

Core Strengthening & Stabilization in Therapeutic Exercise

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What is the CORE?

- Lumbo-pelvic-hip complex
- Location of center of gravity (CoG)
- **Efficient core allows for**
 - Maintenance of normal **length-tension relationships**
 - Maintenance of normal **force couples**
 - Maintenance of optimal arthrokinematics
 - Optimal efficiency in entire kinetic chain during movement
 - ✓ Acceleration, deceleration, dynamic stabilization
 - Proximal stability for movement of extremities

Functional Anatomy

➤ 29 muscles attach to core

➤ Lumbar Spine Muscles

➤ Transversospinalis group

✓ Rotatores

✓ Interspinales

✓ Intertransversarii

✓ Semispinalis

✓ Multifidus

➤ Erector spinae

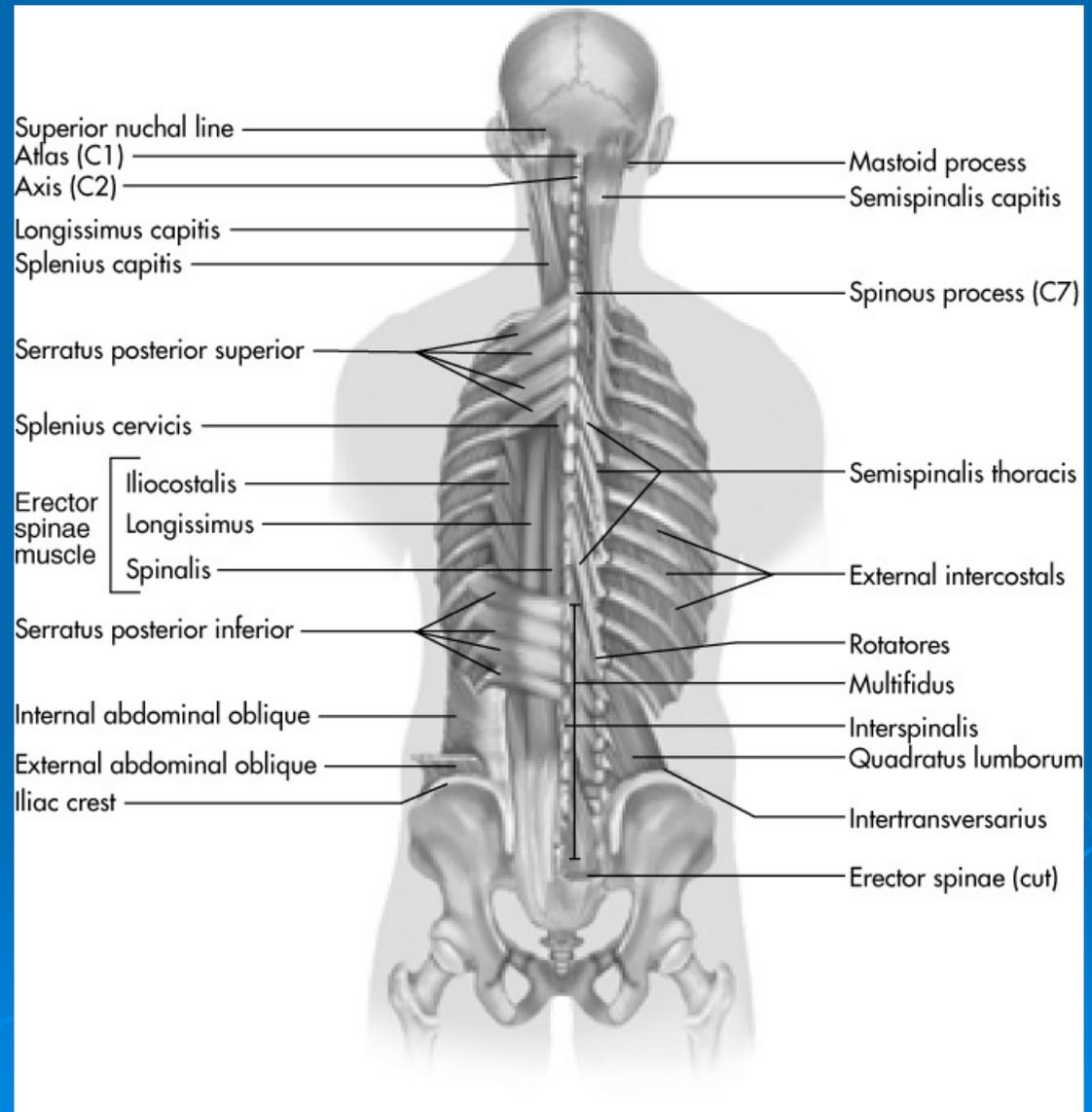
✓ Iliocostalis

✓ Longissimus

✓ Spinalis

➤ Quadratus lumborum

➤ Latissimus Dorsi



➤ **Transversospinalis group**

- Poor mechanical advantage relative to movement production
- Primarily Type I muscle fibers with high degree of muscle spindles
 - ✓ Optimal for providing proprioceptive information to CNS
- Inter/intra-segmental stabilization

➤ **Erector spinae**

- Provide intersegmental stabilization
- Eccentrically decelerate trunk flexion & rotation

➤ **Quadratus Lumborum**

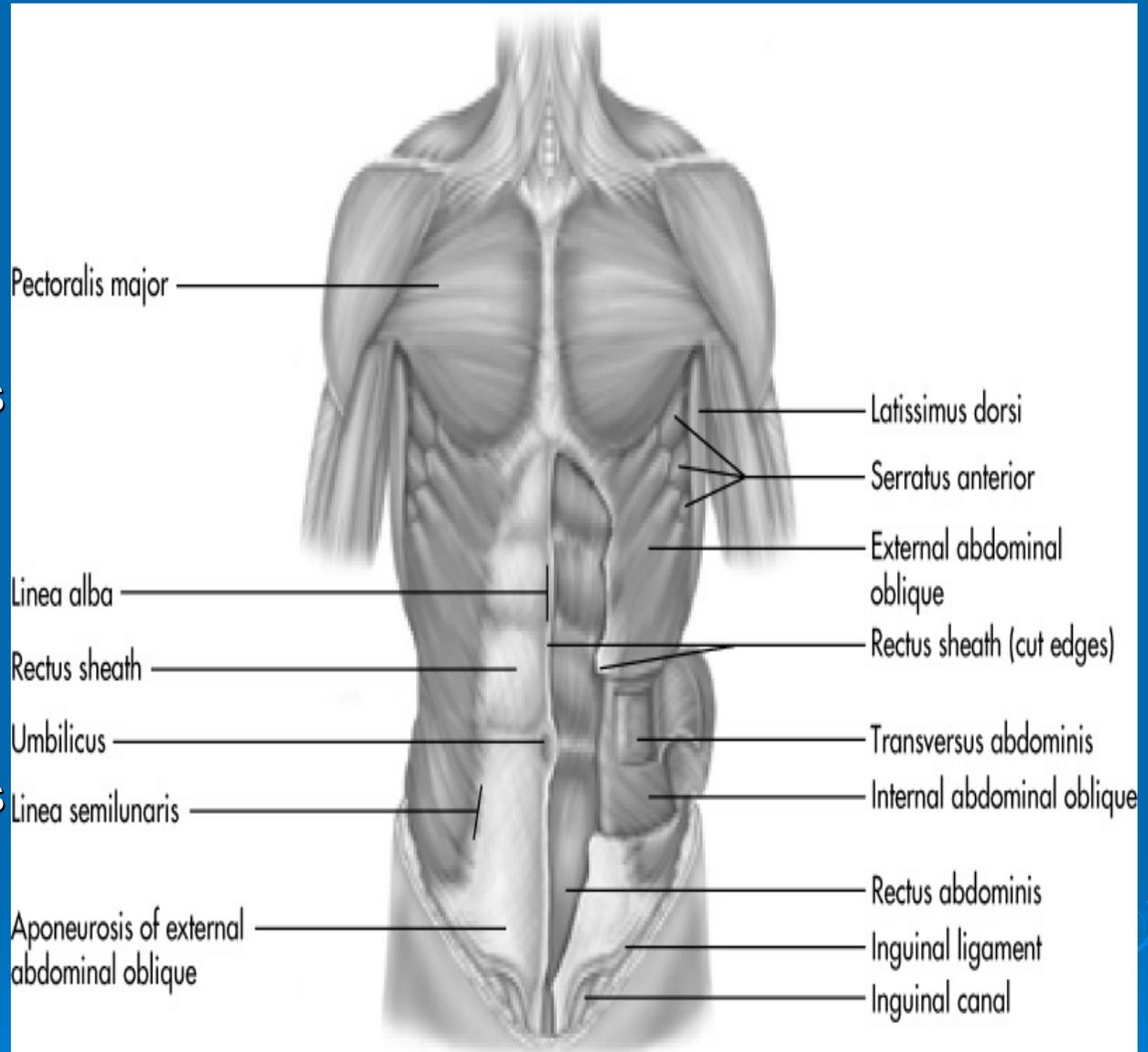
- Frontal plane stabilizer
- Works in conjunction with gluteus medius & tensor fascia latae

➤ **Latissimus Dorsi**

- Bridge between upper extremity & core

➤ Abdominal Muscles

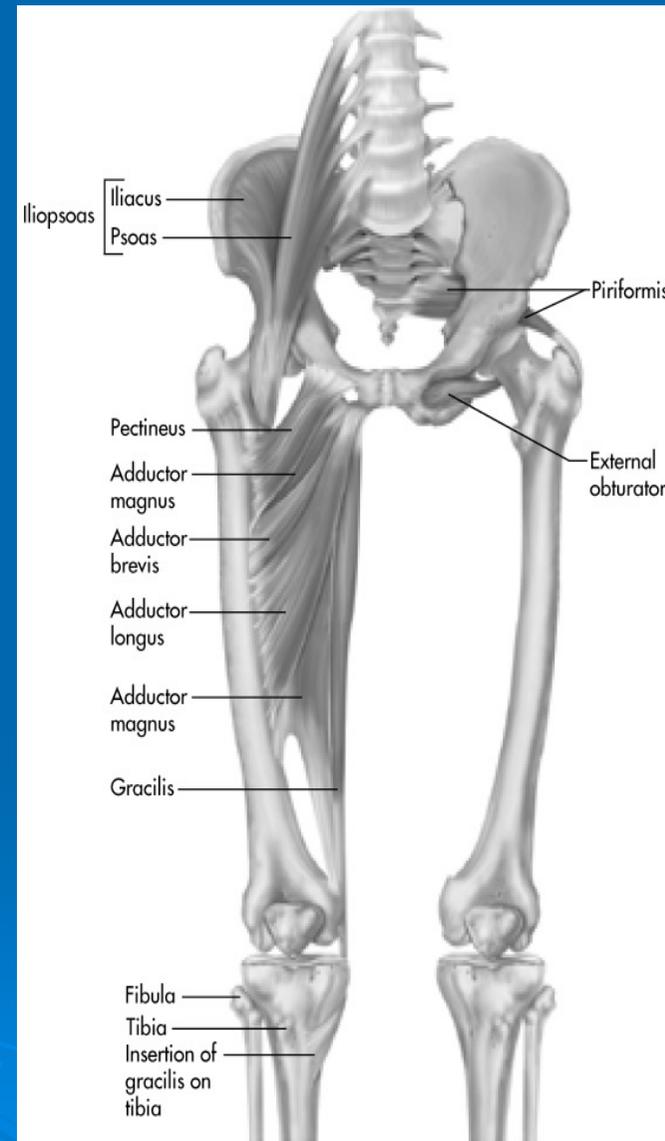
- Rectus abdominus
- External obliques
- Internal obliques
- Transverse abdominus
- Work to optimize spinal mechanics
- Provide sagittal, frontal & transverse plane stabilization



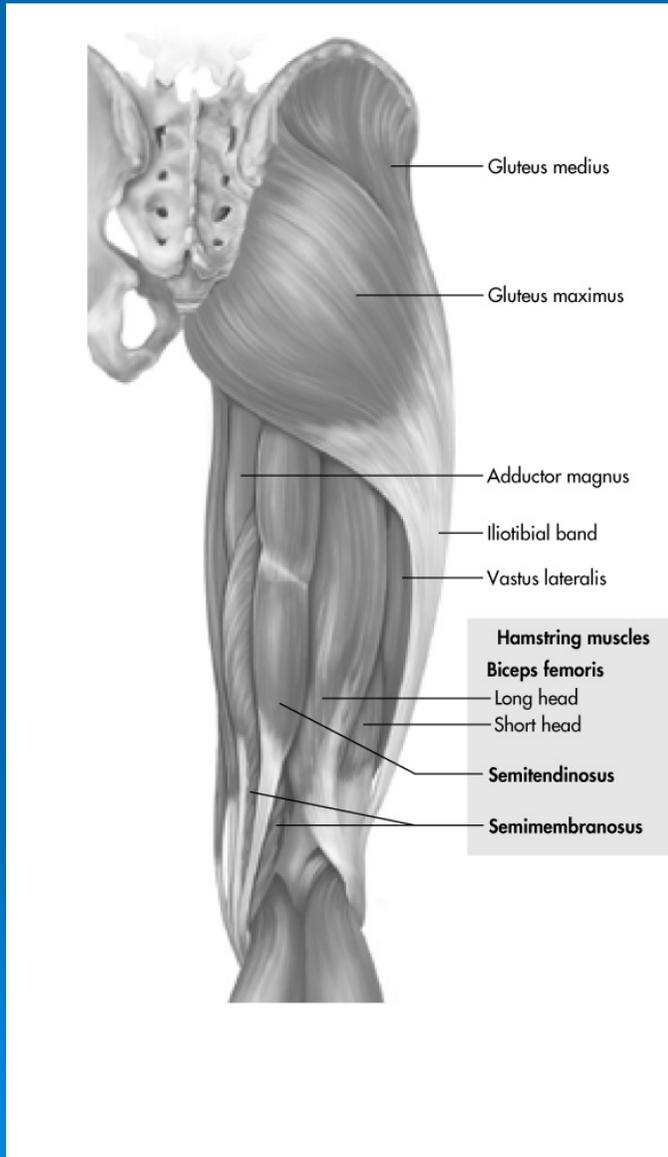
Hip Musculature

➤ Psoas

- Closed chain vs. open chain functioning
- Works with erector spinae, multifidus & deep abdominal wall
 - ✓ Works to balance anterior shear forces of lumbar spine
- Can reciprocally inhibit gluteus maximus, multifidus, deep erector spinae, internal oblique & transverse abdominus when tight
 - ✓ Extensor mechanism dysfunction
- Synergistic dominance during hip extension
 - ✓ Hamstrings & superficial erector spinae
 - ✓ May alter gluteus maximus function, altering hip rotation, gait cycle



Hip Musculature



- **Gluteus medius**
 - Frontal plane stabilizer
 - ✓ Weakness increases frontal & transverse plane stresses (patellofemoral stress)
 - Controls femoral adduction & internal rotation
 - Weakness results in synergistic dominance of TFL & quadratus lumborum
- **Gluteus maximus**
 - Hip extension & external rotation during OKC, concentrically
 - Eccentrically hip flexion & internal rotation
 - Decelerates tibial internal rotation with TFL
 - Stabilizes SI joint
 - Faulty firing results in decreased pelvic stability & neuromuscular control

➤ Hamstrings

- Concentrically flex the knee, extend the hip & rotate the tibia
 - Eccentrically decelerate knee extension, hip flexion & tibial rotation
 - Work synergistically with the ACL to stabilize tibial translation
-
- All muscles produce & control forces in multiple planes

The CORE

- Functions & operates as an integrated unit
 - Entire kinetic chain operates synergistically to produce force, reduce force & dynamically stabilize against abnormal force
- **In an efficient state**, the CORE enables each of the structural components to operate optimally through:
 - Distribution of weight
 - Absorption of force
 - Transfer of ground reaction forces
- Requires training for optimal functioning!
- Train entire kinetic chain on all levels in all planes

➤ Neuromuscular efficiency

- Ability of CNS to allow agonists, antagonists, synergists, stabilizers & neutralizers to work efficiently & interdependently
- Established by combination of postural alignment & stability strength
- Optimizes body's ability to generate & adapt to forces
- Dynamic stabilization is critical for optimal neuromuscular efficiency
 - Rehab generally focuses on isolated single plane strength gains in single muscles
 - Functional activities are multi-planar requiring acceleration & stabilization
- Inefficiency results in body's inability to respond to demands
 - Can result in repetitive microtrauma, faulty biomechanics & injury
 - Compensatory actions result

Core Stabilization Concepts

- A specific core strengthening program can:
 - ✓ **IMPROVE** dynamic postural control
 - ✓ Ensure **appropriate muscular balance & joint arthrokinematics** in the lumbo-pelvic-hip complex
 - ✓ **Allow** for expression of **dynamic functional performance** throughout the entire kinetic chain
 - ✓ **Increase neuromuscular efficiency** throughout the entire body
- Spinal stabilization
 - Must effectively utilize strength, power, neuromuscular control & endurance of the “prime movers”
 - Weak core = decreased force production & efficiency
 - Protective mechanism for the spine
 - Facilitates balanced muscular functioning of the entire kinetic chain
 - Enhances neuromuscular control to provide a more efficient body positioning

Postural Considerations

- Core functions to maintain postural alignment & dynamic postural equilibrium
 - Optimal alignment = optimal functional training and rehabilitation
- Segmental deficit results in predictable dysfunction
 - Serial distortion patterns
 - ✓ Structural integrity of body is compromised due to malalignment
 - ✓ Abnormal forces are distributed above and below misaligned segment

Neuromuscular Considerations

- Enhance dynamic postural control with strong stable core
- **Kinetic chain imbalances = deficient neuromuscular control**
 - Impact of low back pain on neuromuscular control
 - Joint/ligament injury → neuromuscular deficits
- **Arthrokinetic reflex**
 - Reflexes mediated by joint receptor activity
 - Altered arthrokinetic reflex can result in arthrogenic muscle inhibition
 - Disrupted muscle function due to altered joint functioning

Assessment of the Core

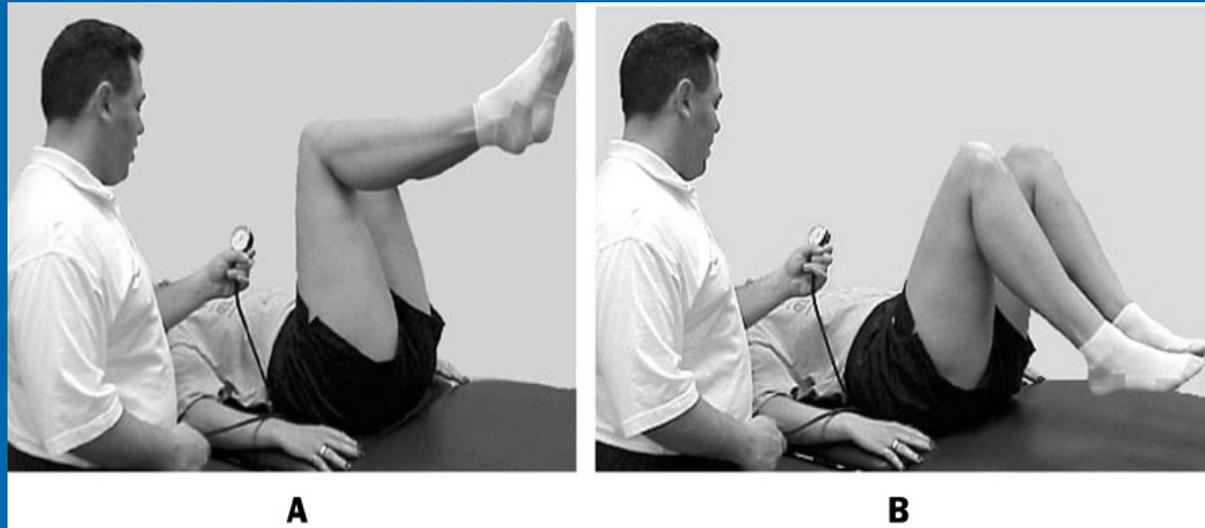
- Muscle imbalances
- Arthrokinematic deficits
- Core
 - Strength
 - Endurance
 - Neuromuscular control
 - Power
- Overall function of lower extremity kinetic chain

Straight-Leg Lowering Test for Core Strength



- Supine w/ knees in extension
- BP cuff placed under lumbar spine (L4-L5) & raised to 40 mmHg
- With knees extended, ✓ hips to 90°
- Performs drawing in maneuver (belly button to spine) & then flattens back maximally into the table & BP cuff
- Lower legs to table while maintaining flat back
- Hip angle is measured with goniometer

Abdominal Neuromuscular Control Test



- Supine w/ knees & hips in 90° ✓
- BP cuff placed under lumbar spine (L4-L5) & raised to 40 mmHg
- Performs drawing in maneuver (belly button to spine)
- Lower legs until pressure decreases
- Assesses lumbar spine moving into extension (ability of lower abs wall to preferentially stabilize the lumbo-pelvic-hip complex)
 - Hip flexors begin to work as stabilizers
 - Increases anterior shear forces & compressive forces at L4-L5
 - Inhibits transversus abdominis, internal oblique & multifidus

Core Muscular Endurance & Power

➤ Endurance

➤ Erector spinae performance

- ✓ Prone with hands behind head & spine extended 30°
- ✓ Measure ability to sustain position with goniometer
 - ✓ Utilize axilla and table for frame of reference
- ✓ Hold & maintain as long as they can

➤ Power

- Backwards, overhead medicine ball jump & throw
- Assessment of total body power production

➤ Lower extremity functional profiles

- Isokinetic tests
- Balance tests
- Jump tests
- Power tests
- Sports specific functional tests

➤ Kinetic chain assessment must assess all areas of potential deficiency

Guidelines for Core Stabilization Training

➤ Perform comprehensive evaluation

- Muscles imbalances, myokinematic deficits, arthrokinematic deficits, core strength/ neuromuscular control/power, overall kinetic chain function
 - Muscle imbalances & arthrokinematic deficits must be corrected prior to initiating aggressive training

➤ Program Requirements

- Systematic
- Progressive
- Functional

➤ **Emphasize muscle contraction spectrum**

- Concentric (force production)
- Eccentric (force reduction)
- Isometric (dynamic stabilization)

➤ **Begin program in most challenging environment that can be controlled**

- Must be challenging with progression through function continuum

➤ **Program Variation**

- ✓ Plane of motion
- ✓ Range of motion
- ✓ Loading (physioball, med. ball, body blade, weight vest, tubing)
- ✓ Body position
- ✓ Amount of control & speed
- ✓ Feedback
- ✓ Duration and frequency (sets, reps, time under tension)

Specific Guidelines – Exercise Selection

- Proprioceptively rich program
 - Safe
 - Challenging
 - Stress multiple planes
 - Incorporate multi-sensory environment
 - Activity specific
 - Progressive functional continuum
 - Slow to fast
 - Simple to complex
 - Known to unknown
 - Low force to high force
 - Eyes open to eyes closed
 - Static to dynamic
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- **Goal of program** - develop optimal levels of functional strength & stabilization
 - Focus on neural adaptations instead of absolute strength gains
 - Increase proprioceptive demands
 - Quality not quantity
 - ✓ Poor technique and neuromuscular control results in poor motor patterns & stabilization

- Focus on function

Questions to Ask Yourself

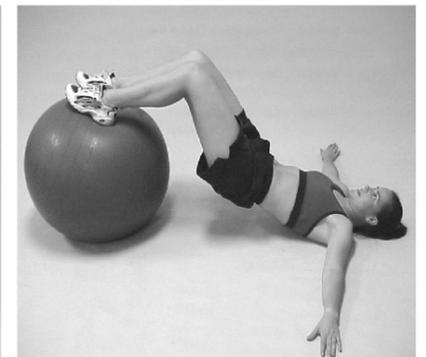
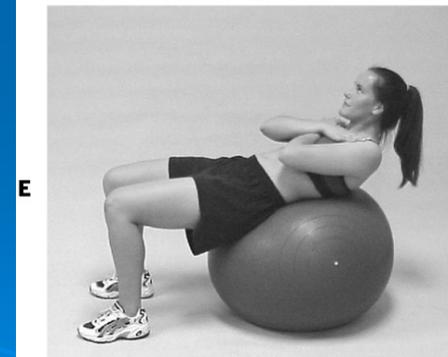
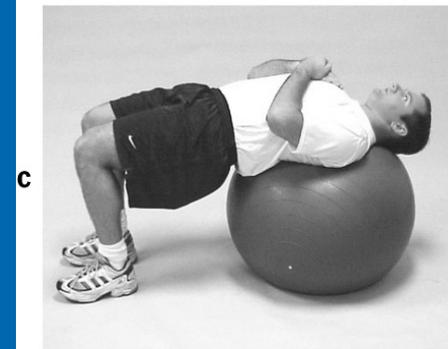
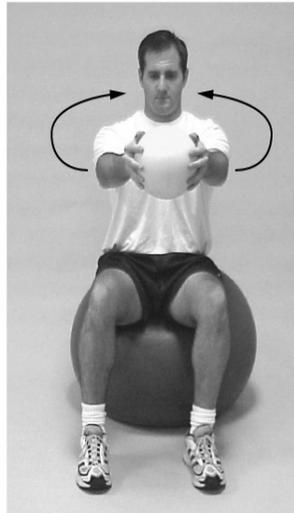
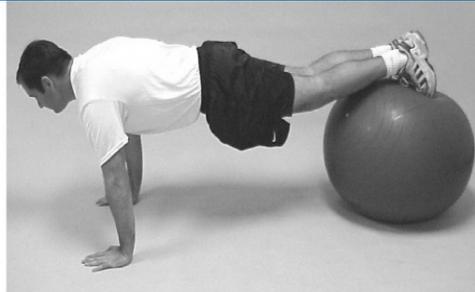
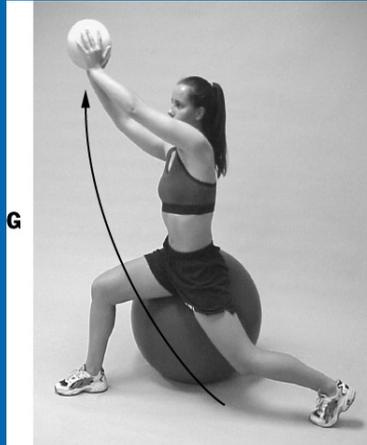
- Is it dynamic?
- Is it multiplanar?
- Is it multidimensional?
- Is it proprioceptively enriched?
- Is it systematic?
- Is it progressive?
- Is it activity-specific?
- Is it based on functional anatomy & science?

Core Stabilization Training Program

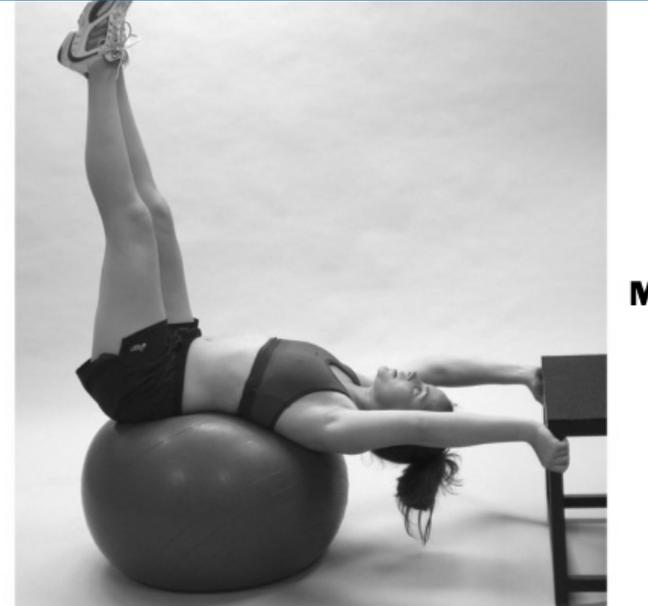
➤ Level I: Stabilization



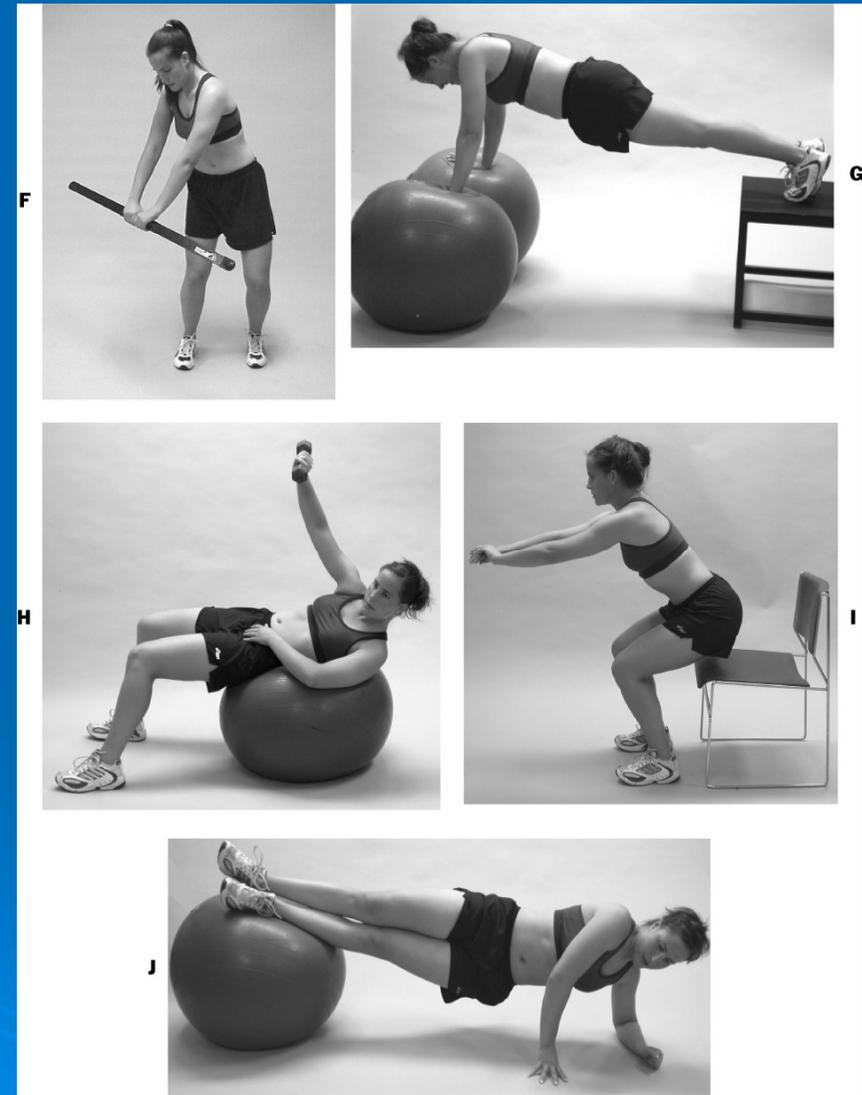
Level II: Stabilization and Strength



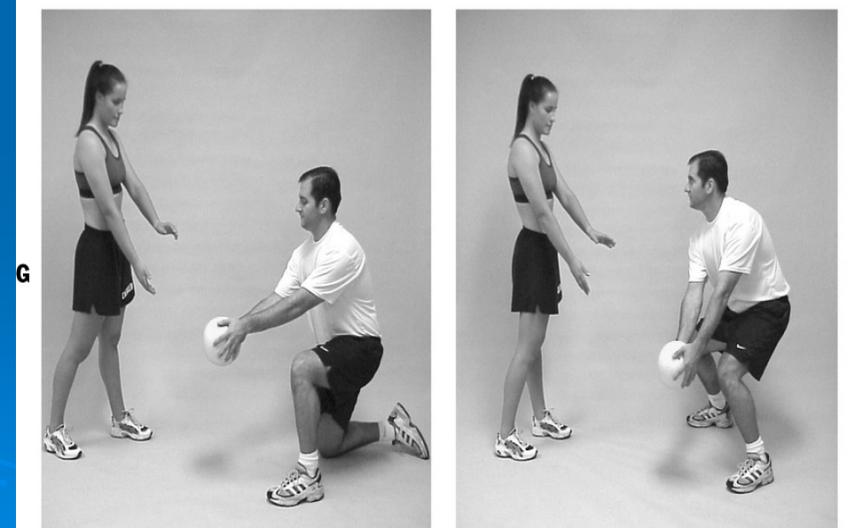
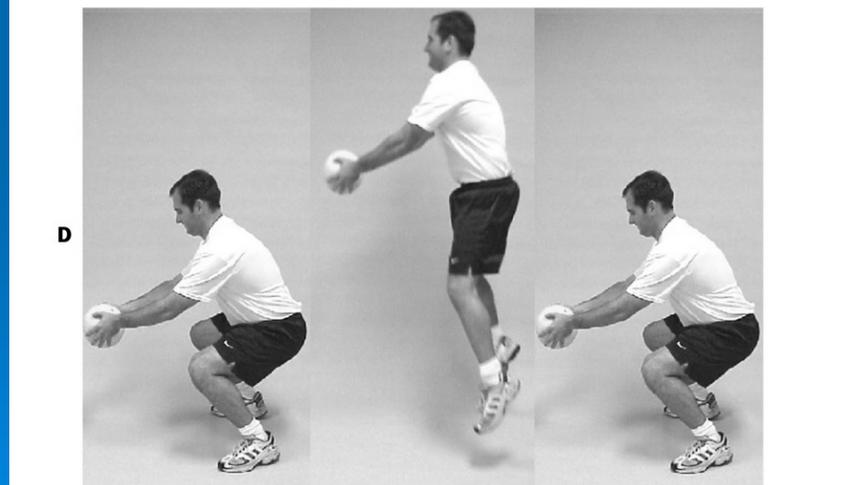
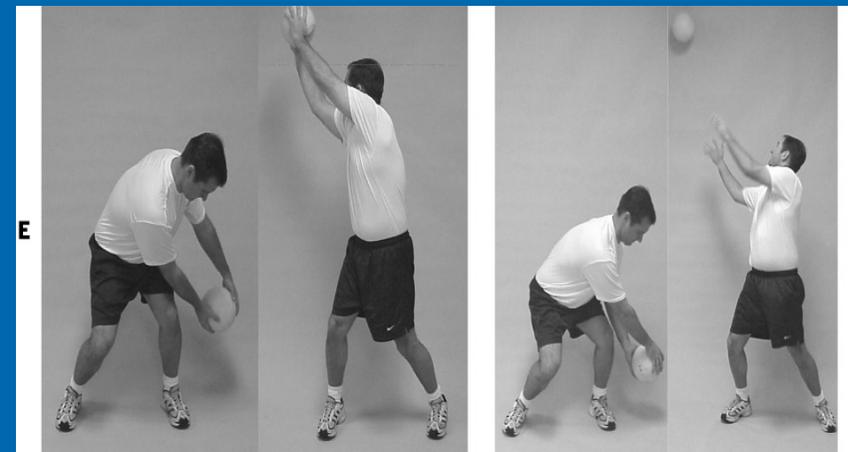
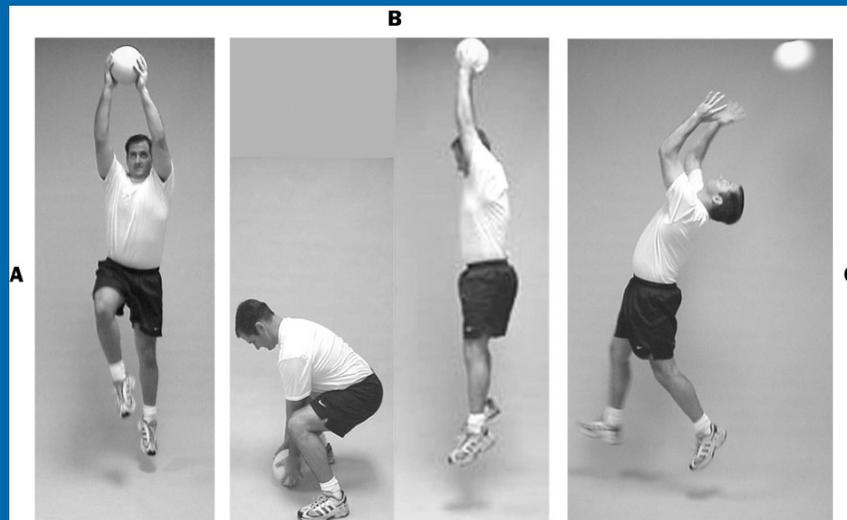
Level II: Stabilization and Strength



Level III: Integrated Stabilization Strength



Level IV: Explosive Stabilization



References

- Prentice, W.E. (2004). Rehabilitation Techniques for Sports Medicine & Athletic Training, 4th ed.
- Houglum, P. (2005). Therapeutic Exercise for Musculoskeletal Injuries, 2nd ed.
- Kisner, C. & Colby, L.A. (2002). Therapeutic Exercise: Foundations & Techniques, 4th ed.