Objectives

- Understand the components of evidenced based core strengthening
- Be able to discuss the role of the inner core in core strengthening and know how to activate it properly
- Be able to identify abnormal patterning during core exercises and know what muscles are overcompensating

Objectives

- Be able to challenge the core through the appropriate progression of exercises
- Know how to address flexibility and strength in the hip in light of the latest research and what exercises are recommended
Overview

- Dynamic core stabilization
  - Research, integrated model of functioning, muscle slings
- Pelvic Rotator Cuff theory
- Activating the core
- LAB
  - Static
  - Dynamic
  - Other therapeutic exercise
    - Stretching
    - Strengthening

Reflection Moment

How do you teach core?
First exercise
List steps
1 minute

Dynamic Core Stabilization
Research • What is Core?
Integrated Model of Function
Core Strengthening from the Inside/Out

Research

- Abdominal canister construct
  - Diaphragm and transversus abdominus (TA) muscles
  - Tonic and phasic activity with rib cage and abdomen
    - Pressure in abdominal cavity
    - Improves control of spine
    - UE and LE movement

Research

- Abdominals work with pelvic floor muscles (PFM)
  - No matter which initiates contraction
  - EMG (fine needle) assessment PFM and rectus abdominus (RA), external oblique (EO), transversus abdominus (TA)

Research

- Position of the spine matters
  - Co-activation PFM and abdominals
    - EO greatest with lumbar flexion
    - TA greatest with lumbar extension
  - What does this mean to us clinically??

Hodges et al. 2000

Sapsford et al. 2001

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Research

- What about the multifidi?
- EMG analysis
  - Supports
    - Superficial
    - Spine orientation
  - Deep
    - Intersegmental motion

Moseley et al. 2002

Research

- Hallowing vs TA?
- TA contraction
- Sacroiliac joint stiffness increased
  - Supports use of TA exercise for LBP treatment

Richardson et al. 2002

Research

- PFM contributes to postural and respiratory function
  - EMG activity anal and vaginal (surface electrodes)
- Respiratory
  - Increased PFM with expiration
- Single and repetitive arm movements
  - PFM EMG was tonic with phasic bursts
  - Influenced by frequency and acceleration of arm movement
  - Responds to increased reactive forces on spine

Hodges et al. 2007
Research

- PFM EMG activity in advance of deltoid
  - Anticipatory postural activity
- PFM EMG modulated with arm movement not respiratory

Hodges et al. 2007

Reflection Moment

Key points of research findings?
Partner activity
1 minute

Research

- Does motor control exercise reduce disability?
  - Greater in those poor ability to recruit
  - Significant moderate correlation
  - Improved TA recruitment and reduction in disability

Ferreira et al. 2010
Research

- Research with single leg squat
  - Intentional core activation
  - Improved hip and knee kinematics
  - More evident in low core group
  - Weaker

- Systematic reviews
  - Therapeutics exercise/EMG muscle onset timing (Crow 2011)
  - Improves TA muscle onset timing in people with LBP
  - Core stability exercise more effective in short term, not long term over general exercise (Wang et al, 2012)
  - Pain and function, 6 and 12 months
  - Stabilization exercises not more effective than other forms of active exercise in the long term (Smith et al 2014)

- Systematic review: stabilization exercises for non-specific LBP (Smith et al 2014) (con’t)
  - Limitations
    - Wide variety of patients
    - Low, medium or high socio-economic groups, employed/unemployed, with or without leg pain, acute or chronic symptoms, high levels of fear avoidance, distressed
    - Wide variety of treatment delivery
    - Class settings, one to one, class/one to one with home exercise, just home exercises, varying amount of therapist contact time
Research

- Rehabilitation strategy re stabilization exercises questioned
  - Encourage unhealthy thoughts and beliefs on pain and movement
  - Biomedical model vs. biopsychosocial model
    - Therapist's beliefs/patient's beliefs (Nijs et al 2013) (O'Sullivan, 2016)

Reflection Moment

Any changes to how you would teach beginning core exercise based on the research?

What is Core?

- What muscles involved? How to strengthen it?
  - Depends who is talking
- Health professionals
- Researchers
- Fitness professionals
- Consumer magazines/internet
What is Core?

Men's Journal
The 10 Moves You Need to Get a Rock-Solid Core

10 MOVES
- Transfer planks
- Hanging leg raises
- Renegade rows
- Ab wheel rollouts
- 4 point touch
- Split stance cable lift
- Dragon flags
- Medicine ball slams
- Weighted back extensions
- Side planking
Inner and Outer Core

- Inner Core (local, postural)
  - Anticipatory system
  - Activate prior to the deltoid in UE tasks
- Outer Core (global, movers)
  - Reactive or external core

Inner Core

- Inner Core Muscles (Lee 2011, Akuthota 2008)
  - PFM
  - TA, IO (internal obliques)
  - Multifidus
  - Diaphragm
  - Deep fibers of the psoas
  - Deep hip rotators

Inner Core

- PFM in pelvic bowl, against pelvic bones
Inner Core

Transversus Abdominus

**Origin:**
- Lower 6 ribs
- Thoracolumbar fascia
- Anterior 3/4 of the iliac crest
- Lateral 1/3 of the inguinal ligament

**Insertion:**
- Linea alba
- Pubic crest
- Pecten of the pubis

**Nerves:**
- Intercostal nerves T7-T11
- Subcostal, iliohypogastric and ilioinguinal nerves

**Action:**
- Compresses abdomen

Internal Oblique

**Origin:**
- Thoracolumbar fascia
- Anterior 3/4 of the iliac crest
- Lateral 1/3 of the inguinal ligament

**Insertion:**
- Lower 3rd or 4th ribs
- Linea alba
- Pubic crest

**Nerves:**
- Intercostal nerves T7-T11
- Subcostal, iliohypogastric and ilioinguinal nerves

**Action:**
- Trunk flexion and lateral flexion
Inner Core

- Deep hip rotators
  - Piriformis
  - Obturator internus
  - Gemilli brothers
  - Superior and inferior

Multifidi
- Origin: sacrum, erector spinae aponeurosis, PSIS, iliac crest
- Insertion: spinous process
- Actions: bilateral trunk extension, unilateral side-bending, contralateral rotation
  - Proprioceptive feedback

Diaphragm
Reflection Moment

What are the outer core muscles?

Outer Core

- Core (Akuthota et al. 2008)
  - "Group of trunk muscles that surround the spine and abdominal viscera"
- Outer core predominance fast twitch fibers, "global" vs "local"
  - Rectus abdominis
  - External obliques
  - Erector spinae
  - Quadratus lumborum

Rectus abdominus

- **Origin:** Anterior pubis
- **Insertion:** Cartilages of ribs 5-7, Xiphoid process of sternum
- **Nerves:** Intercostal nerves
- **Action:** Flexes lumbar spine
  - Active during expiration
  - Maintenance of abdominal tone

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Abdominal muscles

Transverse section of the anterior abdominal wall

Rectus abdominus is surrounded by sheaths both anteriorly and posteriorly

- EO aponeurosis anterior to the rectus abdominus
- IO aponeurosis splits and passes in front and behind (anterior and posterior) to the rectus abdominus
- TA aponeurosis passes behind (posterior) to the rectus abdominus

Dynamic Core Stabilization
Inner and Outer Core

- Core
  - Muscular box
  - 29 pairs of muscles stabilize spine, pelvis and kinetic chain
  - Proper force distribution with minimal
    - Compressive
    - Translational
    - Shearing forces at the joints of the kinetic chain

Akuthota et al 2008
Dynamic Core Stabilization
Inner and Outer Core

- Proximal stability allows distal mobility
- Clinical instability (Panjabi, 2003)
  - No neurological deficit or major deformity or incapacitating pain
  - Vs. mechanical instability

Dynamic Core Stabilization
Inner and Outer Core

Overflow of Internal to External Core

- EMG studies (of PF contraction supine)
  - Lumbar flexion—increased external oblique (EO)
  - Lumbar extension—increased transversus abdominus (TA) over rectus (RA) or EO

Dynamic Core Stabilization

Integrating Model of Function

Function

- Force closure
- Muscle tone
- Motor control
- Neural patterning

Lee & Hodges 2003
Integrated Model of Function

Form Closure

- Force Closure
  - Muscle function
  - Increases during voluntary isometric contractions (EMG)
    - Biceps femoris
    - Gluteus maximus
    - Erector spinae
    - Contralateral latissimus dorsi

Integrated Model of Function

Form + Force Closure
Integrated Model of Function

• What happens when your inner core is weak?
  • Compensation, outer core
  • Movers not stabilizers
  • Splinting occurs
    • Muscle spasms, neural compression, pain

Integrated Model of Function

• Force closure and concept of muscle slings
  • What are muscle slings?
  • Slings
    • Primary (internal, local or anticipatory core)
    • External (global or reactive core)
      • Anterior Oblique
      • Posterior Oblique
      • Longitudinal
      • Lateral

Integrated Model of Function

Muscle Slings

• Posterior
  • Lat dorsi, thoracolumbar fascia (TLF), glut max

• Anterior
  • EO, abdominal fascia, contralateral adductors

• Lateral
  • Glut med/min, TFL, lateral stabilizers of the thoracopelvic region
Pelvic Rotator Cuff

by Janet Hulme

What is it?
Who here uses it?
What muscles are in the PRC?

Obturator internus
Pelvic diaphragm
Urogenital diaphragm
External urinary & anal sphincters
Hip adductors
Pelvic Rotator Cuff

- Acts synergistically
  - TA, multifidus, lumbo-pelvic fascia
- Balance needed
  - Excessive EO, RA>PF
  - PF descends
  - Toothpaste analogy
    - Excessive abdominals >> pelvic floor

Analogies
Pelvic Rotator Cuff

- Must function properly to support the pelvic rotator cuff
  - Breathing diaphragm
  - Latissimus dorsi/contralateral glut max
  - Abdominals (especially TA)
  - Gluteals
  - Multifidus

Core strengthening candidates

- Postpartum
- Positive prone instability test
- Aberrant movement during trunk ROM
- Positive
  - Thigh thrust test
  - Active straight leg raise test
  - Long dorsal sacroiliac ligament
  - Pubic symphysis region
  - Trendelenburg sign
- Long hamstrings, greater than 90
Activating the Core
Inner Core Movement Patterns

Lab
Activating the core
Dynamic lumbar stabilization
Other therapeutic exercise

- Posture considerations
  - Rib cage over the pelvis posture (Lee 2011)
  - Diaphragm
  - Numerous studies looking at function (Hodges 2000, 2007)
  - Upright unsupported posture (Sapsford et al 2008)
  - Increased resting PFM activity
  - Short lordosis posture (Claus et al 2009)
  - Increased multifidus, IO
  - Vs slump and flat lumbar posture
  - Low activity of multifidus, IO
Activating the Core

- Piston action of inner core (Hodges et al. 2000)
  - Diaphragm descent
  - Lengthening of abdominals
  - Pelvic floor dropping
  - Reverse on ascent/exhale
- How would you teach this exercise?

Activating the Core

Progressions
- Stable symmetrical
- Asymmetrical
- Mobility
- Agility

Activating the Core

Concepts
- Neutral pelvis, rib cage
- Exhale with effort
- Watch for substitution patterning (poor movement strategies)
Activating the Core

Awareness of substitution patterning

- Flare of rib cage, weak EO
- Overactive rectus, mounding
- Arching low back, hyperactive erector spinae
- Lifting of buttocks when prone-hip flexor tightness

Reflection Moment

What should you consider regarding your patient’s position when teaching beginning core exercises?

Activating the Core

Static

- Supine (knees straight or bent, hips over wedge for very weak PF)
- Diaphragmatic Breathing/umbrella imagery
- PF activation (stop gas/urine) with exhale (HISS)
- TA
  - Zip up tight jeans
  - Drawing in maneuver
  - Blow up balloon
- Repeat in prone, 4 point, ½ kneel, standing

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Activating the Core

Static

• Repeat in prone, 4 point, ½ kneel, standing
  • Diaphragmatic Breathing/umbrella imagery
  • PF activation (stop gas/urine) with exhale (Hiss)
• TA
  • Zip up tight jeans
  • Drawing in maneuver
  • Blow up balloon
Activating the Core

Dynamic Down - Training vs Up - Training

Challenging the core with movement

- Supine
- Alternate arms
  - Stretching of latissimus/pectoralis
- Alternate knee lifts
  - May need to modify
- Rocking of pelvis
  - Instability indicated
- Combine opposite arm and leg, alternate

- Alternate knee lift modification
  - Heel slides
  - Bent knee abd/adduction

- Alternate knee extension
- SLR
Activating the Core

Dynamic

• Prone (pillow)
  • Glute sets with core activation
  • Closed chain hip extension
  • Alternate arms
  • Alternate arm/legs

Down-Training vs Up-Training

Dynamic

• 4 Point
  • Alternate arms
  • Alternate arm/legs

Down-Training vs Up-Training

Dynamic

• ½ kneel
  • Balance
  • Alternate arms
  • Trunk rotation
Activating the Core

Dynamic

Challenging the core with movement

• Standing
  • Alternate arms
  • Thera-band
• Body Blade
• Standing balance on BOSU

Down-Training vs Up-Training

Activating the Core

Higher Level

• Plank on elbows
  • Knees
  • On toes

Down-Training vs Up-Training

Activating the Core

Higher Level

• Side plank
  • On knees
  • On feet

Down-Training vs Up-Training
Activating the Core

**Higher Level**

- Single leg bridge
- 4 point alternate arm/leg balance

**Down-Training vs Up-Training**

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**Activating the Core**

**Agility/balance**

Whole body movements

- In place lunges, forward, side, back
- Moving forward lunges and side squats with coordinated arm movements/breathing
- High stepping, hand to opposite heel while moving

---

Is your core activated?

Questions??
Reflection Moment
What else besides core?
• Key muscles to stretch?
• To strengthen?

Other Therapeutic Exercise
Targeted stretching
• Muscle groups
  • Hip rotators (IR and ER)
  • Hamstrings
  • Hip flexors/quads
  • Hip adductors
  • Lumbar spine
  • Gastrocnemius
  • Latissimus
  • Pecs
  • Scap depressors/retractors

Other Therapeutic Exercise
• Dynamic vs. static stretching (Behm et al 2011)
  • Dynamic stretching shown to have no negative effect, may augment performance
  • Positive response to neuromuscular system
• Static stretching
  • Not before strengthening, high speed, explosive or reactive activities
  • Important to include to increase ROM/flexibility, post-exercise or separate session
• Sensory theory suggested sensory endpoints important (Weppler et al 2010)
  • How it feels
What are we working on in this exercise?

What are we working on in this exercise?

Other Therapeutic Exercise

Targeted Strengthening
- Gluteus medius
  - Primary role as SIJ stabilizer

Which exercise had the highest EMG activity for gluteus medius all portions?

Pelvic drop  Unilateral wall squat  Wall press

O'Sullivan K et al 2010

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2912252/bin/1758-2555-2-17-2.jpg
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2912252/bin/1758-2555-2-17-3.jpg
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2912252/bin/1758-2555-2-17-4.jpg
Other Therapeutic Exercise

Targeted Strengthening
- Wall press highest activation for all divisions
  - Posterior most activated

Other Therapeutic Exercise

- Gluteus medius
  - Lateral step-up exercises vs. forward step-up?
  - Lateral step-up vs. side-lying abduction?
  - Increased glut med EMG activation lateral step up

Other Therapeutic Exercise

- Resisted side stepping (bands)
  - Which leg had increased EMG activation? Stance or non-stance?
  - Upright vs with squat, when is TFL most active?
    - When is glut max more active?

- Stance leg increased EMG
- With squat increased glut max, decreased TFL
Other Therapeutic Exercise

- **Gluteus medius (Yoo 2014)**
  - Case study: 32 year old woman with left SIJ dysfunction
  - Strengthening all portions of gluteus medius
  - + special tests
  - Gaenslen, Patrick and REAB (resisted abduction)
  - All special tests negative at end of 3 weeks
  - Side-lying left abduction (anterior)
  - Wall press (mid)
  - Pelvic drop (posterior)
  - 3 sets of 30 reps/day

Other Therapeutic Exercise

- **Gluteus maximus (Barker 2014)**
  - Generates compressive forces at SIJ
  - Cadaver dissection (n=11)
  - Originated from gluteus medius fascia, ilium, TLF, ES aponeurosis, sacrum, coccyx, dorsal SIJ ligament and sacrotuberous ligament (all specimens 11)
  - 70% fibers crossed SIJ
  - Assists effective load transfer

Other Therapeutic Exercise

- **Gluteus maximus (Stevens et al 2006)**
  - EMG studies of 4 point exercises normal/healthy
  - Single leg and arm/leg
  - Highest relative muscle activity
    - Ipsilateral
    - Multifidus (MF)
    - Gluteus maximus
    - EO
    - Contralateral
    - IO
Other Therapeutic Exercise

- Gluteus maximus
  - Generates compressive forces at SIJ (Barker 2014)
  - EMG studies of 4 different glut max exercises prone (Sakamoto 2009)
    - Prone hip extension
    - Knee extension
    - Knee flexed
    - Lateral hip rotation with knee extension
    - Lateral hip rotation with knee flexion
  - WHAT DO YOU THINK?

Other Therapeutic Exercise

- Gluteus maximus
  - Increased gluteus maximus EMG
    - Prone hip extension with addition of knee flexion or lateral rotation
    - Decreased semitendinous activity

Summary

- Core strengthening is well accepted to be crucial to optimal functioning
- There is a wide variety of approaches to core strengthening
- Evidence supports isolated muscle training to improve muscle onset timing, especially for the transversus abdominus
- Evidence supports anticipatory inner core muscle activation prior to extremity movement
Summary

- Normal inner core functioning is a balance between the diaphragm, pelvic floor, transversus and multifidus in a rhythmic piston action in normal functioning.
- Muscles work in slings.
- We can move in compensatory patterns with or without pain.
- Impaired hip strength has been identified in people with low back pain.

Summary

- In people who have signs or history of inner core weakness address the inner core before progressing to higher level core work in a logical systematic order to prevent injury and achieve optimal results.

Core strengthening from the Inside Out™!

Thank You!

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