Core Stabilization as an Intervention for Low Back Dysfunction

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What is Core Stability?
Global vs Local Stabilizers of the SIJ/LBP

- Global Muscles
  - Control Movement
  - Typical of Therapeutic Ex programs for the spine

- Local Muscles
  - Directly control lumbar segments
  - Provide an Independent Deep Corset Action

Richardson, et al. The relation between the Transversus abdominis muscles, SIJ mechanics And low back pain. Spine 27(4) 2002
Global vs Local Model

- **Global Muscles**
  - Vertical mm fiber orientation
  - EO
  - Erector Spinae
  - RA

- **Local**
  - Transverse mm fiber orientation
  - Tr Ab
  - Multifidus
  - Lower IO
  - Piriformis
  - Pelvic floor mms
Deep Muscle Corset

- Fascia
- Muscle
- Looking for activation
  - not strength or
  - force/tension development
Recommendations from Richardson

- Need integration (coordination) of deep mm & global mm with focus on spinal posture in weight bearing ASAP
- MUST BE in neutral posture (neutral spine)
- Antigravity mm – must be trained 1st
- Multi-joint system
- Can inadvertently train to not to use intrinsic if overload extrinsic
  - Must work mm corset 1st before lifting legs against gravity
Alternative View: McGill

- Abdominal hollowing to re-groove motor patterns
- Will not achieve stability
  - Intrinsic & extrinsic components to spine stability
- Need IO & EO to complete bracing which gives spine stability
- Stability requires an Orchestra not just an instrument
- Double the amount of EMG of Abs on unstable surface
- Side bridges used to groove motor pattern
  - Lock rib case to pelvis
Side Bridge Exercise

- Activation of Quadratus Lumborum
- Provides abdominal wall stabilization with minimal spine loading
- Modified Position
  - On forearm
- Testing on healthy subjects
- Very difficult movement even in modified position
- May contribute to stabilization – but not at beginning of Therapeutic Ex Continuum

Why is it so important all of a sudden?

- Postural habits
  - Life style – sitting
- Increased Repetitive Activity
- Lack of Multiple Sport Participation
  - Limited cross training
Posterior Spine/Core
**Back Extensors**

- **L₃ Longissiumus fibers** run deep at 45 degree angle
- **Post tilted posture** - (slouching) creates flexed spine and takes longissium from 45 degree angle to parallel (McGill)
- **Stretch Weakness**

- A flexed spine allows for shearing & deactivates the multifidus
  - Swiss ball positioning
Sitting

- Unsupported Sitting
  - Increases psoas activity
    - Junker, et al. MSSE 30(2) 1998
  - Decreases Internal & External Oblique activity compared to standing
  - Cross Legged Sitting decreased Oblique Activity compared to regular sitting
  - After 20 minutes of Lumbar Flexion (feline model)
    - Only 80% recovery after 7 hrs of rest
      - EMG activity of (L₁-L₇) Multifidus
      - Strain of L₄/L₅ Supraspinous ligament
Clinical Implications

Prolonged Sitting In Poor Posture Promotes: Muscular Weakness
✓ multifidi
✓ obliques
The Lower Back
Spine Stiffness

Leonardo Da Vinci
- central muscles stabilize
- lateral muscles move

McGill & Cholewicki
JOSPT 31(2) 2001

Springs
Stiffness

Muscles function as Springs
Muscles act as Guide Wires
Mechanical Components

- Neutral Spine
- Functional Zones
Spine Stabilization

- **Neural Sub-System**
  - Controls active & passive sub-systems
    - Feedback mechanisms
    - “Force transducers” in ligaments, muscles, tendons & neural control centers
  - Compensates to maintain stability .....of the system
    - May compromise locally for global stability
    - Resultant tissue and joint degeneration, abnormal muscle loads, fatigue, etc.
Spine Stabilization - cont

- Passive Sub-System
  - Vertebrae
  - Facet articulations
  - Intervertebral discs
  - Spinal ligaments
  - Joint capsules
  - Passive mechanical properties of the muscles

- Active Sub-System
  - Muscles & tendons
  - Surrounding spinal column
Neutral Spine

- "the posture of the spine in which the overall internal stresses in the spinal column and the muscular effort to hold the posture are minimal"

- What does that look like clinically........??
Neutral Pelvis

- Activation of lumbar multifidus
  - Small and gentle lumbar curve
- Activation of errector spinae
  - Long and accentuated lumbar curve
  - Resultant thoracic and cervical adaptations
Lumbar Lordosis

- Gentle lordotic curve
- Lumbar vertebrae only

- Exaggerated lumbar curve
- Extends to thoracic region

lumbar multifidus

errector spinae
Functional Zones

- Neutral Zone
  - Minimal internal resistance
  - Thought to be controlled by multifidus
    - Kaigel, 1995

- Elastic Zone
  - End of the neutral zone up to the physiological limit

- Note: repeated physiological loading
  - Residual displacement of tissue
Clinical Implications

- Displacement beyond the neutral zone due to compensation would result in damage, degeneration, abnormal muscle loads and muscle fatigue.
- Spinal ROM that is typically measured clinically, encompasses the available displacement from both the neural & elastic zones.
- The current **clinical** model is insensitive to ongoing physiological adaptation & damage and that when changes in spinal ROM are seen clinically, irreparable damage may already be done, precluding prevention intervention strategies.
Role of the Pelvis

The Key Stone to the Core
Connects the Trunk to Lower Extremity
Influences Activation of the Gluteus Maximus

Hip Rotators
Alters Length Tension Relationship of the Lateral Hip Muscles

Hamstrings and Quadriceps
Alters Length Tension Relationship of the TLF & Extensors
Alters Length Tension Relationship of the Latissimus Dorsi & Influences the Entire Shoulder Girdle
Effect of Pain on Stabilization
Pain

- Inhibition
  - Requires pain resolution to get re-activation
  - May required “active” re-activation
- Delayed activation
- Changes in intrinsic (local) muscle pattern
  - More predictable pattern
- Changes in extrinsic (global) muscle patterns
  - Variations per person

✓ Hodges
Fascial Components

A. Vleeming, C.J. Snijders and others
General Principle

- Muscle activation
  - Pulls on fascia
  - Applies tension over an area
Thoracolumbar Fascia

- Superficial Lamina is continuous with:
  - Gluteus maximus & medius
  - Latissimus dorsi
  - Trapezius
  - External Obliques
  - Extensive attachments to sacrum & ilium

- Deep Lamina is continuous with:
  - Sacrotuberous ligament
  - Biceps femoris (thru STL)
  - Serratus posterior
  - Internal Obliques

Contralateral Effects of the TLF

- The Gluteus Maximus – Latissimus Dorsi – Thoracolumbar Fascia Connection
- Provides pathway for uninterrupted mechanical transmission between the pelvis and the trunk
JANDA’S PELVIC CROSSED SYNDROME

Clinical Implications

- Role of Gluts In Pitcher’s Shoulder
- Predictable Shoulder problems some time after Total Hip Replacement (?)
Exercise Sandals
Promoted ~200% increase in
gluteus maximus & medius activation
Bullock-Saxton et al. Spine 18(6) 1993
Form & Force Closure

Form Closure
- Configuration of the Joint (closely fitting) provides stability
  - Sacroiliac joint
  - Arch

Force Closure
- Muscular Contraction provides stability
  - Errector spinae tensions the TLF
  - Latissiumus dorsi & Gluteus Maximus contralateral relationship

Snijders et al. Electromyography and Kinesiology 8, 1998
The Role of Static Posture and Postural Habits

3 Imbalance Syndromes

- Pelvic Crossed Syndrome
  - Lower quarter
- Layer Syndrome
  - Hypertrophic & Hypotrophic areas
  - Imbalance between the phasic & postural muscles
- Proximal or Shoulder Girdle Syndrome

Pelvic Crossed Syndrome

- Weak or inhibited abdominals & gluteus maximus
- Loss of hip extension with resultant compensatory increase in **forward pelvic tilt** & extension of lumbar spine
- Tight erector spinae & iliopsoas
- If weak gluteus medius
  - Tightness in ipsilateral (same side) quadratus lumborum & tensor fasciae latae
The Role of Posture
Asymmetrical Loading

- S  specific
- A  adaptation
- I  imposed
- D  demand

Rotation of car tires
Asymmetrical Hip Rotation

- Three Patterns of Hip Rotation
  - Symmetrical IR & ER
    - Mostly healthy subjects (27%)
  - Asymmetrical (> 10 degrees) IR > ER
    - 41% healthy & 30% LBP
  - Asymmetrical (> 10 degrees) ER > IR
    - Most prevalent in LBP group (48%) vs 27% of healthy subjects

Eastern Athletic Trainers’ Association
January 7, 2005

Stance

Feet Straight Ahead

Gluteus Maximus Activation
Core Stability
Case Study

Three week
Foam Roller Intervention
LOWER QUARTER

- Neutral Spine Positioning
  - abdominal hollowing
- One Knee to Chest
- Focus on Lower Back Contact with Roller as Leg is “Let Down”
- Use Leg as lever arm progression
  - 45°, 90°, 135°
Methods

- Single-subject case study design

Subject
- 28 year old female
- prior complaints of low back pain with difficulty balancing

Data collected 3 x week for 4 weeks

Base line data collected for first week

Treatment Intervention of FRCSP
Methods

✓ Pelvic Inclination
  ASIS & PSIS marked via palpation
  Calipers & protractor used to measure inclination angle
  Average of 3 trials

✓ Center of Balance (COB)
  Average of 3, 30 sec. trials for A/P COB on Chattecx Balance System
Methods

- Strength measured by manual muscle test (MMT)
  - 3 trials averaged
  - Oblique strength measured using hand held force transducer

- Rectus Abdominis measured per Kendall leg lowering MMT
**Methods**

**Core Stability Training**
- ✓ 3’ 6” foam roller
- ✓ Initial postural alignment/neutral
- ✓ Single knee to chest to set posterior pelvic tilt
- ✓ Single leg “let down” with knee flexed to 45 degrees

✓ 10 repetitions
✓ 3 sets, 3 times/week
RESULTS

- With treatment intervention there was an immediate and progressive
  - Oblique muscle strength increase
  - Rectus abdominis muscle strength increase.

- With treatment intervention there was an immediate re-orientation of
  - COB from an abnormally anterior position to a slightly posterior position
  - Pelvic inclination towards neutral
Oblique Muscle Strength

![Graph showing the increase in oblique muscle strength over time for right and left sides. The graph has a horizontal axis labeled 'Time (days)' ranging from 1 to 26 and a vertical axis labeled 'Force (lbs)' ranging from 0 to 50. The graph includes two lines representing right and left sides, with the right side consistently stronger.]
Rectus Abdominis Muscle Strength

![Graph showing the relationship between time (days) and hip flexion angle (degrees). The graph displays a downward trend in hip flexion angle over time.]
A-P COB Alignment

Time (days)

Anterior

Posterior

A-P COB Alignment (cm)
Anterior View

Pre-Foam Roller

Post - 3 weeks Foam Roller
Posterior View

Pre-Foam Roller

Post - 3 weeks Foam Roller
Functional Squat

Pre-Foam Roller

Post - 3 Weeks Foam Roller
Single Leg Stance

Pre-Foam Roller

Post - 3 Weeks Foam Roller
Assessment
Assessment

- Local Muscle Activation
- Global Muscle Re-Balancing
- Local and Global Muscle Coordination
Local Muscle Activation

- Pelvic Floor Muscles
- Diaphragm
- Transverse Abdominis
- Multifidus
Abdominal Hollowing Training: *transverse abdominis training*

- Navel to spine
- Co-activate
  - Pelvic Floor Muscles
  - Multifidus
- Palpation
  - Medial to ASIS
Abdominal Hollowing Training

- Progression
  - Supine
  - Quadruped
  - Sidelying
  - Wall lean
  - Standing
  - Functional activities
The Stabilizer Pressure Biofeedback Unit (TrAb)

- Abdominal Assessment
  - Objective Measures
- Kendall’s Leg Lowering
- Sahrmann’s Lower Abdominal Series

http://www.optp.com/
1-888-819-0121
Pelvic Floor Muscles

1. The Spine
2. The Uterus (Womb)
3. The Rectum
4. The Bladder
5. The Pelvic Floor Muscles

Pubococcygeus
Treatment for Weak Pelvic Floor Muscles

- Kegel Exercises
  - Use primarily in female urinary incontinence
  - Appropriate to use in men
  - 5 minutes – Twice per day
  - Strengths the floor of the Body’s Core
Pelvic Floor Muscles

- Pelvic Floor Exercises for Women
  - http://www.continence-foundation.org.uk/docs/pelvwom.htm

- Pelvic Floor Exercises for Men

- Pelvic Floor Exercises for Pregnancy
  - http://www.epregnancy.com/info/fitness/kegels.htm
Pelvic Floor Exercises – cont.

- Kegel Exercises.com

- The mis-use of Kegle exercises
  - [http://www.incontinet.com/articles/art_urin/bastard.htm](http://www.incontinet.com/articles/art_urin/bastard.htm)

- Kegel Bibliography
  - [http://www.incontinet.com/articles/art_urin/kegelbib.htm](http://www.incontinet.com/articles/art_urin/kegelbib.htm)
Diaphragm

Inhalation: active
✓ Diaphragm expands and flattens
✓ Ribs Abduct/rotate

Exhalation: passive
✓ Diaphragm retracts (up)
✓ Ribs relax
Incorrect Breathing Techniques

- **Upper Lung Breathing**
  - Lift upper chest
  - Raise shoulders
  - Arch Back

- **Diaphragm**
  - Lower abdominal expansion (anterior)
  - Leave lower back unprotected
Incorrect Breathing Techniques

- Hatha Yoga Approach
  - Clavicular Breathing
    - Upper lung breathing
  - Diaphragmatic Breathing
    - Diaphragm depresses with abdominal expansion
  - Intercostal Breathing
    - Rib rotation and abduction
Ideal Breathing Technique

- Combination and Coordination of
  - Upper lung/clavicular breathing
  - Diaphragmatic breathing
  - Intercostal breathing
Breathing Exercise

Goal: Lateral Rib Flare

1. Hold a towel around your ribs, cross it over at the front.
2. Breath in and feel the towel expanding.
3. Gentle squeeze the towel as you breath out.

http://www.nismat.org/ptcor/comp_ther/
Multifidus

- Co-activate
  - Pelvic Floor Muscles
  - Transverse Abdominis

- Palpation
  - Lumbar spine
    - Lateral = errector spinae
Multifidus Training

- Progression
  - Supine
  - Quadruped
  - Sidelying
  - Wall lean
  - Standing
  - Functional activities
Neutral Pelvis

- Activation of lumbar multifidus
  - Small and gentle lumbar curve
- Activation of erector spinae
  - Long and accentuated lumbar curve
  - Resultant thoracic and cervical adaptations
Lumbar Lordosis

- Gentle lordotic curve
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lumbar multifidus

errector spinae
Neuromuscular Implications

- Natural Stance
- Feet Hip Width
- Narrower Stance
- Adjusted Stance
- Gluteus Maximus Activation
Postural Symmetry

Balanced Stance
Postural Asymmetries

- Excessive lumbar lordosis – spondylolysis
- Anterior Inclination of the Pelvis
  - tight hip flexors
  - weak gluteus maximus/gluteus medius
  - weak abdominals
- Center of mass shifted anteriorally
- Thoracic kyphosis
- Shoulder girdle - anterior to pelvis (base)
- Bilateral IR of the upper extremity
  - protracted scapula
  - poor scapula stability
  - GHJ impingement
- Lower Extremity Externally Rotated
  - increased base of support
Sitting Posture

End ROM Stability

Good Mechanical Alignment
Requires Neuromuscular Control
Quadruped Assessment

Natural Position
Collegiate wrestler

Alignment:
Hip to Knee
Shoulder to Wrist
Cervical to Lumbar
Quadruped Assessment and Treatment

Elbow Hyperextension

Therapeutic Intervention

Elbow – Neutral Joint
INTERVENTION
SUPINE POSITIONING

- Correct Start Position
  - reduced lumbar extension
  - reduced thoracic extension
- Appropriate Shoulder Girdle Positioning
  - scapula depression
SUPINE POSITIONING

incorrect

- Poor Positioning
  - inappropriate lumbar positioning
  - inappropriate thoracic cage positioning
SUPINE POSITIONING

incorrect

- Poor Positioning
  - inappropriate lumbar positioning
  - inappropriate thoracic cage positioning
SUPINE POSITIONING
Incorrect / Correct
SUPINE POSITIONING
incorrect

- Excessive shoulder shrug
- Anterior shift of shoulder girdle
- Internal rotation of humerus
UPPER QUARTER

- Position Core
- Depress Shoulder Girdle
  - monitored by opposite hand
- Humeral Flexion
- Stable Lower Quarter
  - (neutral lumbar spine)
UPPER QUARTER

- Glenohumeral abduction
- Shoulder girdle depressed
  - monitored by opposite hand
- Cervical & lumbar neutral
- Humerus ER’d
UPPER QUARTER

- Glenohumeral External Rotation
- Shoulder girdle depressed
  - monitored by opposite hand
- Cervical & lumbar neutral
UPPER QUARTER

- Glenohumeral Internal Rotation (NOT lifting)
- Shoulder girdle depressed
  - monitored by opposite hand
- Cervical & lumbar neutral
ABDOMINAL STABILITY
SUPINE START POSITION incorrect

- Poor Positioning
  - inappropriate lumbar positioning
  - inappropriate thoracic cage positioning
SUPINE START POSTION

- Correct Start Position
  - reduced lumbar extension
  - reduced thoracic extension

- Goal: As much contact with the roller as possible from L5-S1 to T1-T2
SUPINE START POSTION

- Correct Start Position
  - reduced lumbar extension
  - reduced thoracic extension

- Goal: As much contact with the roller as possible from
  - L5-S1 to T1-T2
SUPINE START POSITION

Incorrect / Correct
LOWER QUARTER

- Neutral Spine Positioning
- One Knee to Chest
- Focus on Lower Back Contact with Roller as Leg is “Let Down”
LOWER QUARTER

- Neutral Spine Positioning
- One Knee to Chest
- Focus on Lower Back Contact with Roller as Leg is “Let Down”
- Knee Extended to 45 degrees
  - increased lever arm
LOWER QUARTER

- Neutral Spine Positioning
- One Knee to Chest
- Focus on Lower Back Contact with Roller as Leg is “Let Down”
- Knee Approaching Full Extension
  - increased lever arm
LOWER QUARTER

- Supine Balancing in Neutral Spine
- Lower Quarter Positioning
  - Hips at 90 degrees
  - Knees at 90 degrees
  - No contact between legs
LOWER QUARTER

- Supine Balance - core positioning
- Remove Hands from Floor & Balance
  - Rectus Abdominis (lower)
  - Int/Ext Obliques
  - ?Transverse Abdominis
LOWER QUARTER

- Supine Balancing
  - Stable Core

- Upper Quarter Challenge: FF
  - appropriate shoulder girdle positioning
  - quality glenohumeral motion
  - appropriate scapula rotation
LOWER QUARTER

- Stable Core
- Upper Quarter Challenge: ABD
  - appropriate shoulder girdle positioning
  - quality glenohumeral motion
  - appropriate scapula rotation
UPPER QUARTER

**incorrect**

- Incorrect Start Position
  - elevated shoulder girdle
  - internally rotated humerus
  - cervical extension
UPPER QUARTER

incorrect

- Excessive shoulder shrug
- Anterior shift of shoulder girdle
- Internal rotation of humerus
UPPER QUARTER

*incorrect*

- Adjusted shoulder girdle
- Thoracic cage over extended
- Humerus still internally rotated
- Cervical spine extension
UPPER QUARTER

- Quality Positioning
  - Depressed shoulder girdle
  - Neutral cervical spine
  - Relaxed thoracic cage
  - Humerus in neutral or externally rotated
UPPER QUARTER

- Position Core
- Depress Shoulder Girdle
  - monitored by opposite hand
- Humeral Flexion
- Stable Lower Quarter
  - (neutral lumbar spine)
UPPER QUARTER

- Glenohumeral abduction
- Shoulder girdle depressed
  - monitored by opposite hand
- Cervical & lumbar neutral
- Humerus ER’d
UPPER QUARTER

- Quality Core Positioning
- Appropriate Shoulder Girdle and Humeral Positioning
- Unsupported Arm
UPPER QUARTER

- SCAPTION

- Watch for Cheating:
  - elbow flexion
  - scapula elevation vs. rotation
  - lumbar, thoracic & cervical extension
RESISTED UPPER QUARTER

- MUST Demonstrate:
  - consistent quality of motion in:
    - all glenohumeral cardinal planes
    - with core stability
    - and be pain free
Quadruped

- Hips at 90 degrees
- Hips over Knees
- Knees at 90 degrees
  - padding as needed
- Shoulders at 90 degrees
- Elbows extended but unlocked (pain free wrists)
- Cervical Spine in neutral
Quadruped incorrect

- Hips > 90 degrees
- Hip Not over Knee
- Thoracic Flexion
- Shoulders > 90 degrees
- No Shoulder/Wrist Alignment
- Elbows Locked Out
Quadruped

- ROW
  - Opposite arm stabilization
  - Extensor stabilization in neutral spinal
  - “Scapula” strengthening in shortened position
Quadruped

- Triceps Extension
  - Scapula depressor
  - Opposite arm stabilization
- Extensor stabilization
- “Scapula” strengthening in shortened position
Quadruped

- "T" of TIY
  - Opposite arm stabilization
  - Extensor stabilization with neutral spine
  - Scapula strengthening in shortened position
Quadruped

- “I” of TIY
  - Opposite arm stabilization
  - Extensor stabilization
  - Scapula: shortened position with functional rotation
Quadruped

- “Y” of TIY
  - Opposite arm stabilization
  - Extensor stabilization
  - Scapula: shortened position
  - Overhead recruits lower trapezius
T I Y
Quadruped

- External Rotation
  - Opposite arm stabilization
  - Extensor stabilization
  - Scapula strengthening in shortened position
Quadruped

- External Rotation
  - Opposite arm stabilization
  - Extensor stabilization in
  - Scapula strengthening in shortened position
Quadruped

- **D₂ Pattern**
  - Opposite arm stabilization
  - Extensor stabilization/neutral
  - Scapula: shortened position
  - Functional diagonal pattern
Quadruped

- **D₂ Pattern**
  - Opposite arm stabilization
  - Extensor stabilization
  - Scapula : shortened position
  - Functional diagonal pattern; eyes follow hand
D$_2$ FUNCTIONAL PATTERN
Quadruped

- **Kneeling Thoracic Rotation**
  - Opposite arm scapula stabilization
  - Extensor stabilization in neutral spinal
  - Scapula: shortened position
  - Functional diagonal pattern
Quadruped

- Kneeling Thoracic Rotation
  - Opposite arm scapula stabilization
  - Extensor stabilization
  - Scapula: shortened position
  - Functional diagonal pattern; eyes follow hands
KNEELING THORACIC ROTATION
Quadruped

- “Bird Dog”
  - Opposite scapula & hip stabilization
  - Extensor stabilization in neutral spinal extension/flexion
  - Lower trapezius & gluteus maximus activation
  - Functional diagonal pattern
MULTIFIDUS - incorrect
Shoulder Drop/Hip Over Extended
BIRD DOG PROGRESSION
BIRD DOG PROGRESSION
RESOURCES
Florence & Henry Kendall

1950’s to Present
Shirley Sahrmann

✓ Student of Kendall’s
✓ 1980’s to Present

“Review of Length Associated Changes In Muscle”
Grossman, et al.
Physical Therapy
December 1982
Vladimir Janda – Czechoslovakia
1970’s to Present
Carolyn Richardson

 ✓ Jull
 ✓ Hodges
 ✓ Hides

 ✓ Australian
 ✓ 1980’s to present

New Edition
Vern Gambetta

Strength & Conditioning Focus

http://www.gambetta.com/articles.html
C.H.E.K. Institute

http://www.paulcheck.com/
National Academy of Sports Medicine

Optimum Performance Training
- Integrated Flexibility
- Core Training
- Balance Training
- Power Training
- Strength Training
- Speed Training

Continuing Education/Certifications
- Performance Enhancement
- Personal Training
- Integrated Manual Therapy

Mike Clark
http://www.nasm.org/
Multiple Sources of Literature

- Australians
  - Mc Gill
  - Gracovetsky

- Canadians
  - Vleeming
  - Snijders

- Scandianvians

Various lines of research…..

Not in typical clinical journals
Multiple Clinical Approaches

- Kendall and Sahrman
- Vladimir Janda
- Paul Check
- Vern Gambetteda
- Mike Clark
  ◆ National Academy of Sports Medicine
Summary
Integrated Summary

- Activate the Local Muscle System
- Identify & Rebalance the Global System Muscles
- Coordinate the Local and Global Muscle Systems
- Progress to Traditional Strength & Conditioning
Core Stability

- Requires the stability of multiple joints
- Complex neuromuscular components
- Complex mechanical components
  - Fascial stability
- Requires an integrated approach
  - Addressing one muscle couldn’t possibly be the solution
Summary

- Multidimensional System
  - local system
  - global system
  - compensations
  - interaction with environment