Pediatric Gait

Jenna Lisenby, DPT

Valley Kids Therapy

Objectives

- Appropriately assess pediatric patients for delays in gross motor skills and gait deviations.
- Refer patients with orthopedic and neurological conditions for appropriate therapies and resources in the community

Developmental Milestones

- Foundation to Gait
  - Muscular Strengthening
  - Motor Learning & Planning (Cognitive)
  - Sensory: Vision, Vestibular, Proprioception

Prone Development & Gait

- Tummy time
  - Develop the neck, back, and shoulder muscles needed to meet infant developmental milestones.
  - Prevent early motor delays and conditions such as flat head syndrome (positional plagiocephaly) and twisted neck (positional torticollis).
- GAIT IMPACTS
  - Strengthens cervical posture
  - Strengthens core and upper extremity
  - Posterior trunk extensors
  - Lumbar vs Hip Dissociation

Developmental Impact

- Back to Sleep campaign 1994
  - Federal statistics from 2005 ➔ 60% increase in developmental delays in the last 10-15 years.
  - Co-morbid factor of missed developmental milestones?
- Decreased tummy time associated with delays in reaching early milestones 1
- “The studies have consistently shown that there was transient delay in motor development for healthy term and low-risk preterm infants who were not exposed to the prone position” 2

Impact on Gait

- Considerations:

  Torticollis

  - Directional preference
  - Muscular imbalance
  - Postural Instability
  - Compensation for future gross motor milestone

https://www.bing.com/videos/search?q=one+leg+crawl+torticollis&&view=detail&mid=96A7CD4A86A3607A2B9E96A7CD4A86A3607A2B9E&&FORM=VDRVRV

https://www.bing.com/videos/search?q=one+leg+crawl+torticollis&&view=detail&mid=BBD9809CAD90A13F3701BBD9809CAD90A13F3701&rvsmid=96A7CD4A86A3607A2B9E96A7CD4A86A3607A2B9E&FORM=VDQVAP

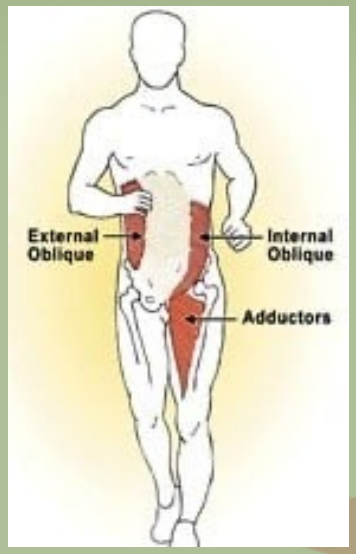
https://www.bing.com/videos/search?q=one+leg+crawl+torticollis&&view=detail&mid=9884424545390 79C4A74988442454539079C4A74&rvsmid=96A7CD4A86A3607A2B9E96A7CD4A86A3607A2B9E&FORM=VDQVAP

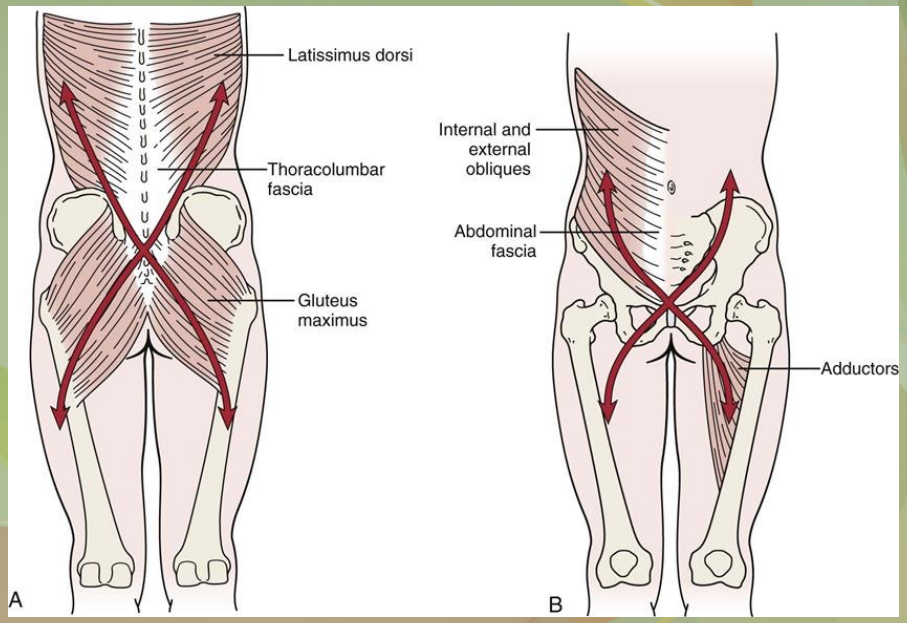
One Leg Crawl

One Leg Crawl

Rolling & Gait

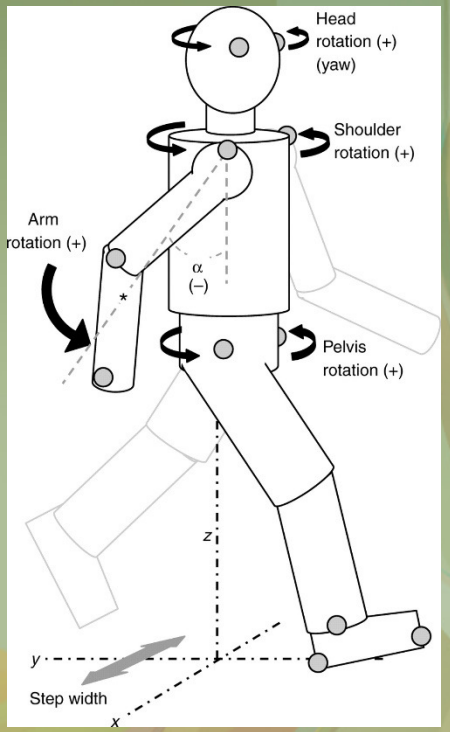
- Rolling
  - Symmetry
  - Directional preference
  - Trunk and gluteal strength with rotation
  - Core strengthening





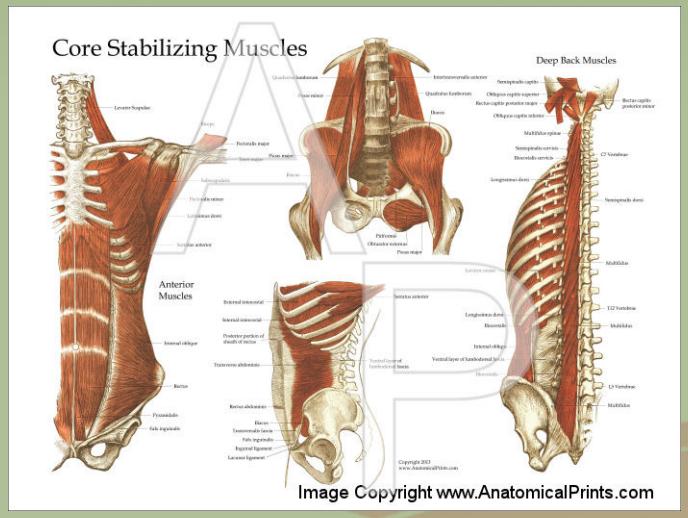
Sitting & Gait

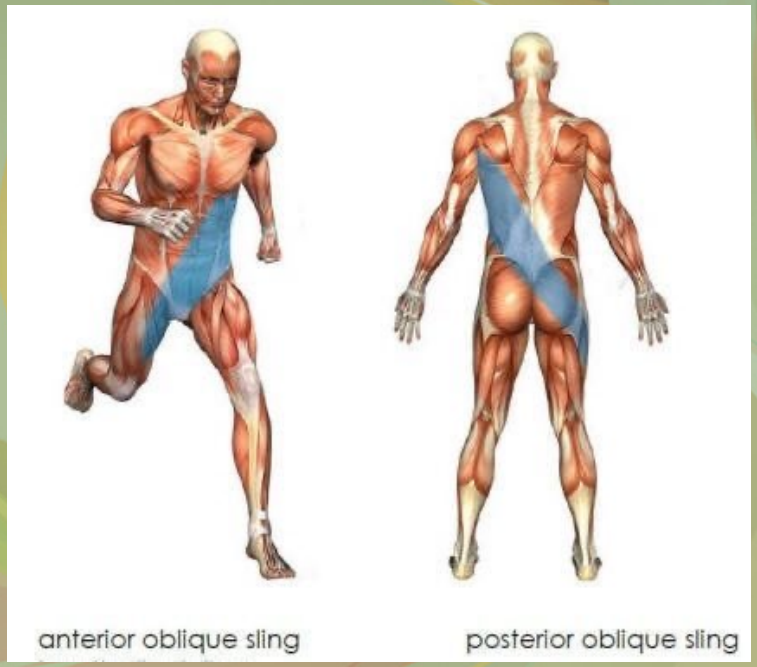
- Postural Stability in sitting and in quadruped
- Lateral pivoting with reaching across midline
- Considerations:
  - Thoracic and lumbar alignment
  - Scapular Symmetry
  - Neutral Head Alignment



Crawling & Gait

- Crawling
  - Facilitates trunk stability with contralateral extremity coordination
  - Symmetrical stride length bilaterally
  - Core strength and stability
  - Exploration / Sensory





Pulling to Stand / Cruising & Gait

- Pulling to Stand
  - Weight shift posterior to anterior
  - Bilateral lower extremity weight bearing
    - Working foot intrinsic musculature
  - Lateral stability in standing
  - Weight bearing through lower extremities
  - Transitioning via ½ kneeling (hip dissociation)

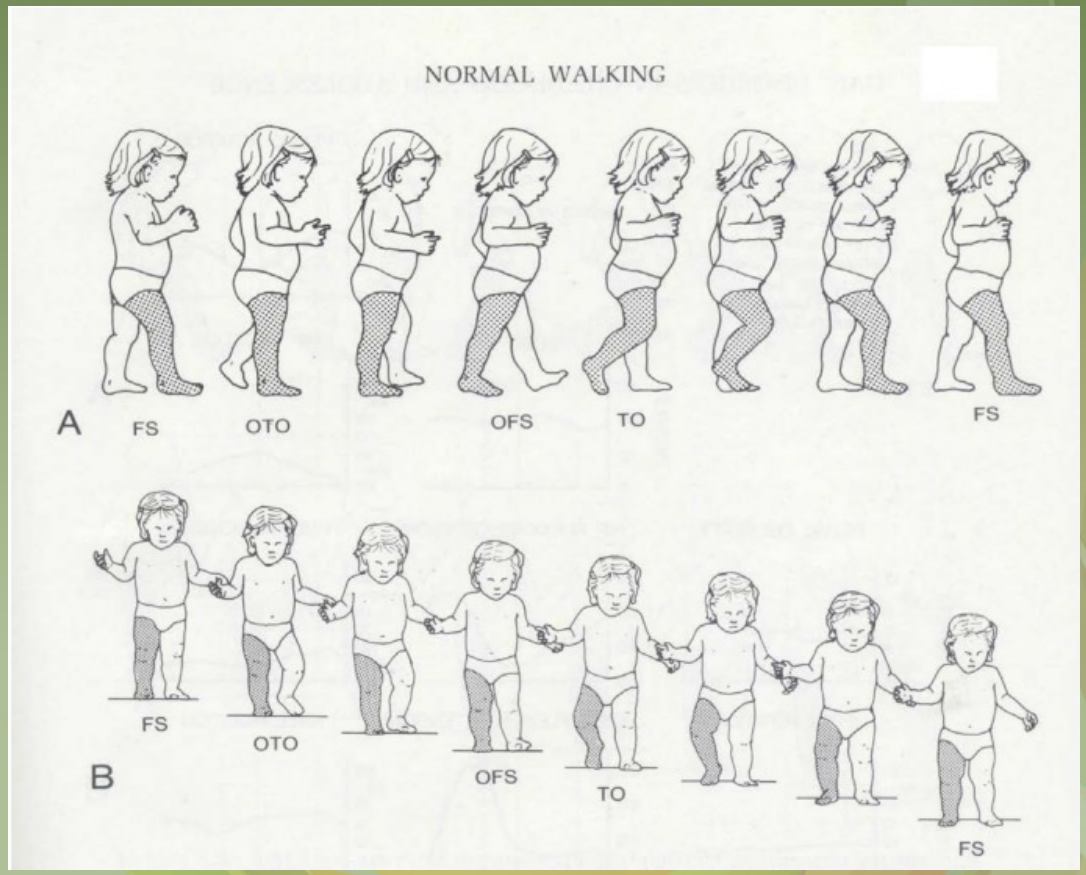
Walking Independently

– Walking

- Standing without support first – 20-30 seconds
- Average 13.5 months independent walking
- Should not be on toes >25% of the time
- Average falling – 12 + times per day
- Poor awareness of changes in surfaces
- Wide base to more narrow
- Guard high to low (arm position)

1 Year Old

- Wide base of Support
- High Guard Upper Extremity Posture
- Absent reciprocal arm swing
- Flat foot strike
- Excessive hip rotation

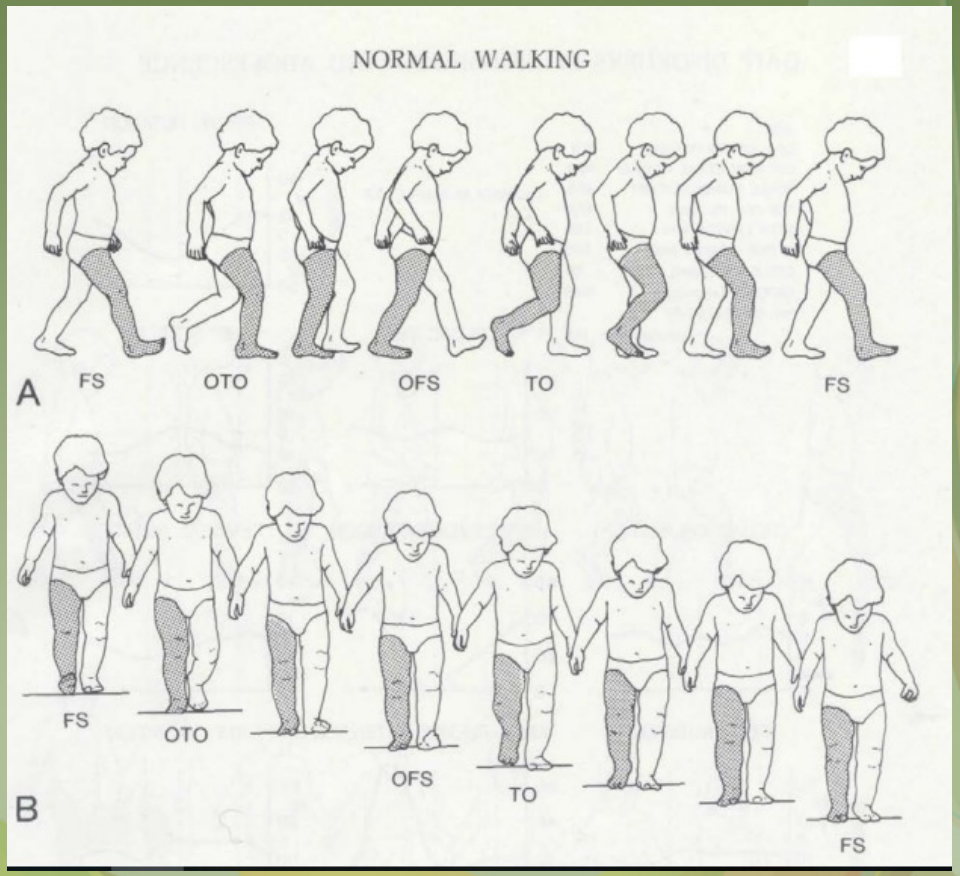


Gait Progression

- Walking
  - Becomes more smooth
  - Base becomes more narrow
  - Arms swing
  - Not up on toes
  - Continues to fall, less frequently
  - Begins to run
- Standing / Squatting
  - Able to squat down and pick up toys
  - Able to stand from the middle of the floor
    - Dynamic stretching of achilles

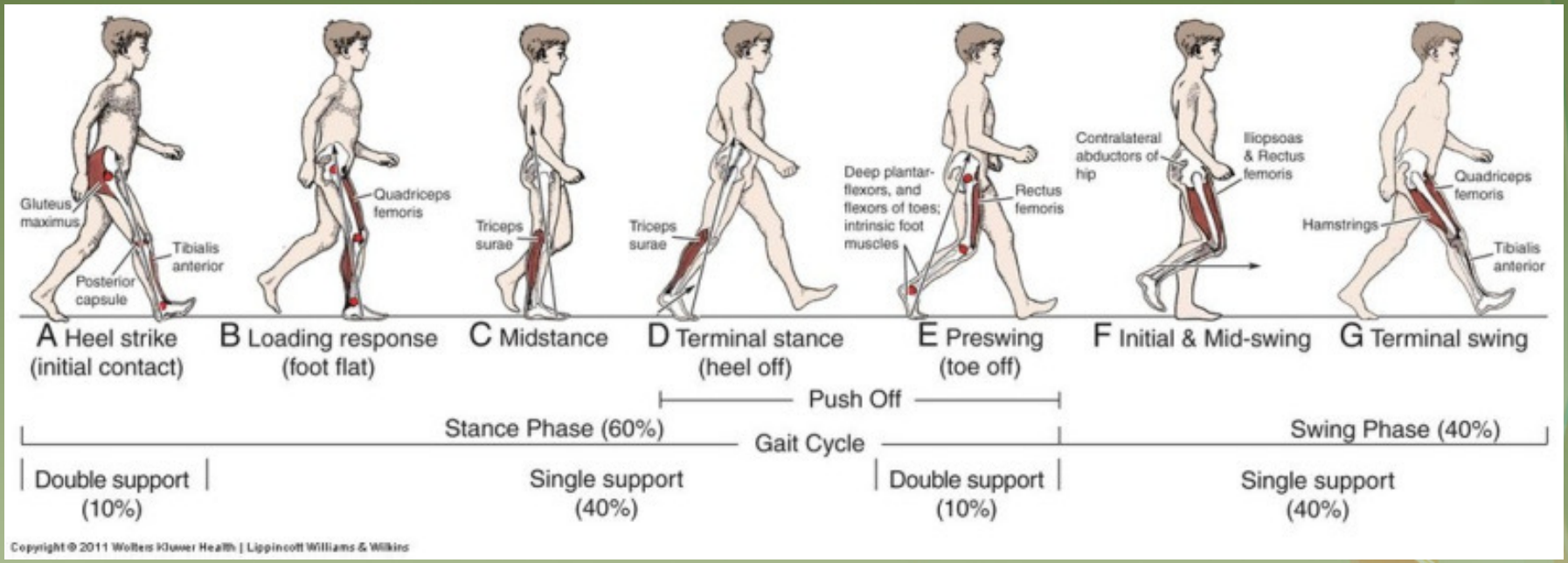
2 Years Old

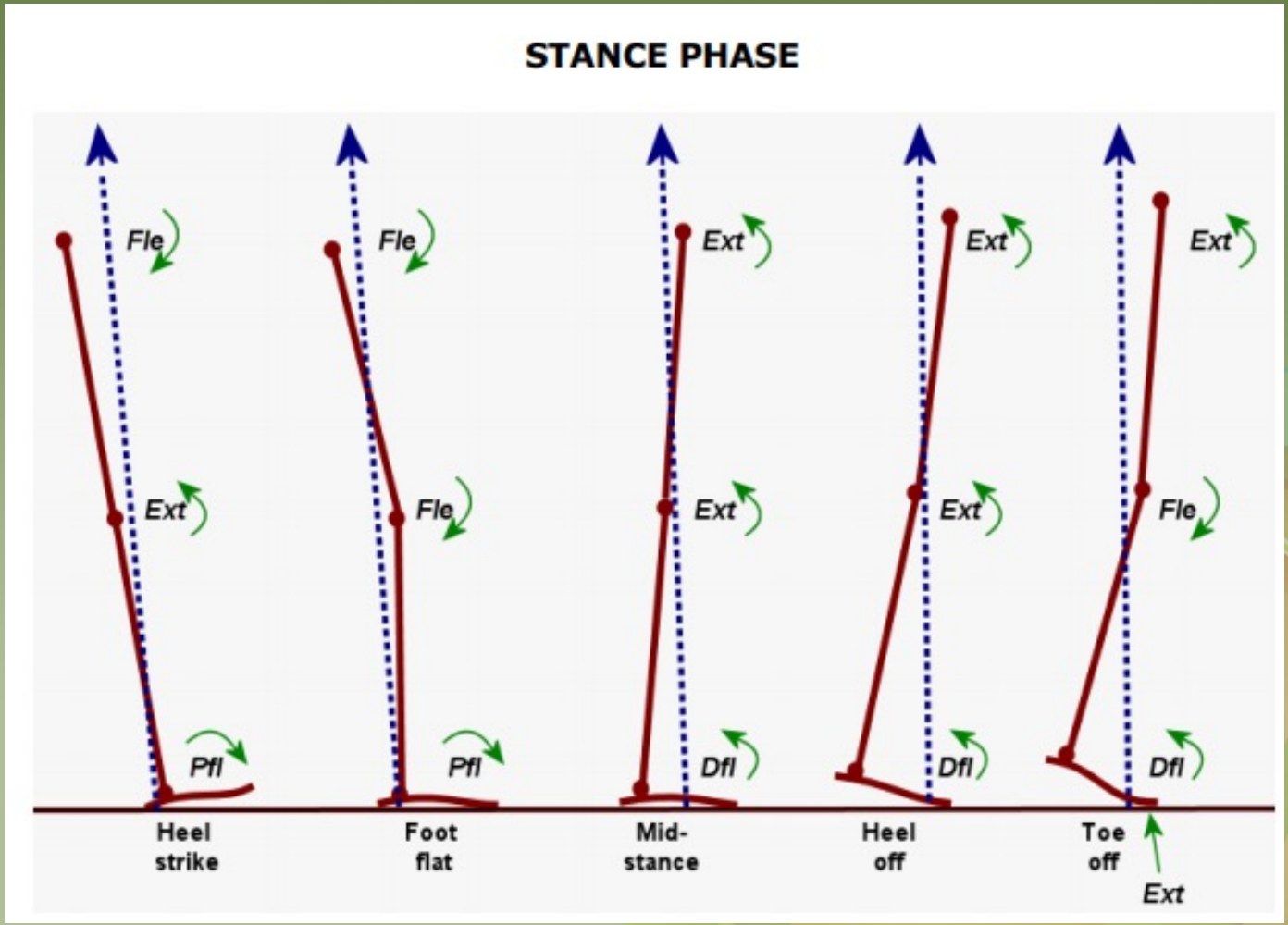
- Demonstrates:
- Heel strike
- Reciprocal arm swing with 65% of pediatric population
- Average cadence 171 steps per minute
- Decreased hip rotation
- Narrowing of base of support



Mature Gait Mechanics

- Phases
  - Heel Strike
    - 6 months after independent walking
  - Midstance
  - Heel Off
  - Toe Off
  - Swing


Gluteus maximus
Tibialis anterior
Posterior capsule
Quadriceps femoris
Triceps surae
Triceps surae
Deep plantar-flexors, and flexors of toes; intrinsic foot muscles
Rectus femoris
Contralateral abductors of hip
Iliopsoas & Rectus femoris
Hamstrings
Quadriceps femoris
Tibialis anterior
A Heel strike (initial contact)
B Loading response (foot flat)
C Midstance
D Terminal stance (heel off)
E Preswing (toe off)
F Initial & Mid-swing
G Terminal swing
Push Off
Stance Phase (60%)
Gait Cycle
Swing Phase (40%)
Double support (10%)
Single support (40%)
Double support (10%)
Single support (40%)
Copyright © 2011 Wolters Kluwer Health | Lippincott Williams & Wilkins


STANCE PHASE
Fle
Ext
Pfl
Fle
Fle
Pfl
Ext
Ext
Dfl
Ext
Ext
Dfl
Ext
Fle
Dfl
Heel strike
Foot flat
Mid-stance
Heel off
Toe off
Ext

Gait Analysis

What to look for while assessing gait:

- Stability
- Velocity
- Step length
- Consistency
- Upper Extremity Support / Assistance
- Upper Extremity Movement
- Symmetry

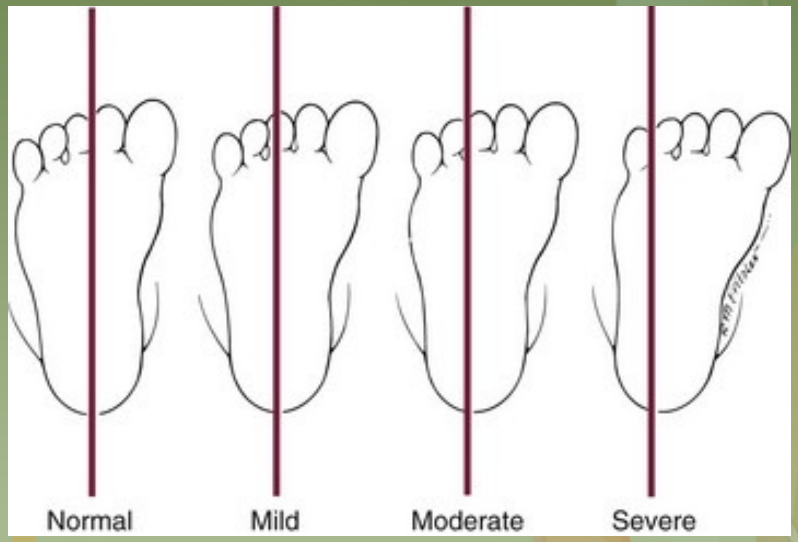
Gait Deviations

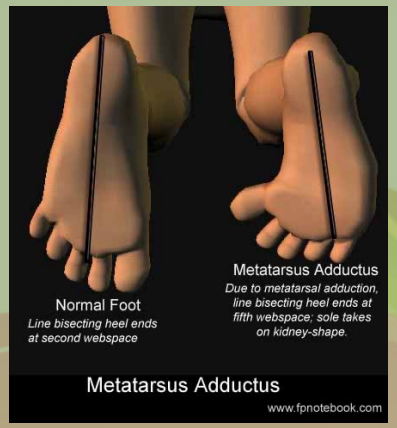
Orthopedic

- Metatarsus Adductus
- Pes Planus
- Genu Valgum and Varum
- In Toeing
- Out Toeing
- Leg Length Discrepancy
- Scoliosis

Metatarsus Adductus

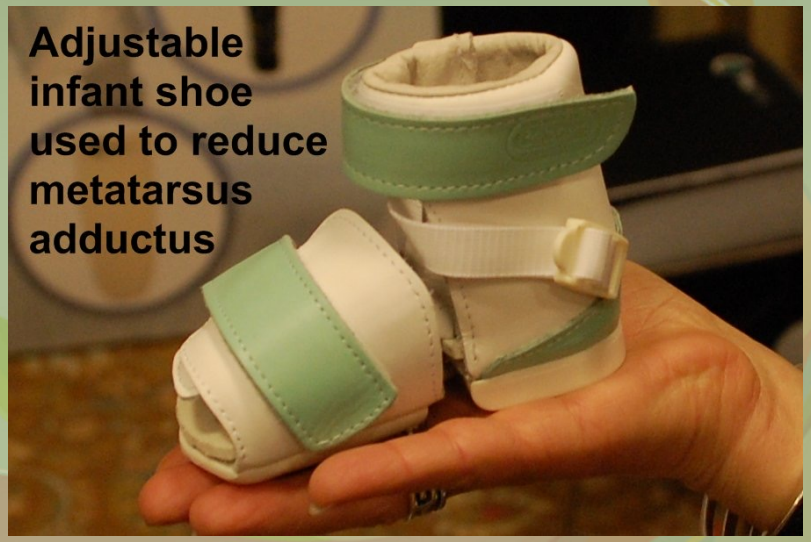
- The diagnosis if a 'C'-shaped curve, rather than a straight border, is present on the lateral aspect of the foot.
- About 90% of cases resolve by one year of age.
  - Mild to Moderate
- Severe cases benefit from intervention
- **10% have acetabular dysplasia**





Metatarsus Adductus

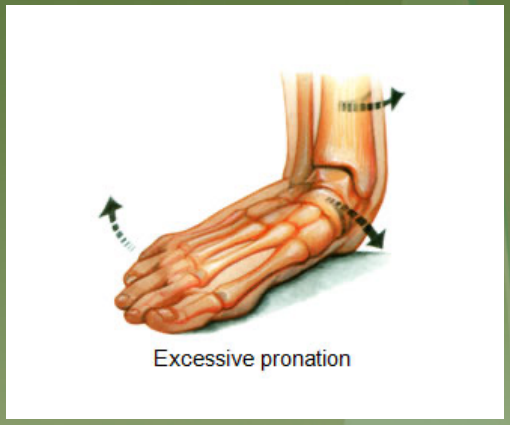
- Treatment usually involves special exercises, and applying casts or special corrective shoes, and has a high rate of success in babies aged 6-9 months.



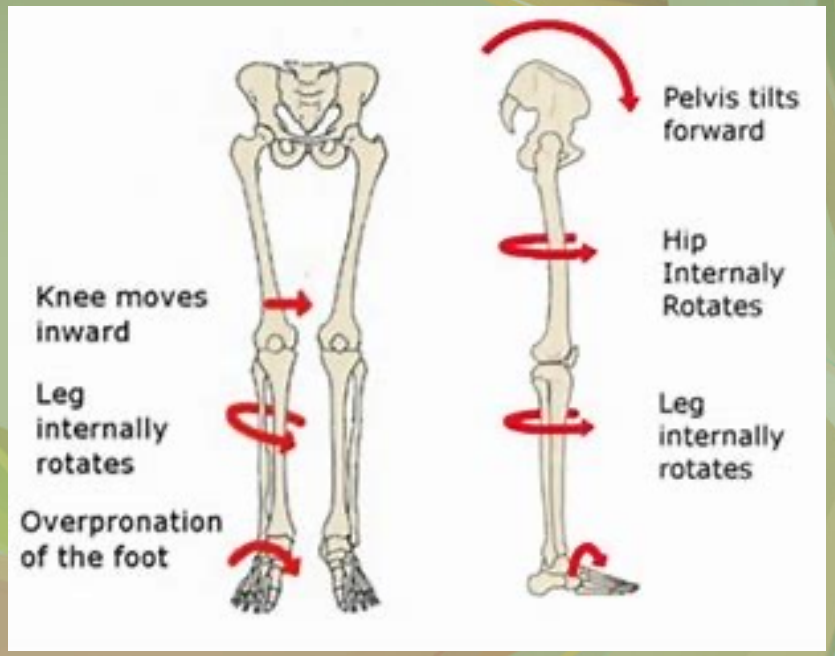
Pes Planus

- Inversion at talocrural joint
- Valgus and pronation at calcaneus and midfoot
  - Normal calcaneal valgus is 8 degrees at 1 year of age
  - Calcanealvalgus should be 0 by 8 years of age
- Causes:
  - Joint/ligamentous laxity
  - Low muscular tone

Pes Planus



- Looking up the kinetic chain:
  - Excessive medial rotation of tibia
  - Valgus loading of the knee (increase Q angle)
  - Possible hip internal rotation
  - Wide base of support
  - Anterior pelvic tilt



Pes Planus

- Treatment
  - Inserts in shoes
    - Full or ¾ length
  - UCBL if calcanealvalgus is significant
  - AFO if ankle significantly involved

Genu Valgum and Varum

Varum – Bowed Legs

- Decreased Q Angle
- Medial Tibiofemoral joint compression
- Supination at Ankle and Foot

Valgum – Knocked Knees

- Increased Q angle
- Lateral tibiofemoral compression
- MCL stress
- Increased patellar subluxation

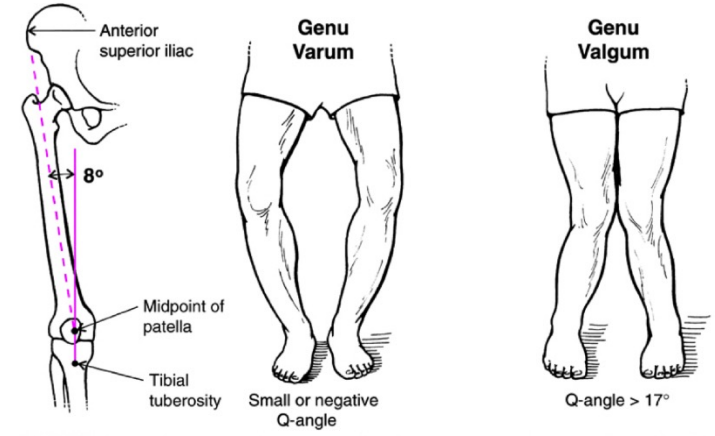
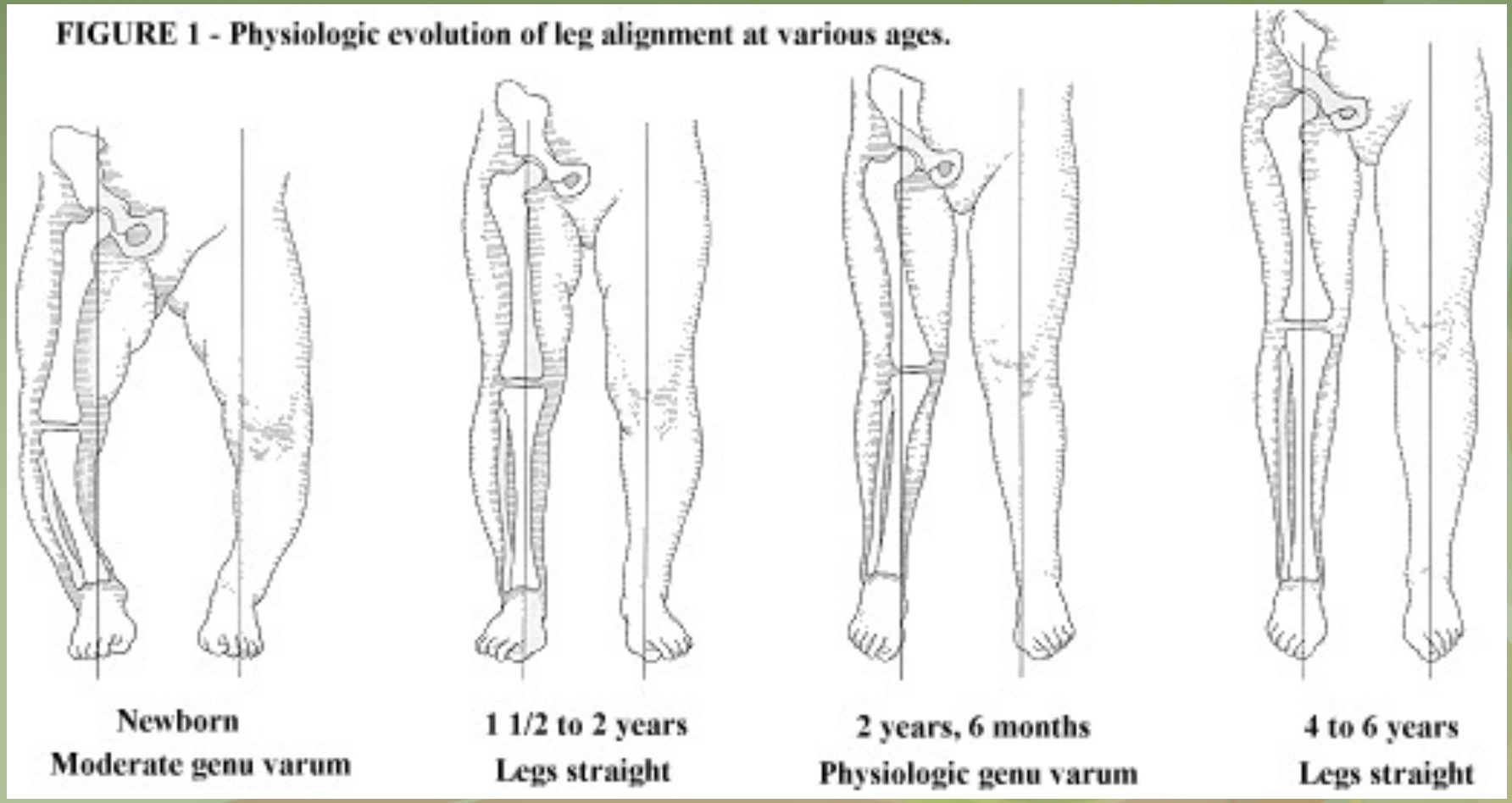
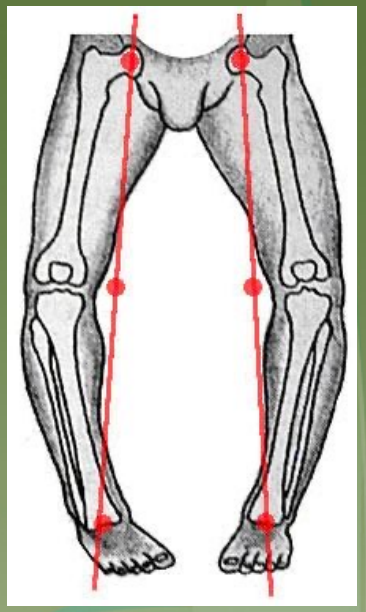


FIGURE 6-25 The Q-angle is measured between a line from the anterior superior iliac spine to the middle of the patella and the projection of a line from the middle of the patella to the tibial tuberosity. Q-angles range from 10 to 14° for males and 15 to 17° for females. Very small Q-angles create a condition known as genu varum, or bowleggedness. Large Q-angles create genu valgrum, or knock-kneed position.

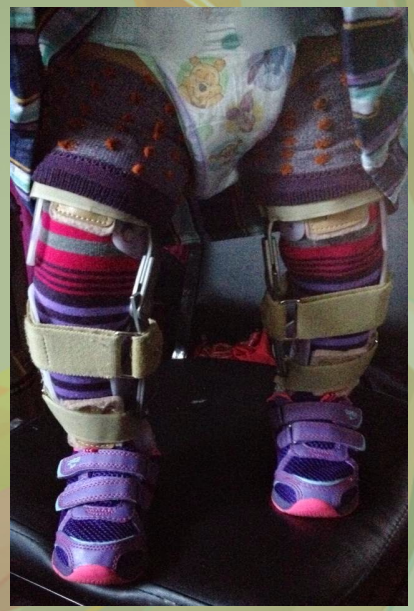
Genu Valgum and Varum



Genu Varum

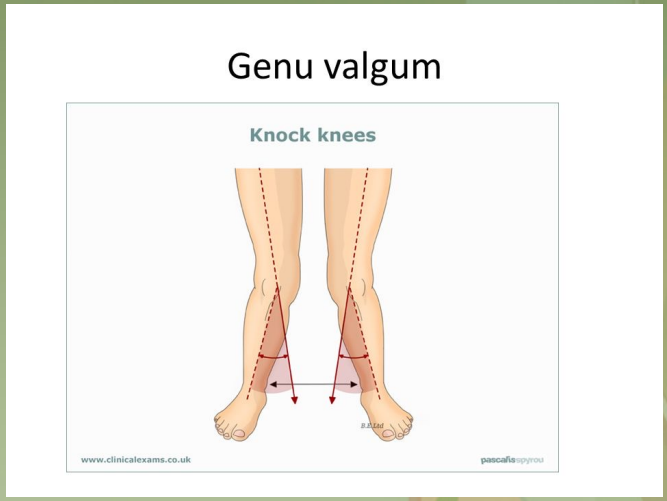


- Causes
  - Physiologic (naturally occurring) newborn
  - Blounts (autosomal recessive growth disorder)
    - AKA – “Tibia vara” – tibia bends outward
    - Affects growth plates around knee, inside slows or stops
  - Rickets (softening of bone due to Vitamin D deficiency)
  - Skeletal Dysplasia
- Treatment
  - Physiologic spontaneously resolves by 3-4 years
  - Blounts
    - Leg bracing
    - Surgery (osteotomy or hemiepiphysiodesis - lateral)
    - Weight management
  - Rickets is Vitamin D supplementation
    - Possible absorption disorder (Celiac, CF, Kidney)



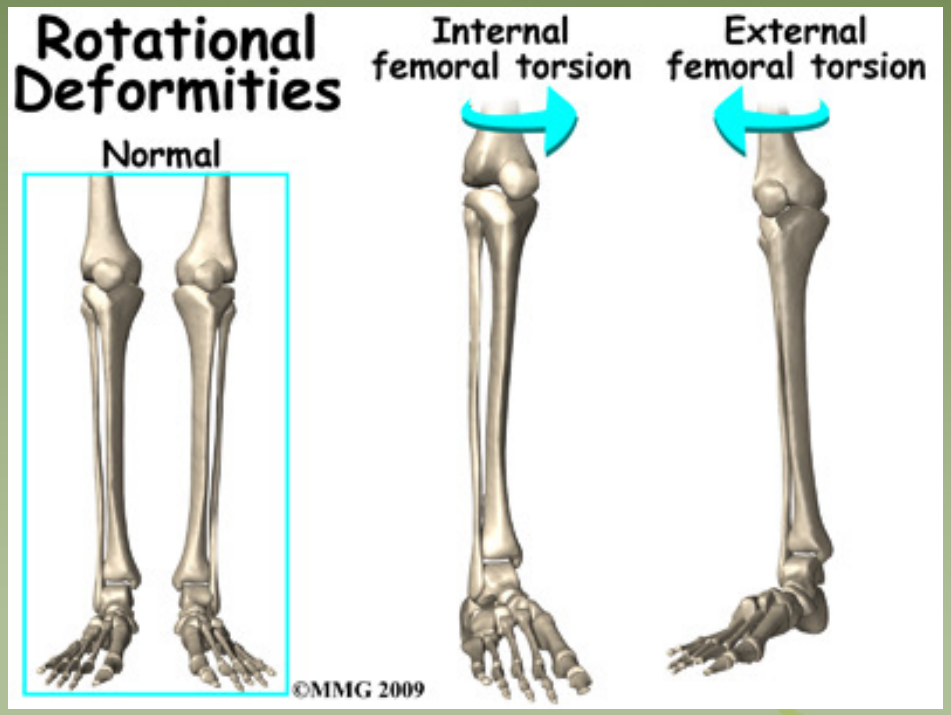
Genu Valgum

- Children 3-4 years have up to 20º
- Age 7 = Valgus <12º, intermalleolar distance <8cm

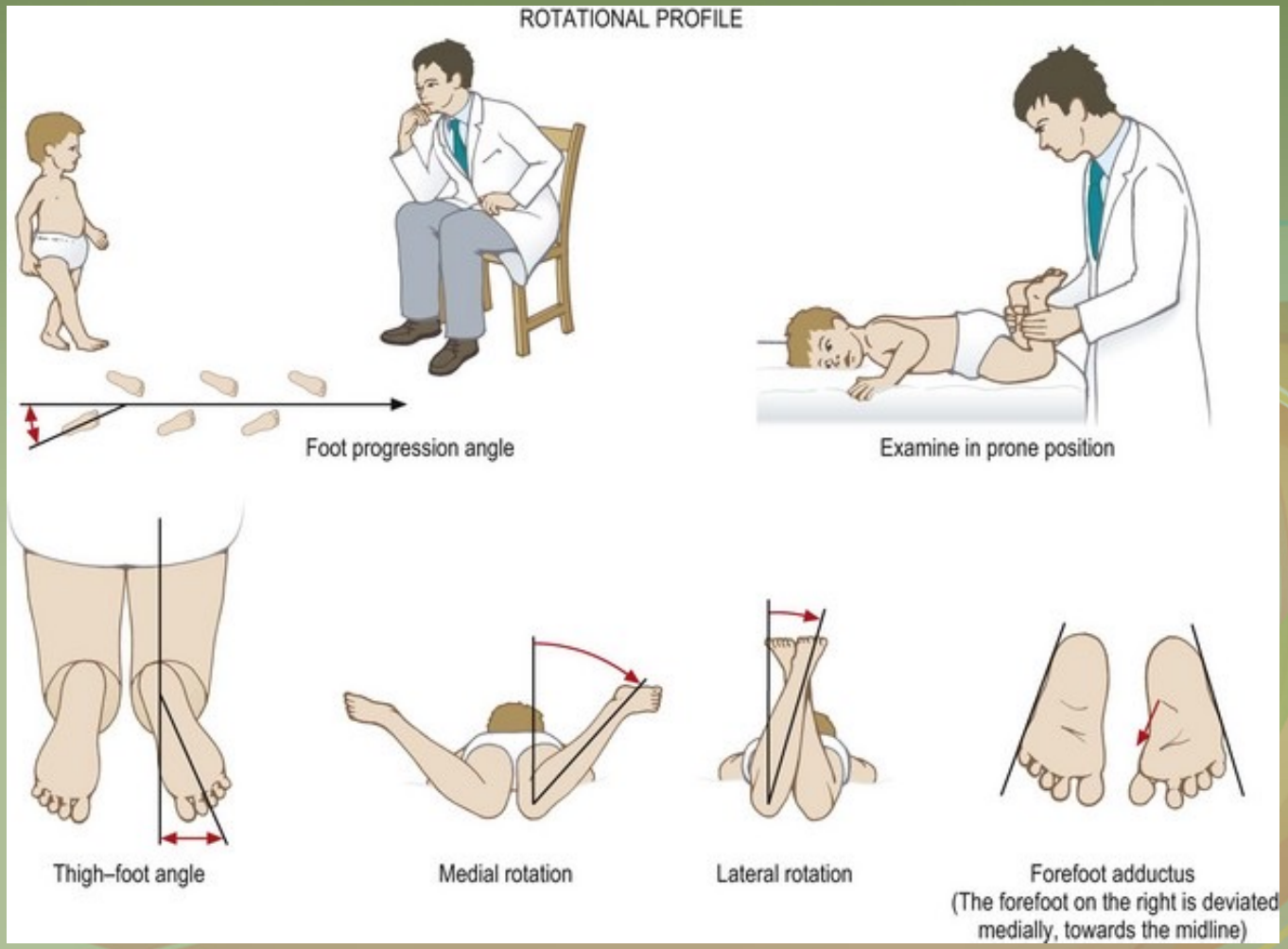


- Causes
  - Physiologic (75% self correct 3-5 years)
  - Injury – usually unilateral
  - Obesity
- Treatment
  - Observational if <15º in a child < 6 years old
  - Bracing ineffective
  - Orthotics to decrease valgus angle
  - Surgical
    - Hemiepiphysiodesis of medial side if >15º in a child < 10 years old

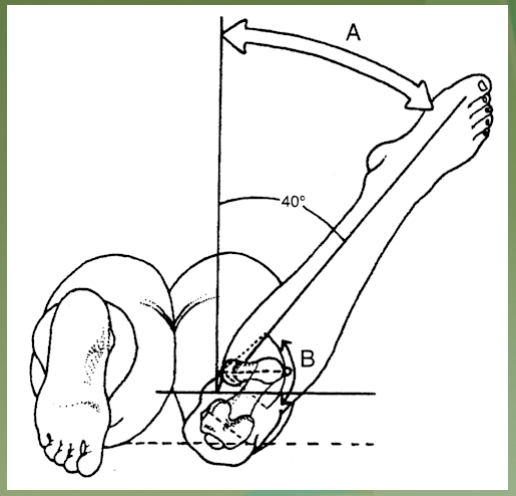
Rotational Deformities



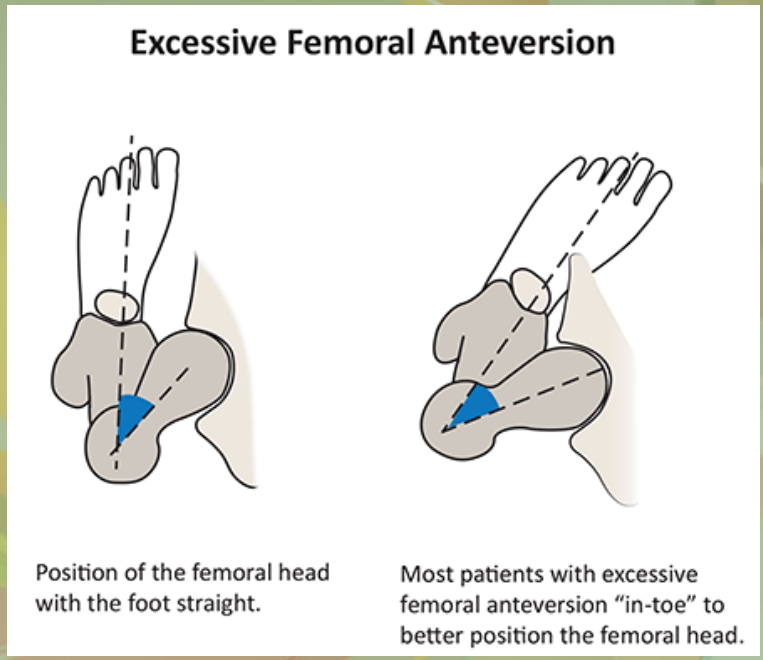
Rotational Deformities



In Toeing

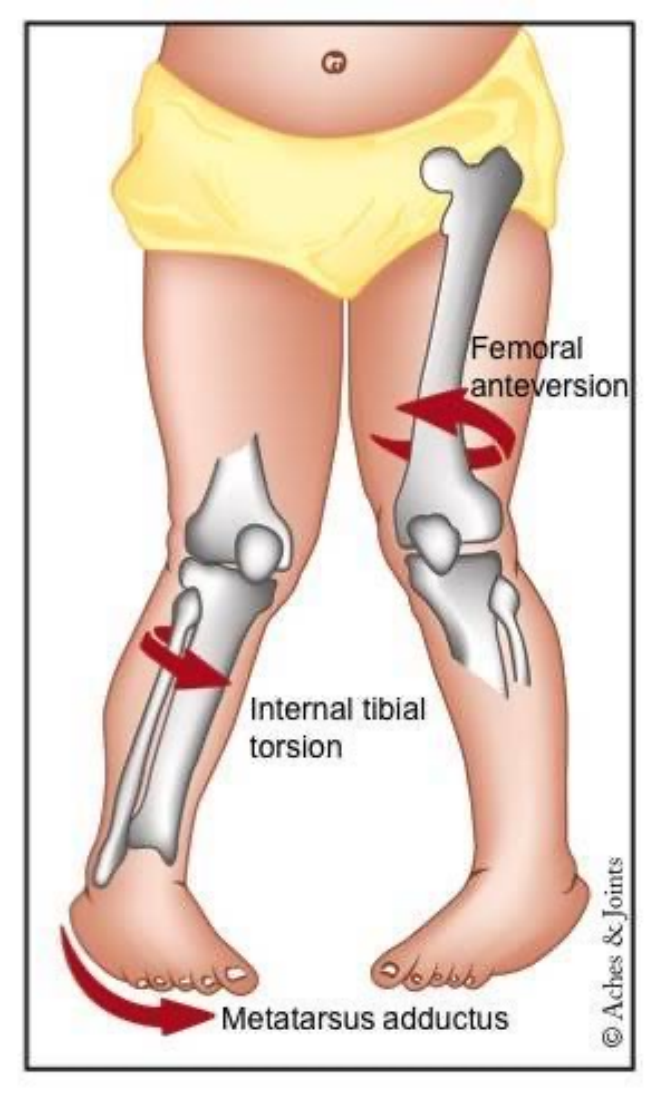


- Excessive femoral anteversion - the most common cause of in-toeing.
- The normal range is from 30-40° at birth and decreases progressively throughout growth to about 15° at skeletal maturation.
  - Craig's test
- Children walk or stand with both patellae and feet pointing inward. If found in conjunction with internal tibial torsion it may lead to patellofemoral subluxation.



In Toeing

- Decreased gluteal recruitment during single leg stance
- Knees and toes point inward
- Valgus loading at patellofemoral joint
- Possible pronation of calcaneus and mid foot



In Toeing

- Structural vs Functional
  - Structural: the femoral neck internally rotated
    - Craigs Test >45
  - Functional: Increased hip mobility due to repeated posture and/or gluteal weakness
  - Neurological – Cerebral Palsy
  - Associated with children that W sit

Out Toeing

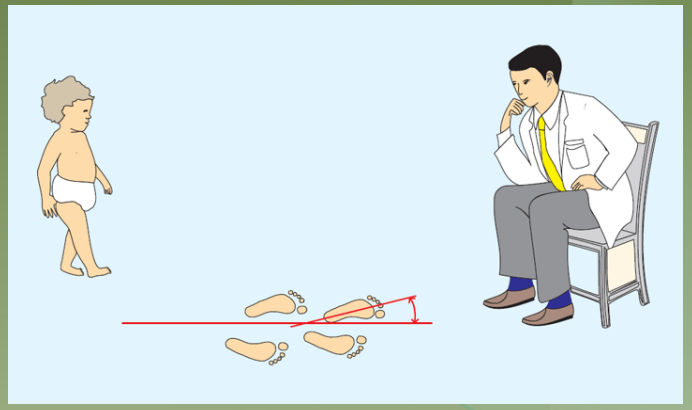
Pes planus is the most common cause of out-toeing. Flat feet give the appearance of “too many toes.”

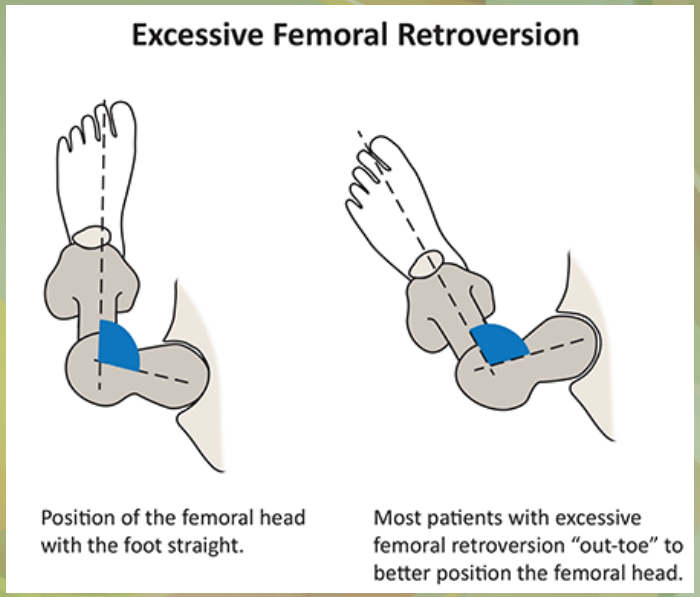
Femoral retroversion not as likely of cause

The normal range is 40-80 degrees of external rotation.

Children walk or stand with both patellae and feet pointing outward.

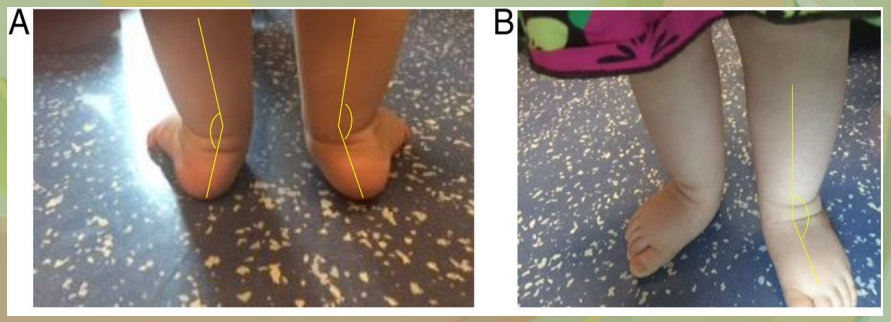
May have external tibial torsion



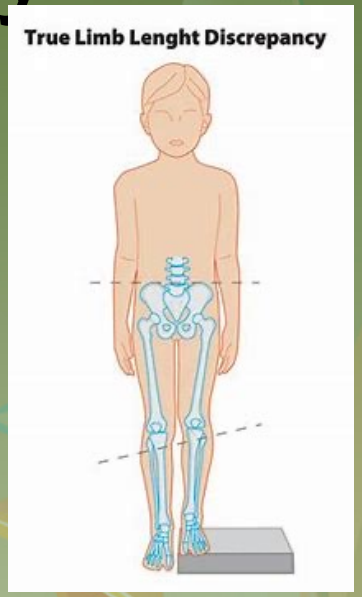


Out Toeing

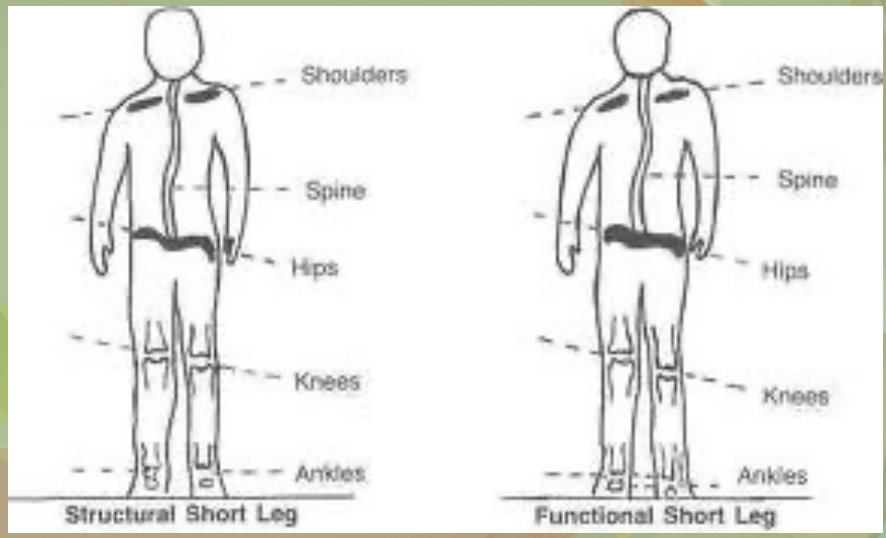
- Rule out SCFE
- Rule out Legg-Calve Perthes
- Look at tibial torsion
- External contracture of hip
- Causes & Treatment
  - Typically corrects by age 10
  - May need orthotics
  - Surgery for severe cases



Leg Length Discrepancy

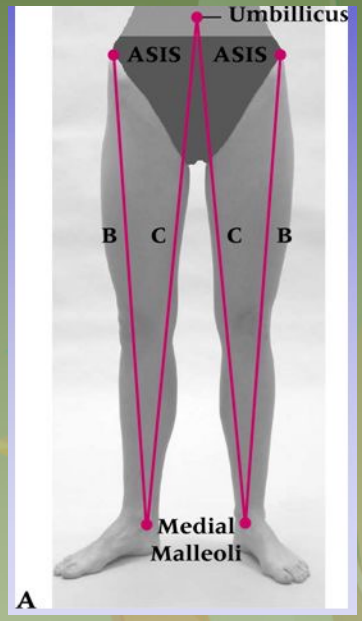


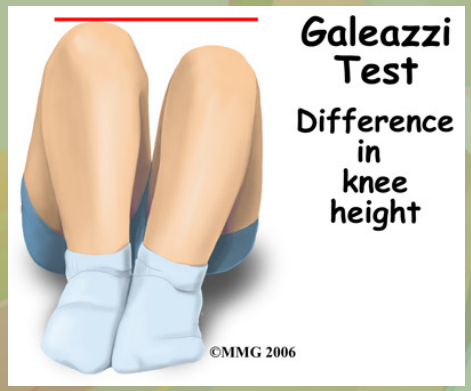
- Hip hike through stance phase
- Structural:
  - Tibia or femur length is not symmetrical bilaterally
- Functional:
  - Muscular imbalance
  - Pelvic alignment
  - Asymmetrical foot alignment



Leg Length Discrepancy

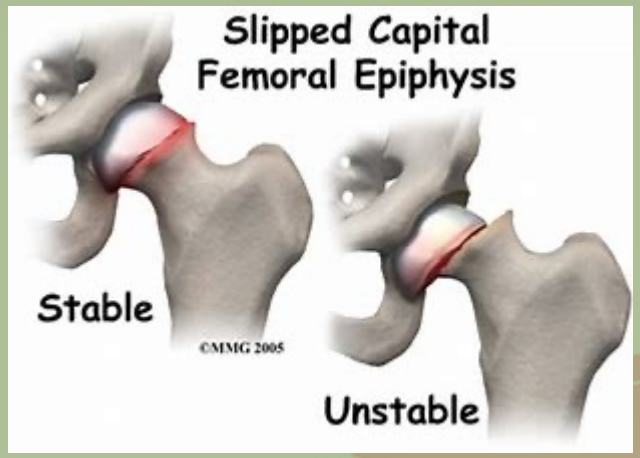
- Assessment: Standing and Supine
  - ASIS
  - PSIS
  - Greater Trochanter
  - Fibular Head
  - Malleoli
  - Measure ASIS to Medial Malleoli
  - Galeazzi sign

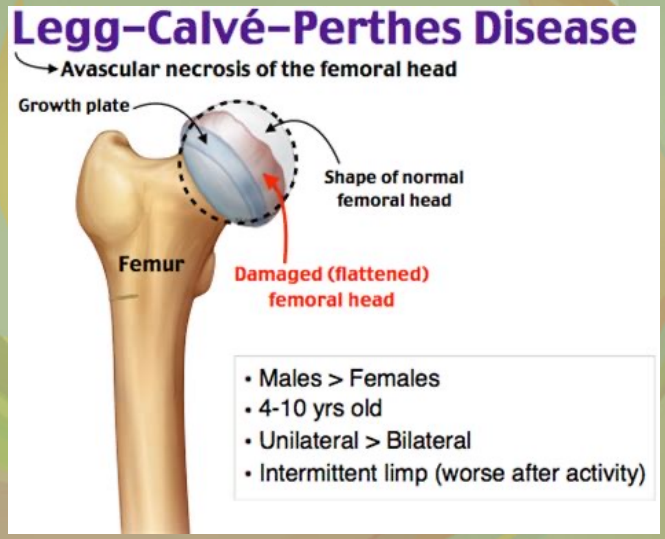




Leg Length Discrepancy

- Rule Out
  - Hip Dysplasia
  - Legg Calve Perthes syndrome
  - Slipped Capital Femoral Epiphysis
  - Arthrogryposis

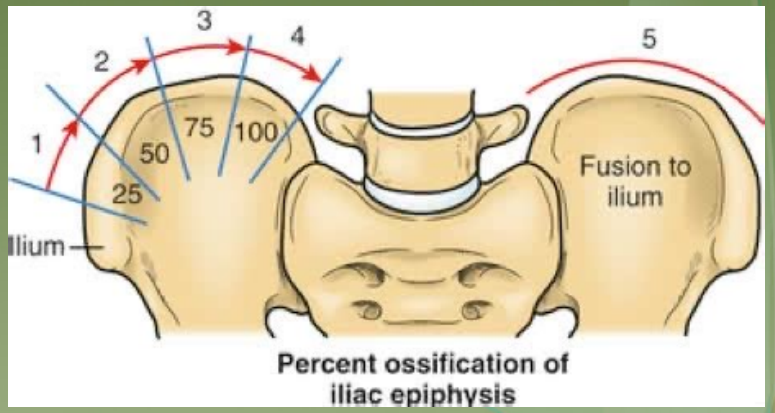




Scoliosis

- Structural:
  - Rigid curvature of spine
  - C curve: usually thoracic area (right convex)
  - S curve: usually with cervical and lumbar component
- Functional:
  - Muscular Imbalance
  - Poor Posture
  - Residual torticollis?
  - Secondary to LLD

Scoliosis



- Curvature
  - Look at Risser level
  - 20 degree or less = PT
    - Assess LLD and muscular imbalance
    - Core stabilization
  - 20+ degree = Scoliosis clinic
    - Likely PT for postural work and core stabilization
    - Possible bracing
  - 50+ degree & functional impact = Surgical

Toe Walking

- Children who ambulate with bilateral toe to toe pattern
- Should resolve after 6 months of independent walking

Toe Walking

- Considerations:
  - Habitual
  - Sensory Involvement
  - Achille Contracture (chicken or egg)
  - Leg Length Discrepancy if only one foot
  - Sever's with single Leg
  - Rule Out Neurological Involvement

Toe Walking

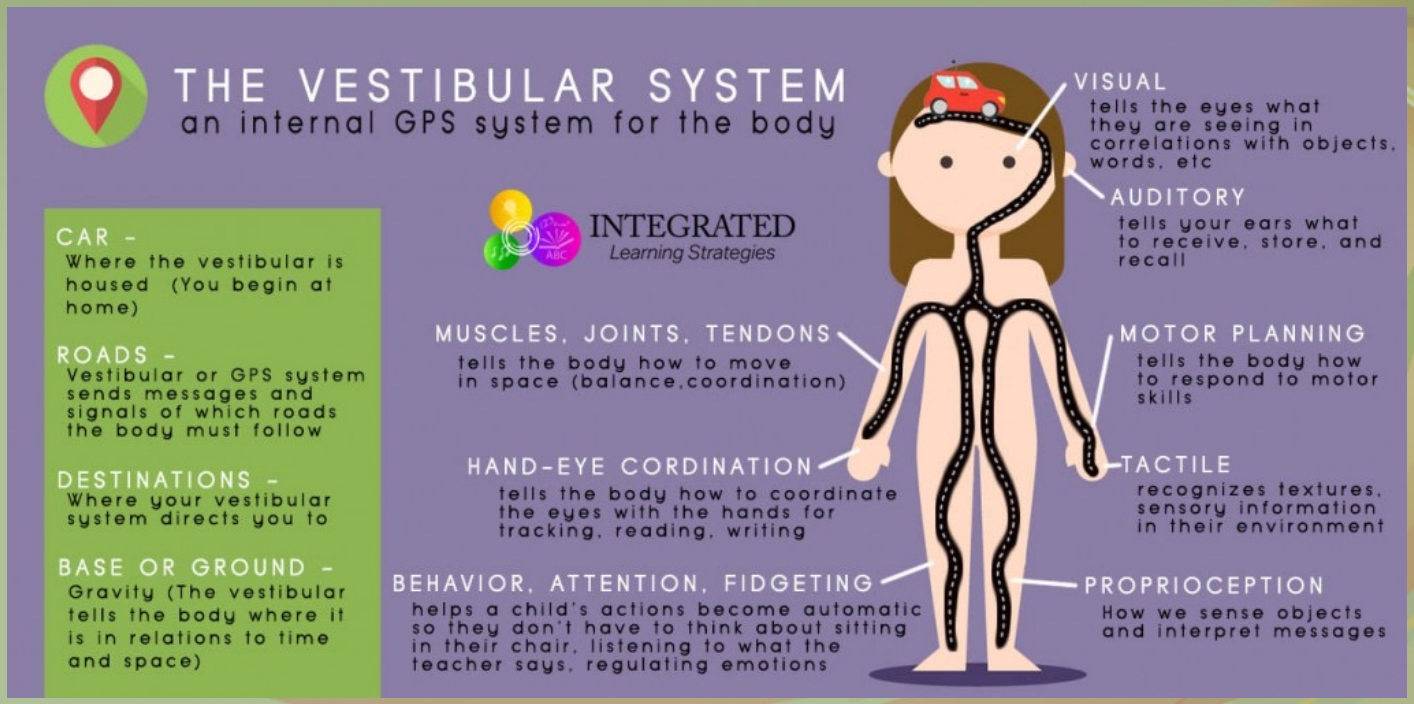
- Assessment
  - Range of Motion
  - Gait & Mobility
    - Squat / Floor to stand
  - Strength & tone
  - Leg length
  - Neurological
    - Deep Tendon Reflexes
    - Retained Reflexes
  - Ankle/foot alignment
  - Sensory / Vision

Vestibular Disorders

- Affect:
  - Safety
  - Gait
  - Coordination
  - Perception
  - Participation with Physical Education

Vestibular Disorders

- Manifestations
  - Increased falls
  - Postural dysfunction
  - Abnormal perception of motion
  - Blurred or Bouncing Vision



Vestibular Development

- Primitive and mature reflexes require many inputs from the vestibular system and output reflexes of the vestibulocular and vestibulospinal
- Age 4-6 the vestibular symptom is mostly developed
- After age 5 children should be able to use visual fixation to assist with postural stability

Symptom History

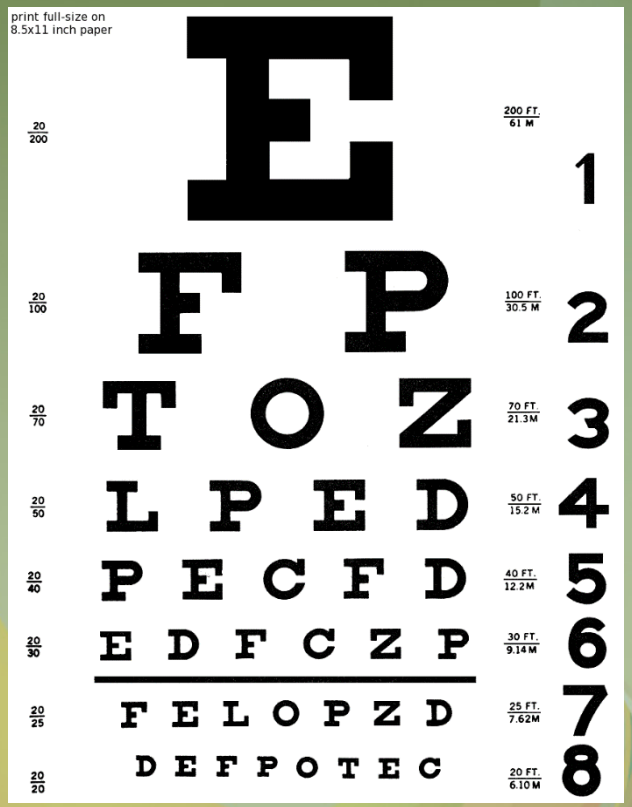
- Decreased visual-spatial abilities
- Hearing loss
- Motion sensitivity/sickness
- Nystagmus
- Praxis
- Frequent falls
- Difficulty in the Dark
- Fear of movement

Vestibulocular Reflex

- 20% of toe walkers have abnormal VOR
- Interventions include visual exercises with prism glasses with toe walkers
- Approximately 75% of the time, ambient prism lenses will lead to an immediate change.

Vision Development

- Bouncing Vision
- Depth Perception
- Corrective Lens
  - Large Base of support
  - Increased upper extremity support with ambulation
  - Increased episodes of falling



Questions?