ACE Personal Trainer Manual, 4th edition

Chapter 9: Functional Programming for Stability-Mobility and Movement

Learning Objectives

- This session, which is based on Chapter 9 of the *ACE Personal Trainer Manual* (4th ed.), covers stability and mobility training and movement training.
- After completing this session, you will have a better understanding of:
  - Neurophysiological properties that impact movement
  - The various components of stability and mobility training
  - The five primary patterns of movement training and how they are addressed in the movement-training phase

Introduction

- Today's decreasing levels of activity and commonplace poor posture lead to muscle imbalances.
- This session focuses on the need to reestablish stability and mobility across the joints, as well as how to train the five basic movement patterns:
  - Bend-and-lift movements (e.g., squatting)
  - Single-leg movements (e.g., single-leg stance and lunging)
  - Pushing movements (primarily in the vertical/horizontal planes)
  - Pulling movements (primarily in the vertical/horizontal planes)
  - Rotational (spiral) movements

Movement

- Improving clients' movement efficiency and ability to perform daily activities is one of many possible definitions of functional training.
- The ability to move efficiently requires appropriate levels of both stability and mobility.
  - Joint stability
    - Ability to maintain or control joint movement or position
  - Joint mobility
    - Range of uninhibited movement around a joint or body segment

Movement Efficiency

- Movement efficiency involves a synergistic approach between stability and mobility.
  - “Proximal stability promotes distal mobility.”
- The relationship between stability and mobility throughout the kinetic chain is complex.

Mobility and Stability of the Kinetic Chain

- While all joints demonstrate varying levels of stability and mobility, they tend to favor one over the other, depending on their function.
  - For example, while the lumbar spine demonstrates some mobility, it is generally stable, protecting the low back from injury.
  - On the other hand, the thoracic spine is designed to be more mobile to facilitate a variety of movements in the upper extremity.
  - The foot is unique, as its level of stability varies during the gait cycle.

Glenohumeral = Mobility

Scapulothoracic = Stability

Thoracic spine = Mobility

Lumbar spine = Stability

Hip = Mobility

Knee = Stability

Ankle = Mobility

Foot = Stability

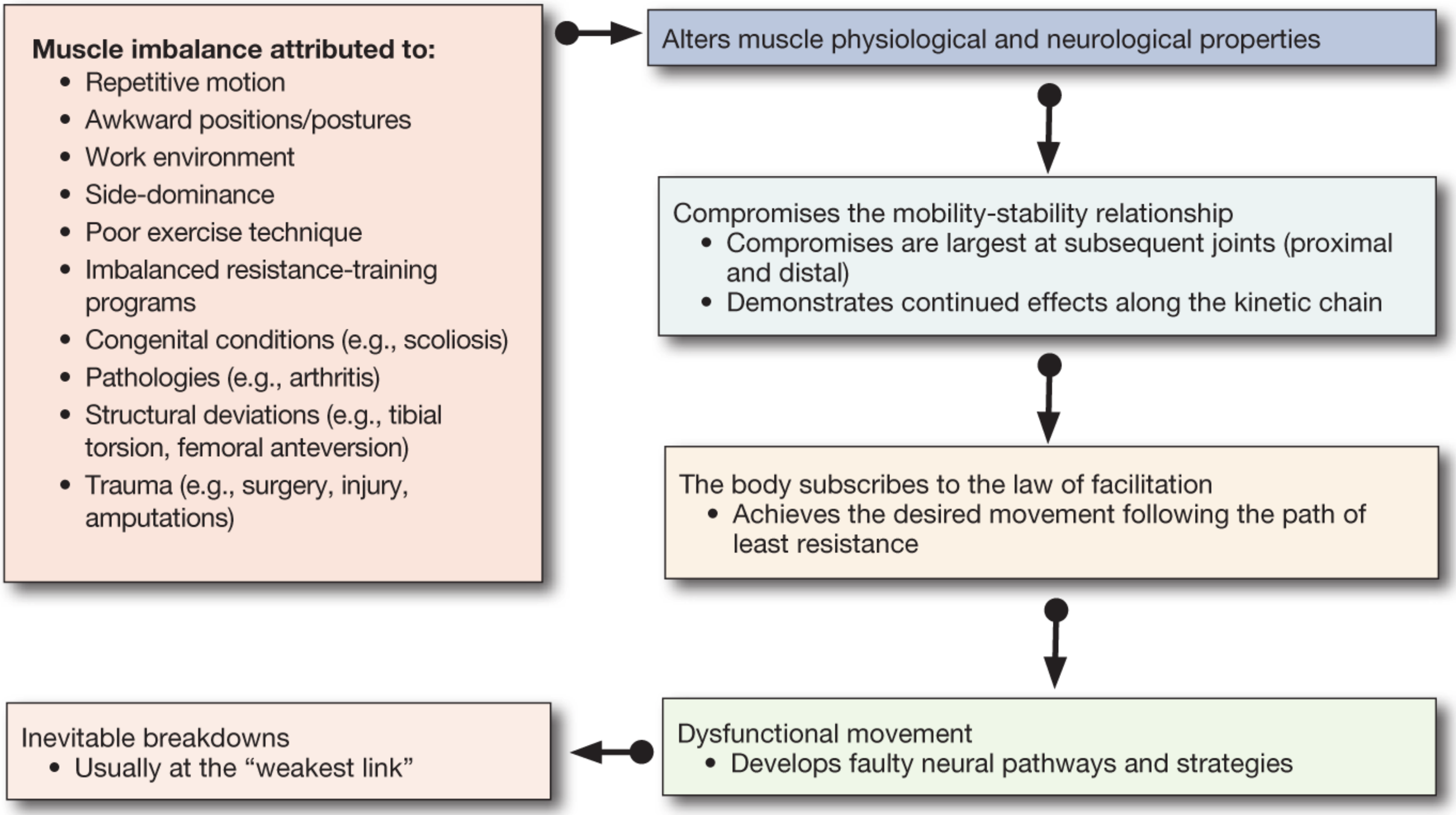
Poor Posture

- When mobility is compromised, the following movement compensations typically occur.
  - The joint will seek to achieve the desired range of motion (ROM) by incorporating movement into another plane.
  - Adjacent, more stable joints may need to compromise some degree of stability to facilitate the level of mobility needed.

Lack of Mobility

- A lack of mobility can be attributed to reduced levels of activity and conditions that promote muscle imbalance.
  - Loss of mobility leads to compensations in movement and potential losses to stability at subsequent joints.
  - Muscle imbalances ultimately contribute to dysfunctional movement, as illustrated on the following slide.

Dysfunctional Movement



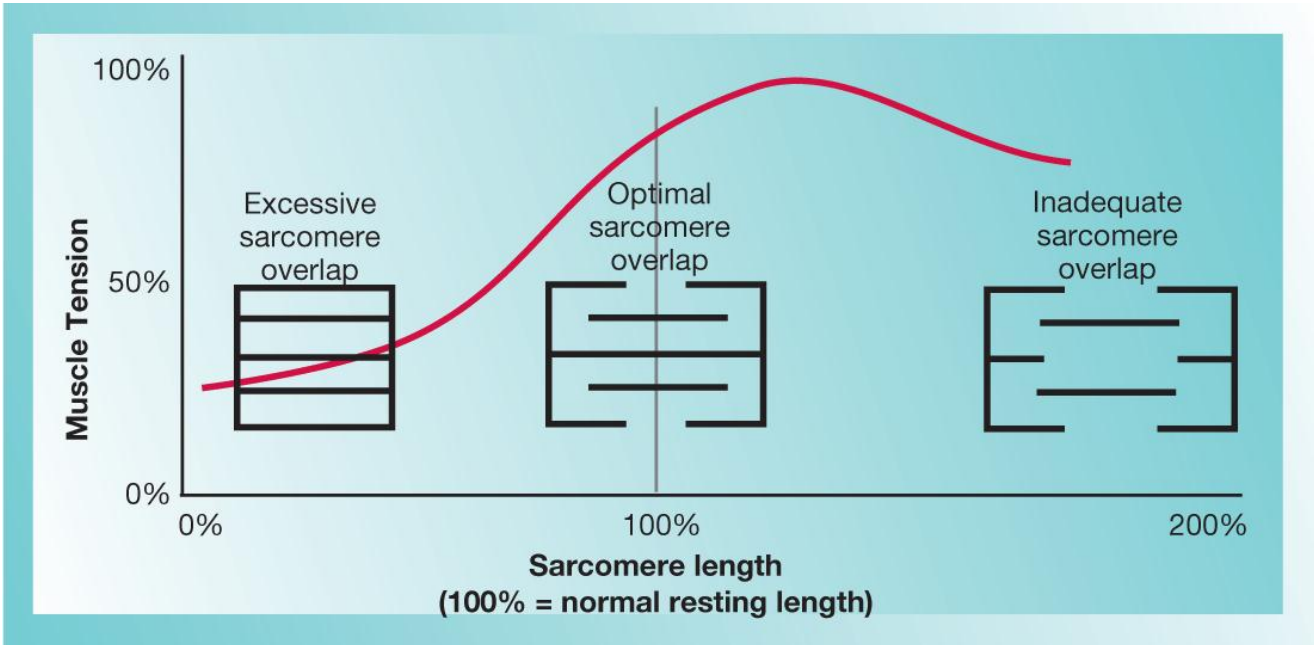
Movement Compensations

- Movement compensations generally represent an inability to maintain muscle balance and neutrality at the joint.
- Periods of inactivity when joints are held passively in shortened positions result in muscle shortening.
- Muscle shortening and lengthening alter both the physiological and neural properties within the muscle.

Length-tension Relationships

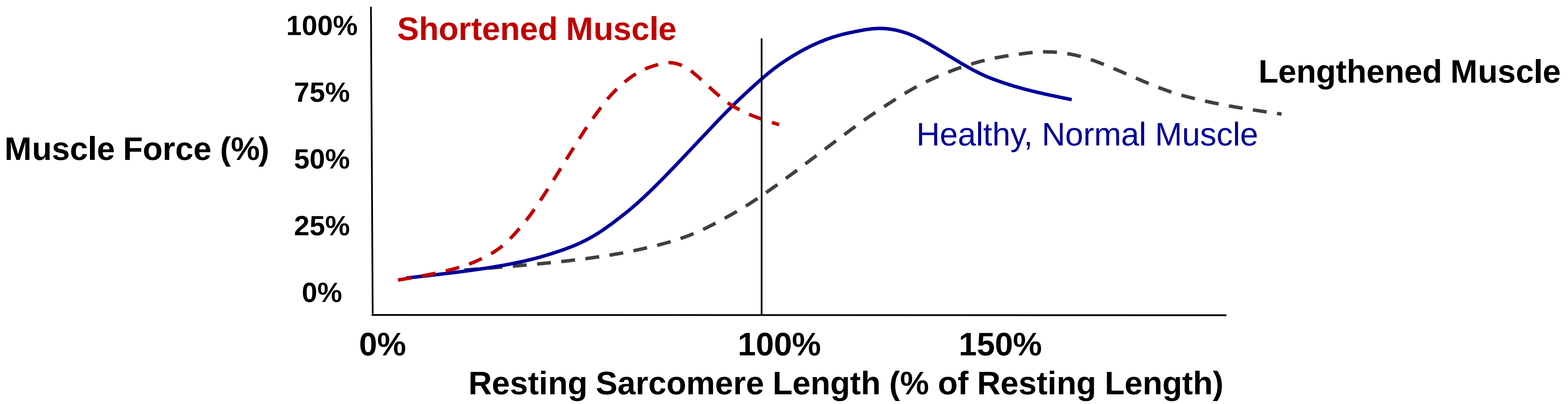
- The length-tension relationship is the relationship between the contractile proteins of a sarcomere and their force-generating capacity.
  - A slight stretching of the sarcomere beyond its normal resting length increases its force-generating capacity, as illustrated on the following slide.
  - Stretching of the sarcomere beyond optimal length reduces the potential for contractile protein binding.
  - Shortening the sarcomere beyond resting length results in an overlap of contractile proteins.

Length-tension Relationship Illustration



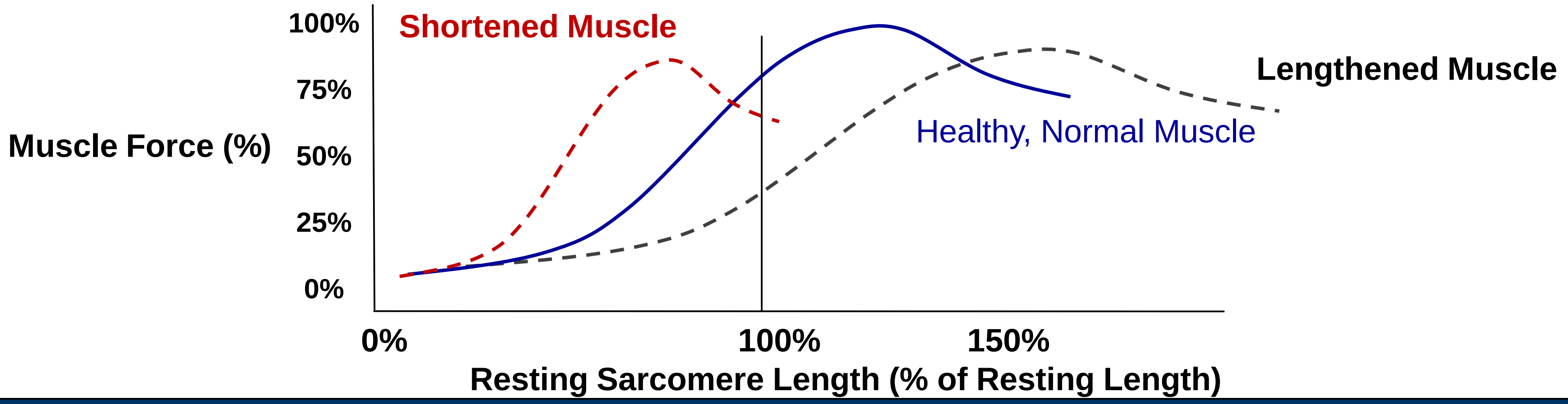
Length-tension Curve Shifts to the Left

- Muscle immobilization, passive shortening, trauma, and aging all shorten muscles, thereby shifting the length-tension curve to the left.
  - Muscles can shorten in as little as two to four weeks when held in passively shortened positions.
  - Simply stretching a tight muscle does not restore its normal force-generating capacity due to the reduced number of sarcomeres.
  - Passive stretching or elongation of a tightened muscle will gradually add sarcomeres back in line.



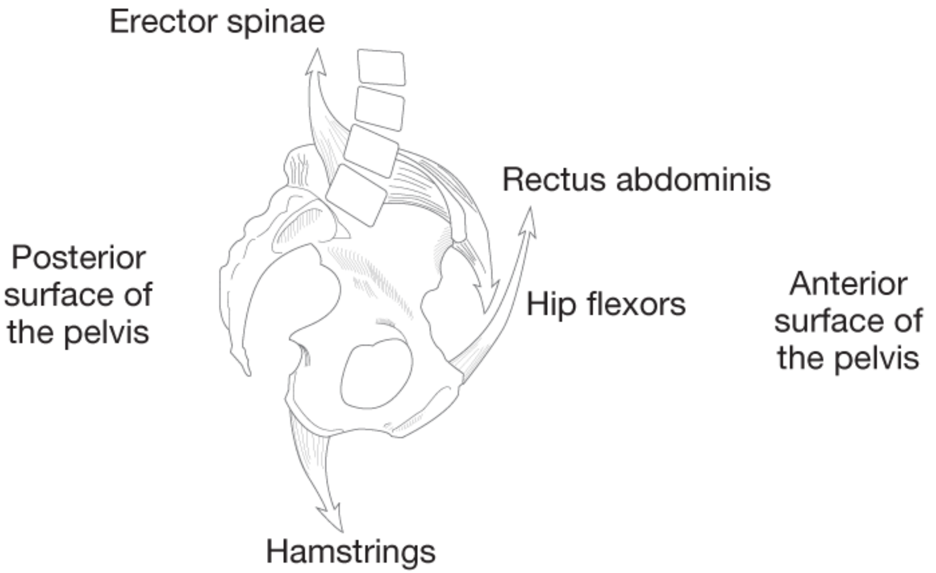
Length-tension Curve Shifts to the Right

- When muscles lengthen on the opposing side of the joint, they undergo an adaptive change and add sarcomeres in series.
  - Muscles may demonstrate greater force-generating capacities in lengthened positions.
  - Muscles demonstrate reduced force-generating capacity in the normal-resting-length or shortened positions.
  - Restoring the muscle's force-generating capacity is best achieved by strengthening a muscle in normal-resting-length positions.



Force-couple Relationships

- Muscles rarely work in isolation, but instead function as integrated groups.
  - Many function by providing opposing, directional, or contralateral pulls at joints (termed force-couples).
  - For example, maintenance of a neutral pelvic position is achieved via opposing force-couples between four major muscle groups.



Neural Control

- Joint movement is dependent on nerve activity.
  - To help stabilize and control movement within the joint, some degree of simultaneous co-contraction of the antagonist also occurs.
- When a muscle becomes shortened, increased tonicity occurs within the muscle (hypertonicity).
  - A hypertonic muscle requires a smaller or weaker nerve impulse to activate a contraction (lowered irritability threshold).
  - When an individual tries to activate the antagonist at a joint, the reduced irritability threshold of the agonist may prematurely activate the muscle and inhibit the action of the antagonist.

Reciprocal Inhibition and Synergistic Dominance

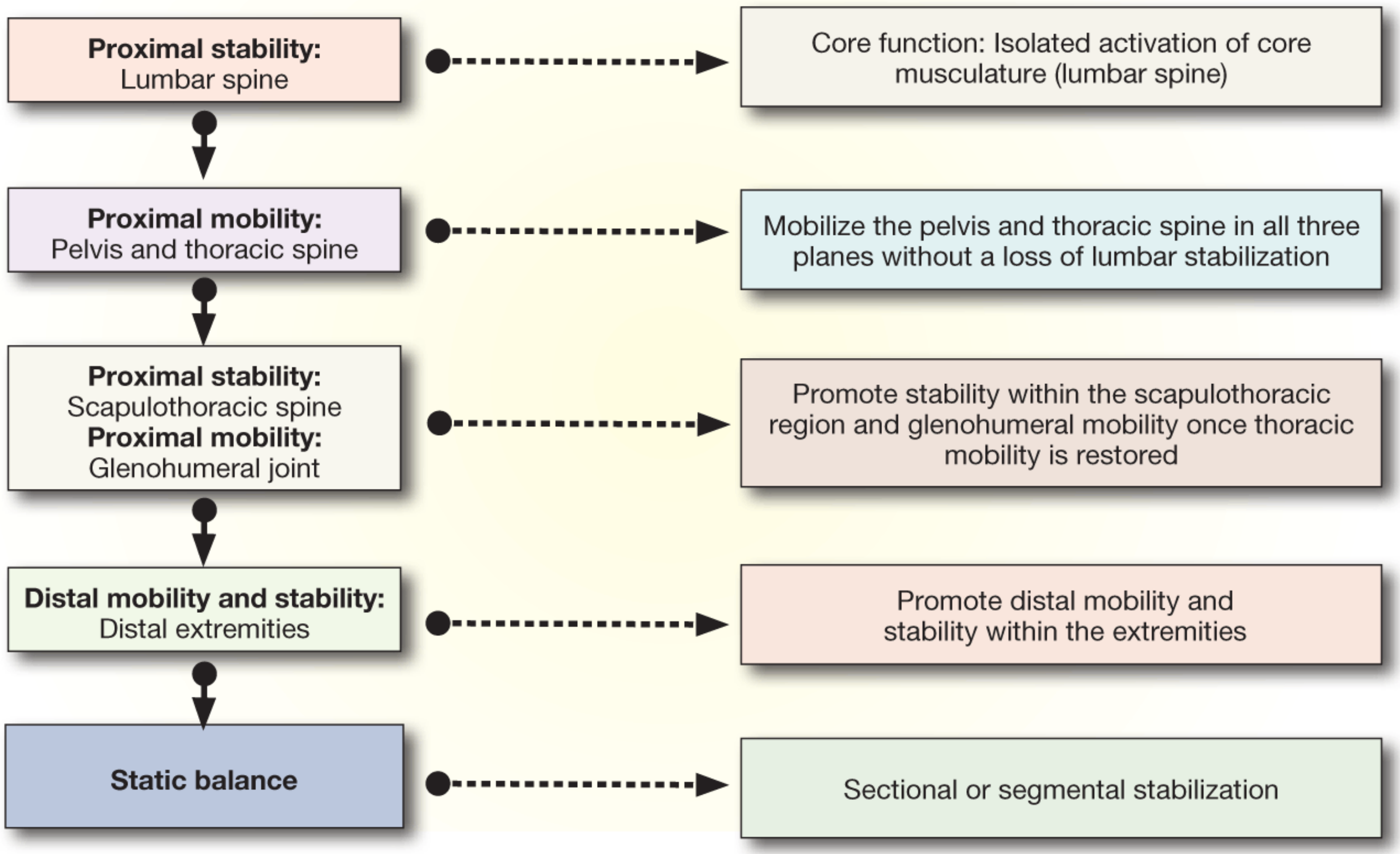
- Hypertonic muscles decrease the neural drive to the opposing muscle via reciprocal inhibition.
- Reciprocal inhibition of the opposing muscles contributes to further weakening of the antagonist.
  - This reduces its ability to generate adequate levels of force to move the joint.
  - When other muscles at the joint (synergists) assume the responsibility of becoming the prime mover, it is called synergistic dominance.
- Compromised joint movement alters neuromuscular control and function.

Phase 1: Stability and Mobility Training

- The objective of this phase is to reestablish appropriate levels of stability and mobility throughout the kinetic chain following the principle of "proximal stability promotes distal mobility."

Stability and Mobility Programming Components

- The figure below illustrates a programming sequence to promote stability and mobility within the body.



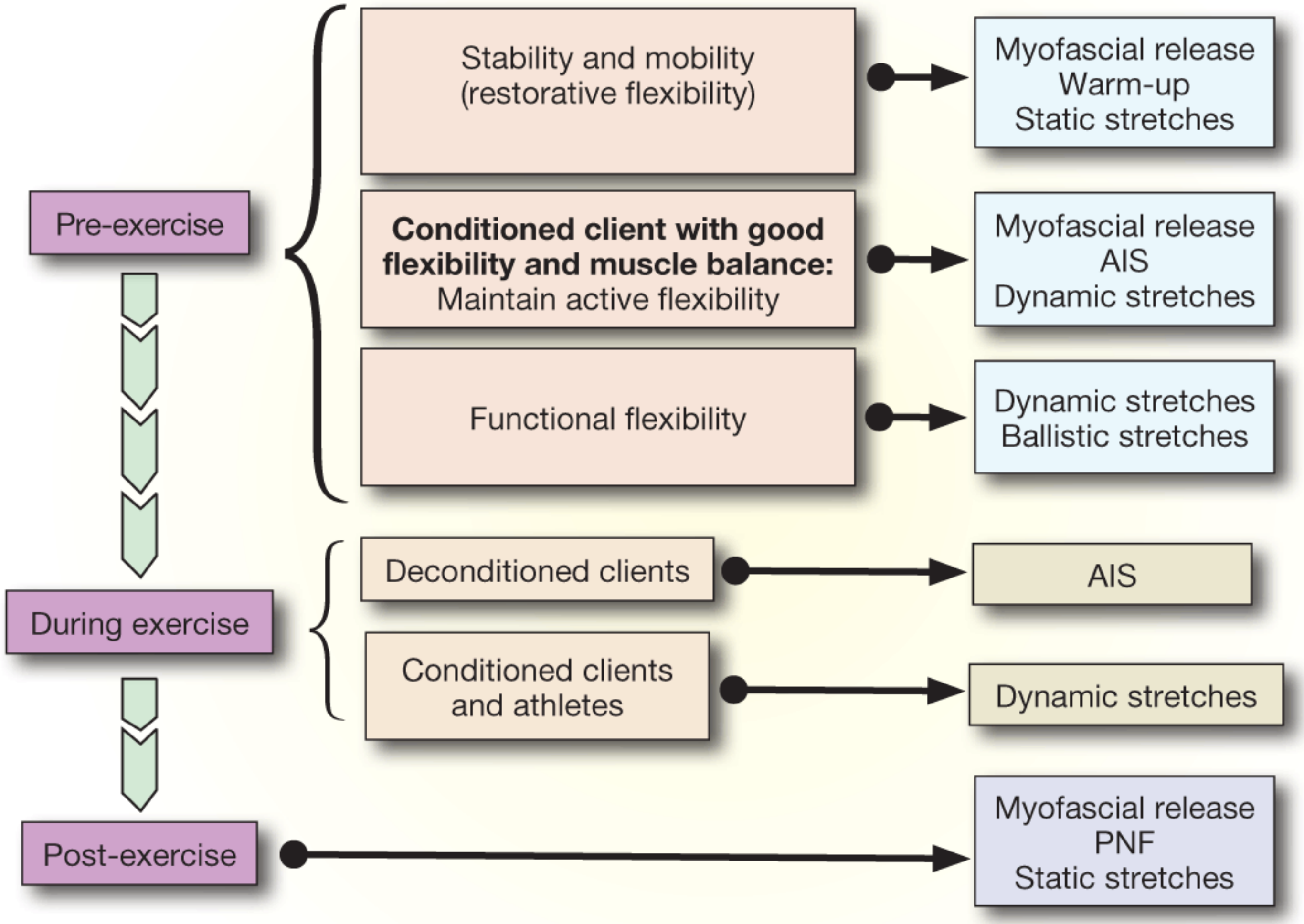
Stabilizers versus Prime Movers

- Muscles that act primarily as stabilizers generally contain greater concentrations of type I muscle fibers.
  - Type I muscle fibers enhance a stabilizer muscle’s capacity for endurance.
  - These muscles are better suited for endurance-type training (higher-volume, lower-intensity).
- Muscles primarily responsible for joint movement and generating larger forces generally contain greater concentrations of type II muscle fibers.
  - These muscles are better suited for strength- and power-type training (higher-intensity, lower-volume).

Stretching Techniques

- Much of this phase is devoted to improving muscle flexibility.
- Passive elongation of the tightened muscles is generally needed to impose the appropriate overload to begin the morphological process of adding sarcomeres back into the muscle.
  - The *ACE Personal Trainer Manual* (4th ed.), provides specific guidelines on passive elongation.
- The application of different stretching modalities is effective in restoring and maintaining good posture, and muscle balance.
  - The following slide provides a template, along with suggestions on which stretching technique is best to include during each phase of a workout session.

Stretching Techniques Template



Note: AIS = Active isolated stretching; PNF = Proprioceptive neuromuscular facilitation

Myofascial Release

- To perform myofascial release, clients perform small, continuous, back-and-forth movements (using a stick or foam roller) over the tender region(s) for 30 to 60 seconds.
- This technique:
  - Realigns the elastic muscle fibers from a bundled position into a straighter alignment with the muscle and fascia
  - Resets the proprioceptive mechanisms of the soft tissue
  - Should precede static stretching
  - Helps reduce hypertonicity within the underlying muscles

Static Stretches

- Static stretches should be taken to the point of tension and held.
  - This timeframe is adequate to evoke the appropriate neurological responses to relax the muscle and allow stretching of the non-elastic tissue of the muscle.
  - Clients should perform 4 or more repetitions for 15–60 seconds each.

Proprioceptive Neuromuscular Facilitation

- To conduct proprioceptive neuromuscular facilitation (PNF), clients can perform a “hold-relax” stretch.
  - Passively move the joint to the point of tension.
  - Perform a mild isometric contraction (<50% MVC) in the stretched muscle for 6–15 seconds
  - Follow with a 10- to 30-second assisted or passive static stretch.

Active Isolated Stretches and Dynamic/Ballistic Stretches

- In active isolated stretches (AIS), clients can perform 1–2 sets x five to 10 repetitions at a controlled tempo.
  - These stretches should be held at the end range of motion for 1–2 seconds.
- Dynamic and ballistic stretches should be performed for 1–2 sets x 10 repetitions.
  - Ballistic stretches involve a high risk of injury and should be reserved only for well-conditioned individuals (e.g., athletes).

Strengthening Postural Muscles

- The goal is to condition the postural muscles (tonic) that typically contain greater concentrations of type I fibers.
  - Strengthening muscles to improve posture should ideally begin with a series of low-grade isometric contractions.
  - Higher intensities that require greater amounts of force will generally evoke faulty recruitment patterns.
- The exercise volume can be gradually increased to:
  - Improve strength and endurance
  - Reestablish muscle balance at the joints

Stabilization Through External Support

- Many deconditioned individuals lack the ability to stabilize their entire kinetic chain.
  - Consequently, the initial emphasis should be on muscle isolation using supportive surfaces prior to introducing integrated strengthening exercises.
  - The use of support offers the additional benefit of kinesthetic and visual feedback.

Dynamic Strengthening

- Strengthening exercises should ultimately progress to dynamic movement.
  - Control ROM initially to avoid excessive muscle lengthening (where the muscle is strong).
- Dynamic strengthening to improve posture does not involve heavy loads, but volume to condition the type I fibers.
  - Plan on 1–3 sets of 12–15 repetitions when introducing dynamic strengthening exercises.
- Follow a progression for strengthening of weakened muscles:
  - 2–4 repetitions of isometric muscle contractions, each held for 5–10 seconds at <50% of MVC in a supported, isolated environment
  - Progress to dynamic, controlled ROM exercises incorporating 1–3 sets of 12–15 repetitions.

Proximal Stability: Activating the Core

Proximal Stability:
Lumbar Spine

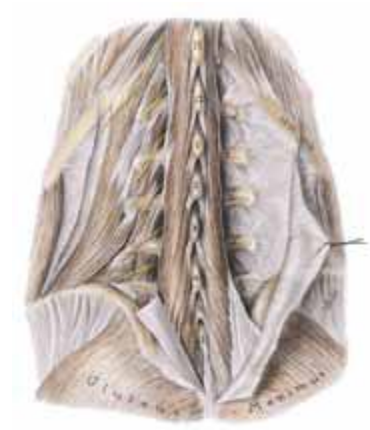
- The goal of this stage is to promote stability of the lumbar spine by improving the reflexive function of the core musculature.
  - The core functions to effectively control the position and motion of the trunk over the pelvis.
  - The term “core” generally refers to the muscles of the lumbo-pelvic region, hips, abdomen, and lower back.
  - Rather than identify each muscle, the following slides categorize the muscles and structures by function and location.

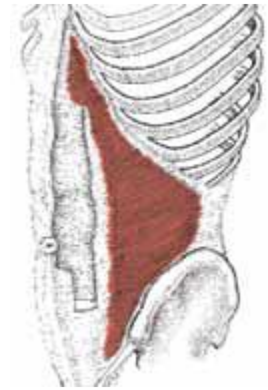
Deep Layer

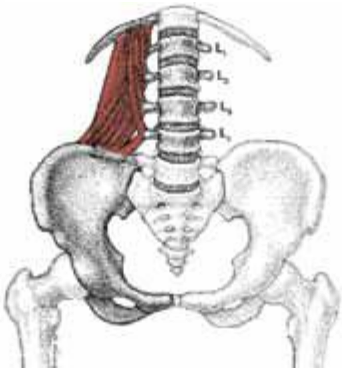
- The deep or innermost layer of the core consists of:
  - Vertebral bones and discs
  - Spinal ligaments running along the front, sides, and back of the spinal column
  - Small muscles that span a single vertebra that are generally considered too small to offer significant stabilization of the spine
- These small muscles offer little support or contribution to moving the spine given their small size, but are rich in sensory nerve endings and provide continuous feedback to the brain regarding loading and position of the spine.

Middle Layer

- The middle layer consists of muscles and fasciae that encircle the lower regions of the spine.
- These muscles include the:
  - Transverse abdominis (TVA)
  - Multifidi
  - Quadratus lumborum
  - Deep fibers of the internal oblique
  - Diaphragm
  - Pelvic floor musculature and the adjoining fasciae







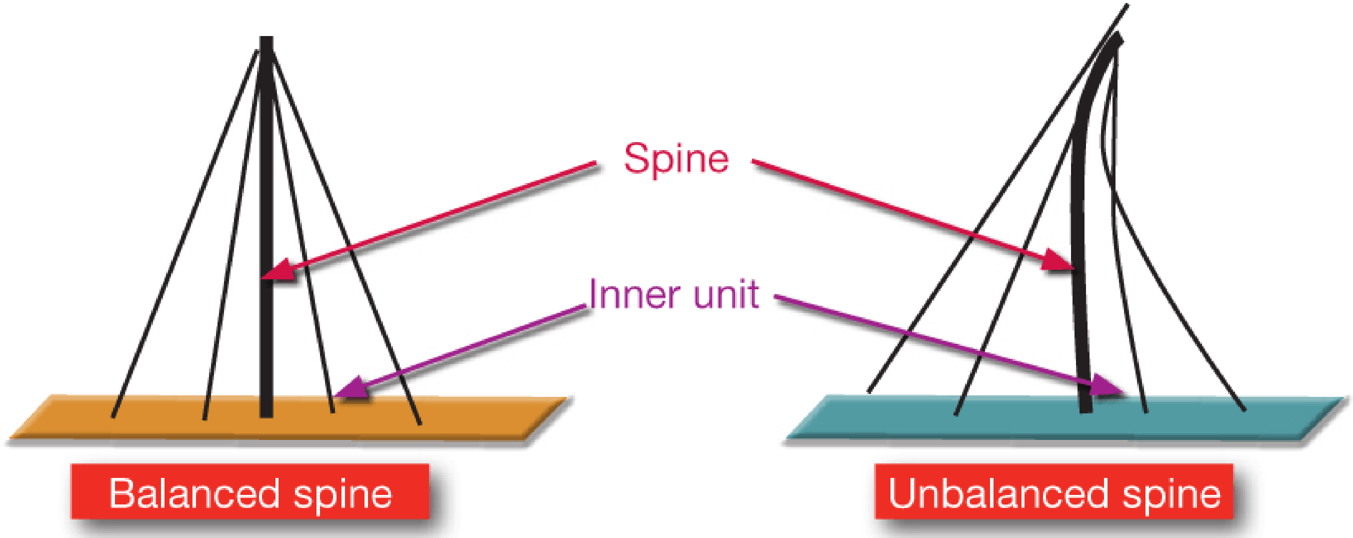
- This is the muscular layer usually referred to as the core.

Outer Layer

- The outermost layer consists of larger, more powerful muscles that span many vertebrae.
- Muscles in this region include the:
  - Rectus abdominis
  - Erector spinae
  - External and internal obliques
  - Iliopsoas
  - Latissimus dorsi

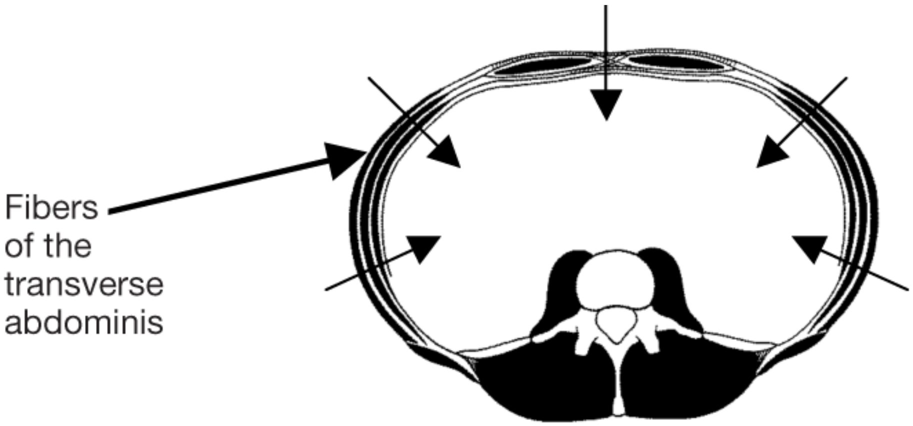
Relationship Between Vertebrae and Core Muscles

- The relationship between the vertebrae and the core muscles can be likened to a segmented flagpole with guy wires controlled by the neural subsystem.
  – The segmented pole represents the vertebrae, while the guy wires represent the core layer.
  – Balanced tension within the guy wires increases tension to stiffen the flagpole and enhance spinal stability.



"Hoop Tension"

- The TVA is the key muscle that works reflexively with the neural system.
- Activation of the core muscles, primarily the TVA, produces a "hoop tension" effect.
  - This contraction pulls the abdominal wall inward and upward, compressing the internal organs.
  - This reduces joint and disc compression by creating a rigid cylinder to stabilize the spine against loading forces.



Neural Dysfunction of the TVA

- TVA malfunction and limited co-contraction of core muscles have been found in individuals suffering from low-back pain.
  - Delayed activation of the TVA may inadequately stabilize the lumbar spine during movements of the upper and lower extremities.
  - Individuals lacking appropriate TVA function may need to rely on synergistic muscles to assume the role of stabilizing the spine.

Model for Core and Balance Training

- The body's COM is located within the region of the core.
  - Controlling the COM within the BOS is critical to balance training.
  - Core conditioning and balance training are fundamentally the same thing.
- To effectively activate and condition the core—and train balance—trainers can utilize a progressive training program.

Stage 1: Core function
Emphasizes core-activation exercises and isolated stabilization under minimal spinal loading

→

Stage 2: Static balance
Emphasizes sectional and whole-body (integrated) stabilization under a fixed base of support

→

Stage 3: Dynamic balance
Emphasizes whole-body (integrated) stabilization under a dynamic base of support

Activation of the TVA

- Activation of the TVA draws the abdomen inward toward the spine—often referred to as "centering," "drawing-in," or "hollowing."
  - Centering serves essential motor re-education purposes, but it does not ensure the same degree of stability as an activation pattern called "bracing."
  - Bracing is the co-contraction of the core and abdominal muscles to create a more rigid and wider base of support (BOS) for spinal stabilization.
- The concept of "centering" should be mastered first, reestablishing the core's reflexive function, before introducing the concept of "bracing."

Activating the Core: Supine

Table 9-1	
Exercise Progression for Core Activation	
Pelvic floor contractions ("Kegels," or the contraction to interrupt the flow of urine)	Perform 1–2 sets x 10 repetitions with a 2-second tempo, 10–15 second rest intervals between sets
TVA contractions (drawing the belly button toward the spine)	Perform 1–2 sets x 10 repetitions with a 2-second tempo, 10–15 second rest intervals between sets
Combination of both contractions	Perform 1–2 sets x 10 repetitions with a 2-second tempo, 10–15 second rest intervals between sets
Contractions with normal breathing	Perform 1–2 sets x 5–6 repetitions with slow, 10-second counts while breathing independently, 10–15 second rest intervals between sets Progress to 3–4 sets x 10–12 repetitions, each with a 10-second count, 10–15 second rest intervals between sets

Note: TVA = Transverse abdominis

Progressing Core Activation: Quadruped

a.

b.

Table 9-2

Exercise Progression for Core Stabilization

1. Raise one arm 0.5 to 1 inch (1.25 to 2.5 cm) off the floor and perform the sequence of controlled shoulder movements: • 6–12 inch (15–30 cm) sagittal plane shoulder movements (flexion/extension) • 6–12 inch (15–30 cm) frontal plane shoulder movements (abduction/adduction) • 6–12 inch (15–30 cm) transverse plane shoulder movements (circles or circumduction)	Perform 1–2 sets x 10 repetitions with a 2-second tempo, use 10–15 second rest intervals between sets
2. Raise one knee 0.5 to 1 inch (1.25 to 2.5 cm) off the floor and perform the sequence of controlled hip movements: • 6–12 inch (15–30 cm) sagittal plane hip movements (flexion/extension) • 6–12 inch (15–30 cm) frontal plane hip movements (abduction/adduction) • 6–12 inch (15–30 cm) transverse plane hip movements (circles)	Perform 1–2 sets x 10 repetitions with a 2-second tempo, use 10–15 second rest intervals between sets
3. Raise contralateral limbs (i.e., one arm and the opposite knee) 0.5 to 1 inch (1.25 to 2.5 cm) off the floor and perform the sequence of movements: • Repeat the above movements in matching planes (i.e., simultaneous movement in the same plane with both limbs) or alternating planes (i.e., mixing the planes between the two limbs). • This contralateral movement pattern mimics the muscle-activation patterns used during the push-off phase portion of walking and is an effective exercise to train this pattern.	Perform 1–2 sets x 10 repetitions with a 2-second tempo, use 10–15 second rest intervals between sets

Proximal Mobility: Hips and Thoracic Spine

Proximal Mobility:
Pelvis and Thoracic Spine

- The goal of this stage is to improve mobility of the two joints immediately adjacent to the lumbar spine.
- Trainers should follow some fundamental principles when programming to improve mobility in these body regions:
  - These regions are typically prone to poor mobility.
  - When stretching, clients must avoid undesirable or compensated movements at successive joints.
  - Supportive surfaces should be utilized while promoting mobility.
  - Incorporate flexibility exercises that lengthen the muscles in all three planes.

Hip and Thoracic Spine Mobility Exercises

- Specific exercises for promoting mobility include:
  - Supine 90-90 neutral back
  - Cat-camel
  - Pelvic tilts
  - Pelvic tilts progressions: supine bent-knee marches
  - Pelvic tilts progressions: modified dead bug with reverse bent-knee marches
  - Hip flexor mobility: lying hip flexor stretch
  - Hip flexor mobility progression: half-kneeling triplanar stretch
  - Hamstrings mobility: lying hamstrings stretch
  - Hip mobilization with glute activation: shoulder bridge (glute bridge)
  - Hip mobilization: supine 90-90 hip rotator stretch
  - Posterior compartment mobilization: table-top kneeling lat stretch
  - Thoracic spine (T-spine) mobilization exercises: spinal extensions and spinal twists
  - Thoracic spine (T-spine) mobilization: prisoner rotations
  - Posterior mobilization: rocking quadrupeds

Proximal Stability: Scapulothoracic Region; Distal Mobility: Glenohumeral Joint

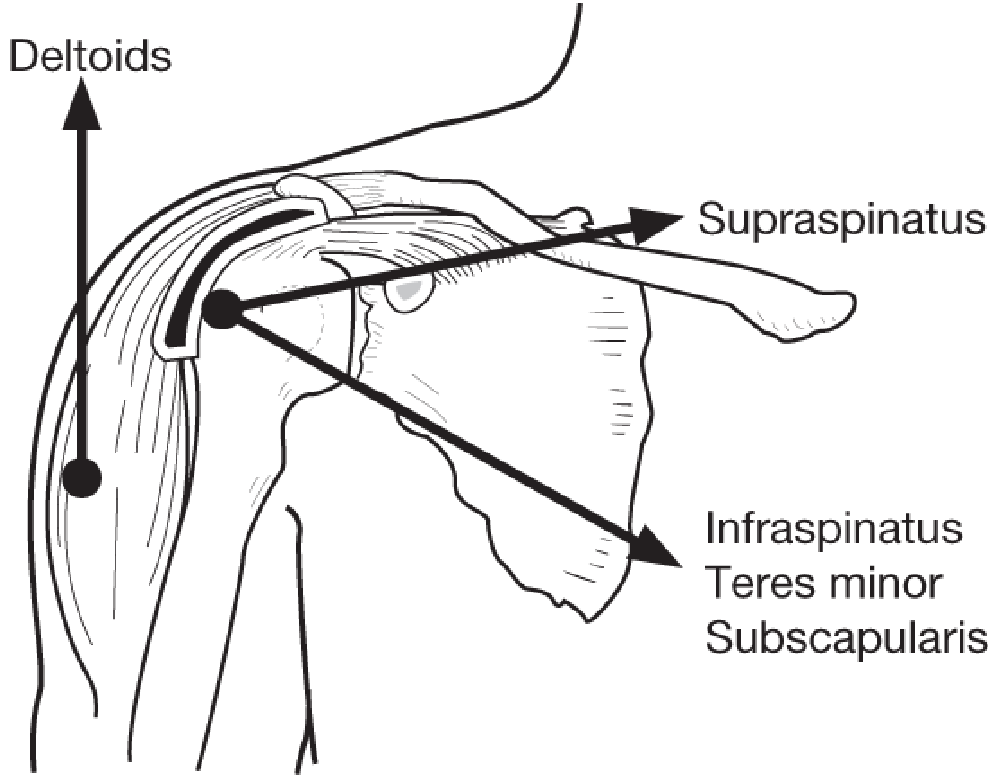
Proximal Stability: Scapulothoracic Spine
Proximal Mobility: Glenohumeral Joint

- This stage is designed to improve stability within the scapulothoracic region during upper-extremity movements to facilitate appropriate mobility at glenohumeral joint, which is a highly mobile joint.
  - Promoting stability within this joint requires muscle balance within the force-couples of the joint.
  - As many of these muscles also cross the glenohumeral joint, they require substantial mobility.

Force-couple Relationships of the Shoulder

- A normally positioned scapula promotes muscle balance and effective force-coupling relationships.
- Problematic movements are associated with arm abduction and a lack of scapular stability during horizontal push-and-pull movements.
  - During abduction, the rotator cuff muscles play an important role in initiating movement and facilitating an inferior glide of the humeral head.
    - They contract in anticipation of deltoid action.
  - Collaborative action of the supraspinatus acting as the primary abductor for the first 15 degrees of abduction and the infraspinatus, subscapularis, and teres minor depressing the head of the humerus inferiorly within the glenoid fossa permits rotation to occur.
  - After ~15 degrees of abduction, the deltoid takes over as the primary abductor and the rotator cuff muscles continue to depress and stabilize the humeral head.
  - If the deltoid acted alone, pure superior glide would occur, which would impinge the humeral head against the coracoacromial arch at approximately 22 degrees of abduction.

Muscle Action Involved in Abducting the Arm



Promoting Stability Within the Scapulothoracic Region

- During pushing and pulling movements, key parascapular muscles co-contract to permit movement and stability of the scapulae.
- When the thoracic spine lacks appropriate mobility, it affects mobility and muscle action within the glenohumeral joint.
- Promoting stability within the scapulothoracic region requires thoracic mobility in addition to other key factors:
  - Tissue extensibility (both active and passive structures)
  - Healthy rotator cuff muscle function
  - Muscle balance within the parascapular muscles
  - The ability to resist upward glide and impingement against the coracoacromial arch during deltoid action

Stretching the Shoulder Capsule

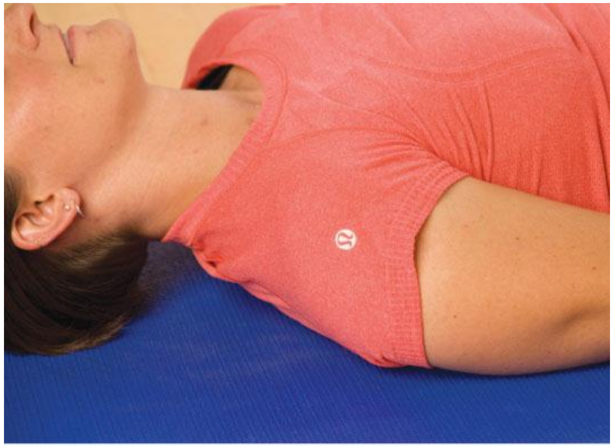
- To enhance tissue extensibility, trainers can employ several different stretching modalities.
  - Myofascial release using a stick or foam roller will help realign the elastic fibers and reduce hypertonicity.
  - When stretching the shoulder capsule with a client, trainers must address the inferior, posterior, anterior, and superior components.

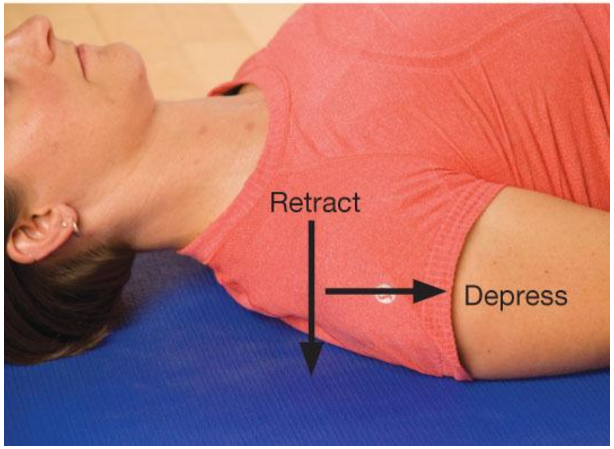
Closed-chain versus Open-chain Exercises

- Closed kinetic chain (CKC) movements
  - The distal segment is fixed (e.g., pull-ups and push-ups)
  - A key role of the serratus anterior is to move the thorax toward a more fixed, stable scapulae.
  - CKC exercises load and compress joints, increasing kinesthetic awareness and proprioception.
  - Many are too challenging for deconditioned individuals
- Open kinetic chain (OKC) movements
  - A key role of the serratus anterior is to control movement of the scapulae against a more fixed ribcage.
  - Generally considered more functional, as they closely mimic daily activities
  - Isolated OKC exercises, however, are not as effective in restoring coordinated parascapular control.
- Initially, clients should use the floor to provide kinesthetic feedback and OKC movements to improve control and movement efficiency.

Exercises for Scapulothoracic Region Stability

- Shoulder setting
  - The first step is to help the client recognize the normal resting position of the scapulae kinesthetically.
    - Have the client feel the correct scapulae position against the floor.
  - The exercise pictured here helps achieve this awareness by teaching the client to “pack” the scapulae.
  - A variety of exercises can be used to condition the rotator cuff muscles.
    - Whichever exercises the trainer and client select, the client must perform them from the packed shoulder position.





Exercises for Scapulothoracic Region Stability

- Specific exercises for proximal mobility of the hips and thoracic spine include:
  - Internal and external humeral rotation
  - Diagonals
  - Reverse flys with supine 90-90
  - Prone arm lifts
  - Closed kinetic chain weight shifts
  - Arm roll

Distal Mobility

- Within the distal segments of the body, the gastrocnemius and soleus muscles (triceps surae) are often problematic.
- Tightness within the triceps surae or a foot positioned in pronation may often exhibit calcaneal eversion.
- During the bend-and-lift movement screen, an individual who is unable to keep the heels down will need to improve ankle mobility and calf flexibility.
- After reestablishing flexibility within the calf muscles, individuals can progress to performing the dynamic ankle mobilization exercise presented here.

Distal Mobility and Stability:
Distal Extremities

Balance

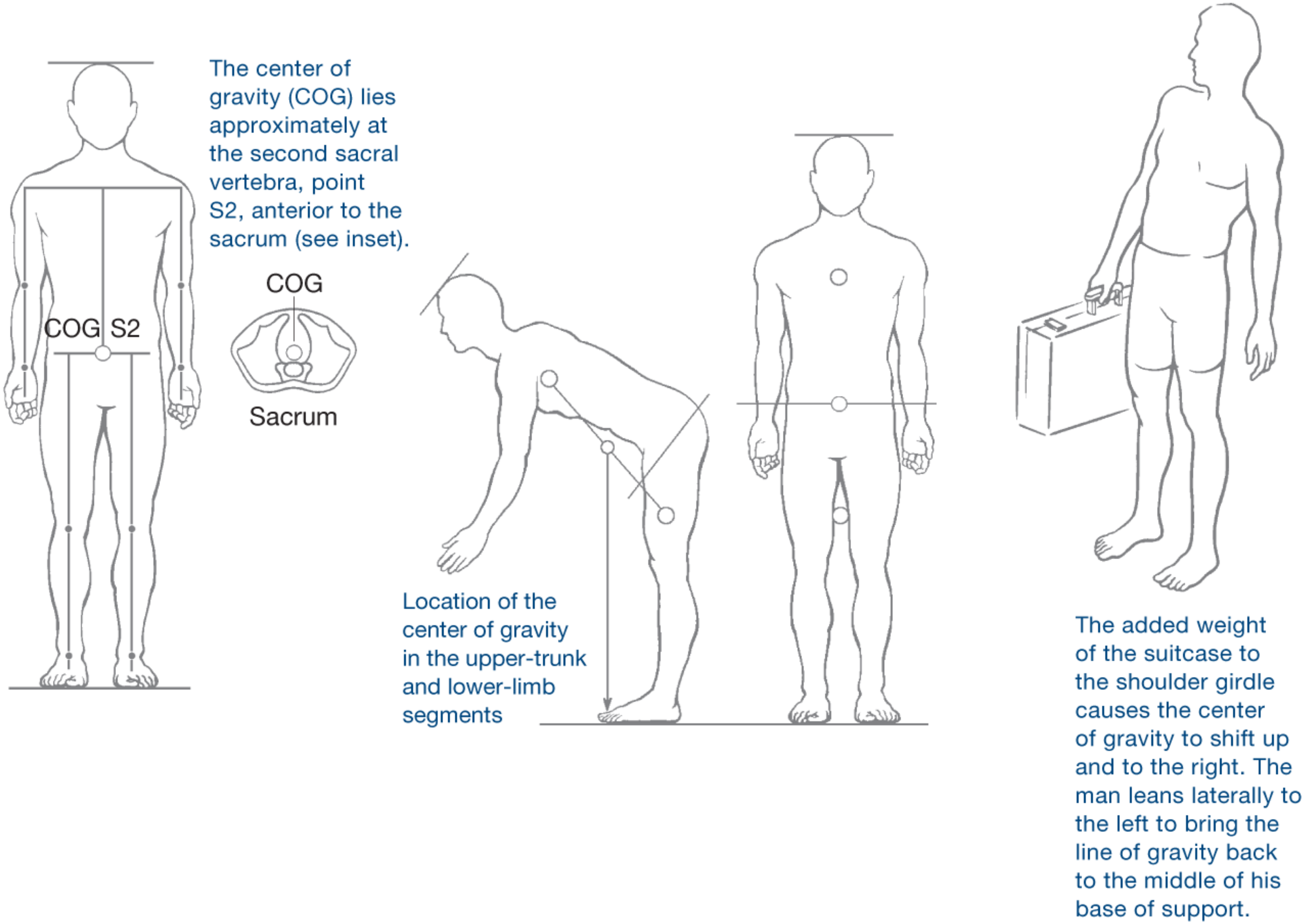
Static Balance

- The ability to move efficiently requires control of the body's postural alignment, or balance.
  - Balance is the foundational element of all programming.
  - Balance also contributes to improving the psychological and emotional states by building self-efficacy and confidence.
- Balance is subdivided into:
  - Static balance
  - Dynamic balance

Balance Terminology: Center of Mass

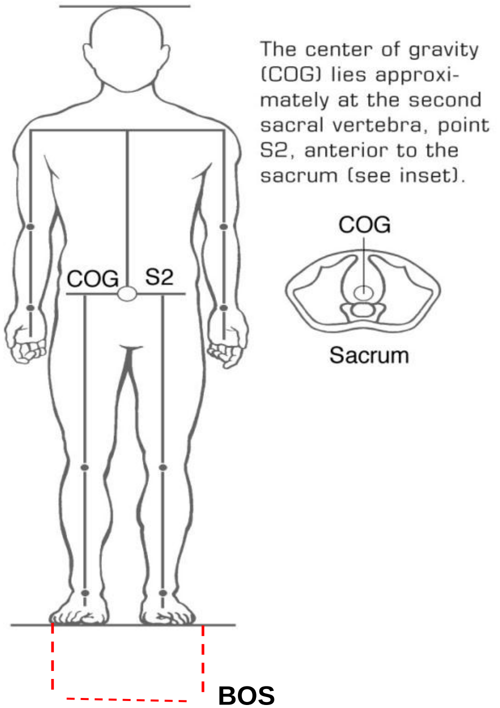
- COM, or center of gravity (COG), represents that point around which all weight is evenly distributed.
  - It is generally located about 2 inches (5.1 cm) anterior to the spine in the location of the first and second sacral joints.
  - COM varies in individuals by body shape, size, and gender.
  - A person's COM constantly shifts as he or she changes position, moves, or adds external resistance (illustrated on the following slide).

Center of Gravity Illustrated



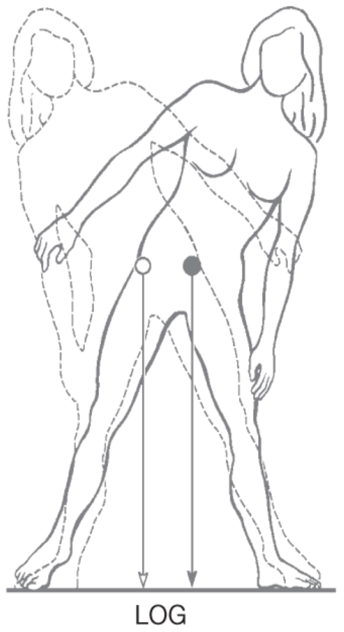
Balance Terminology: Base of Support

- BOS is defined as the two-dimensional distance between and beneath the body's points of contact with a surface.
  - The body is considered stable when its line of gravity (LOG) falls within its BOS.
  - The LOG is a theoretical vertical line passing through the COM, dissecting the body into the sagittal and frontal planes.



Balance Terminology: Line of Gravity

- Maintaining balance becomes more challenging when:
  - The LOG or the COM falls near, or outside of, the BOS
  - One challenges the body's limits of stability (LOS)
- LOS is the degree of allowable sway away from the LOG that can be tolerated without a need to change the BOS.



Training Static Balance

- Static balance training begins with segmental or sectional stabilization training.
- This entails the use of specific static-balance exercises performed over a fixed BOS that impose small balance challenges on the body's core.
  - The client adopts a seated position and engages the core musculature.
  - Clients can be gradually progressed by following the training guidelines presented on the following slide.
  - As each variable or condition is introduced, the trainer may need to remove others temporarily until the client regains postural control.
- Balance is a trainable skill and improvements are evident within a few weeks.

Training Guidelines: Static Balance (Segmental)

Table 9-3

Training Guidelines for Static Balance

Training Variables	Training Conditions
2–3 times per week Perform exercises toward the beginning of workouts before the onset of fatigue (which decreases concentration) Perform 1 set of 2–4 repetitions, each for 5–10 seconds	Narrow BOS (e.g., wide to narrow) Raise COM (e.g., raising arms overhead) Shift LOG (e.g., raising arms unilaterally, leaning or rotating trunk) Sensory alteration [e.g., shifting focal point to a finger 12 inches (30 cm) in front of one's face, performing slow hand-eye tracking, or performing slow head movements such as looking up and down] Sensory removal (e.g., closing eyes)

Note: BOS = Base of support; COM = Center of mass; LOG = Line of gravity

Progression: Static Balance (Segmental)

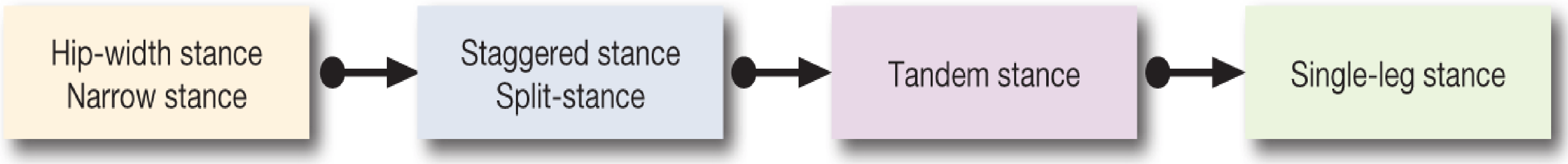
- If appropriate and consistent with the client's goals, trainers can introduce two more challenging variables:
  - Reduce the points of contact
  - Add additional unstable surfaces
- Trainers should introduce each of these challenges separately, gradually increasing the exercise difficulty by manipulating the variables and conditions provided on the previous slide.
- Next, trainers can introduce the second challenge in a similar manner.

Static Balance: Integrated (Standing)

- The natural progression from seated exercises is to standing exercises, thereby integrating the entire kinetic chain.
  - During integrated movements, the effects of external loads, gravity, and reactive forces all increase.
  - McGill introduced the concept of bracing discussed previously, explaining how it improves spinal stability by providing a wider BOS.
- To teach a client how to brace, a trainer can simply have the client stand in a relaxed position and engage the core muscles.
  - The client can then imagine a person standing in front of him or her who is about to deliver a quick jab to the stomach.
  - In anticipation of the jab, the individual should stiffen up the trunk region by co-contracting both layers of muscles.

Standing Static Balance Training Progressions

- The trainer can introduce standing static-balance training on stable surfaces before progressing to:
  - Static unstable surfaces
  - Dynamic unstable surfaces
- Both forms of training are important to developing efficiency within the proprioceptive, vestibular, and visual systems.
  - All balance exercises should ultimately incorporate some form of dynamic balance training on stable surfaces to mimic ADL.
  - When designing static balance-training programs, trainers should follow the stance-position progressions illustrated below.
  - The trainer should identify which stance position challenges the client's balance threshold and then repeat the exercises outlined previously.



Phase 2: Movement Training

- Human movement can essentially be broken down into five primary movements that encompass all ADL.
  - Bend-and-lift movements (e.g., squatting)
  - Single-leg movements (e.g., single-leg stance and lunging)
  - Pushing movements (primarily in the vertical/horizontal planes)
  - Pulling movements (primarily in the vertical/horizontal planes)
  - Rotational (spiral) movements
- This phase teaches these five movements patterns.
  - If a client can perform these five primary movements effectively, it decreases the likelihood for compensation, pain, or injury.

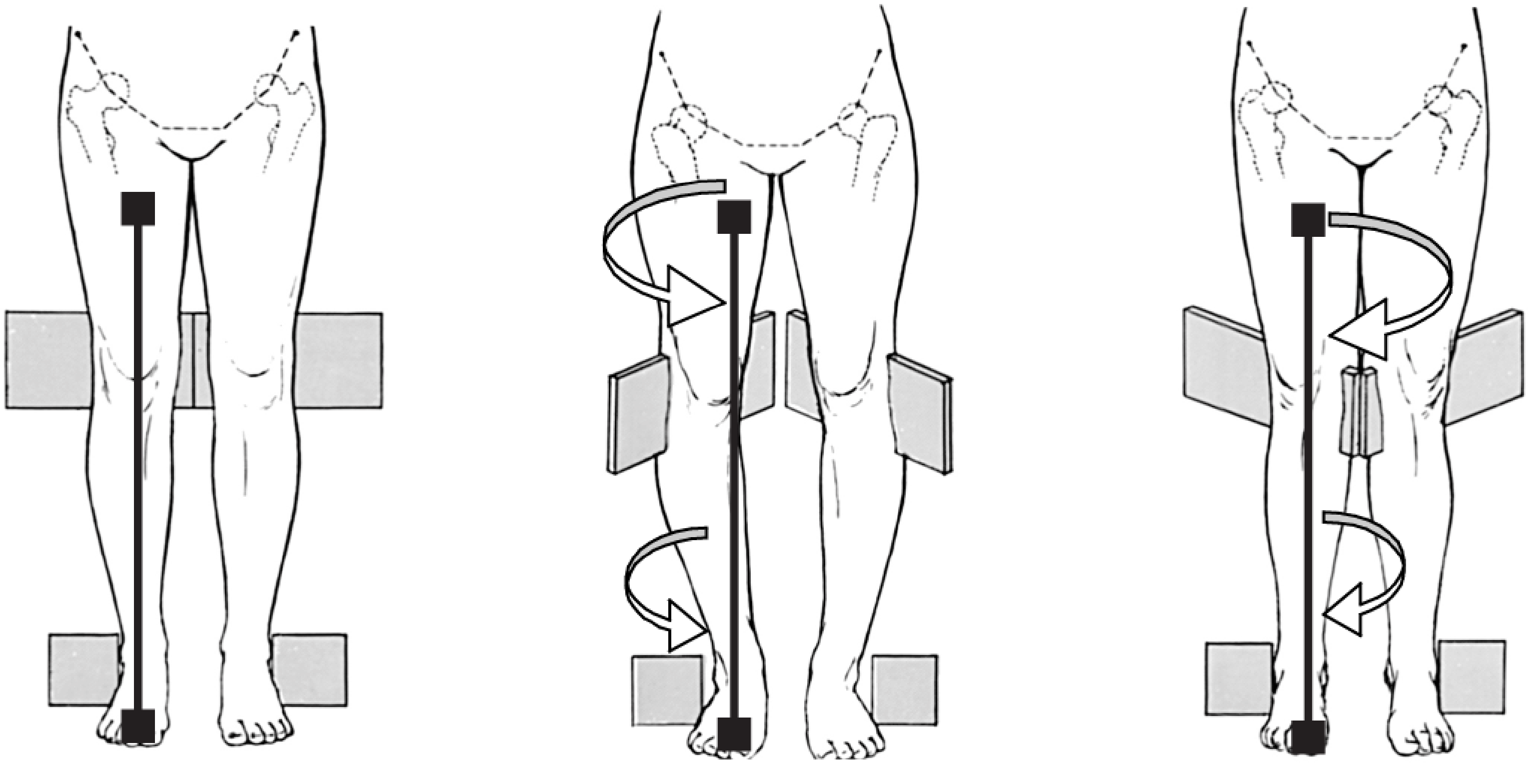
Abilities versus Skills

- Trainers should differentiate between abilities and skills when establishing the timeframes needed to teach movement patterns.
- Abilities
  - Inherited traits that are stable and enduring
  - Underlie the performance of many skills
- Skills
  - Developed and modified with practice
- Two to four weeks is usually adequate, but trainers might need to devote extra time when teaching movement patterns.

Lower Extremity Kinematics

- Before teaching the movement patterns, it is important to understand certain kinematics within the lower extremity.
  - An important relationship exists among the ankle, knee, and hip.
  - During the heel-strike instant of gait, the ankle dissipates forces upward through the knee and beyond.
  - To help tolerate these forces, the foot normally moves into pronation as a person bears weight onto that foot.

Ankle Pronation and Supination



Neutral subtalar position with neutral knee alignment

Pronation with internal rotation of the knee

Supination with external rotation of the knee

Pronation and the Gluteals

- Internal rotation between the femur and tibia places stress on the medial surface of the knee and forces the knee into abduction (valgus stress).
  - This increases the strain placed on the anterior cruciate ligament (ACL).
  - A key factor in protecting the knee is the gluteal group, which functions to decelerate internal hip rotation.
  - A common postural deviation is to stand in pronation.

Glute Dominance

- Glute dominance implies reliance on eccentrically loading the gluteus maximus during a squat (bend-and-lift) movement.
  - The first 10 to 15 degrees of the downward phase are initiated by pushing the hips backward, creating a hip-hinge movement.
  - In the lowered position, this maximizes the eccentric loading on the gluteus maximus.
  - Glute dominance also helps activate the hamstrings, which pull on the posterior surface of the tibia.

Quad Dominance

- Quad dominance implies reliance on loading the quadriceps group during a squat (bend-and-lift) movement.
  - The first 10 to 15 degrees of the downward phase are initiated by driving the tibia forward, creating shearing forces across the knee as the femur slides over the tibia.
  - In this lowered position, the gluteus maximus does not eccentrically load.
  - Quad-dominant individuals transfer more pressure into the knees, placing greater loads on the ACL.

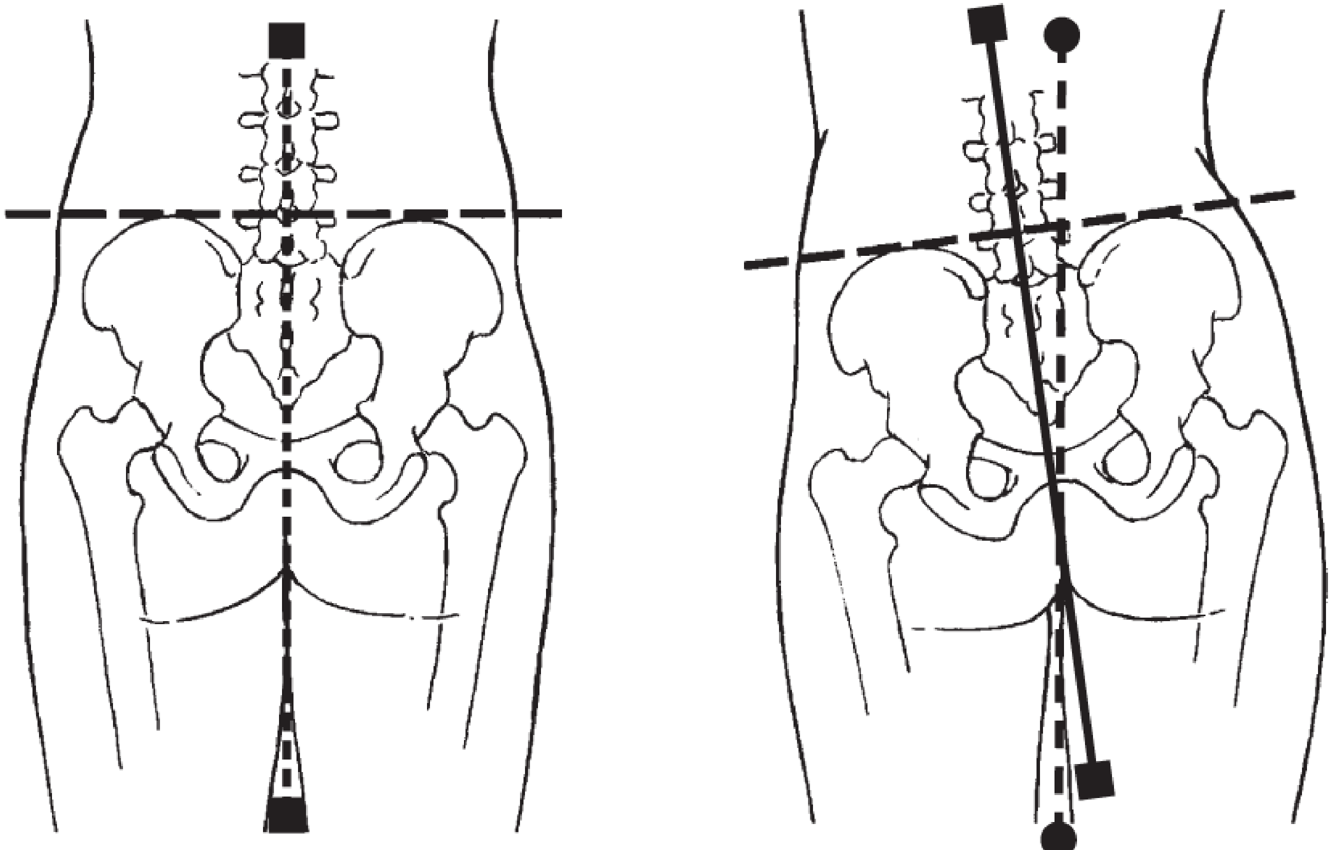
Lower-extremity Mechanics and Women

- Proper lower-extremity mechanics are important to preserve the integrity of the knee.
- They are even more critical to women given their:
  - Larger Q-angle (the angle formed by the longitudinal axis of the femur and the line of pull of the patellar ligament)
  - Increased joint laxity associated with hormones
  - Smaller ligaments and surface area for attachment
  - Weaker muscles
  - Motor skill development differences

Weight Transference During Gait

- As the body moves to accept weight onto the stance-leg, it must also preserve optimal alignment among the hip, knee, and foot.
  - This weight transference normally involves a 1- to 2-inch (2.5- to 5.1-cm) lateral shift of the hips over the stance-leg, coupled with tilting that hip upward by approximately 4 to 5 degrees (i.e., hip adduction).
  - In the first illustration on the following slide, the line of gravity passes vertically through the vertebrae and sacrum, whereas in the second illustration, the right hip is elevated (as it would be during gait when one accepts weight onto the right leg).

Normal Hip Position versus Right Hip Adduction



a. Normal hip position

b. Right hip in adduction

Gluteal and Quadratus Lumborum Actions

- As the right hip and femur are positioned closer to the midline (as seen in the second illustration on the previous slide), they are classified as moving into adduction.
  - This movement involves the collaborative actions of the right gluteal group to control excessive hip adduction and the left quadratus lumborum to prevent excessive hip tilting.
  - Weakness in any of these muscle groups can create potential knee issues by allowing excessive hip adduction.

Primary Movements: Bend-and-lift Patterns

- The bend-and-lift movement associated with the squat is subject to much controversy given its potential for harm to the knees and low back.
  - Faulty movement patterns associated with poor technique will ultimately lead to overload and potential injury.
  - One limiting factor to good technique is a lack of ankle mobility.
- To evaluate this limitation, have the client place one foot on a low riser [<12 inches (30 cm)], positioning the tibia perpendicular to the floor.
  - The client leans slowly forward, dorsiflexing the ankle until the heel lifts off the floor or the ankle falls into pronation.
  - Mobility <15 degrees merits a need to improve ankle flexibility prior to teaching the full bend-and-lift movement.

Hip ROM During a Squat

- The hips typically exhibit between 100 and 135 degrees of flexion.
- The amount of hip flexion required during a squat averages 95 degrees.
  - Hence, it is important to shift the pelvis posteriorly during the downward phase to facilitate adequate hip flexion.
- The hip-hinge exercise discussed later in this session teaches clients how to shift their hips backward to:
  - Promote additional hip flexion
  - Reduce the shearing forces across the knee joint

Lumbar Forces During a Squat

- During a squat movement, the inability to stabilize the spine increases compressive and shear forces on the lumbar vertebrae.
  - Squatting (with external loads) with excessive lumbar extension dramatically increases the compressive forces on the lumbar spine.
  - The pelvic tilts and back alignment and figure-4 exercises discussed later in this session promote optimal spinal alignment.

Bend-and-lift Movement Progressions

- Considering the variations present in most individuals' daily movements, clients should be trained functionally to mimic these patterns.
- Bend-and-lift movements should be progressed to include variations in foot position coupled with various arm movements.
  - Trainers should teach these variations beginning with the arms at the sides prior to moving into high-arm positions.
  - High-arm positions require a greater degree of thoracic mobility, which many clients may lack.
  - Trainers should teach the bend and lift in the dead-lift position first, before introducing the front-squat position and then the back and overhead positions.

Bend-and-lift Movement Training Sequence

- Specific exercises for the bend-and-lift movement pattern include:
  - Hip hinge
  - Pelvic tilts and back alignment
  - Lower-extremity alignment
  - Figure-4 position
  - Squat variations

Single-leg Stand Patterns

- Standing efficiently on a single leg mandates stability in the stance-leg, hip, and torso, while simultaneously exhibiting mobility in the raised leg if stepping is involved.
  - Weakness in the hip abductors reflects an inability to control lateral hip shift.
  - Before learning any single-leg movements, clients should learn how to effectively control hip adduction.

Static Balance on a Single Leg

- Once an individual demonstrates the ability to effectively stand on one leg, the trainer can introduce dynamic movements.
  - Next, various forms of resistance that increase the stabilization demands can be introduced.
  - The following slide presents a functional series of movements based off the Balance Matrix created by noted physical therapist Gary Gray.

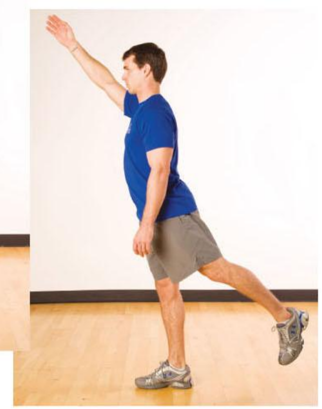
Single-leg Movement Patterns


Flexion/extension in the sagittal plane


Rotation in the transverse plane


Adduction/abduction in the frontal plane


Rotation in the transverse plane

Contralateral flexion/ extension in sagittal plane


Contralateral rotation in transverse plane

Single-leg Exercises

- Progression for the single-leg stance involves adding external resistance and increasing the balance challenge.
- A primary single-leg pattern involves teaching clients how to lunge effectively.
  - Lunge mechanics are very similar to the squat or bend-and-lift mechanics.

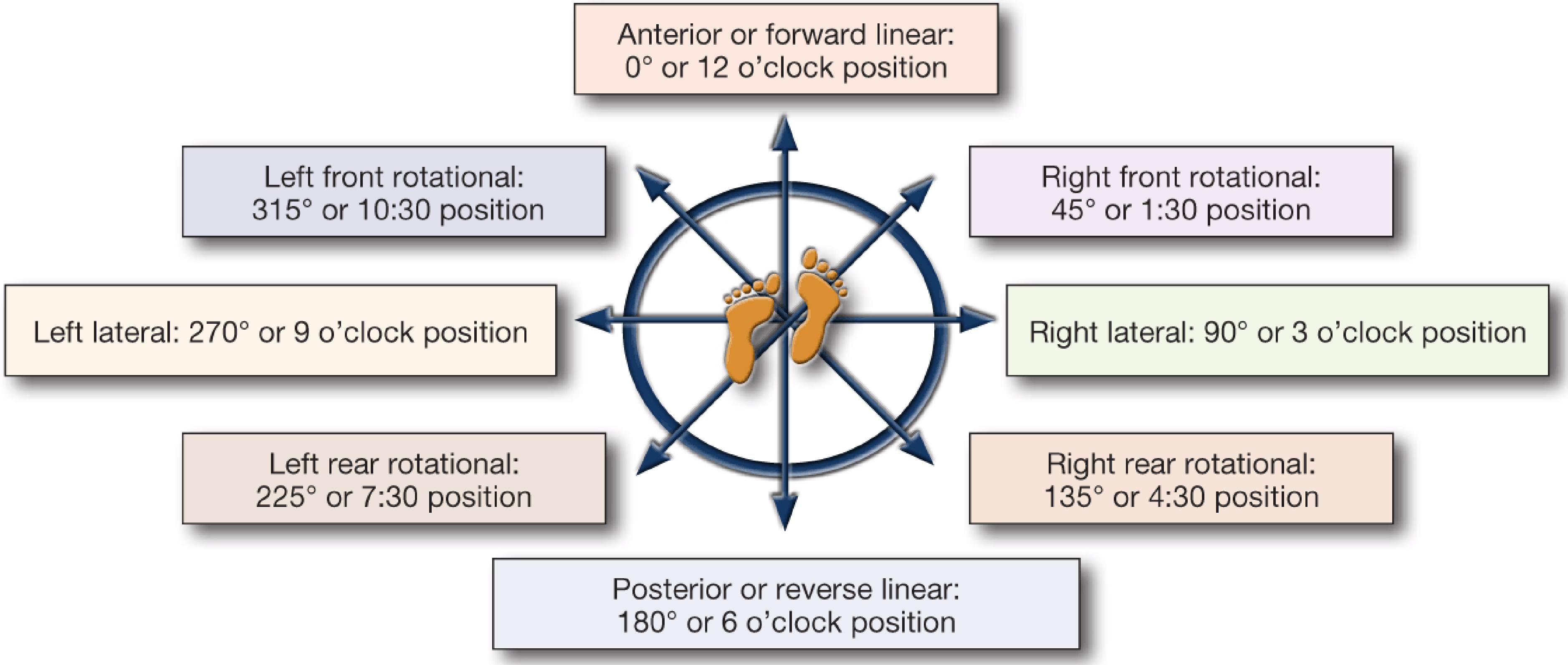
Lunge Training Sequence

- Specific exercises for the lunge movement pattern include:
  - Half-kneeling lunge rise
  - Lunges
  - Lunge matrix (Gary Gray)

Single-leg Exercise Progressions

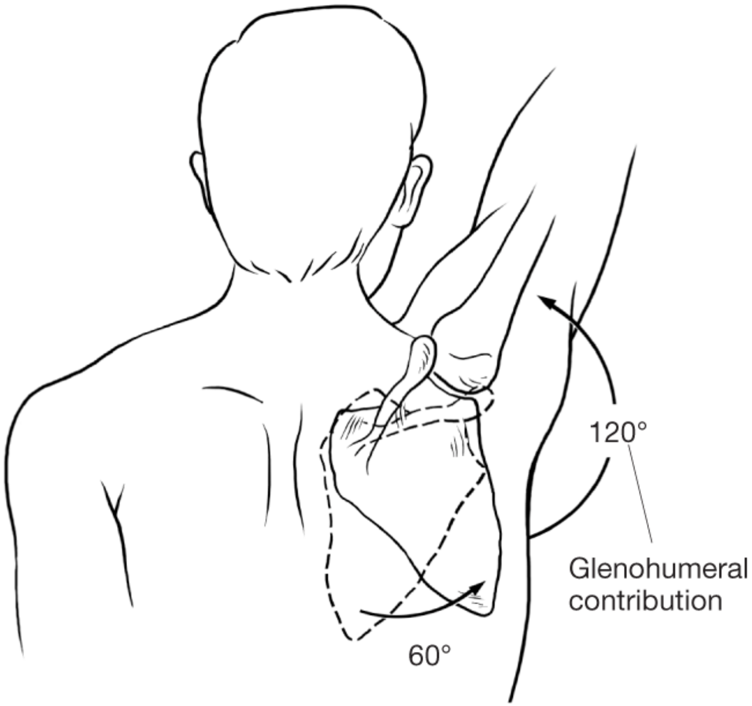
- Once a client demonstrates proficiency with the standard lunge pattern, progress the exercise to include:
  - Directional changes
  - Different foot positions
  - Upper-extremity movement
- High-arm positions require a greater degree of thoracic and hip mobility, which a client may lack.
- When working with athletes, movements can progress to jumps, hops, or bounds.

Directional Movements for Lunges, Jumps, etc.



Pushing/Pulling Movements

- During shoulder flexion and overhead presses, movement to 180 degrees is achieved by the scapulae rotating against the ribcage and the humerus rotating within the glenoid fossa.
  - The movement generally requires approximately 60 degrees of scapular rotation and 120 degrees of glenohumeral rotation.
  - The scapulae need to remain stable to promote normal mobility within the glenohumeral joint.
  - Faulty activation of specific scapular muscles compromises scapular stability.



Integrating Whole-body Movement Patterns

- In previous stages, stability and mobility exercises for the shoulder girdle focused on isolated action.
  - The emphasis during this phase of training shifts toward integrating whole-body movement patterns.
  - Exercises can begin with more traditional pushing movements that target the shoulder girdle in a bilateral or unilateral fashion.

Scapular Stability During Shoulder Movement

- To facilitate scapular stability during movement, mobility within the thoracic spine must first be established.
- Gary Gray uses his Thoracic Matrix exercise to integrate the entire kinetic chain.
  - Moves the thoracic spine three-dimensionally through each plane, driving with the arms or by using a dowel or light bar in various standing or lunging positions

Considerations for the Overhead Press

- Many clients simply yield to gravity during the eccentric or downward phase of a shoulder press.
  - This creates instability within the shoulder joint, given the changing roles of the deltoids between the starting and overhead position.
  - If the latissimus dorsi is engaged to begin the lowering phase, it helps stabilize the shoulder and precipitates greater force production during the lifting phase.

Pulling Movements

- Pulling movements follow many of the same principles as pressing movements with regard to stabilizing the scapulothoracic region.
- Trainers need to identify whether they want to train a client to:
  - Pull from a position of scapular stability, implying that the movement is purely from the shoulder
  - Intentionally incorporate scapular retraction into the pulling motion
- Exercises can begin with more traditional pulling movements that target the shoulder girdle in a bilateral or unilateral fashion.

Pushing and Pulling Training Sequence

- Specific exercises for pushing and pulling movement patterns include:
  - Thoracic matrix
  - Bilateral and unilateral presses
  - Bilateral and unilateral rows
  - Overhead presses

Rotational Movements

- Rotational movements generally incorporate movement into multiple planes simultaneously.
- Many of these movements increase the forces placed along the vertebrae.
  - Performing rotation exercises without thoracic mobility or lumbar stability may compromise the shoulders and hips, and increase the likelihood for injury.
- Mobility and stability in the thoracic and lumbar spine are critical in:
  - Facilitating synchronous movement
  - Dissipating the generated ground and reactive forces over larger surface areas
- The need for thoracic mobility is greater during rotational movements than with pushing and pulling movements, given the three-dimensional nature of the movement patterns.

Considerations for Rotational Movements

- Trainers need to remember that the thoracic spine offers greater mobility than the lumbar spine.
  - Therefore, lumbar stability and control of lumbar rotation while promoting movement within the thoracic spine should be emphasized.

Rotational Movement Training Sequence

- Specific exercises for rotational movement patterns include:
  - Wood-chop spiral patterns
  - Full wood-chop and hay-bailer patterns

Summary

- This session introduced the relationship of the entire kinetic chain with reference to postural alignment of the joints.
- Proper execution of functional movements enhances movement efficiency, as well as the integrity of the joint structures and soft tissues.
- This session covered:
  - Biomechanical and physiological concepts of movement
  - Phase 1: Stability and mobility training
  - Phase 2: Movement training