Core Strengthening & Stabilization in

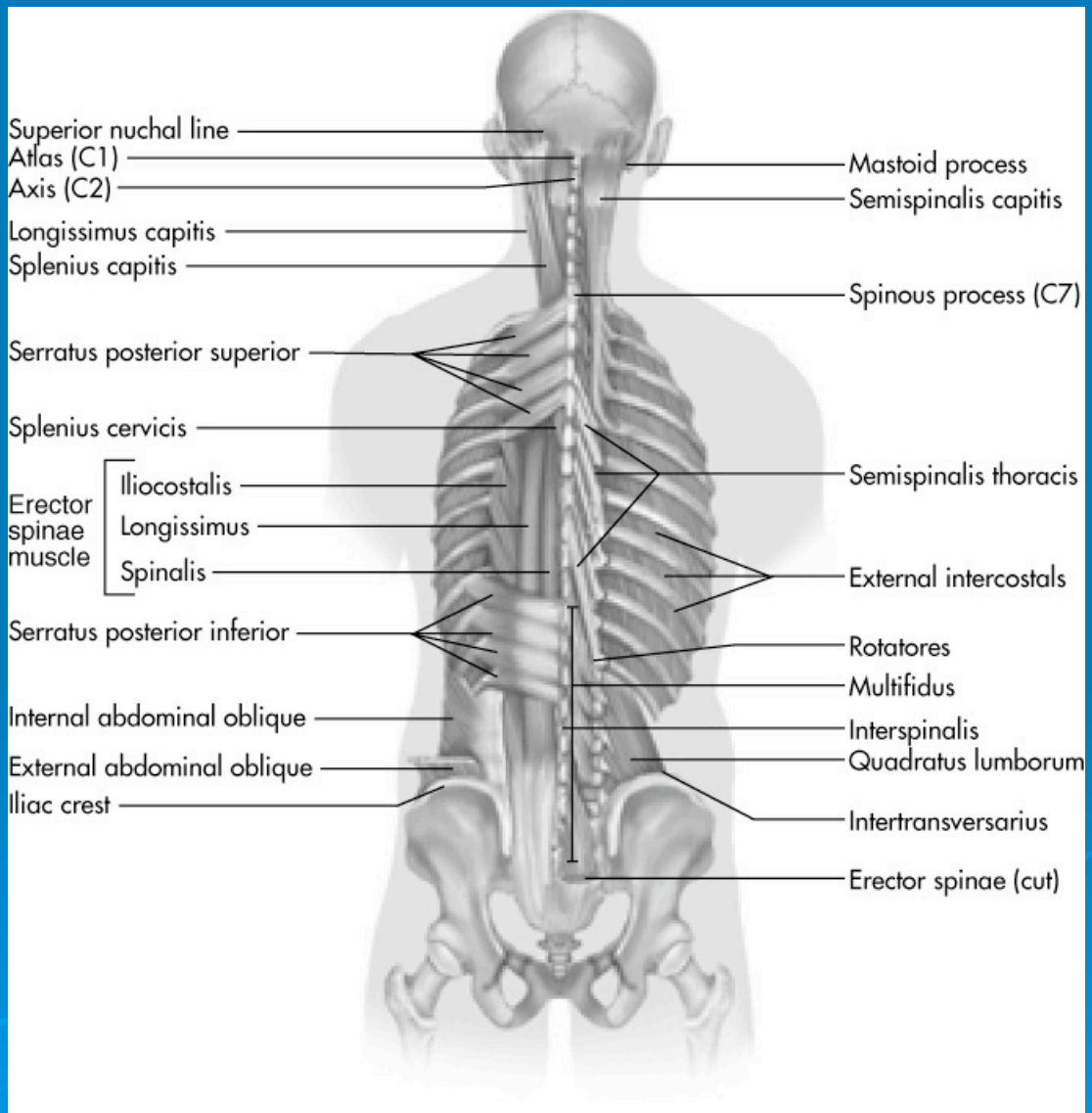
What is the CORE?

- 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

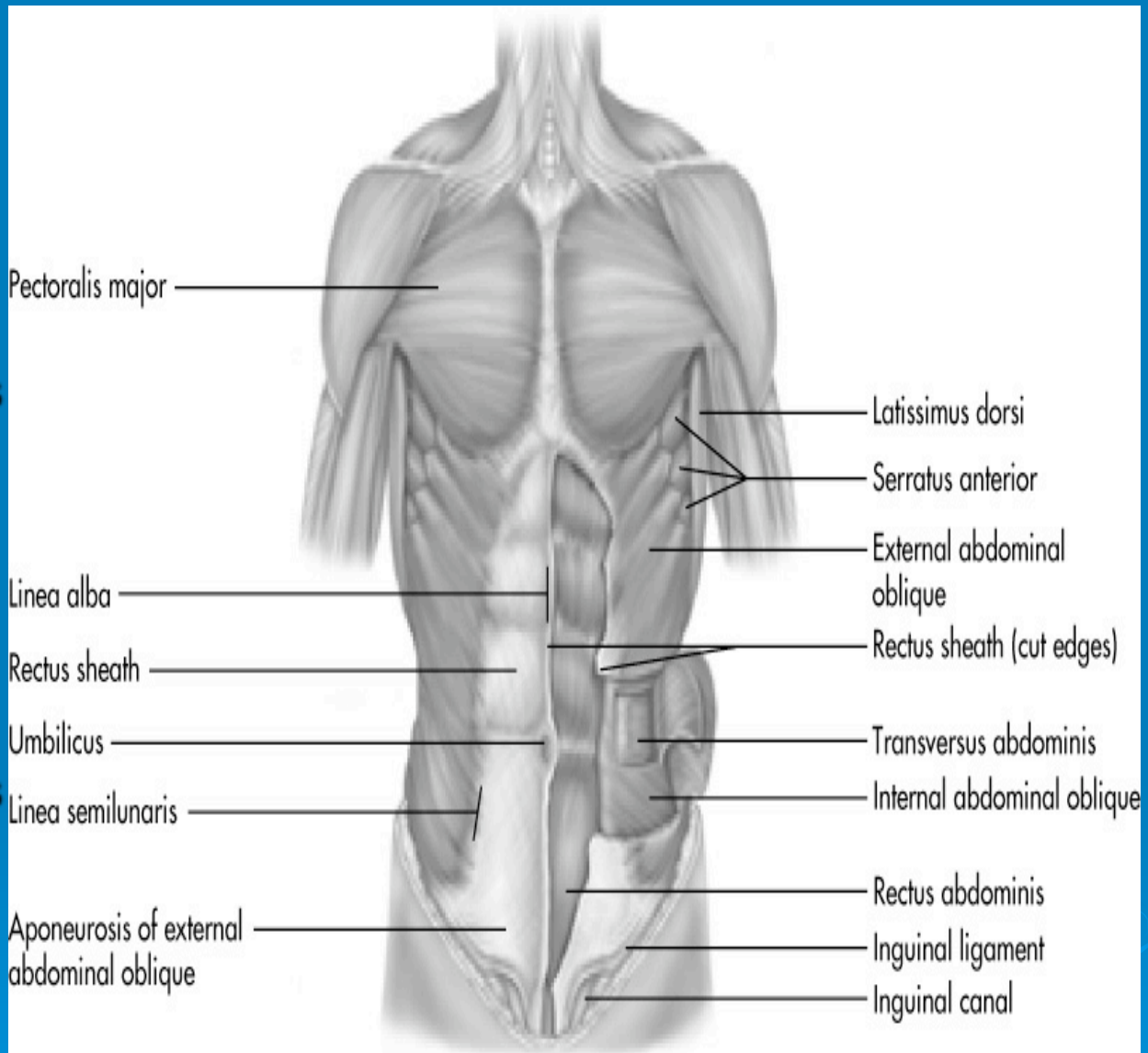


- **Transversospinalis group**
  - Poor mechanical advantage relative to movement production
  - Primarily Type I muscle fibers with high degree of muscle spindles
    - ✓ Optimal for providing proprioceptive information to CNS
  - Inter/intra-segmental stabilization
- **Erector spinae**
  - Provide intersegmental stabilization
  - Eccentrically decelerate trunk flexion & rotation
- **Quadratus Lumborum**
  - Frontal plane stabilizer
  - Works in conjunction with gluteus medius & tensor fascia latae
- **Latissimus Dorsi**

Abdominal Muscles

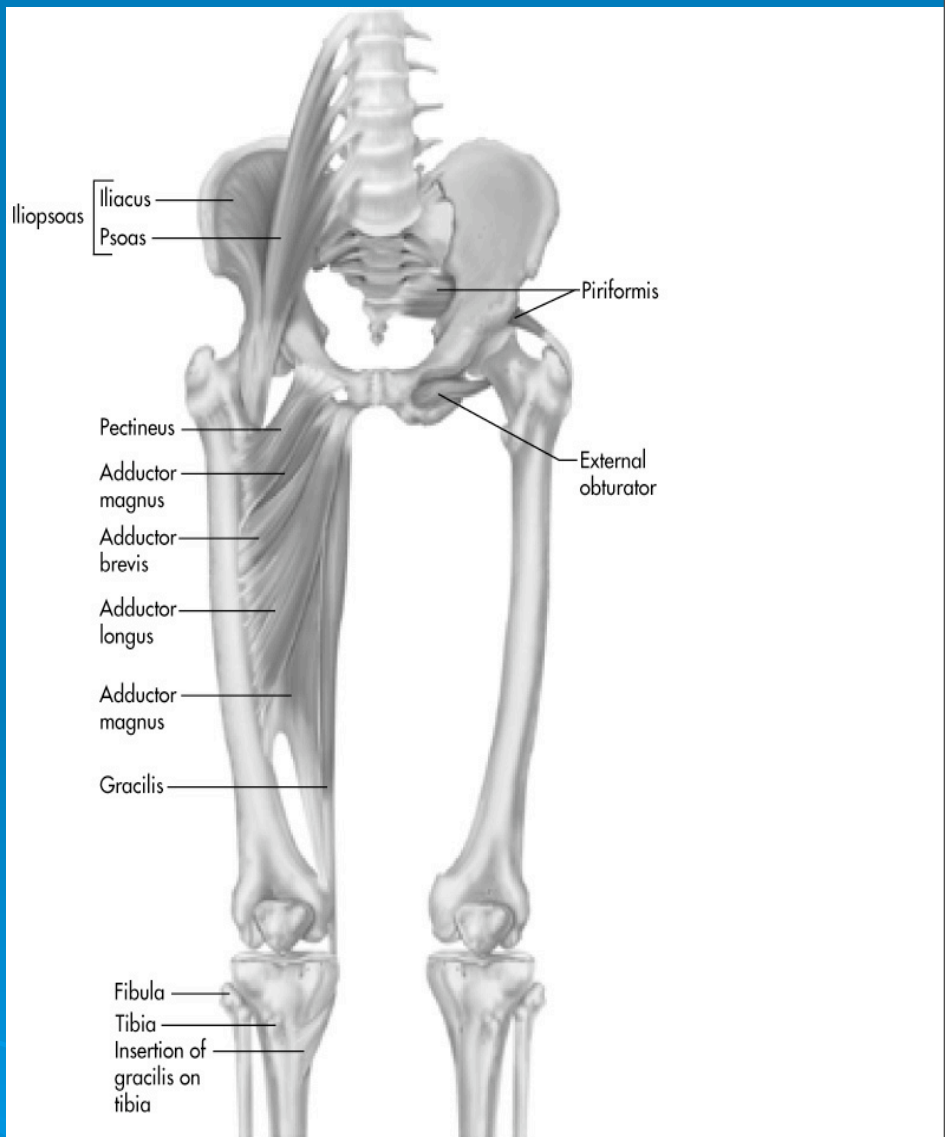
- Rectus abdominus
- External obliques
- Internal obliques
- Transverse abdominus

- Work to optimize spinal mechanics
- Provide sagittal, frontal & transverse plane stabilization

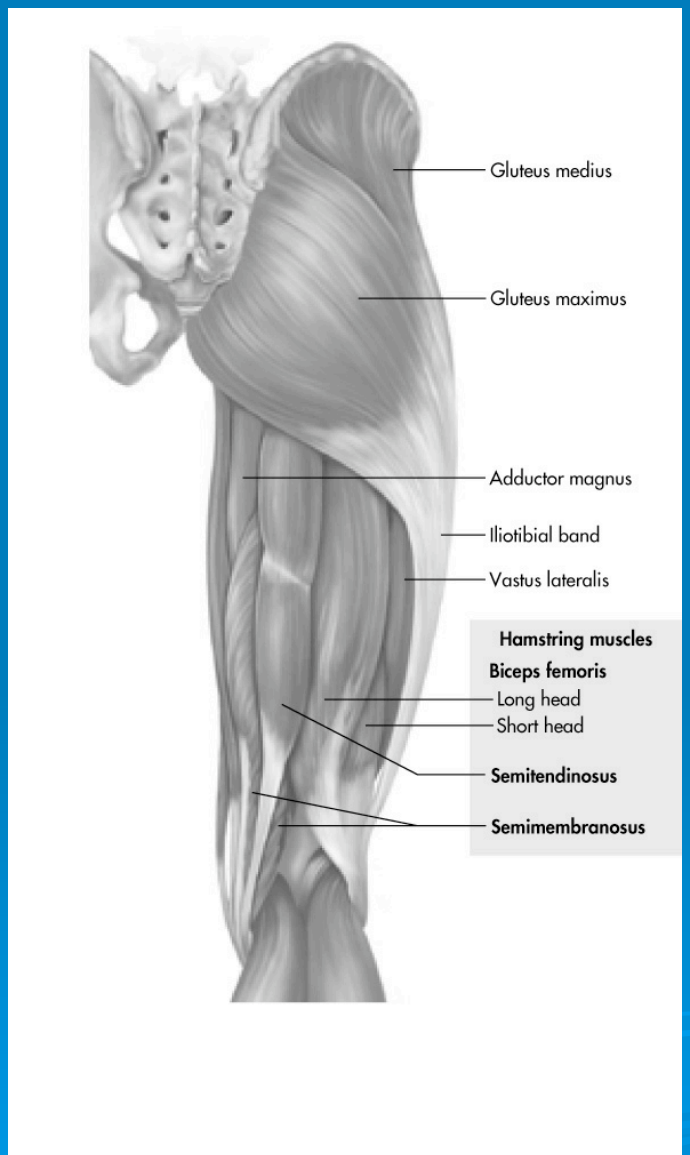


Hip Musculature

- 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,



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

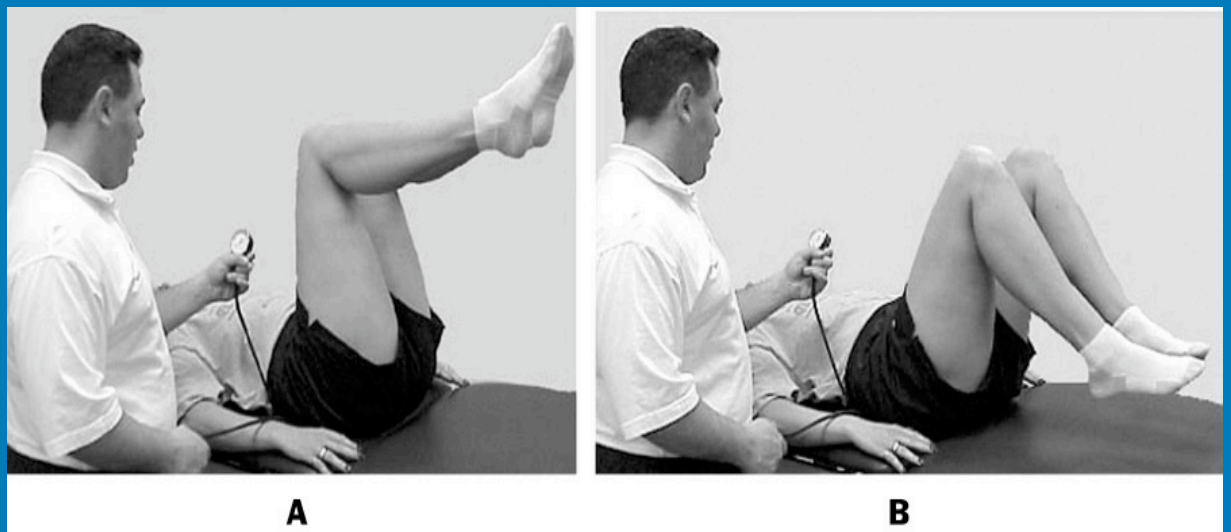
Assessment of the Core

- 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 30º
    - ✓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

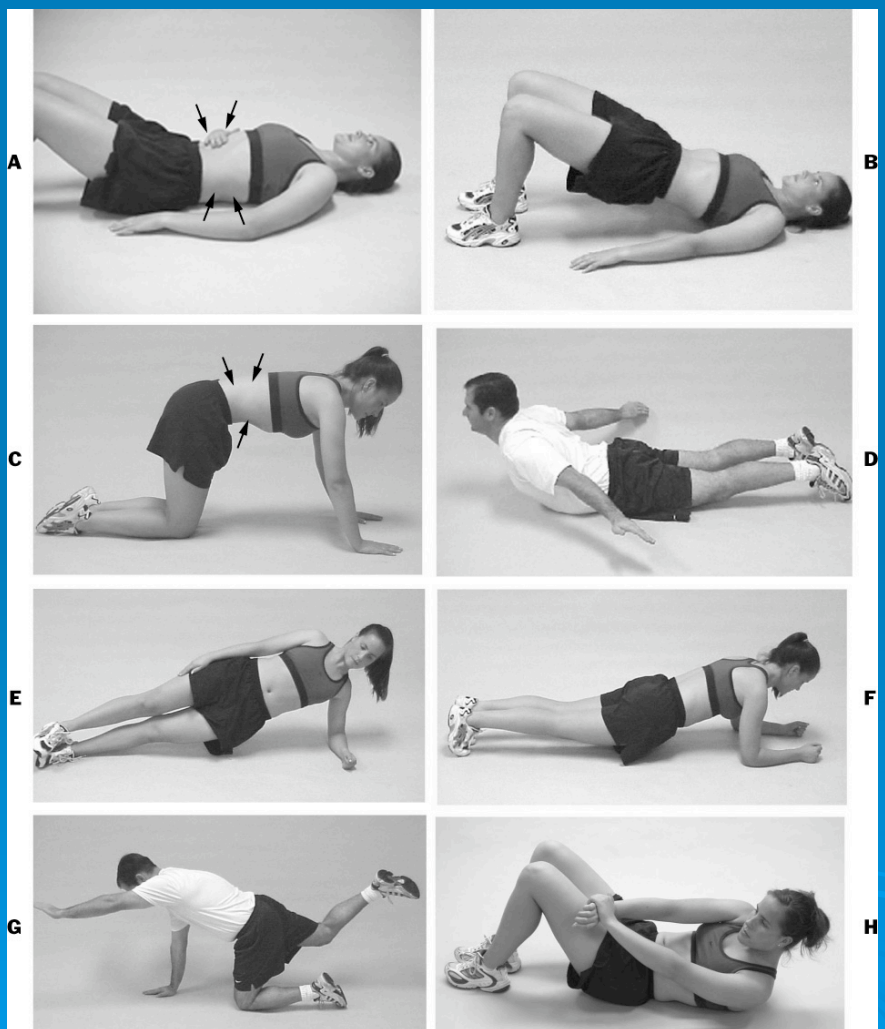
- Goal of program - develop optimal levels of functional strength & stabilization
  - Focus on neural adaptations instead of absolute strength gains
  - Increase proprioceptive demands
  - Quality not quantity
    - ✓Poor technique and neuromuscular control results in poor motor patterns & stabilization
- Focus on function

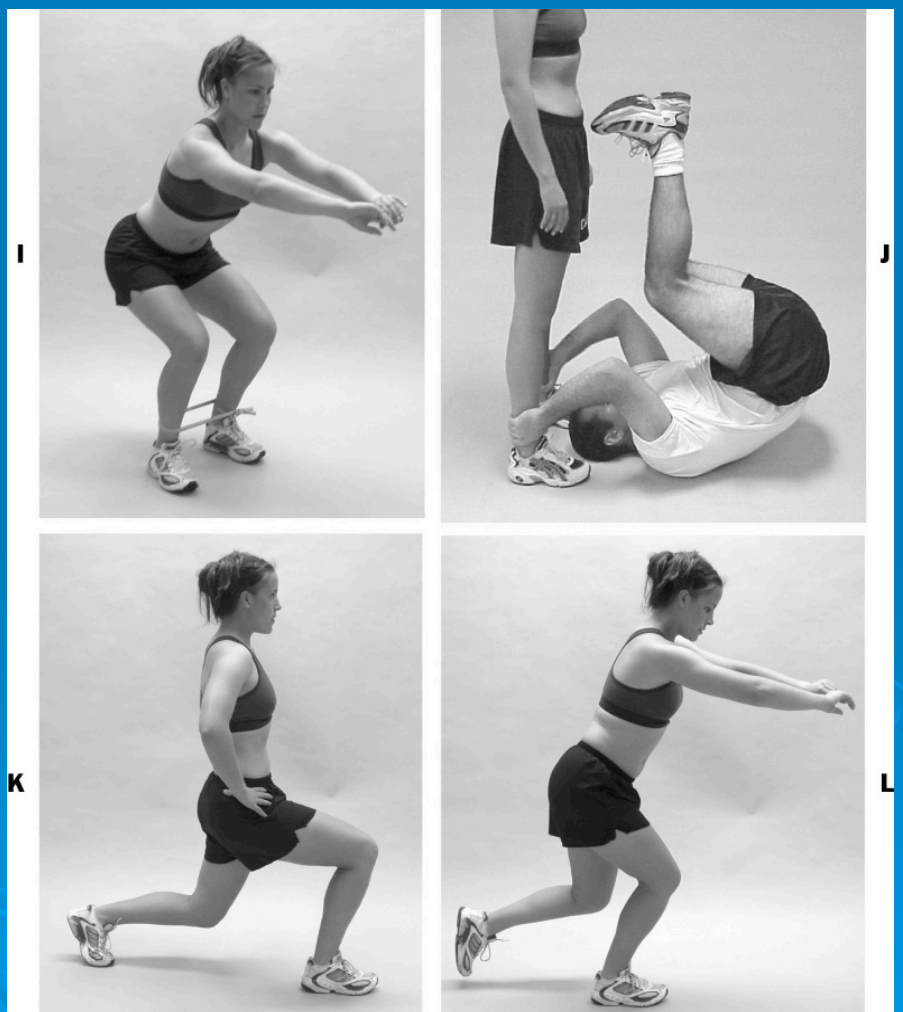
Questions to Ask Yourself

- 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?

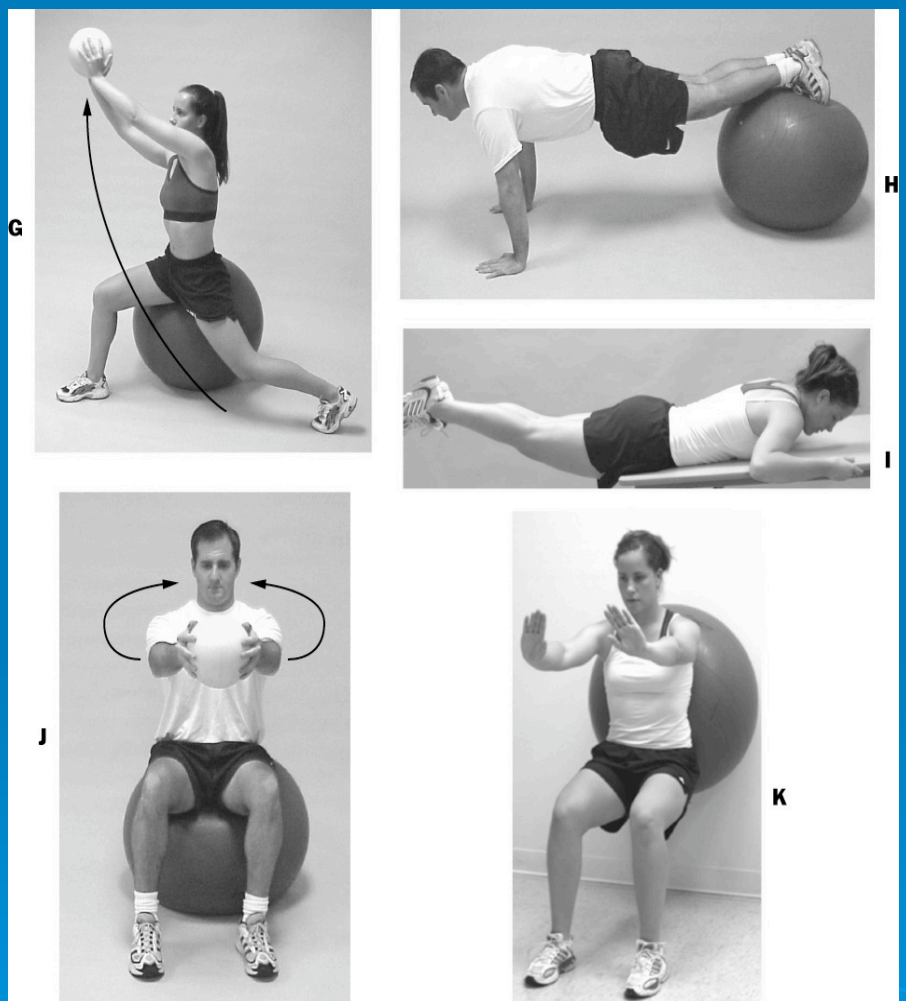
Core Stabilization Training Program

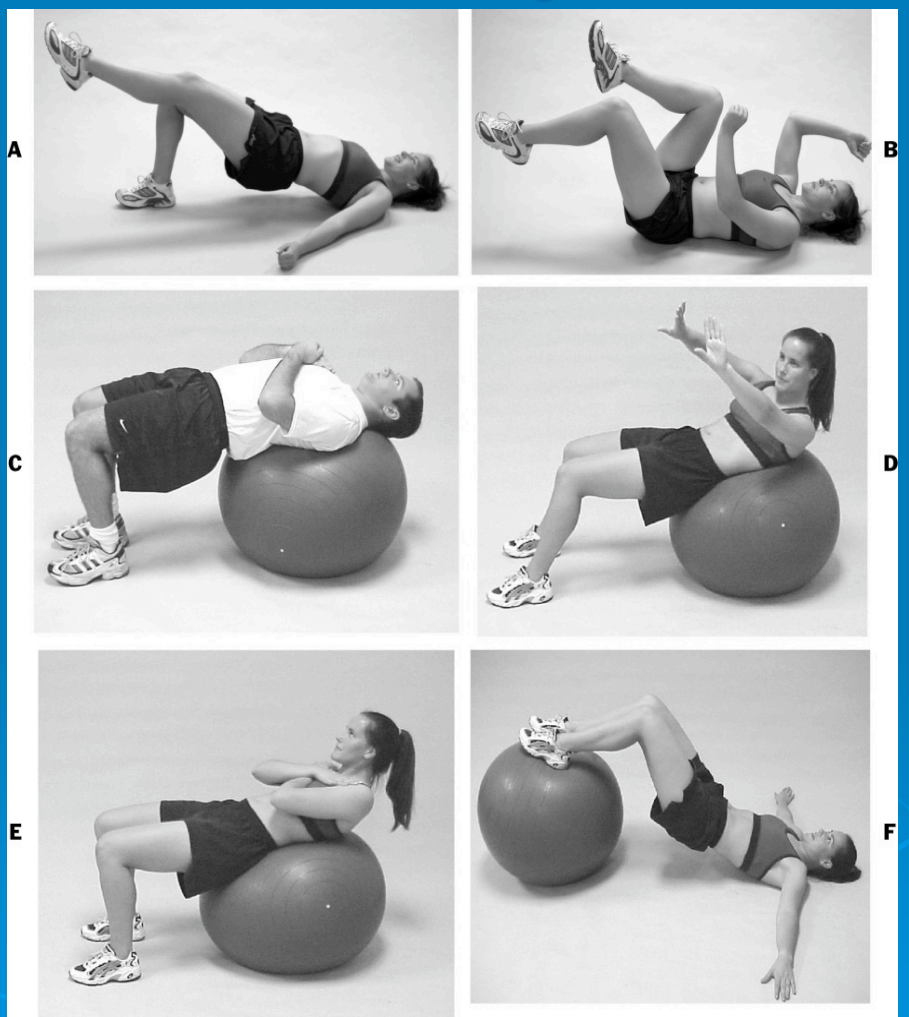
- Level I: Stabilization





Level II: Stabilization and Strength





Level II: Stabilization and Strength

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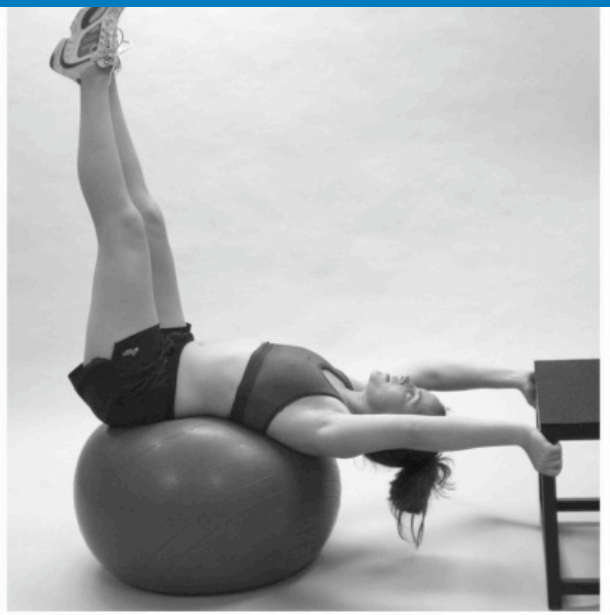

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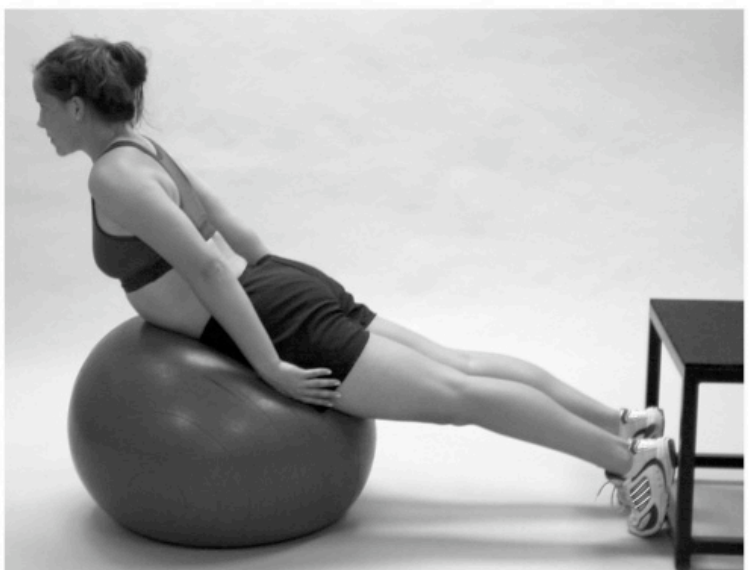
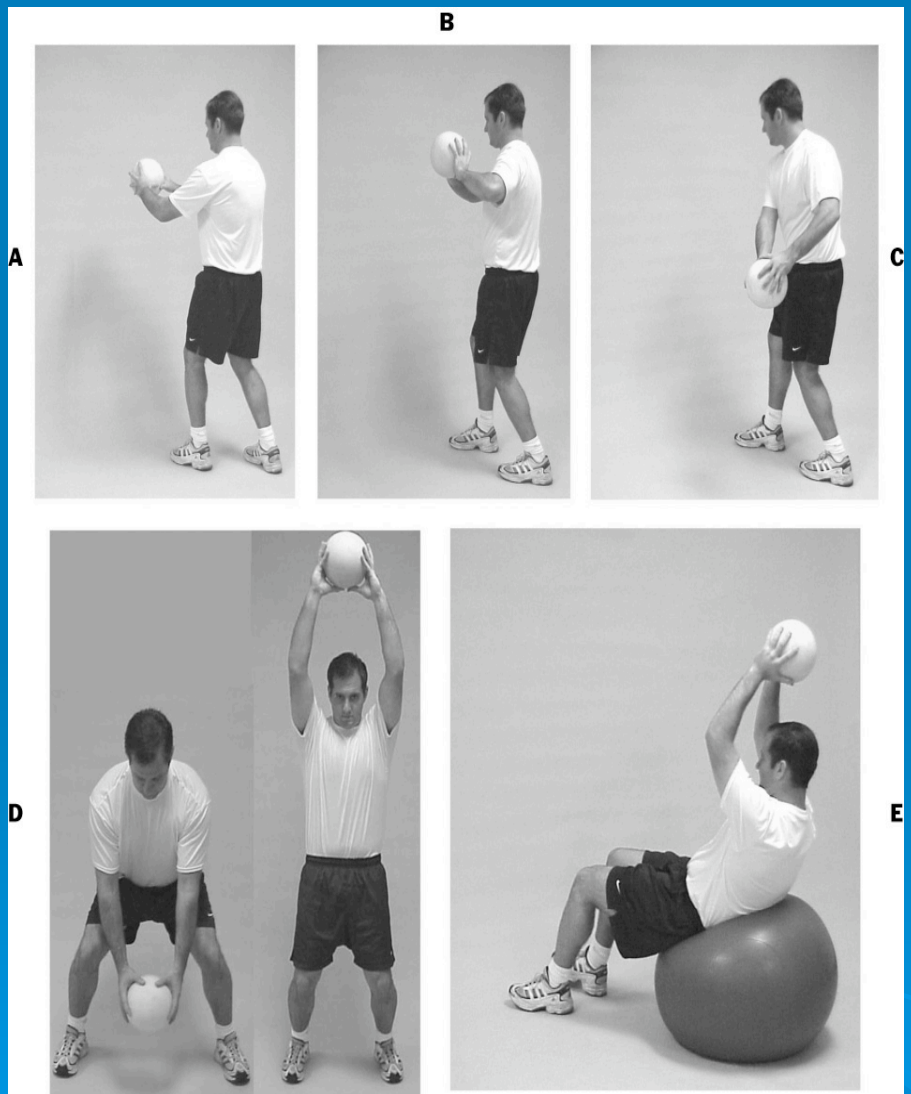
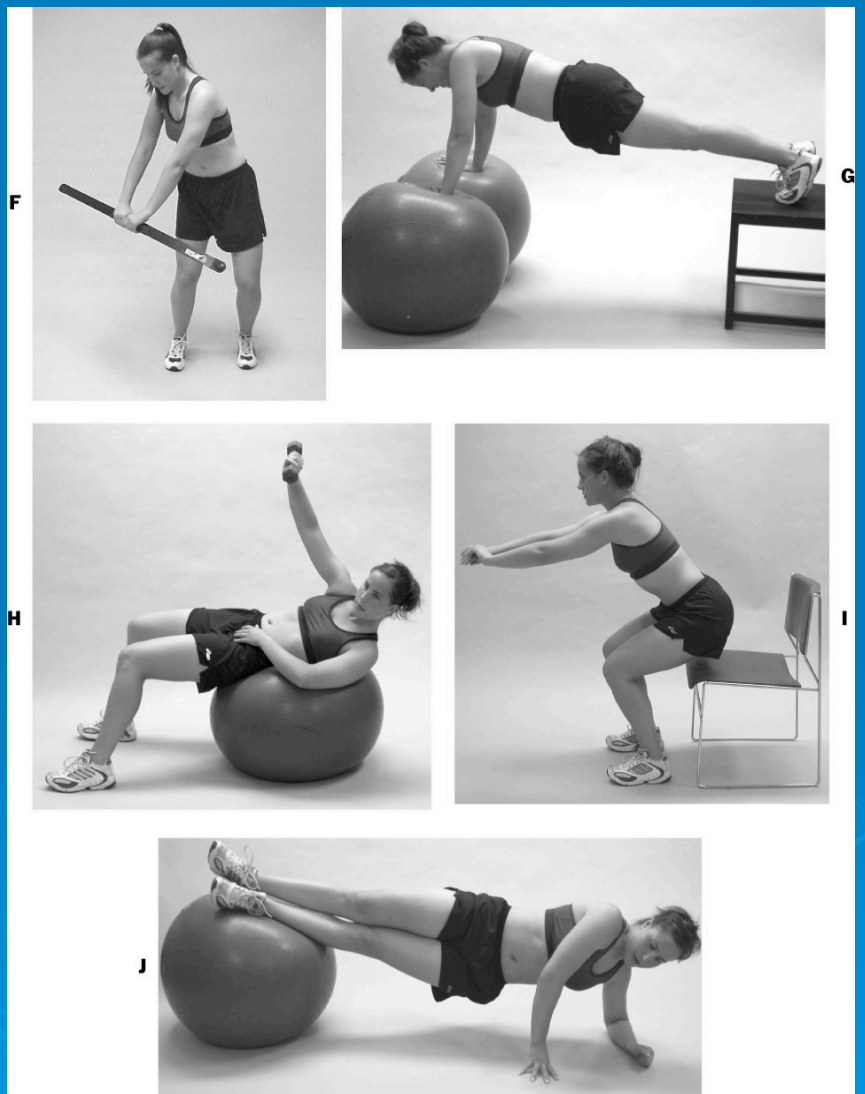
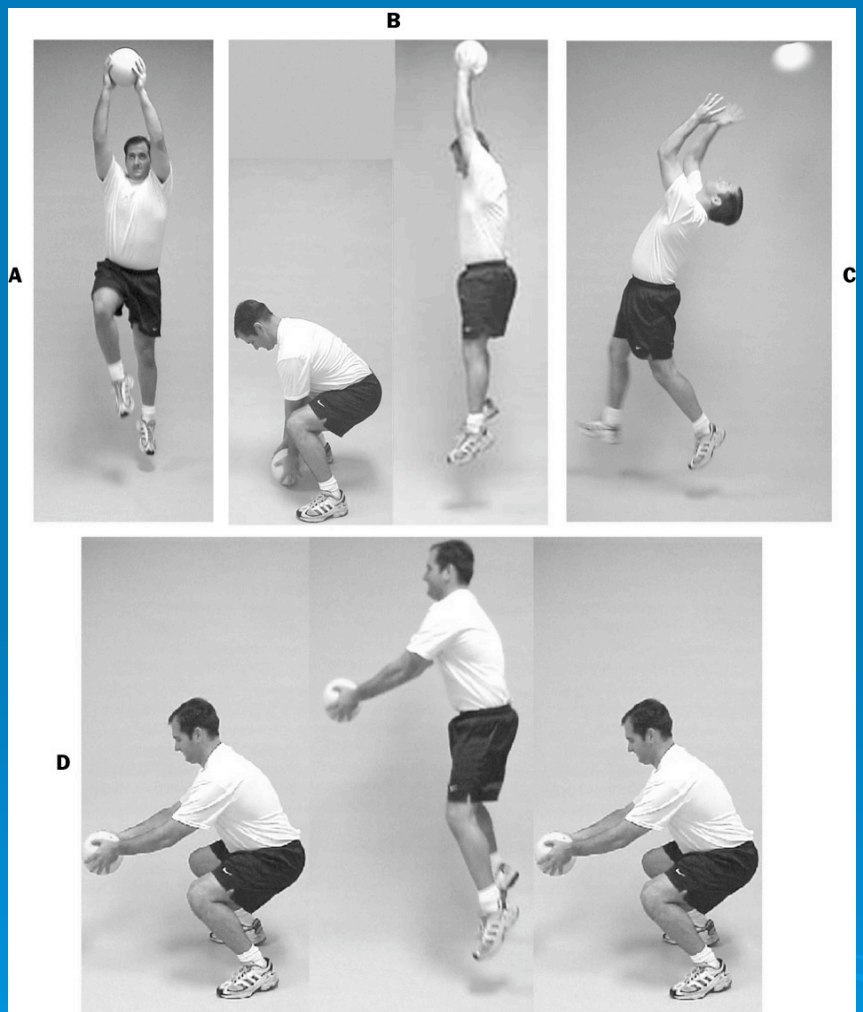


Level III: Integrated Stabilization Strength





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.