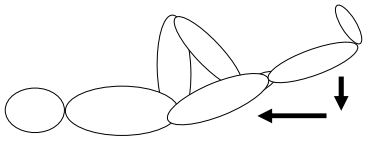
Exercises for The Lower Abdominal Muscles

Level III





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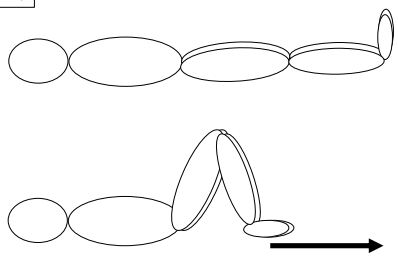
Exercises for The Lower Abdominal Muscles

Level IV



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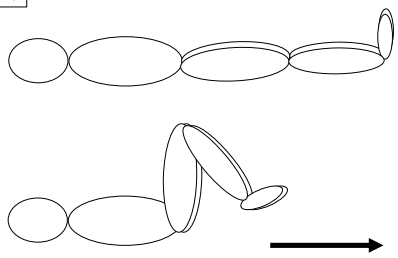
Exercises for The Lower Abdominal Muscles

Level V



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