Ankle Foot Orthotic Course

Chapter 2:

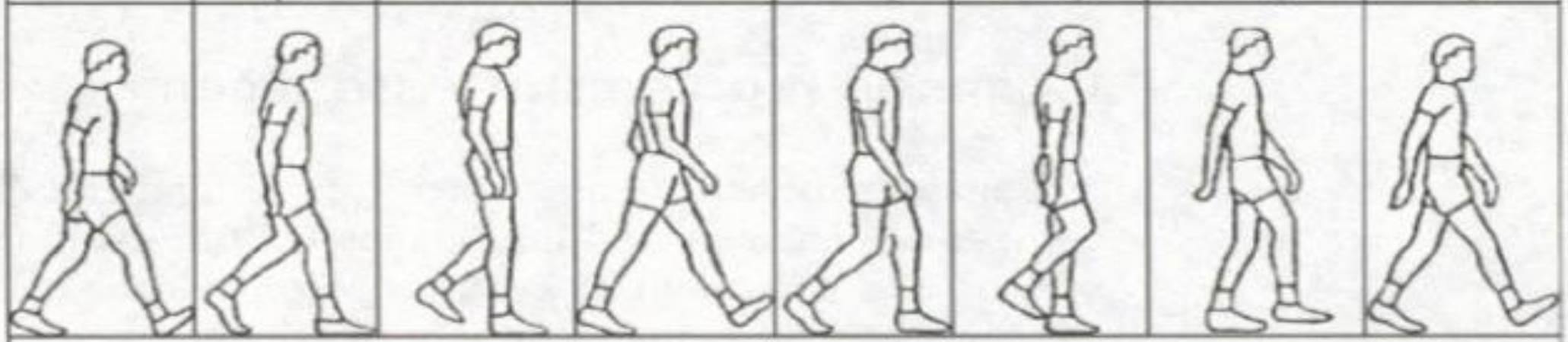
Review Normal Gait & Pathological Gaits

Objectives

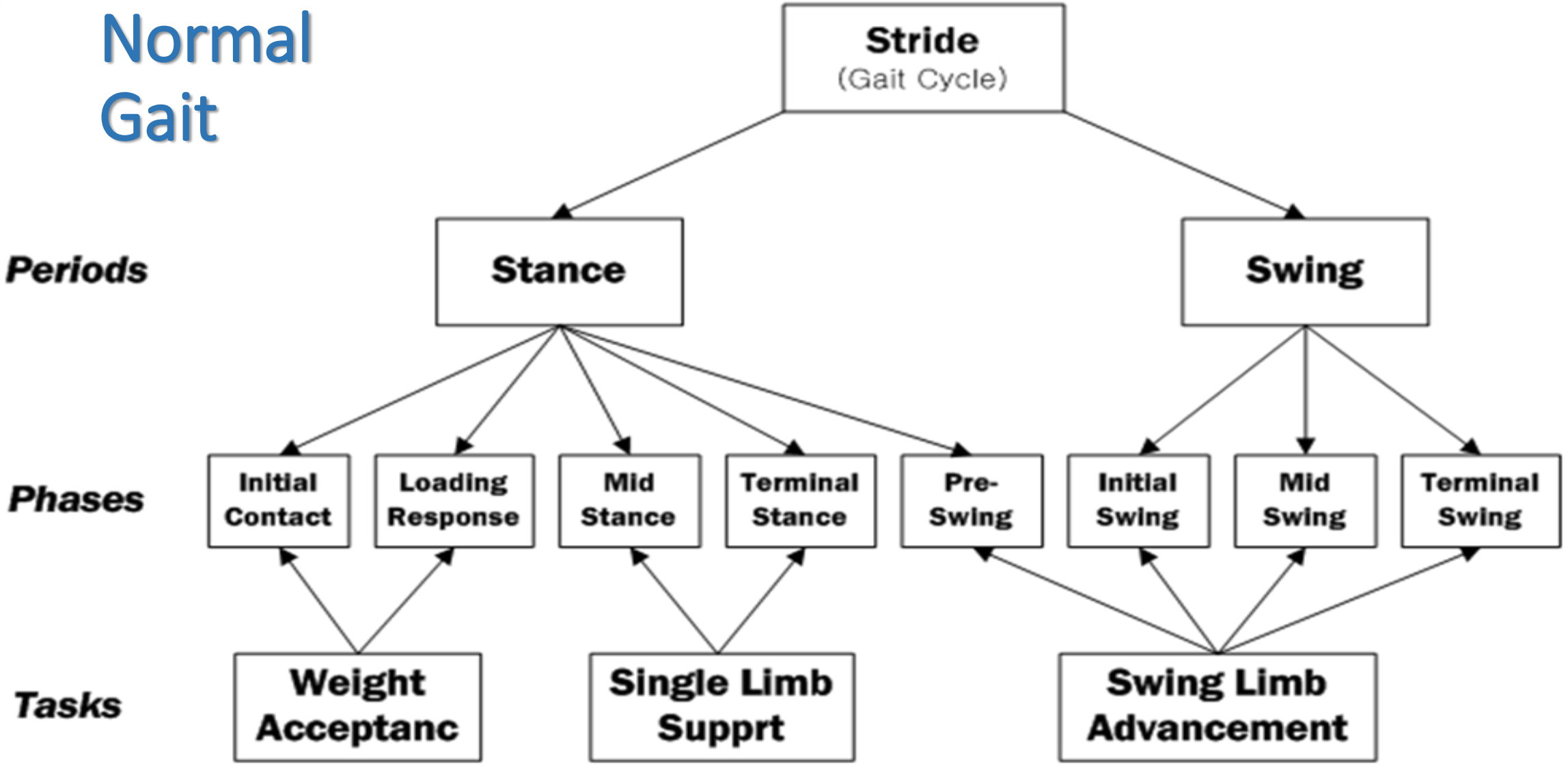
By the end of sessions the students will be able to:

- Describe the causes of pathological gaits
- Explain how to do gait analysis
- Explain the different pathological gait patterns at the ankle, knee, hip and trunk
- Explain the causes of those gait deviations

Review Normal Gait

	Stance (60%)					Swing (40%)		
	Initial Contact	Loading Response	Mid-stance	Terminal stance	Pre-swing	Initial swing	Mid-swing	Terminal swing
								
Hip	30° flexion	Extending to 5° flexion	Extending to neutral	10° of hyper extension	Neutral extension	20° Flexion liopsoas	30° Flexion	30° Flexion
Knee	Full extension	15° Flexion	Extending to neutral	Full extension	35° Flexion	60° Flexion	From 60° to 30° flexion	Extension to 0°
Ankle	Neutral heel first	15° Plantar flexion	From plantar flexion to 10° Dorsi flexion	Neutral with tibia stable and heel off prior to initial contact of opposite foot	20° Plantar flexion	10° Plantar flexion	Neutral	Neutral

Review Normal Gait



Tasks During Gait Cycle

Weight Acceptance

- This is the most demanding task in the gait cycle
- Three functional patterns are needed
  - Shock absorption
  - Initial limb stability
  - Preservation of progression

- The challenge is the abrupt transfer of body weight onto a limb that has just finished swinging forward and has an unstable alignment

Tasks During Gait Cycle

Single Limb Support

- Lifting the other foot for swing begins the single limb support interval for the stance limb
- This continues until the opposite foot again contacts the floor
- During the resulting interval, one limb has the total responsibility for supporting body weight in both the sagittal and coronal planes while progression must be continued
- Two phases are involved in single limb support
  - Mid stance
  - Terminal stance
- They are differentiated primarily by their mechanisms of progression

Tasks During Gait Cycle

Limb Advancement

- To meet the high demands of the advancing limb, preparatory posturing begins in stance
- Then the limb swings through three postures as it lifts itself, advances and prepares for the next stance interval
- Four gait phases are involved
  - pre-swing (end of stance)
  - initial swing
  - mid swing
  - terminal swing

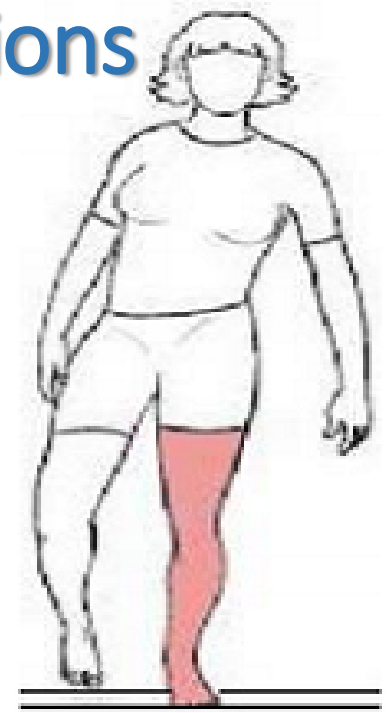
Pathological Gait

- Abnormal movements may be performed for one of two reasons
  - The patient has no choice, the movement is being “forced” on the patient by **weakness, spasticity or deformity** (Primary deviation)
  - The movement is a compensation
    - Patient is doing this to correct another problem which therefore needs to be identified (secondary deviation)

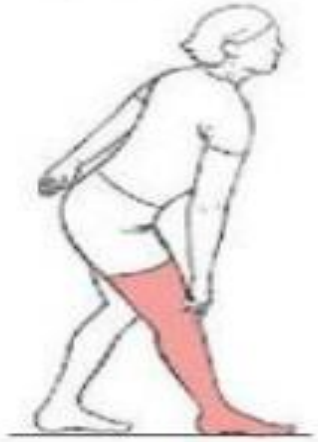
Pathological Gait

- Pathological gait may be caused by
  - Pain
  - ROM limitation
  - Muscular weakness or paralysis
  - Neurological involvement (UMNL/LMNL)
  - Leg Length Discrepancy or Functional Leg Length Discrepancy

Common Gait Deviations

Gait Deviation	Presentation	Gait Cycle Observations	Possible Causes
Lateral Trunk Bending 	Bending the trunk towards the side of the supporting limb during stance phase Commonly described as Trendelenburg Gait Purpose: reduce the forces in the abductor muscles and hip joint during single leg stance	Observed from coronal plane Stance Phase modification As the swing leg leaves the ground, the trunk leans towards the side of the stance phase leg The trunk returns to an upright position at the beginning of the next double support phase	• Painful hip • Hip abductor weakness: abductors are too weak to contract with sufficient force to stabilize the pelvis during single leg stance • Wide walking base • Unequal leg length

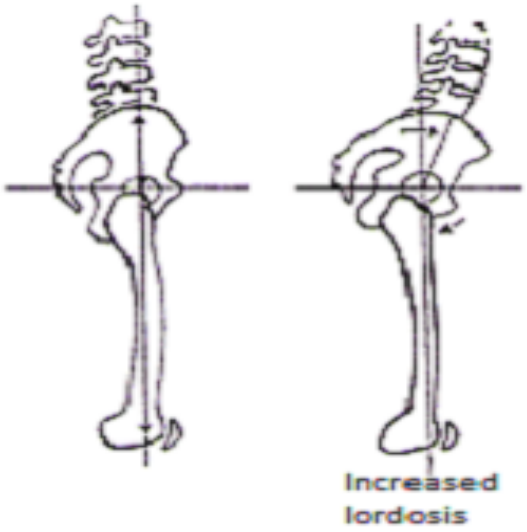
Common Gait Deviations

Gait Deviation	Presentation	Gait Cycle Observations	Possible Causes
Anterior Trunk Bending 	Patient leans their body forward Sometimes patients will keep one hand on the affected thigh to stabilise the knee 	Observed from sagittal plane Stance Phase modification The patient flexes their trunk early in stance phase to keep the GRF anterior to the knee If one leg is affected, the trunk straightens around the time of opposite initial contact If two legs are affected, the trunk may be flexed throughout the gait cycle	• Compensate for inadequate knee extensors: Weak or paralysed quadriceps • Hip extensor weakness • Hip flexion contracture

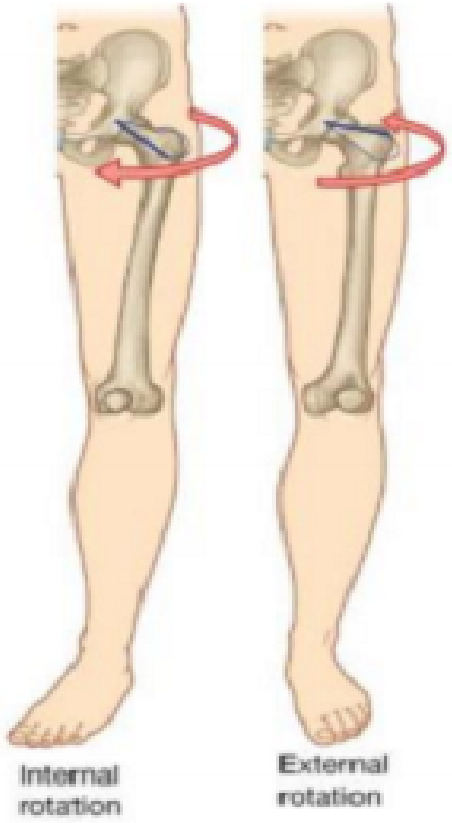
Common Gait Deviations

Posterior Trunk Bending 	Patient leans their body backwards	Observed from sagittal plane Stance Phase modification The patient moves their trunk backwards early in stance phase to keep the GRF posterior to the hip joint	• Compensates for ineffective hip extensors: weak gluteus maximus

Common Gait Deviations

Gait Deviation	Presentation	Gait Cycle Observations	Possible Causes
Increased Lumbar Lordosis 	Patient leans their body backwards	Observed from sagittal plane Stance Phase modification Reaches a peak at the end of stance phase on the affected leg The patient moves their trunk backwards early in stance phase to keep the GRF posterior to the hip joint	• Flexion contracture of the hip

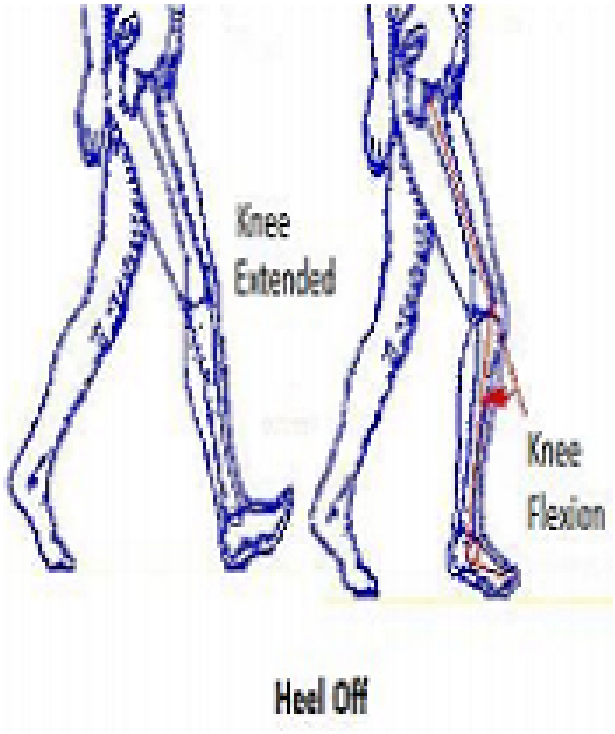
Common Gait Deviations

Abnormal Hip Rotation  	Either excessive internal or external rotation of the hip and involves the whole leg	Observed from coronal plane May involve both stance and swing phase modifications Excessive rotation of the hip Involves the whole leg The foot will show abnormal toe-in or toe-out alignment	• Spasticity or weakness of the muscles producing hip rotation Eg. Weakness of biceps femoris or spasticity of the medial hamstrings will cause internal rotation • A fault with how the foot contacts the ground • A compensatory movement to overcome some other problem

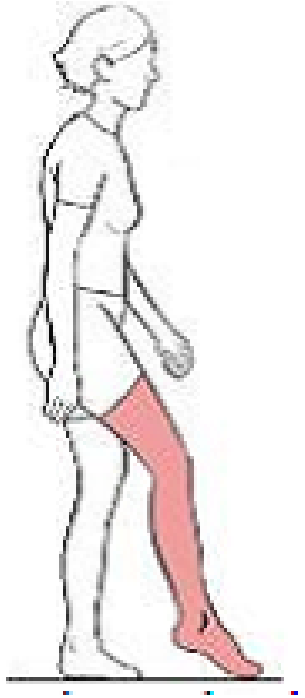
Common Gait Deviations

Gait Deviation	Presentation	Gait Cycle Observations	Possible Causes
Excessive Knee Extension (Genu Recurvatum) 	Full extension or hyperextension of the knee: the knee is angulated backwards	Observed from sagittal plane Stance Phase modification Normal stance phase flexion of the knee is lost and replaced by full extension	• Quadriceps weakness • Quadriceps spasticity • Triceps surae spasticity • Plantarflexion contracture • Leg length discrepancy • Hamstrings weakness

Common Gait Deviations

Excessive Knee Flexion 	Unable to extend the knee during stance phase	Observed from sagittal plane Stance Phase modification The knee fails to extend during initial contact and heel rise Rapid forward tibial progression	• Flexion contracture of the knee • Flexion contracture of the hip • Spasticity of the knee flexors • Plantarflexion weakness • If normal plantarflexion of the ankle is prevented during loading response • Leg length discrepancy

Common Gait Deviations

Inadequate Dorsiflexion Control 	Initial forefoot contact Foot slap at loading response Toe-drag or lack of clearance at swing	Observed from sagittal plane Stance Phase and Swing Phase modifications Heel strike may be absent with initial contact made at the forefoot Unable to resist plantarflexion moment at loading response resulting in foot slap	• Weakness or paralysis of the anterior tibial muscles • Functional leg length discrepancy: steppage gait

Common Gait Deviations

Gait Deviation	Presentation	Gait Cycle Observations	Possible Causes
Insufficient Pre-swing 	The entire foot lifts off the ground at once Reduced stance phase duration on affected side Asymmetry in gait timing	Observed from sagittal plane Stance Phase modifications Weight is primarily taken on the heel There is no Pre- swing phase The whole foot is lifted off the ground at once	• Rupture of the Achilles Tendon • Weakness of the soleus and gastrocs • Pain under the forefoot

Common Gait Deviations

Abnormal Walking Base 	Wider or narrower than the usual 5-10cm Short stride length Scissor gait: swing phase leg crosses the midline	Observed from coronal plane Wider walking base is usually for increased stability Narrow walking base is usually from hip adduction tightness: seen during swing phase	Wide Base • Abducted hip • Valgus knee • Increase lateral movement of the trunk • Deficiency of sensation or proprioception • Poor balance Narrow Base • Hip adduction tightness

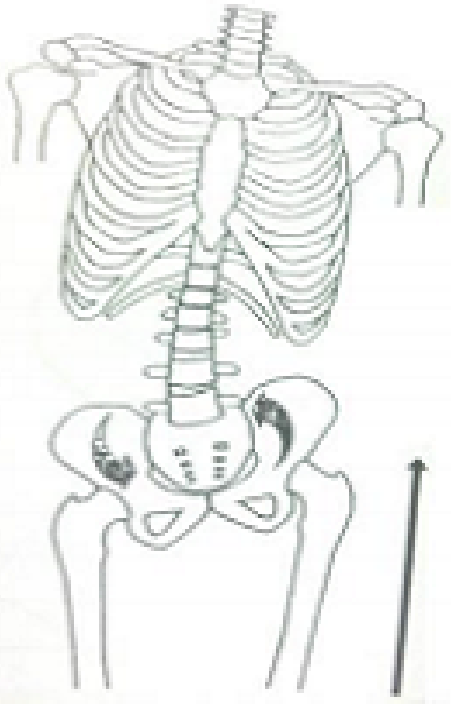
Functional Leg Length Discrepancy

- A functional Leg Length Discrepancy means the legs are not different length but one or both leg is not able to adjust the appropriate length for ground clearance
- 4 gait abnormalities are attempted by patients to overcome a functional leg length discrepancy
  1. Circumduction
  2. Hip hiking
  3. Steppage or excessive knee and hip flexion
  4. Vaulting

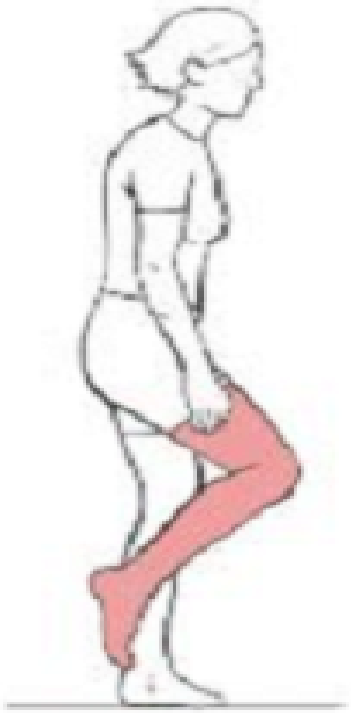
1. Circumduction

Gait Deviation	Presentation	Gait Cycle Observations	Possible Causes
Circumduction 	Swinging the leg outward ensures that contact with the ground is avoided Swing phase on the sound leg is normal	Observed from coronal plane Swing Phase modification The knee and ankle are stiff The foot moves through an arc away from the body	• Functional Leg Length Discrepancy due to: Weak hip flexors

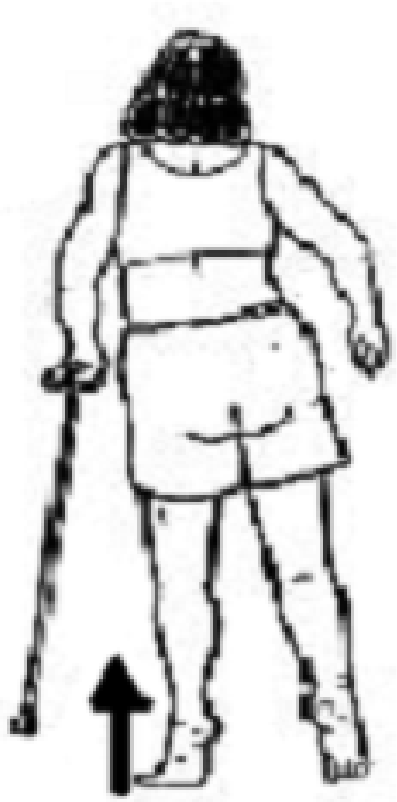
2. Hip Hiking

Hip Hiking			
	The pelvis lifts on the side of the swinging leg Slow walking	Observed from coronal plane Swing Phase modification The pelvis lifts on the side of the swinging leg through contraction of the spinal muscles and lateral abdominal wall	Functional Leg Length Discrepancy due to: • Weak knee flexors: the knee extends prematurely and the leg is too long at the end of swing phase

3. Steppage

Gait Deviation	Presentation	Gait Cycle Observations	Possible Causes
Steppage 	Exaggerated hip and knee flexion to lift the foot higher than normal for toe clearance	Observed from sagittal plane Swing Phase modification Exaggerated hip flexion Exaggerated knee flexion	Functional Leg Length Discrepancy due to: • Weak dorsiflexors • Plantarflexion contracture

4. Vaulting

Vaulting 	The patient raises up on their toes of the stance limb for clearance of the swinging leg Slow walking Energy inefficient	Observed from coronal plane Stance Phase modification The patient rises up on the toes of the stance phase leg Exaggerated vertical movement of the trunk	Functional Leg Length Discrepancy due to: • Weak knee flexors: the knee extends prematurely and the leg is too long at the end of swing phase

Any Questions ?

Thank you