The Myth of Core Stability

Prof. Eyal Lederman DO PhD
The beliefs

1. That certain muscles are more important for stabilisation of the spine, in particular transverses abdominis (TA).
2. That weak abdominal muscles lead to back pain
3. That strengthening abdominal or core muscle can reduce back pain
4. That a strong core will prevent injury.
The myths

- Single muscle activation issue
- TA and stability issues
- The timing issue
- The strength issue
- Motor learning training issues
Passive stability
Active stability
“It was also proposed that the width of the neutral zone was related to the stability of the joint. These conclusions were drawn from cadaver experiments and mathematical models on which an extensive amount of damage had to be inflicted to the joint before an unstable response was obtained. So far, the neutral zone argument has remained academic.”

Neuromuscular re-organisation to injury

Lederman E. 2005 Science and practice of manual therapy. Elsevier
Complexity of tensional fields

Lederman E. 2005 Science and practice of manual therapy. Elsevier
Complexity of tensional fields

Lederman E. 2005 Science and practice of manual therapy. Elsevier
During movement, muscle that are “not working” are just as important as muscles that are working!
CONCLUSIONS: No single muscle dominated in the enhancement of spine stability, and their individual roles were continuously changing across tasks. Clinically, if the goal is to train for stability, enhancing motor patterns that incorporate many muscles rather than targeting just a few is justifiable.

What is co-contraction?
Stability is only another motor control pattern

Skills

Composite abilities
- Balance, coordination, relaxation, control, reaction time, transition rate

Synergetic abilities
- Co-contraction (Stability, dynamic / static)
- Reciprocal activation (Movement)

Contraction abilities
- Force (static & dynamic), velocity and length

Increase co-contraction

Increase stability

Increase in spinal compression
Reduce range of movement
Increase energy expenditure
Individuals in an externally loaded state appear to select a natural muscular activation pattern appropriate to maintain spine stability sufficiently. Conscious adjustments in individual muscles around this natural level may actually decrease the stability margin of safety.

Many roles for TA (with all the other muscles)

- Spinal stabilisation
- Respiration
- Vocalisation
- Support of abdominal contents
- Part of inguinal valve
Are abs essential for stability?
Are abs essential for stability?

TA is absent or fused to the internal oblique muscle as a normal variation

Gray’s Anatomy (36th edition 1980, page 555)
Abdominal muscles in preg
Is LBP in pregnancy due to loss in stability?

- Body mass index,
- History of hypermobility
- History of amenorrhea (Mogren & Pohjanen, 2005)
- Low socioeconomic class,
- Previous LBP (Orvieto et al., 1990)
- Posterior fundal location of placenta
- Correlation between fetal weight to LBP with radiation (Orvieto et al., 1990)
Is LBP in pregnancy due to loss in stability?

Postpartum, Rectus abdominus takes about 4 weeks to re-shorten, and 8 weeks for pelvic stability to normalize (Gilleard & Brown, 1996)

Out of 869 pregnant women who were recruited for the study, 635 were excluded because of their spontaneous unaided recovery within a week of delivery (Bastiaenen et al., 2006)

Whereas all non-pregnant women could perform a sit-up, 16.6% of pregnant women could not perform a single sit-up. There was no correlation between the sit-up performance and backache. (Fast et al., 1990)

There are no known biomechanical predisposing factors for developing back pain during pregnancy!

Not even trunk muscle control or stability!
In patient with pelvic girdle pain increased intra-abdominal pressure could exert potentially damaging forces on various pelvic ligaments.

Study recommends teaching the patients to reduce their intra-abdominal pressure, i.e. no CS.

Mens et al., 2006
Are abs essential for stability?

Weight gains and obesity are only weakly associated with LBP

(Leboeuf-Yde, 2000)
Are abs essential for stability?

Results in weakness of abdominal muscles. No effect on back pain or impairment to the patient’s functional / movement activities, measured up to several years after the operation (Mizgala et al., 1994; Simon et al., 2004).
Are abs essential for stability?

Conclusion:

- Imbalances between anterior and posterior trunk muscles are a normal variation
- Weak abdominals do not lead to instability or back pain
Executive stage

Effector stage

Motor stage

Altered proprioception + nociception

“Motor templates” for injury?

Functional organisation to injury

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<table>
<thead>
<tr>
<th>The injury response</th>
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</thead>
<tbody>
<tr>
<td>Reflexive:</td>
<td></td>
</tr>
<tr>
<td>Avoidance &amp; hypersensitisation</td>
<td></td>
</tr>
<tr>
<td>Psychological / psychomotor:</td>
<td></td>
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<tr>
<td>Sense of weakness</td>
<td></td>
</tr>
<tr>
<td>General fatigue</td>
<td>Ferrari R. A re-examination of the whiplash associated disorders (WAD) as a systemic illness Annals of the Rheumatic Diseases 2005;64:1337-1342</td>
</tr>
<tr>
<td>Nausea</td>
<td>Ferrari R. A re-examination of the whiplash associated disorders (WAD) as a systemic illness Annals of the Rheumatic Diseases 2005;64:1337-1342</td>
</tr>
</tbody>
</table>
Co-contraction will be effected

Tissue damage

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But also movement is affected!

- Muscle hyperexcitability and / or hypertonicity
- Muscle wasting / weakness
- Tissue damage

Preventing movement in this direction

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Complexity in injury / pain

**Multifidus**  
(Carpenter & Nelson, 1999),  
**Psoas**  
(Barker et al., 2004),  
**Diaphragm**  
(Hodges et al., 2003),  
**Pelvic floor muscles**  
(Pool-Goudzwaard et al., 2005),  
**Gluteals**  
(Leinonen et al., 2000)

If a muscle is not involved it is still part of the protection schema / strategy!
The timing issue
(and the ascendance of TA)
“delay of TrA is likely to be longer than that for DM due to its long elastic anterior fascias. Earlier activity of TrA may compensate for this delay”.

What are the time differences?

20 ms (one fiftieth of a second)!
Pain evasion strategy?

Perhaps there is a protective advantage in delaying TA onset times?
Can CS exercise change timing?

Not have been shown!
Conflicts with motor learning and training principles

- Overloading principle
- The similarity and specificity principle
- Economy of movement
- Internal-external focus principles
Overloading principle

and

The core strength issue
Force levels of trunk muscles

In standing, ES, psoas and QL are virtually silent! In some subjects there is no detectable EMG activity in these muscles (Andersson et al., 1996).

During walking rectus abdominis has an average activity of 2% MVC and external oblique 5% MVC (White & McNair, 2002).

Co-contraction in standing is less than 1% MVC rising up to 3% MVC when a 32 Kg weight is added to the torso. With a back injury it is estimated to raise these values by only 2.5% MVC for the unloaded and loaded models (Cholewicki et al., 1997).

During bending and lifting a weight of 15 kg co-contraction increases by only 1.5% MVC (van Dieen et al., 2003b).
myth of strong abs

In a study of fatigue in CLBP, four weeks of stabilisation exercise failed to show any significant improvement in muscle endurance (Sung, 2003).
myth of strong abs

No study has shown that strengthening core muscle will re-normalise motor control!
Similarity and specificity principles and Core exercise
Neuromuscular adaptation - code elements

- Cognition
- Active
- Feedback
- Repetition
- Similarity
Similarity principle

You learn what you’ve practiced
Similarity principle: dissimilarity
Specificity of training

Higher centres
Spine
Muscle

Higher centres
Spine
Muscle

Higher centres
Spine
Muscle

Yoga
Weight training
Running

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"There is no basis to expect training effects from one form of exercise to transfer to any other form of exercise. Training is absolutely specific."

Tim Noakes - Professor of Exercise and Sports Science, Department of Physiology, University of Cape Town, SA.
“DM and TrA do not maintain tonic co-contraction. However, these muscles do share functional similarities. As with tonic activation of DM, training co-contraction of DM and TrA as part of therapeutic exercise programmes is unlikely to restore typical activation patterns”

“EMG studies refute the belief that DM is tonically active during static postures, trunk movements and gait. It is, therefore, unlikely that training tonic activity of multifidus restores the normal function of this muscle”

A study proving that you can’t learn to play the piano by practicing on a banjo....

Trunk co-contraction exercise

Core co-contraction exercise

Exercise “X”

External oblique

Erector spinae

Exercise “X”
“to improve locomotion (and motion), mechanical work should be limited to just the indispensable type and the muscle efficiency be kept close to its maximum. Thus it is important to avoid: .... using co-contraction (or useless isometric force)”


“At higher levels of competition, it is likely that 'natural selection' tends to eliminate athletes who failed to either inherit or develop characteristics which favour economy”

Core stability in prevention of injury and therapeutic value
## Prevention of injury

<table>
<thead>
<tr>
<th>Description</th>
<th>Outcome</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Helewa <em>et al.</em>, 1999) asymptomatic subjects (n=402) back education or back education + abdominal strengthening exercise</td>
<td>Observed for 1 yr Abs strengthening no added protection</td>
<td>Recruited asymptomatic subjects identified as having weak abdominal muscles, but no back pain!</td>
</tr>
<tr>
<td>Nadler <em>et al.</em>, 2002 Core-strengthening program effect on LBP collegiate athletes (n=257)</td>
<td>No effect</td>
<td></td>
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</table>
## CS Therapeutic Value

<table>
<thead>
<tr>
<th>Description</th>
<th>CS Compared to:</th>
<th>Result</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>O'Sullivan <em>et al.</em>, 1997</td>
<td>CLBP (spondylolysis or spondylolisthesis)</td>
<td>General practitioner care</td>
<td>CS better</td>
</tr>
<tr>
<td>Hides <em>et al.</em>, 2001</td>
<td>Recurrence after first episode LBP</td>
<td>General practitioner care + medication</td>
<td>CS better</td>
</tr>
<tr>
<td>Goldby <em>et al.</em>, 2006</td>
<td>CLBP</td>
<td>Control and MT</td>
<td>CS first MT second</td>
</tr>
<tr>
<td>Stuge <em>et al.</em>, 2004</td>
<td>LBP in preg</td>
<td>Physical therapy</td>
<td>CS better</td>
</tr>
<tr>
<td>Nilsson-Wikmar <em>et al.</em>, 2005</td>
<td>LBP in preg</td>
<td>General exercise</td>
<td>Same</td>
</tr>
<tr>
<td>Franke <em>et al.</em>, 2000</td>
<td>CLBP</td>
<td>General exercise</td>
<td>Same</td>
</tr>
<tr>
<td>Koumantakis <em>et al.</em>, 2005</td>
<td>CLBP</td>
<td>General exercise</td>
<td>Same</td>
</tr>
<tr>
<td>Rasmussen-Barr <em>et al.</em>, 2003;</td>
<td>CLBP</td>
<td>General exercise</td>
<td>Same</td>
</tr>
<tr>
<td>Mindy C et al 2006</td>
<td>Recurrent LBP</td>
<td>Exercise + MT</td>
<td>Same</td>
</tr>
</tbody>
</table>
Core stability in relation to risk and prognostic factors for LBP
## Etiology of back pain

<table>
<thead>
<tr>
<th></th>
<th><strong>Risk factors</strong></th>
<th><strong>Prognostic factors</strong></th>
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</thead>
<tbody>
<tr>
<td><strong>Physical</strong></td>
<td>Age 35-55</td>
<td>Older age</td>
</tr>
<tr>
<td></td>
<td>Previous history of LBP</td>
<td>Initial high intensity pain</td>
</tr>
<tr>
<td></td>
<td>Possibly genetic factors?</td>
<td>Referred pain to LEX</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Restriction in two + segments</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Delay in treatment</td>
</tr>
<tr>
<td><strong>Occupational</strong></td>
<td>Frequent bending</td>
<td>Increase work tempo</td>
</tr>
<tr>
<td></td>
<td>Frequent lifting</td>
<td>Increase quantity of work</td>
</tr>
<tr>
<td></td>
<td>Unusual sitting posture?</td>
<td>Work relations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Unavailability of light duties</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Frequent lifting</td>
</tr>
<tr>
<td><strong>Psychological</strong></td>
<td>Low job satisfaction</td>
<td>Physical distress</td>
</tr>
<tr>
<td></td>
<td>Low social support</td>
<td>Somatisation</td>
</tr>
<tr>
<td></td>
<td>Cognition</td>
<td>Catastrophising</td>
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<tr>
<td></td>
<td>Fear avoidance</td>
<td></td>
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<td></td>
<td>Depression</td>
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<td></td>
<td>Anxiety</td>
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<td></td>
<td>Distress</td>
<td></td>
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<td></td>
<td>Sexual &amp; physical abuse</td>
<td></td>
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</tbody>
</table>
CS in relationship to biomechanical factors: sitting

<table>
<thead>
<tr>
<th>Sitting condition</th>
<th>Risk factor</th>
<th>CS implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal prolong sitting</td>
<td>no</td>
<td>Non</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Core tensing irrelevant</td>
</tr>
<tr>
<td>Unusual sitting posture</td>
<td>Yes</td>
<td>Advice on posture.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Core tensing irrelevant</td>
</tr>
<tr>
<td>Sitting + whole body vibration</td>
<td>Yes</td>
<td>Advice on occupation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Core tensing irrelevant</td>
</tr>
<tr>
<td>CLBP + sitting</td>
<td>May exacerbate existing LBP</td>
<td>Avoid prolong sitting</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Encourage a dynamic working patterns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Core tensing irrelevant</td>
</tr>
</tbody>
</table>
Which is better for developing spinal stability?

- No difference in muscle activation of 14 trunk muscles
- No difference in stability and spinal compression values

In patients with CLBP lifting is associated with higher levels of trunk co-contraction and spinal loading
Marras et al., 2005; Cholewicki et al., 1997

Bending and lifting is associated with low abdominal muscle activity, which contributes to further spinal compression
de Looze et al., 1999

Any further tensing of the abdominal muscle may lead to additional spinal compression.
“Since the spinal compression in lifting approach the margins of safety of the spine, these seemingly small differences are not irrelevant”
Biggemann et al., 1988

Psychological stress during lifting resulted in a dramatic increase in spinal compression associated with increases in trunk muscle co-contraction and less controlled movements
Davis et al., 2002
Can core tensing be dangerous?

CLBP patients naturally increase co-contraction during movement.

Remember + co-contraction = + spinal compression.
Exercise seems to help

- May normalise motor control
- Musculoskeletal system loves movement and exercise
- “Exercise is good for you”
- Improve blood flow – exercise increases capillary density in muscle
- Improve transsynovial flow in facet joints – may help reduce joint effusion inflammation
- Lymph flow highly responsive to movement and exercise – help reduce build up of fluid in tissue etc.
- Exercise may reduce pain by modulating nociception
- Exercise also empower the patient – strong correlation between socio-economic / psychological factors and chronic back pain
People of the world relax (your trunk)

Tightening your trunk muscles will not:

- Prevent back injury
- Prevent back pain*
- Will not cure back pain*
- Will not improve your sports performance

* More than general exercise

P.S playing the banjo may help exercise your trunk muscles (but you may lose some friends)
Lecture notes and references
see:
WWW.CPDO.NET

For a way of working with
motor control see:
Neuromuscular Re-abilitation

Apologies to all banjo players