Integration of the Kinetic Chain:

The Trunk

Michael Higgins PhD, ATC, PT, CSCS
University of Virginia

Sasha Digges, PT, ATC, CSCS
PEAK PHYSICAL THERAPY & SPORTS REHABILITATION

Central Theme

Objective/Goals

• Review Stabilization strategies/systems
• Review important anatomy
• Assessment of trunk musculature
• Program design
• Integration of exercises
• Proper exercise technique

Stabilizing Systems

• 3 Subsystems
  – Passive
    • Vertebrae
    • Discs
    • Ligaments
  – Active
    • Muscle and tendons that apply force to the
  – Neural

**Local vs Global**

- **Local**
  - mono-articular deep muscles
  - attachments on or near the vertebrae
  - primary function eccentrically to control movement and maintain static stabilization

- **Global**
  - typically bi-articular superficial
  - muscles that connect the trunk to the extremities
  - Primarily function concentrically to produce large torques for movement and power

**Global system**

- Are muscles with axial-appendicular attachments
  - (ie, gluteus maximus, glutus medius, hip adductors, rectus femoris, illoposas, trapezius, latissimus dorsi, deltoid, pectoralis major)

  - Transfer force and momentum between the extremities and core along the kinetic chain.

  - Are separate yet integral to core stability because they have fascial attachments that stiffen the core and transfer force through the kinetic chain.

**Global system**

- **Rotators and Intertransversari**
  - Small cross-sectional areas
  - Contribution to rotation is minimal
  - Vertebral position sensors

**Target Muscles**

- Uni-segmental
  - Force transducers
  - Provide feedback on spinal position
  - Work closely with neural system

  EXAMPLES:
  - Intertransversi muscles
  - Interspinalis muscles
**Longissumus, Iliocostalis and Multifidus group**

- Divided into pars thoracic and pars lumborum
- Pars thoracics have a strong extensor moment with low compressive force
- Pars lumborum generates posterior shear forces that support reaction anterior shear force of the upper vertebrae

**Multifidus**

- Forces only affect small areas of the spine
- Produce extension torque
- Hypothesis – also provides somatosensory input for positional awareness.

**Target Muscles**

- Multisegmental muscles
  - Produce and control spinal motion
  - Examples:
    - Transversus Abdominis
    - Rectus Abdominis
    - Lumbar Erector Spinae
    - Quadratus Lumborum
    - Obliques

**Transversus Abdominis**

- Inner surfaces of cartilage of lower six ribs to linea alba by aponeurosis
- Abdominal hollowing*
- Draw abdomen up and in
- Incorporate into the exercise program

**Rectus Abdominis**

- Pubic crest and symphysis to 5th, 6th and 7th rib costal cartilage
- Major trunk flexor*
- All sections of the rectus are activated together
- No functional separation appears to exist between upper and lower abs*

**Erector Spinae**

- Superman exercises
  - > 4000N of spinal compression
- Quadruped exercises
  - Minimizes spine load

*Lehman, McGill, 2001
**Quadratus Lumborum**

- Attach to TP of all lumbar vertebrae, pelvis and rib cage
- Acts as a buttress to lateral instability
- Appears to be highly involved in spine stability

**Internal/External Oblique**

(Anterior view)

- Anterior and lateral fibers
- IO has upper and lower anterior fibers
- Lower anterior fibers support and compress lower abdominal viscera with TA

**Internal/External Oblique**

(Posterior view)

- Obliques are regionally activated (superior vs inferior)
- Increase activity when spine is axially compressed*

*Juker MG and Kropf, 1998

**Don’t Forget Important Muscles**

- gluteus maximus
- gluteus medius
- hip adductors
- rectus femoris
- iliopsoas
- trapezius
- latissimus dorsi
- deltoid
- pectoralis major

**Serape Connection**

This figure shows the muscles involved in the serape effect.
EVALUATION

Testing Muscle Endurance

- **Side Bridge test**
  - Tests lateral muscles (obliques)
  - Top foot placed in front of bottom foot
  - Failure occurs when straight line position is lost and hip touches table


Testing Muscle Endurance

- **Flexion Test**
  - Tests abdominal muscles (rectus)
  - Hips and knees at 90° angle
  - Trunk rests against a board angled at 60° off the horizontal
  - Board is pulled back 4 in.
  - Failure occurs when any part of the back touches the board

Testing Muscle Endurance

- Extension Test
  - Tests back muscles (erector)
  - Hold in horizontal position
  - Failure occurs when upper body drops from horizontal


Endurance Norms

- Men
  - Extension
    - 160 sec.
  - Flexion
    - 135 sec.
  - Side bridge
    - 96 sec.

- Women
  - Extension
    - 185 sec.
  - Flexion
    - 134 sec.
  - Side Bridge
    - 76 sec.

Endurance Ratios

- Right-sb/Left sb endurance < 0.05
- Flexion/extension endurance < 1.0
- SB (either side)/extension endurance < 0.75

Neutral Spine

- Helps decrease shear loads
- Very important to teach
  - Hip Hinge
  - Squat
    - Depth
    - Foot width
  - Deadlift
    - Pull height
  - Kettlebell

Finding the Best Exercise(s)

- Access Athlete
- Access Sport Demand
- Choose best exercise

Program sessions

- Remove the cause
- Preparation / prehabilitation / warmup
- core work
- movement patterns
- specific athleticisms
- specific concerns
Training Considerations

• Peak / taper
• Phase and periodization
• Rest and recovery
• Injury history

Guidelines

• Groove motion patterns, motor patterns, corrective exercise
• Build whole body and joint stability
• Improve Speed & Agility
• Build Strength
• Increase Endurance
• Develop Power & Explosiveness

Goals of Training

• Produce high levels of muscle activation
• Low level of spinal loading
• Consider strength, endurance and neuromuscular factors

Things to consider

• The spine needs to move – but is limited in the number of bends. The more the load while bending, the fewer the tolerable bends. Choose best way to use these.
• Loading and work causes adaptation but also temporary weakening. Muscle, bone, connective tissue will adapt. Discs do not. Repeated bending will eventually tip the balance to cumulative damage outstripping the pace of repair.
• Sparing the spine while training will lead to higher tolerable volume of training. Hundreds of situps will limit training volume.
• Restoration and interval training – more frequent rest intervals for tissue repair than muscle intervals.

Integration vs Isolation

• Isolation
  – Crunch
  – Oblique crunch
  – Planks

• Integration
  – Plank with extremity movement
  – Four point kneeling with extremity resistance
  – Paloff / Pistol presses
  – Battling ropes

McGill SM. Ultimate Back Fitness and Performance. 2004
McGill SM. Low Back Disorders. 2002
Stabilization Myths

- Sit ups
  - Replicates potential injury mechanism
  - Cause increase compression of lumbar spine and discs
  - Do not press low back against floor
- Leg raises
  - Increase psoas activation and spine compression

Loads During Sit Up

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Moment (Nm)</th>
<th>Compression (N)</th>
<th>Shear (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Straight Leg</td>
<td>66</td>
<td>3234</td>
<td>257</td>
</tr>
<tr>
<td>Bent Knee</td>
<td>64</td>
<td>3413</td>
<td>302</td>
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</table>

Spinal loads for specific exercises

<table>
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Rectus Abdominals

Stabilization Myths

- Strength
  - Poor association with low back health
- Range of Motion
  - Increased ROM may lead to greater risk of back injury
  - Must have enough stability for all motions
- Endurance
  - Most important in preventing back dysfunction
Transverse Abdominal Contraction

Abdominal Crunch

Stir the pot

Plank to side plank

Pray to side plank

Four point Kneeling
Four point kneeling square

Pistol / Paloff press (Lateral flexion)

Pistol / Paloff press (rotation)

Pistol / Paloff press (flexion)

Exercise Progression
Abdominal Bracing Exercises (NWB)

Exercise | Criterion for Progression
---|---
Abdominal bracing (supine) | 30 reps with 8 second hold
Abdominal bracing (supine) with heel slide | 20 reps per leg on 4 second count
Abdominal bracing (supine) with leg lifts | 20 reps per leg on 4 second count
Abdominal bracing (supine) with bridging | 30 reps with 8 second hold
Abdominal bracing (supine) with single leg bridging | 30 reps with 8 second hold


Exercise Progression
Abdominal Bracing Exercises (WB)

Exercise | Criterion for Progression
---|---
Abdominal bracing (standing) | 30 reps with 8 second hold
Isometric Torsion (row, cable) | 20 reps per side on 6 second count
Abdominal bracing walking | 10 minute with abdominal brace

Only progress to this group if patient is able to complete 20 reps second hold of abdominal bracing with bridging

Exercise | Criterion for Progression
---|---
Abdominal bracing (standing) | 30 reps with 8 second hold
Isometric Torsion (row, cable) | 20 reps per side on 6 second count
Abdominal bracing walking | 10 minute with abdominal brace

# Exercise Progression

## Anterior Trunk Exercises

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<thead>
<tr>
<th>Exercise</th>
<th>Criterion for Progression</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curl up elbows down with TAC (brace)</td>
<td>30 reps with 6 second hold</td>
</tr>
<tr>
<td>Curl up elbows up with TAC (brace)</td>
<td>40 reps with 6 second hold</td>
</tr>
</tbody>
</table>


## Posterior Trunk Exercises

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Criterion for Progression</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palms on counter: Alternating UE</td>
<td>30 reps X 8 seconds per side</td>
</tr>
<tr>
<td>Palms on counter: Alternating LE</td>
<td>30 reps X 8 seconds per side</td>
</tr>
<tr>
<td>Palms on counter: Alternating UE/opp LE</td>
<td>30 reps X 8 seconds per side</td>
</tr>
<tr>
<td>Elbows on counter: Alternating UE</td>
<td>30 reps X 8 seconds per side</td>
</tr>
<tr>
<td>Elbows on counter: Alternating LE</td>
<td>30 reps X 8 seconds per side</td>
</tr>
<tr>
<td>Elbows on counter: Alternating UE/opp LE</td>
<td>30 reps X 8 seconds per side</td>
</tr>
</tbody>
</table>

Only progress to this group if patient is able to complete 10 reps X 8 second hold of abdominal bracing in supine.


## Posterior Trunk Exercises (cont)

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Criterion for Progression</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bolster: Alternating UE</td>
<td>30 reps X 8 seconds per side</td>
</tr>
<tr>
<td>Bolster: Alternating LE</td>
<td>30 reps X 8 seconds per side</td>
</tr>
<tr>
<td>Bolster: Alternating UE/opp LE</td>
<td>30 reps X 8 seconds per side</td>
</tr>
<tr>
<td>Quadruped: Alternating UE</td>
<td>30 reps X 8 seconds per side</td>
</tr>
<tr>
<td>Quadruped: Alternating LE</td>
<td>30 reps X 8 seconds per side</td>
</tr>
<tr>
<td>Quadruped: Alternating UE/opp LE</td>
<td>30 reps X 8 seconds per side</td>
</tr>
</tbody>
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Only progress to this group if patient is able to complete 10 reps X 8 second hold of abdominal bracing in supine.


## Lateral Trunk Exercises

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Criterion for Progression</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abdominal brace with leg lift (sidelying)</td>
<td>30 reps X 8 seconds per side</td>
</tr>
<tr>
<td>Side bridge on wall with brace</td>
<td>30 reps X 8 seconds per side</td>
</tr>
<tr>
<td>Side bridge on wall with brace (distance)</td>
<td>30 reps X 8 seconds per side</td>
</tr>
<tr>
<td>Side bridge with knees bent</td>
<td>30 reps X 8 seconds per side</td>
</tr>
<tr>
<td>Side bridge with knees bent and TAC</td>
<td>30 reps X 8 seconds per side</td>
</tr>
<tr>
<td>Side bridge with knees extended</td>
<td>30 reps X 8 seconds per side</td>
</tr>
<tr>
<td>Side bridge with knees extended and TAC</td>
<td>30 reps X 8 seconds per side</td>
</tr>
</tbody>
</table>

Only progress to this group if patient is able to complete 10 reps X 8 second hold of abdominal bracing in supine.


## Advanced Exercises

- Rotation with tubing, physioball/standing
- Roll outs/walk outs
- Plate or ball tornados
- Stir the Pot on ball
- Bird Dogs with arm and leg movement
- Flutters
- Inverted pull ups
- Staggered push ups
- Single arm DB snatches
- Kettlebell Swings (snatches)
- Overhead squat
- SA overhead squat
- Suspension training
- Band/chain squats
- Crawling
- Bears
- Battling ropes

## Glut/Ham Row Press
Flutter Fall Outs

Tricep Extensions

Overhead Squat

- Neutral spine a must
- Incorporates thoracic and lumbar extensors
- Increases demand by using weights in the hands

Overhead Band Squat

Corner Barbell Squat Press
**Exercise Progression**

Gluteal Integration with Abdominal Bracing Exercises

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Single leg hip ER with ankle together and TAC (clam shells)</td>
<td>30 reps X 8 second hold side</td>
</tr>
<tr>
<td>Supine gluteal sets</td>
<td>30 reps with 8 second hold</td>
</tr>
<tr>
<td>Bridge with gluteal activation</td>
<td>30 reps with 8 second hold</td>
</tr>
<tr>
<td>SL bridge maintaining hip position</td>
<td>40 reps with 8 second hold</td>
</tr>
</tbody>
</table>

**QUESTIONS**

Any questions?

THANK YOU

Michael Higgins PhD, ATC, PT, CSCS
University of Virginia
mjh7s@virginia.edu

Sasha Digges Jr., PT, ATC, CSCS
PEAK PHYSICAL THERAPY & SPORTS REHABILITATION
SASHA@INEEDPEAKPT.COM
TWITTER: @SASHADIGGESPT