The Hip Joint

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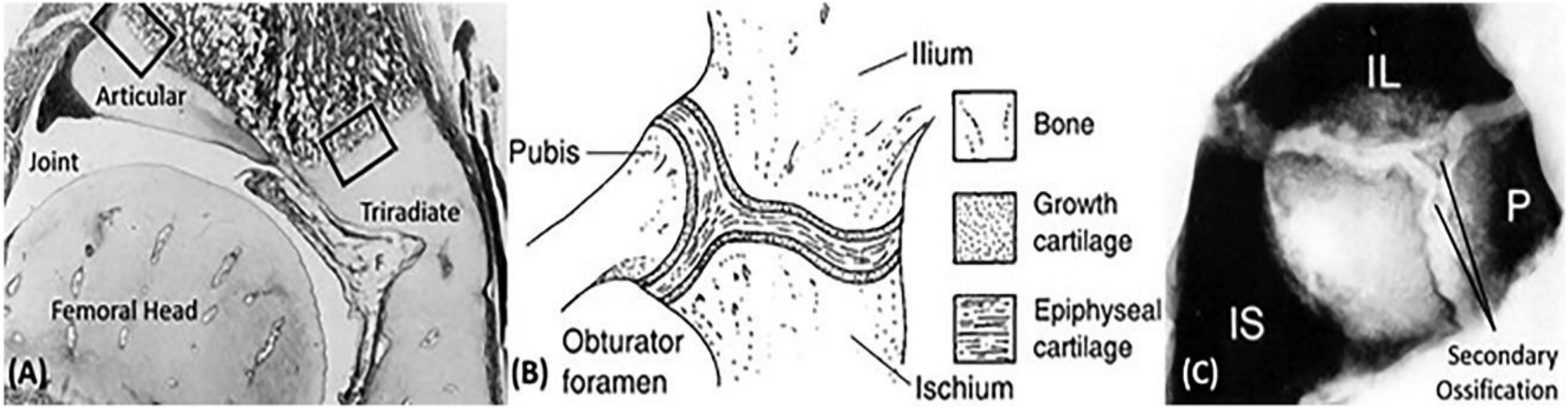
Paediatric hip: Changing structure with Growth

- Consider prenatal & postnatal development of acetabulum within the pelvis & femoral head of the femur relationships
- Soft tissue changes: Muscles
- Pelvi-femoral group:adductors, hamstrings, graciliss, sartoris, tensor fasciae latae, pectineus & rectus femoris
- Pelvi-trochanteric group: obturators, quadrates femoris, psoas tendon
- Gluteal group
- Joint capsule & Ligaments
- Femoral neck angle or head affected by structural changes or muscular & somatic strains

Infant Hip Joint

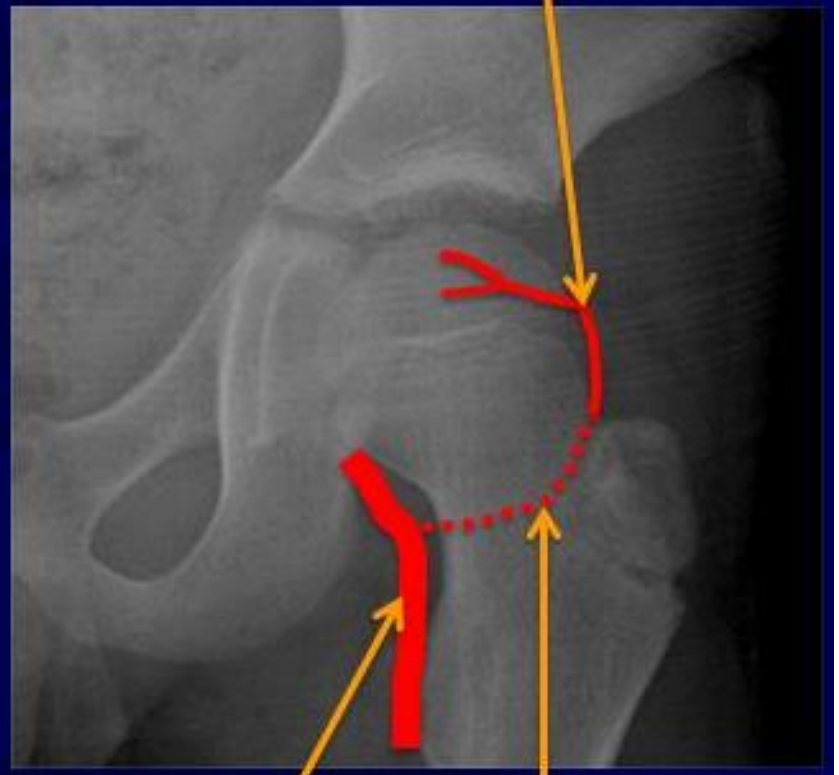
Vascular Channels in cartilaginous femoral head, Acetabular cartilage & Labrum at periphery

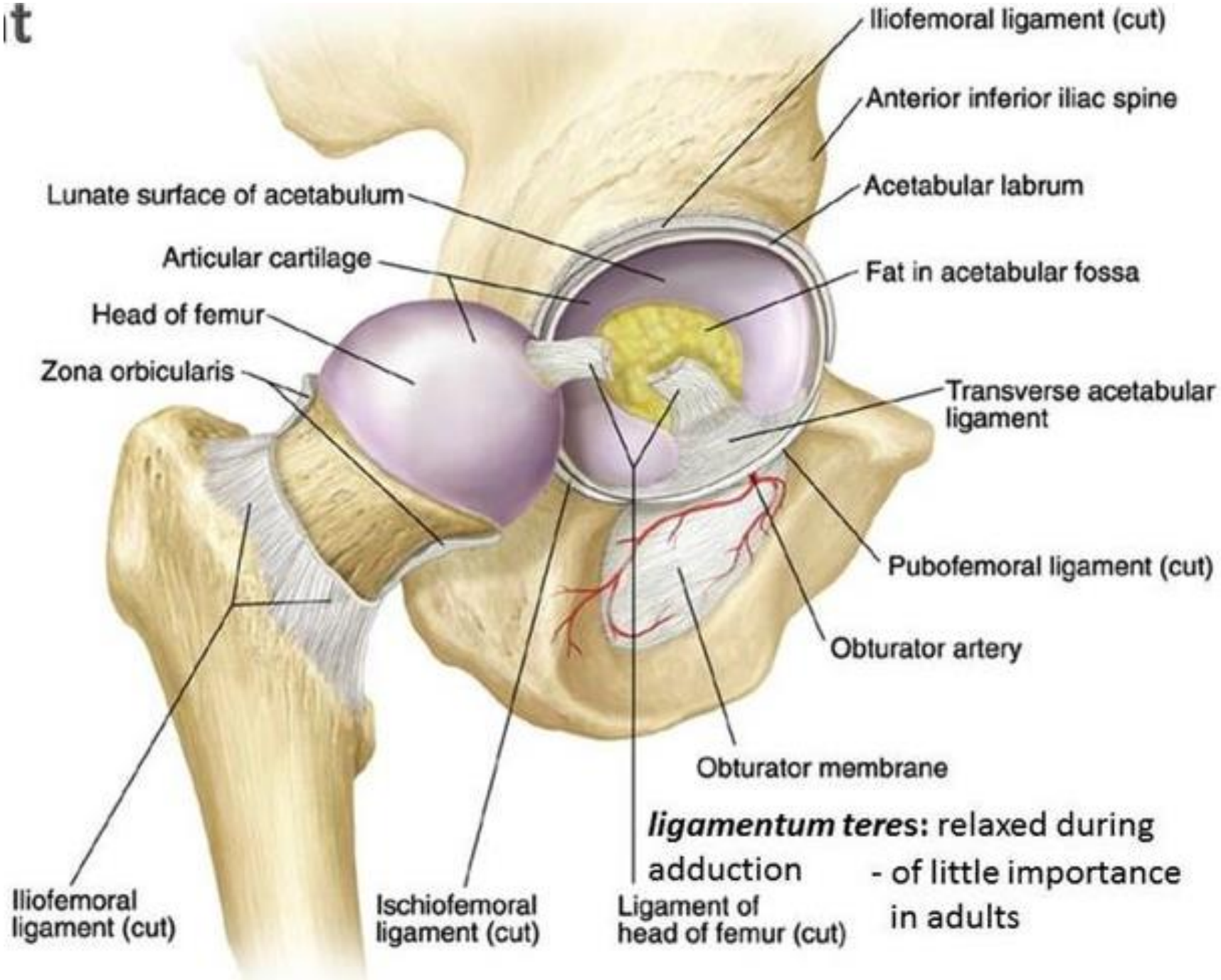


(*Lovell & Winter's Pediatric Orthopaedics*. Vol. 2. 7th ed. Philadelphia: Lippincott Williams & Wilkins, 2014)

Pediatric Hip: Anatomy

- Lateral Circumflex
  - Supplies the anterior portion of the femoral epiphysis and physis until 5-6 months of age
  - Contribution to femoral head blood supply diminishes by 3 years of age
- Medial Circumflex
  - Major blood supply to proximal femur
  - The entire blood supply to the proximal femoral epiphysis comes from the lateral epiphyseal branches of the medial circumflex by 3 years of age
- 20 % blood supply to femoral head by artery of ligamentum teres after 8 years of age



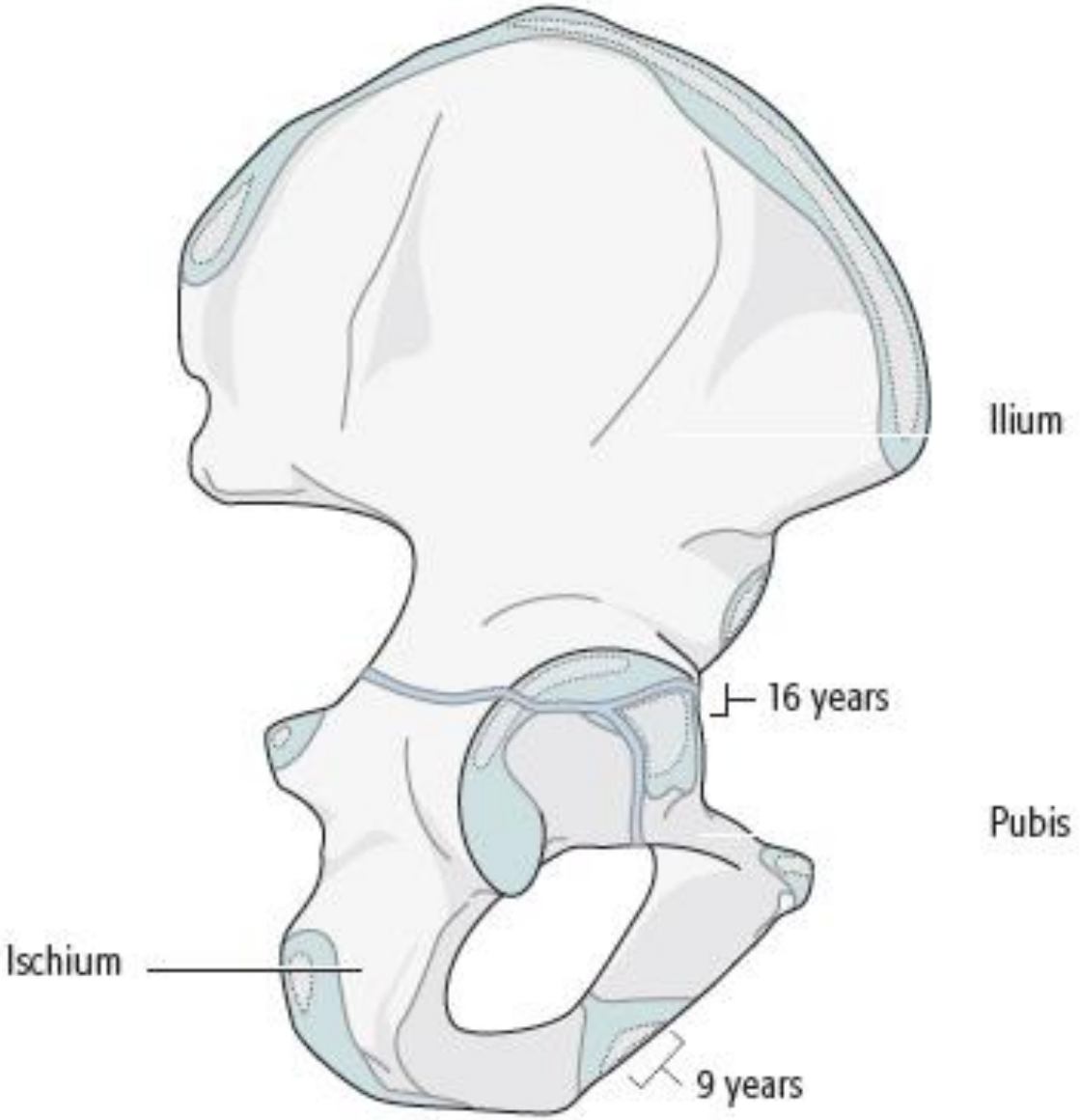


***ligamentum teres*: relaxed during adduction**

- of little importance in adults

Ligamentum Teres

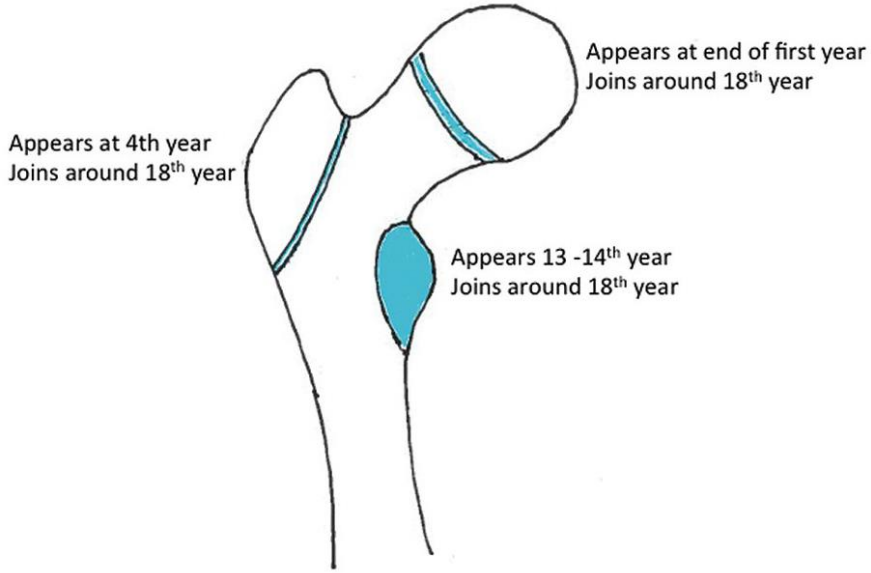
- Functionally, a fulcrum for movements in the acetabulum

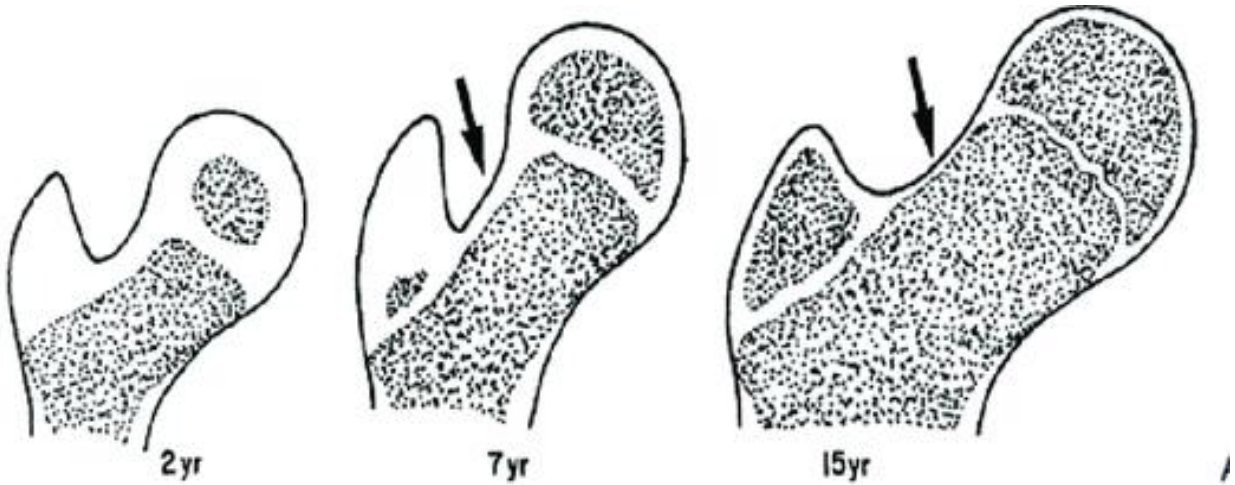


Acetabulum

- Formed at meeting place of 3 pelvic bones: ilium, ischium & pubis
- Each has a centre of ossification
- 3 centers meet at triradiate cartilage & fuse at 16 - 18 yoa

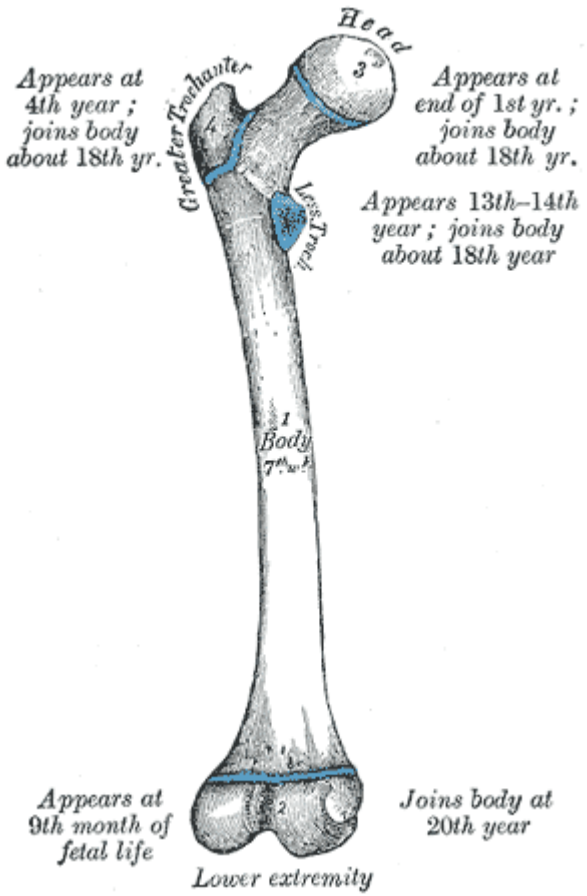
Ossification of proximal femur



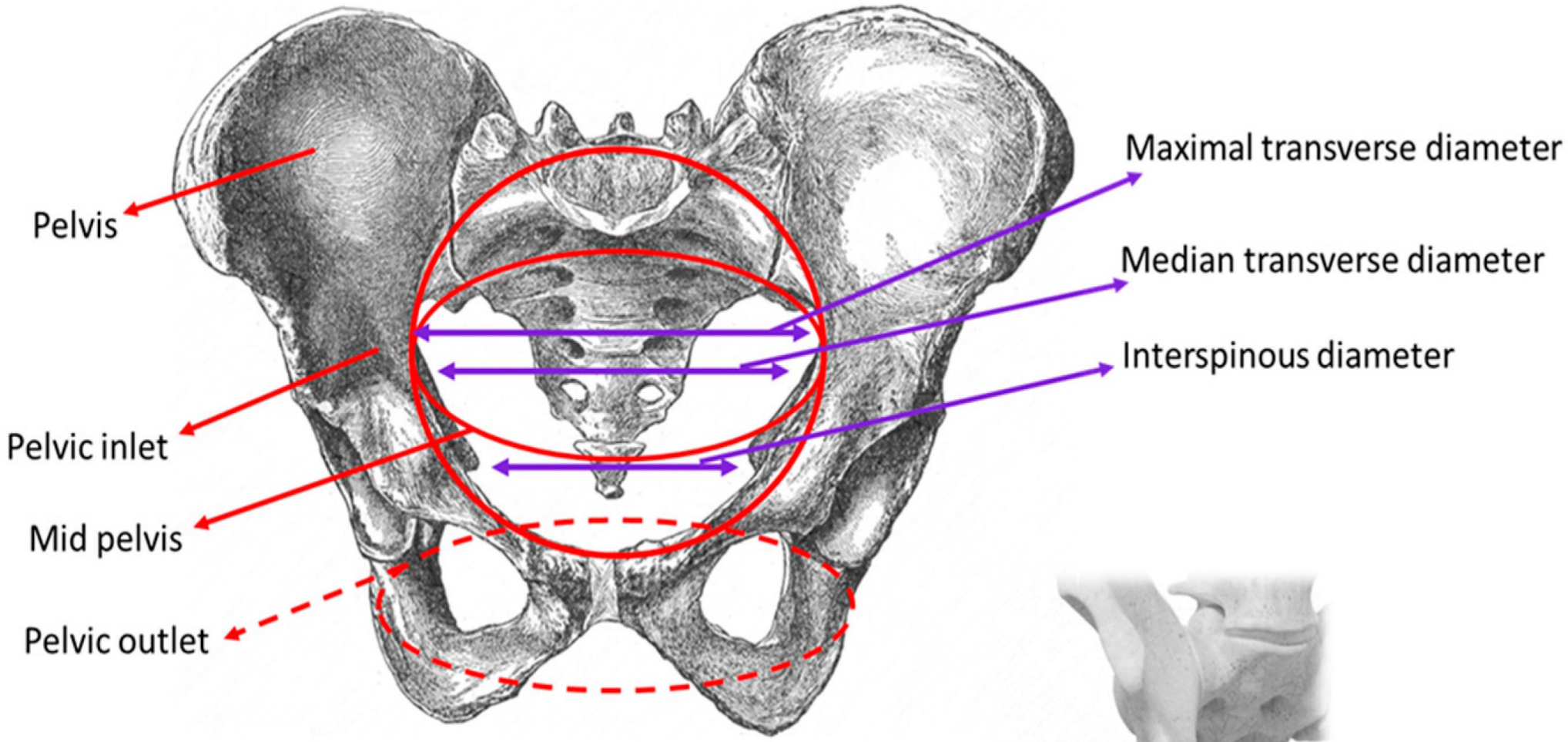


Significance: Prolonged & staggered ossification & vascular pattern subjects developing hip to greater vulnerability than other joints, in face of trauma & excessive use

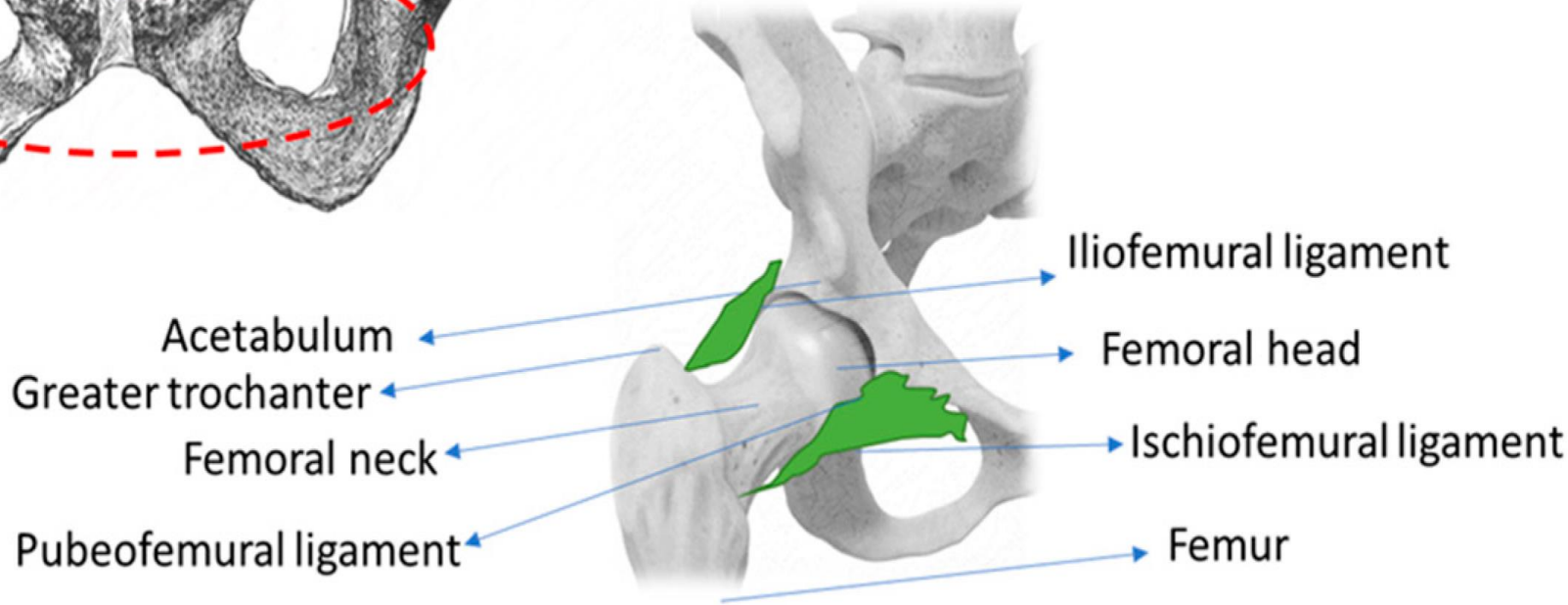
Ossification

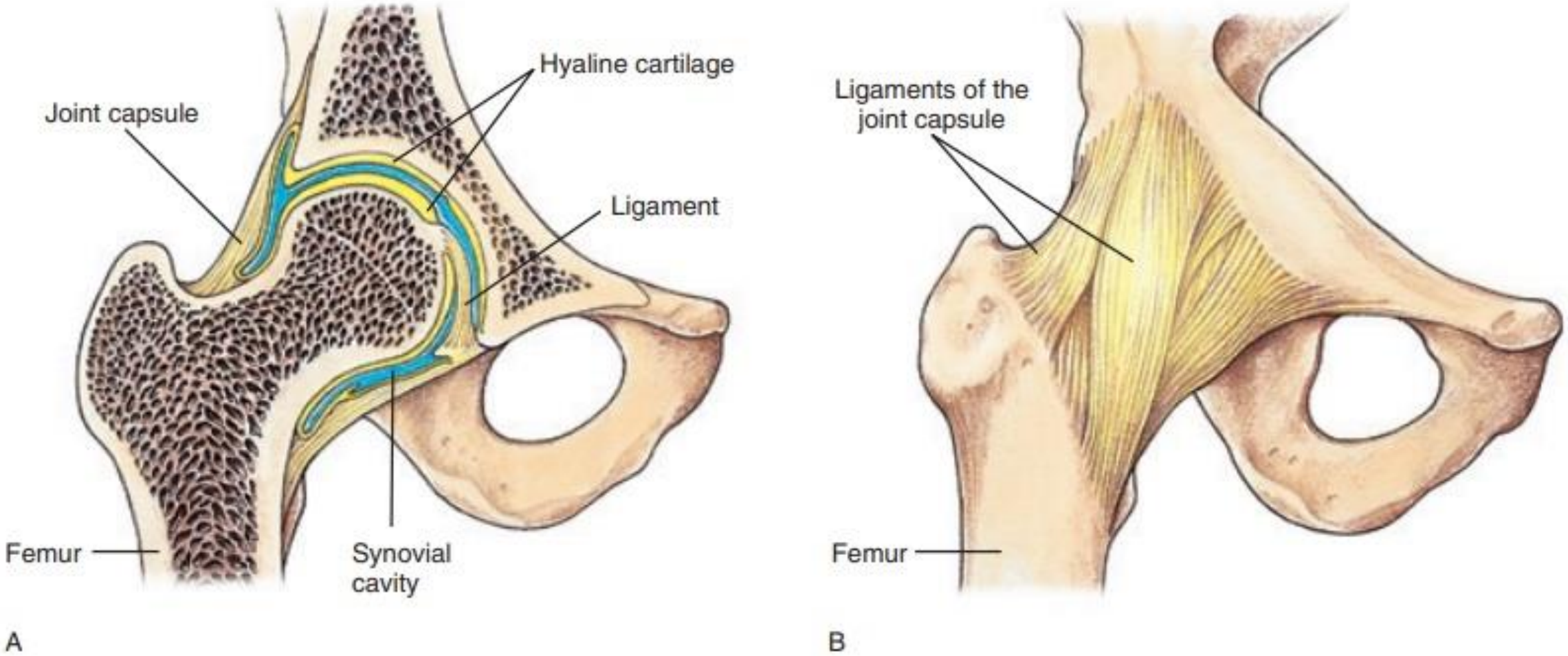


- 7/40 Shaft of femur
- Birth Femoral Condyles
- 1 year Femoral head
- 4 years Greater Trochanter
- 14 years Lesser Trochanter
- Fusion of centres Reverse order - LT fuses first with shaft & condyles at 20 yoa



Hips need integrity within whole pelvis

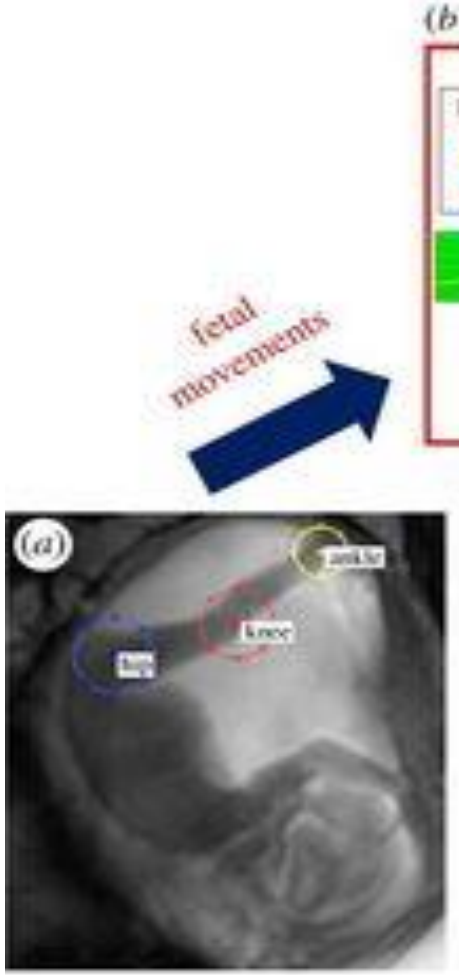




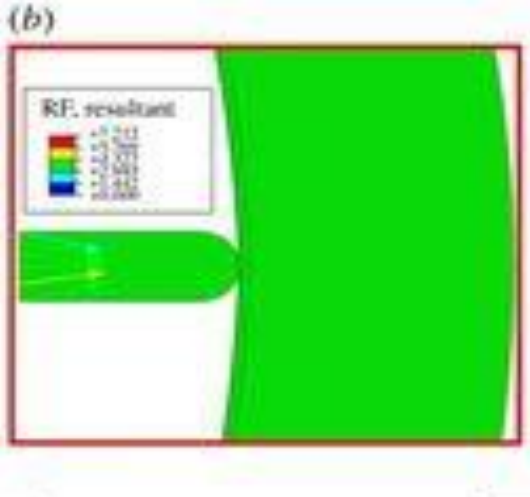
The hip joint, showing (**A**) a cross-section and (**B**) the ligaments of the joint capsule.

Stresses & strains on foetal skeleton during development

computational model Vol:15, Issue: 138, DOI: (10.1098/rsif.2017.0593)



Tracking foetal joint movements



Reaction force from foetal movements against uterine wall

kinematics

Musculoskeletal modelling to predict muscle forces

muscle forces

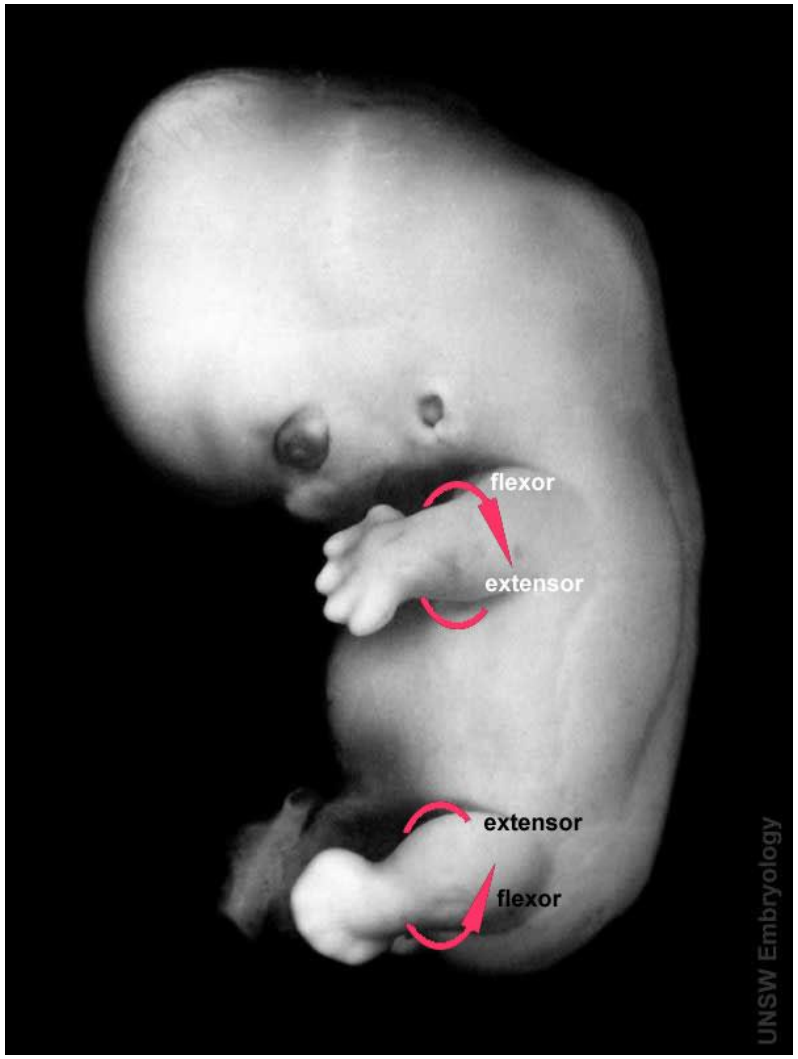
Muscle forces

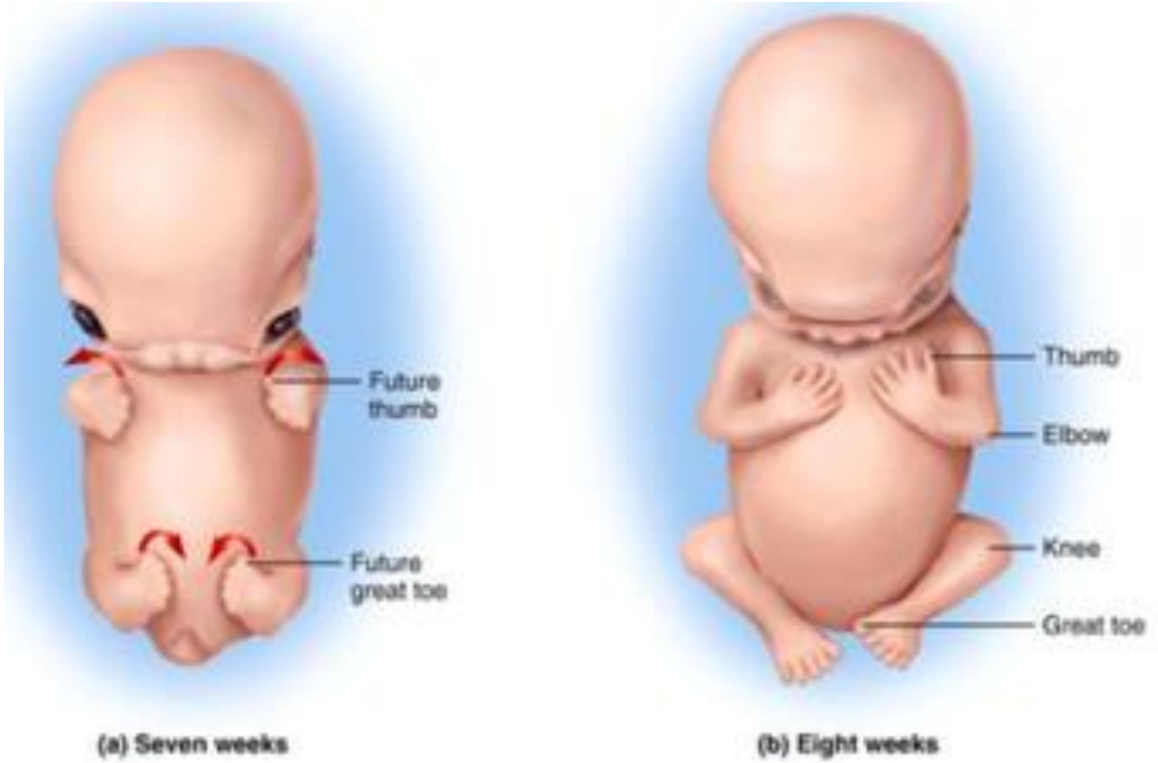
Ad magnus

G Max

B Fem

Carnegie stage 19 Limb rotation during development



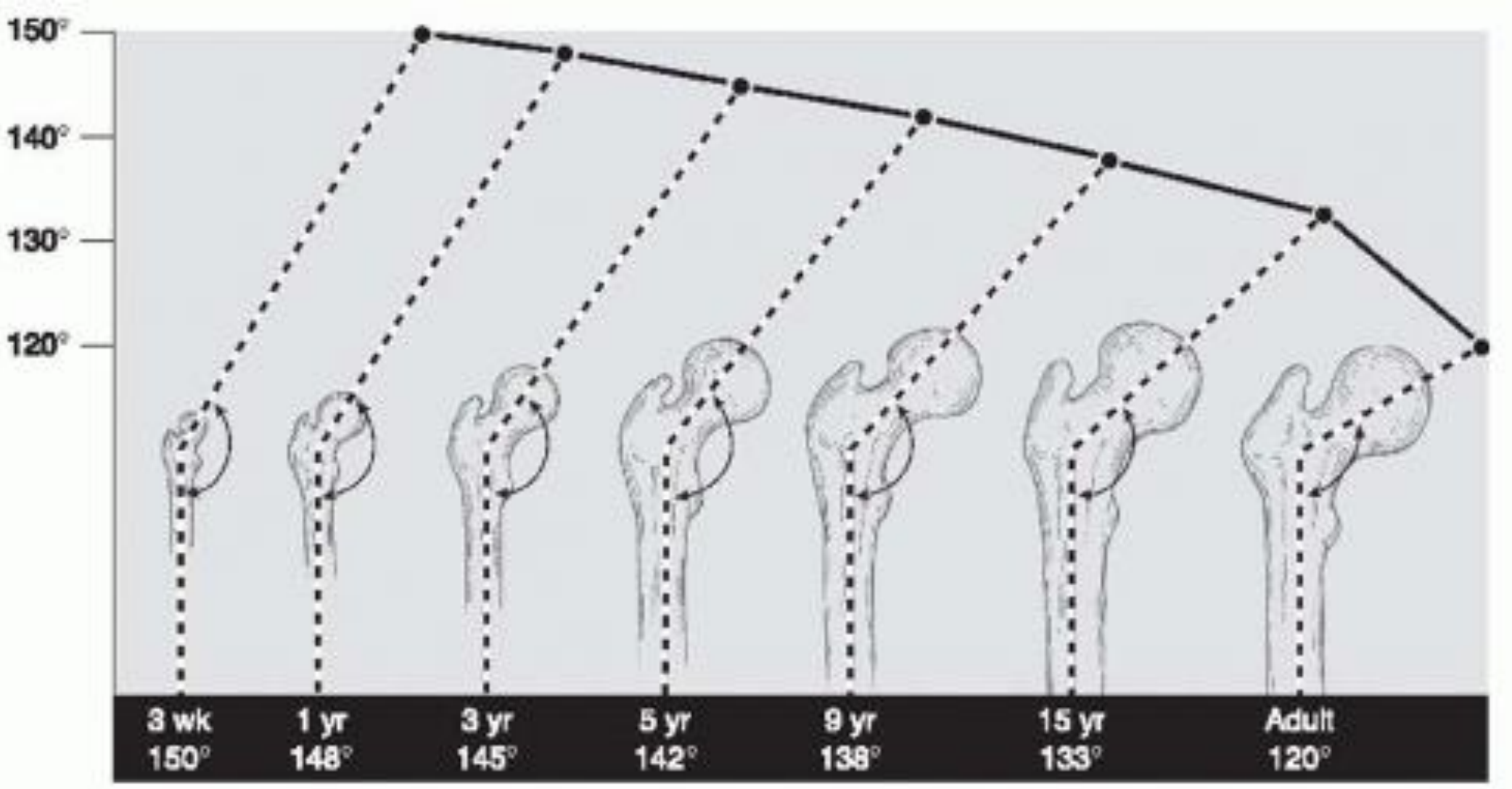


Rotation of upper and lower limbs in opposite directions

- **largest digit medial in foot and lateral in hand**
- **Elbow flexes posteriorly and knee flexes anteriorly**

Hill, M.A. (2021, September 23) **Embryology** *Stage19- limb rotation. jpg* https://embryology.med.unsw.edu.au/embryology/index.php/File:Stage19-_limb_rotation.jpg © Dr Mark Hill 2021, ***UNSW Embryology*** ISBN: 978 0 7334 2609 4 - UNSW CRICOS Provider Code No. 00098G

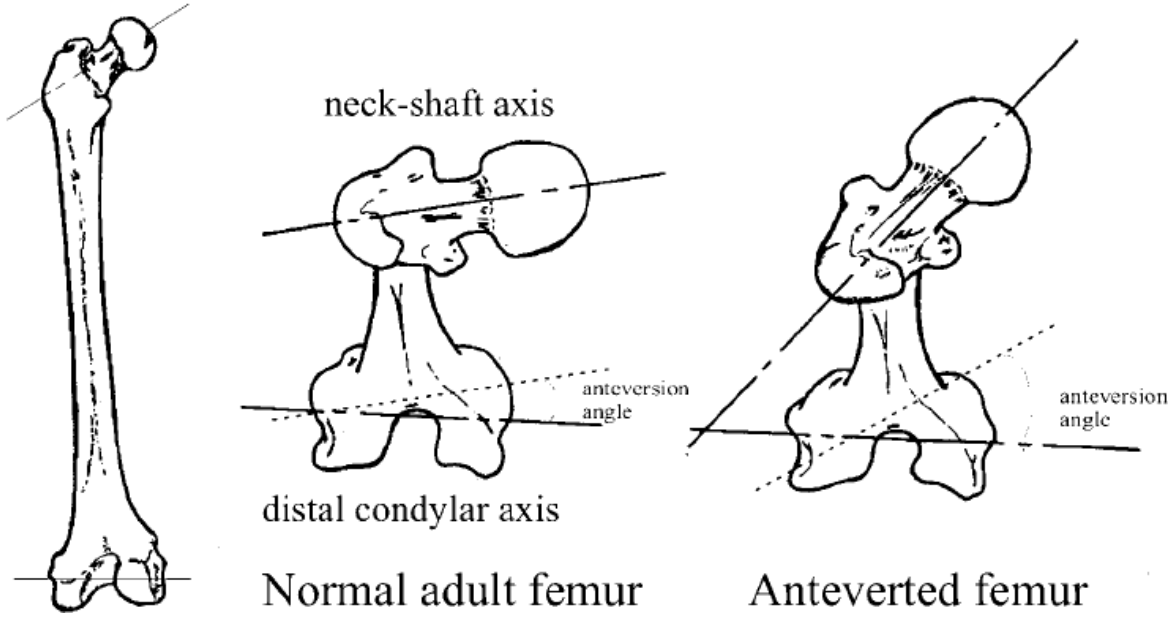
Evolution of the neck-shaft angle in the hip



Postnatal development of Hip

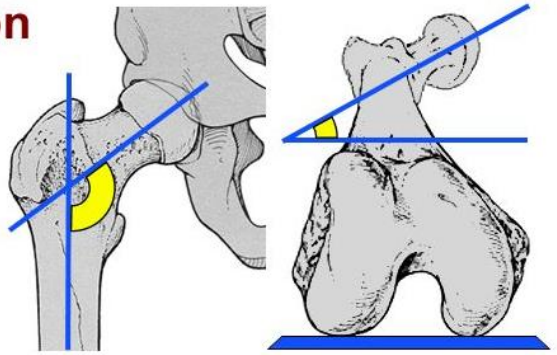
- Product of concurrent acetabular & proximal femoral growth from their corresponding growth plates.
- Absence of appropriate contact between acetabulum & proximal femur yields an incongruent joint.
- Multiple disease processes may be understood in light of this growth process, including Legg-Calvé-Perthes disease & developmental dysplasia of the hip.

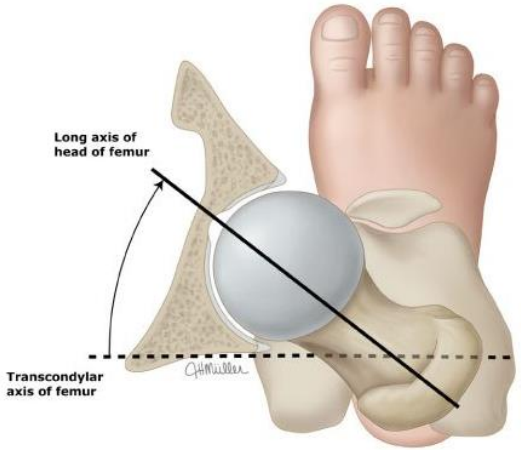
Developmental Femoral Angles



The normal femoral neck anteversion angle
The Neck – Shaft Angle

1. **Angle of inclination**
   - =125º is normal
   - >125º is coxa valga
   - <125º is coxa vara
2. **Angle of torsion**
   - 12 to 14º is normal
   - Head forward is anteversion or internal femoral torsion (toeing in) – common & usually outgrown in children
   - Head back is retroversion (toeing out)





Femoral torsions & progression angle of gait

- Femur requires to internally rotate 4-6 degrees from initial contact to midstance. If this is not available then that range of motion is compensated for elsewhere, usually lumbar spine, knees or feet.
- Sway back lumbar posture
- Contractile tissue deficits eg weak iliopsoas

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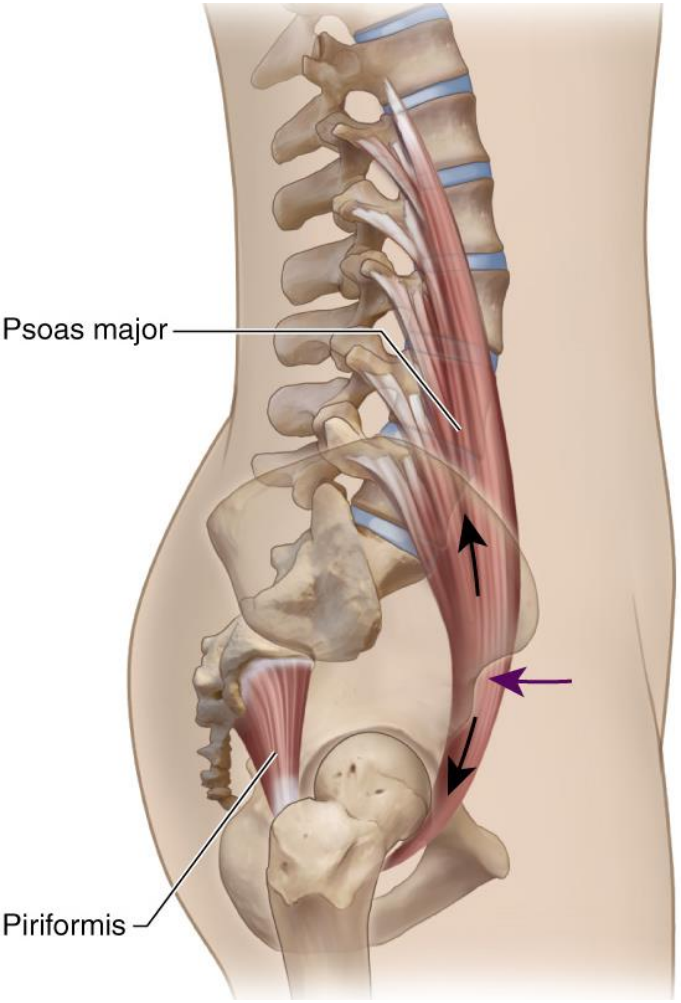
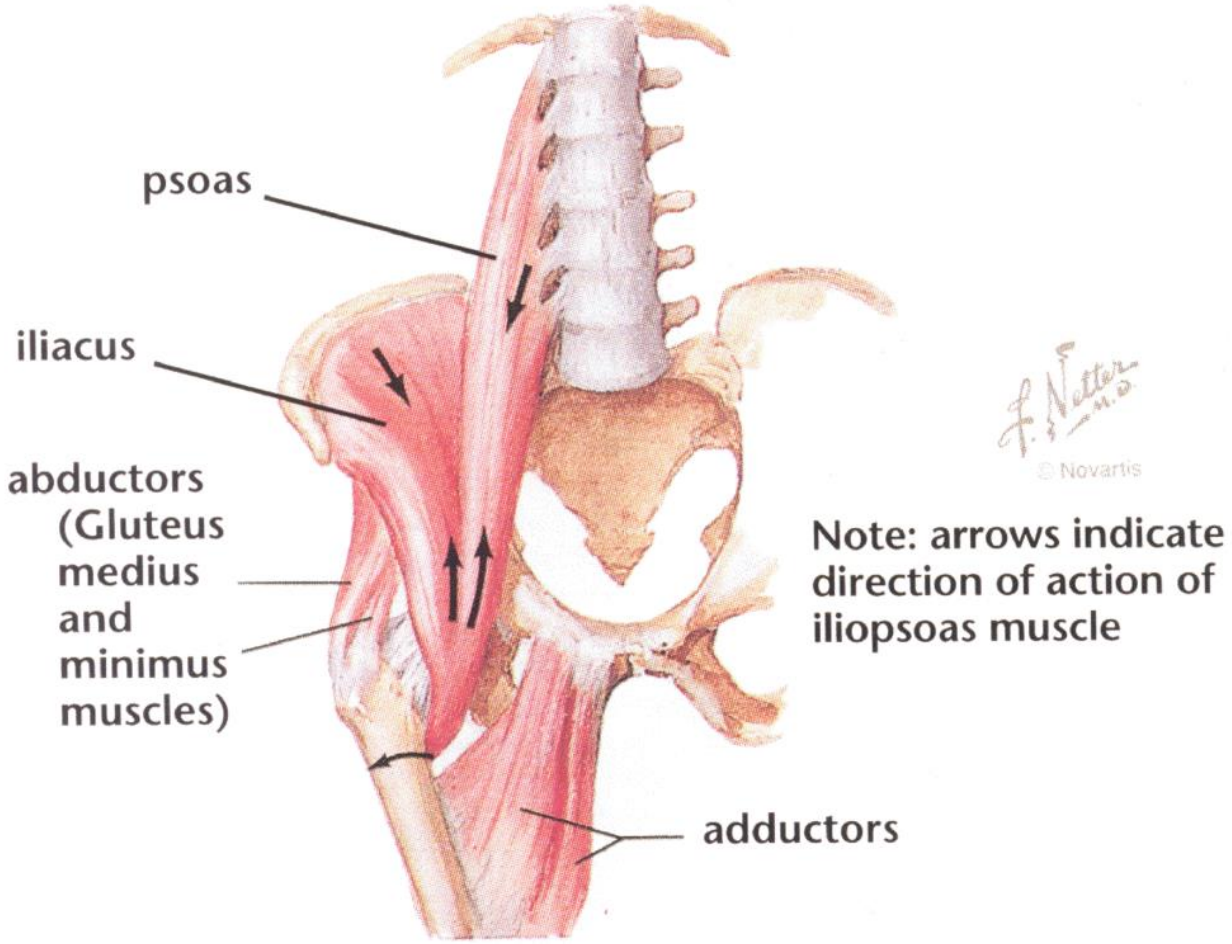
Hip Joint begins at the waist





Biodynamically, a functional fulcrum being the neurophysiological origin of the lower extremity

Postnatal development of Hip: Prone Position

- At birth acetabulum is flat, faces anteriorly
- Hips loaded & extended > Stresses anterior capsule
- This produces non-perpendicular & torsional load on femoral head & neck
- The rotation induces causes a posterolateral shift in position
- Delayed, abnormal weightbearing, laxity of connective tissues affects remoulding retroversion process

Lower limb development after birth

- Consider Lower limb as a whole
- Mechanics of abdomen & pelvis affect functioning of limb as a whole
- Hip begins at the thoracolumbar area
- Femoral Rotation biodynamically induced by muscular forces, especially the iliopsoas, medial & lateral hip rotators

Getting ready for ambulation

- Hip remodels through mechanical forces of movement, growth, enlarging muscles, compression forces of weight bearing & eventually gait
- The Hip develops through reciprocal mechanical loading & tensile forces through different components
- Abnormal loading or torsion or tensile forces can affect development
- Remoulding of head as loaded & extended hip stresses anterior part of capsule at femoral neck

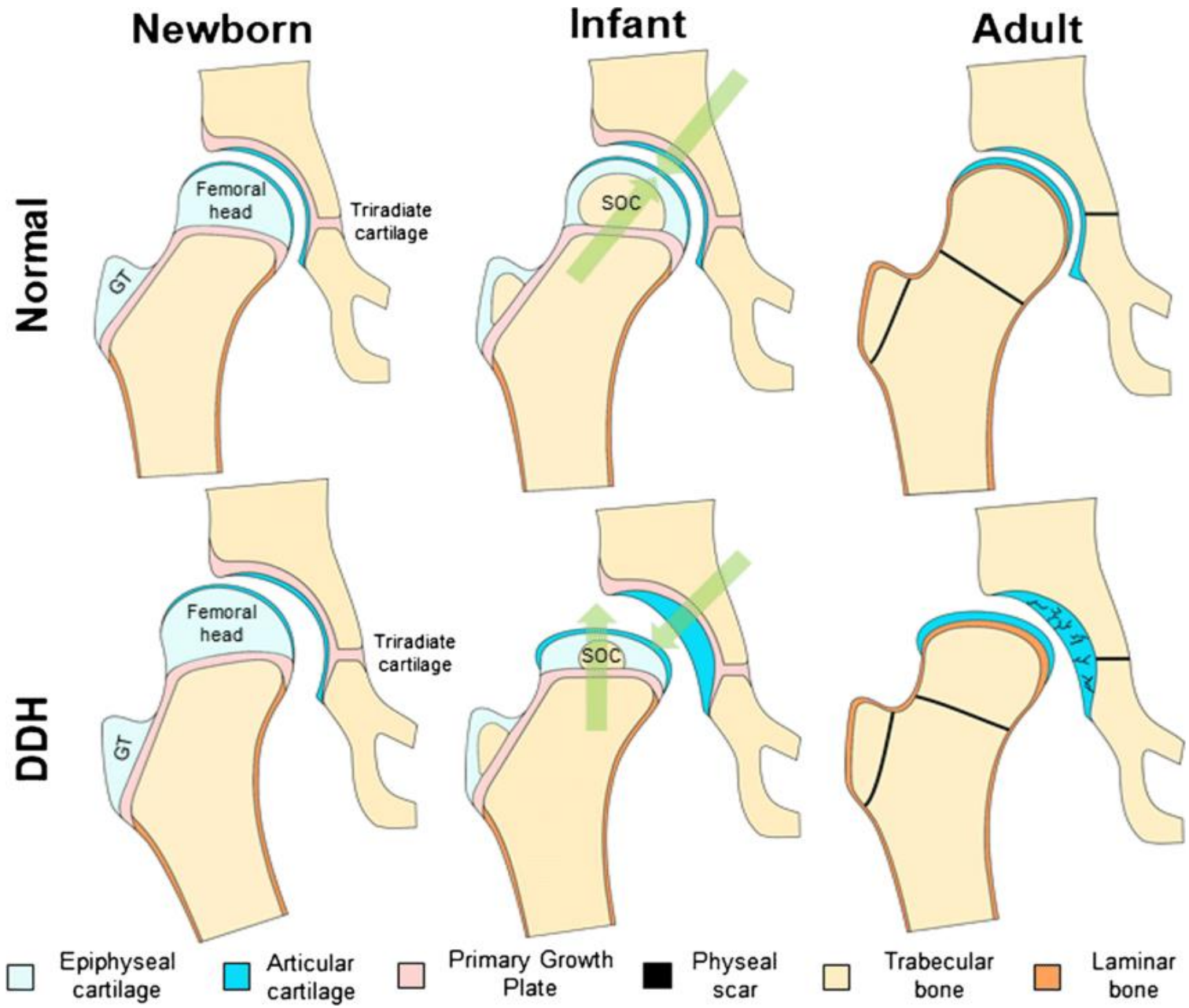
Observation of Hips

- Symmetry & Equality of leg length
- Toe numbers
- Creases at sole of foot for gestational age
- Normal to have slight bowing of legs, reflecting intra-uterine position, decreases over time
- Baby may appear folded up – accordian style
- Gentle pressure on soles of feet, baby resumes intra-uterine position revealing how legs became bowed

Developmental Dysplasia of the Hip (Congenital dislocation of the hip, or hip dysplasia)

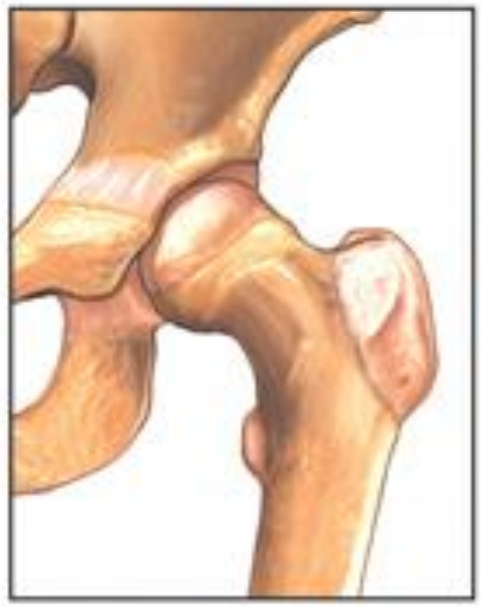
- Poor acetabular support to femoral head & Compromised passive stability of hip joint lead to increased mechanical pressure on acetabular labrum & cartilage
- Shallow acetabulum & reduced weight bearing increase load on muscles acting close to hip joint & muscle-tendon-related pain may potentially coexist with intra-articular pathology.

Jacobsen et al **Muscle-tendon-related pain in 100 patients with hip dysplasia: prevalence and associations with self-reported hip disability and muscle strength** *Journal of Hip Preservation Surgery*, Vol 5, Issue 1, Jan 2018, Pp 39–46, https://doi.org/10.1093/jhps/hnx041


Newborn
Infant
Adult
Normal
DDH
Femoral head
Triradiate cartilage
GT
SOC
Epiphyseal cartilage
Articular cartilage
Primary Growth Plate
Physeal scar
Trabecular bone
Laminar bone

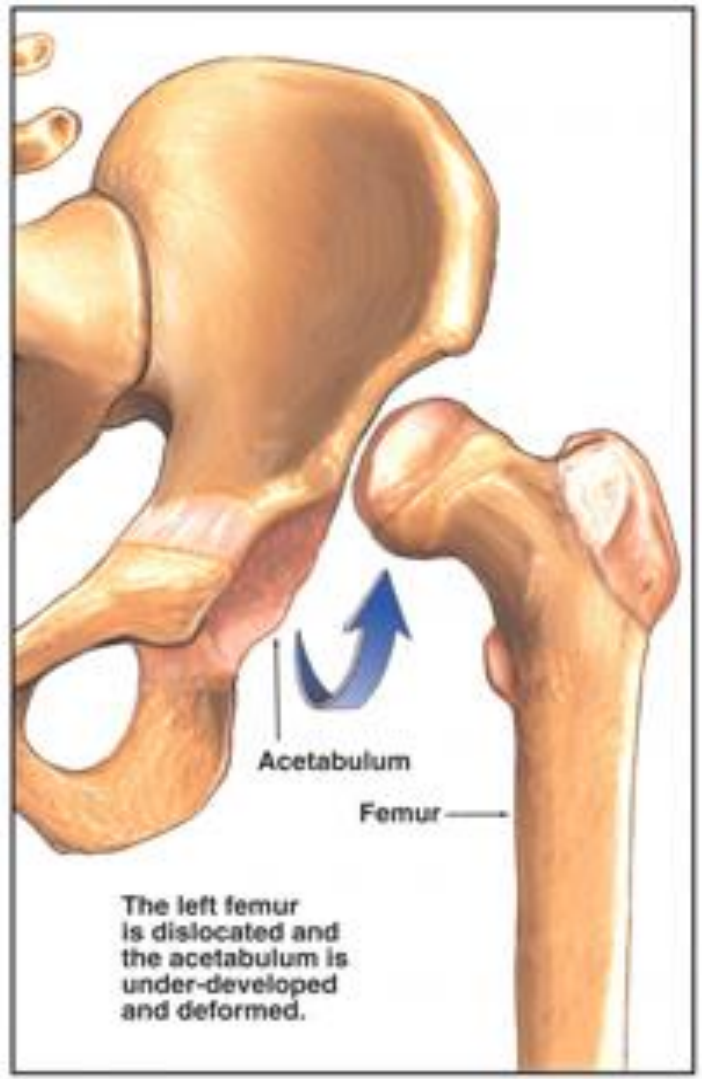
Developmental Dysplasia of the Hip

- **Dislocated:** No contact between cartilages on head & acetabulum Head external to acetabulum, lies supero-laterally
- Reduceable in the neonatal period.
- **Dislocatable: H**ead in acetabulum but may be displaced.
- **Subluxable:** The cartilages are touching but head not properly seated within the acetabulum. But will not displace.
- **Dysplastic: A**cetabulum is underdeveloped & shallow > does not adequately support the femoral head. More common in older adolescents than younger children.



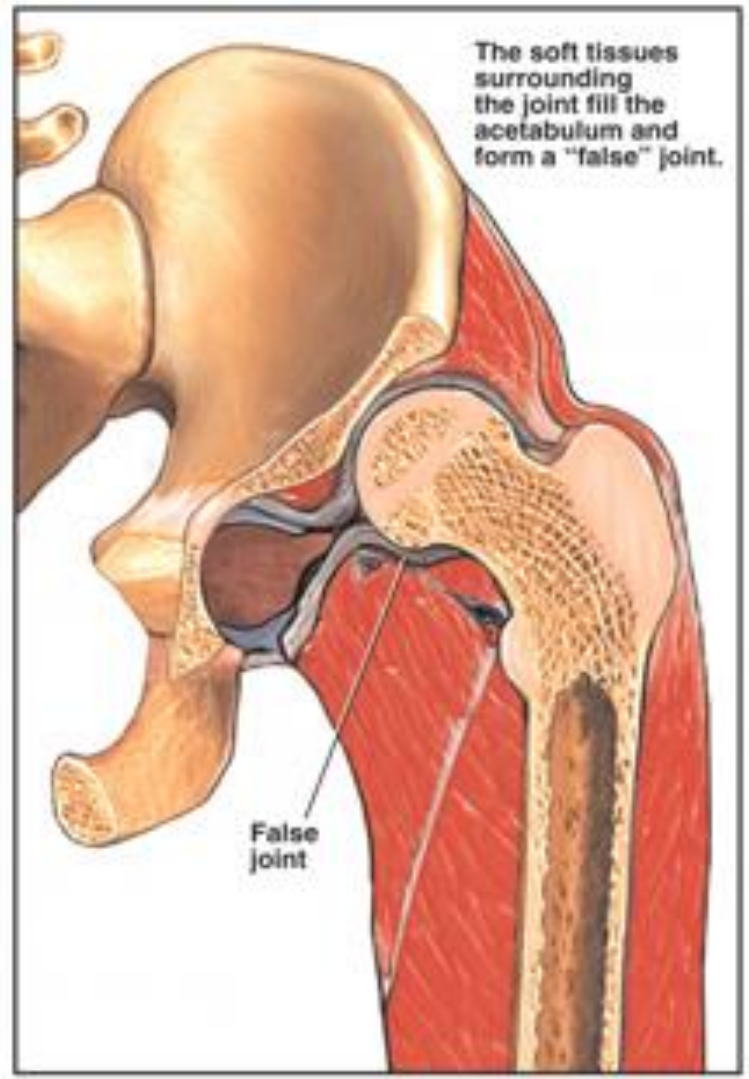
Anatomy of a Normal Left Hip

Dislocation of the Left Hip



Anterior view of the left hip

Dislocation of the Left Hip

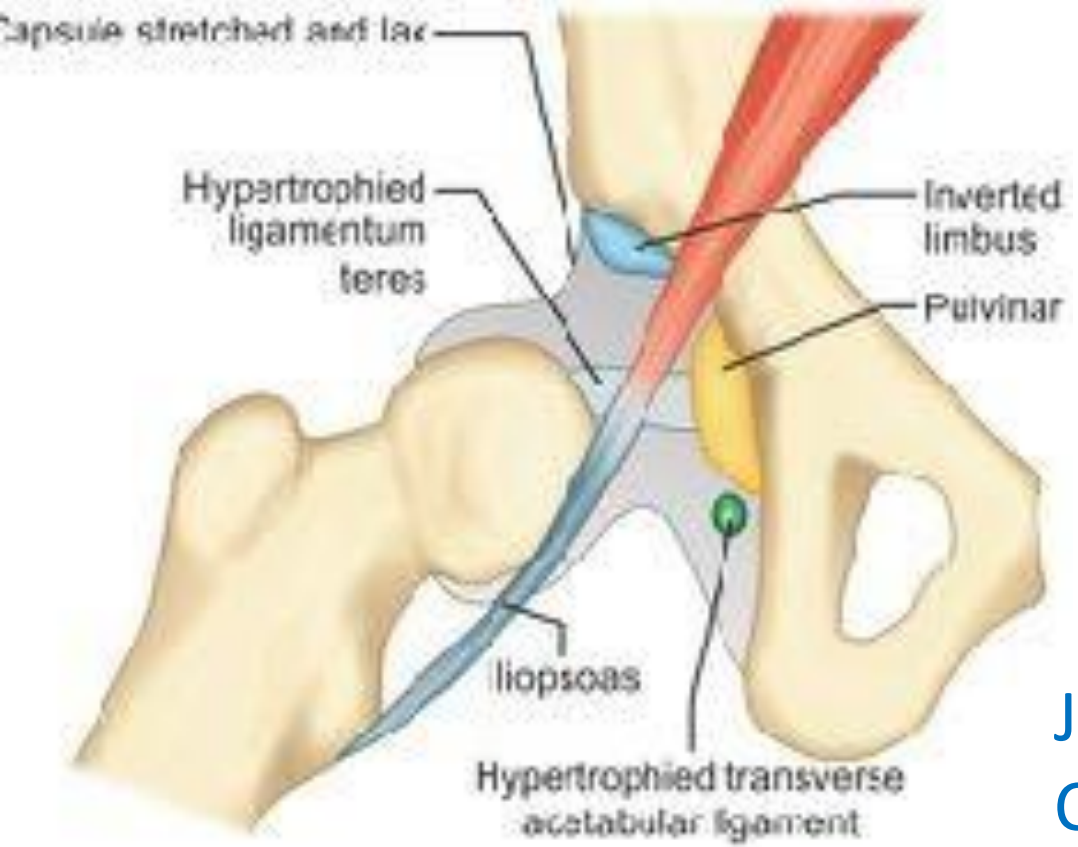


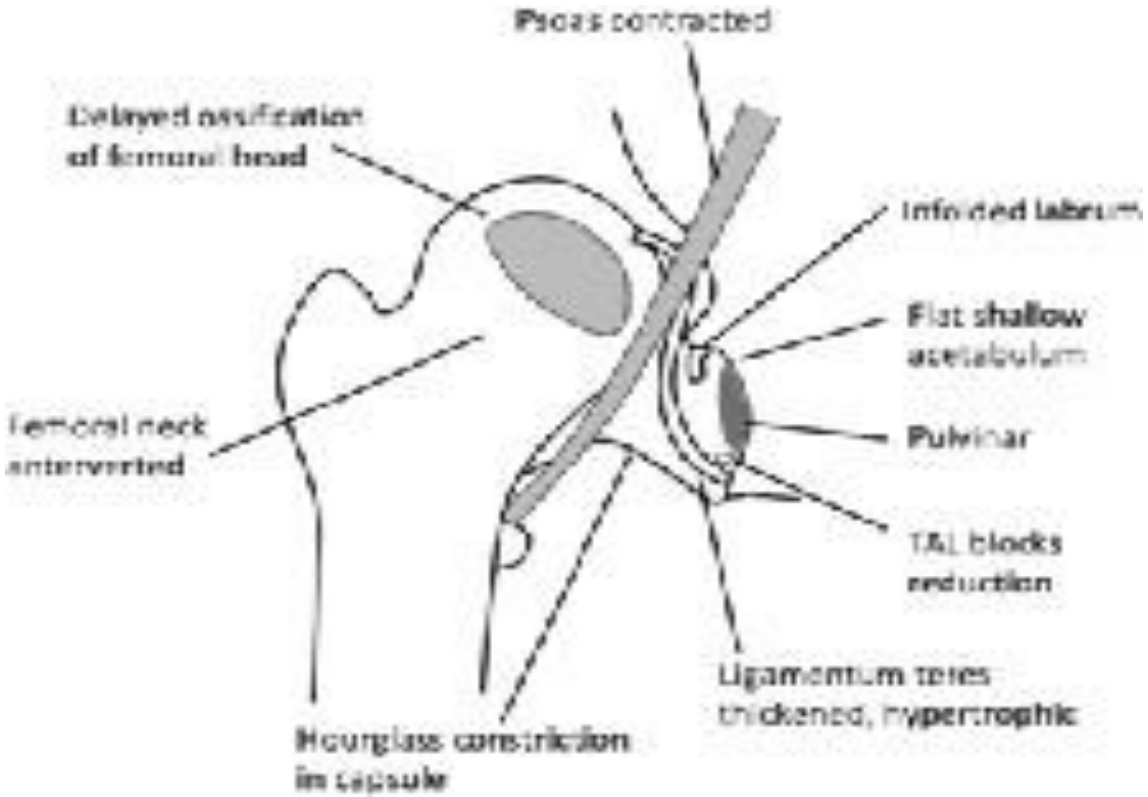
Cut-away view of the left hip

Developmental Dysplasia of the Hip

- 1 or 2 in every 1,000 babies needs treatment
- Without early treatment, DDH may lead to:
- Locomotion problems: Limp, Pain, Early O/A
- Early diagnosis & treatment > less likelihood of surgery, & more likely to develop normally
- Can develop over time
- Repeat hip examination until child is walking normally with no sign of limp or altered gait

Hip Dysplasia





Joint capsule & ligamentum teres strained
Capsule > hourglass shape
Fibrocartilage enter labrum joint >>>
deteriorate joint stability
Contracture iliopsoas & gluteal muscles

Hip Dysplasia

- Can develop over time
- Observe use of lower leg
- Reaching over to same side when seated
- Repeat hip examination until child is walking normally with no sign of limp or altered gait

Signs of hip dysplasia

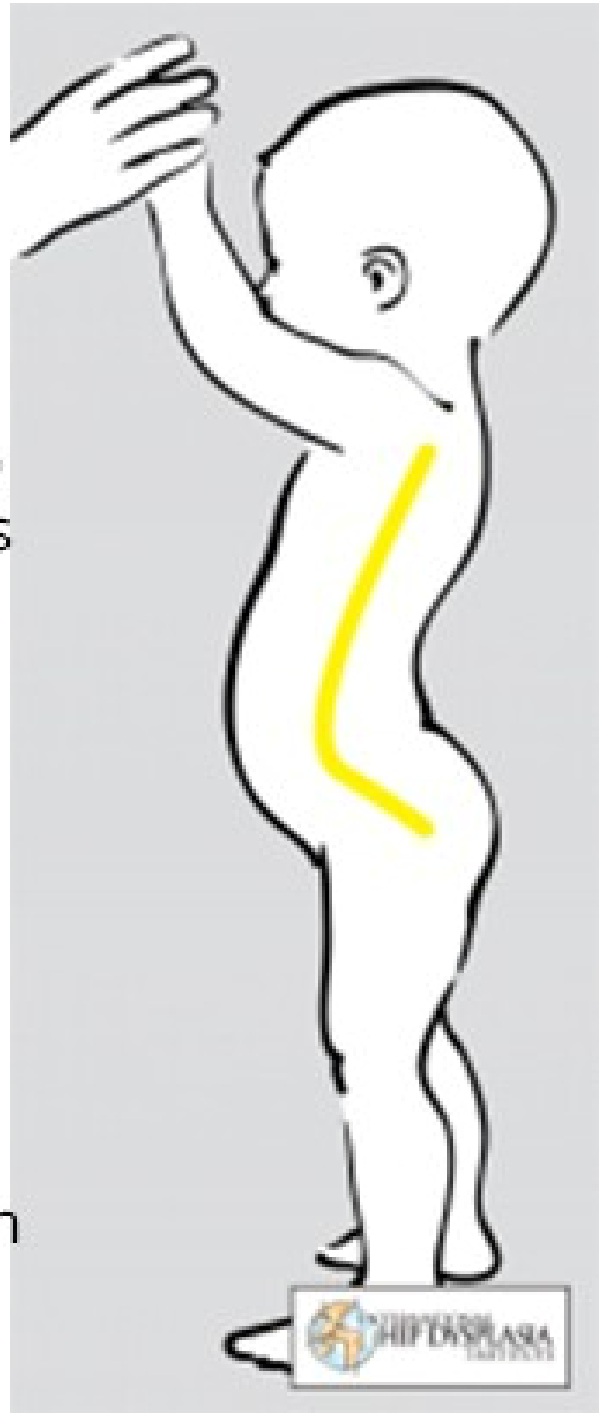
Swayback – A painless but strong curve in the lower back and an exaggerated waddling limp.

Hip Click - Hip clicks or pops can sometimes suggest hip dysplasia but a snapping sound can occur in normal hips from developing ligaments in and around the hip joint.

Asymmetrical buttocks - Creases can suggest hip dysplasia in infants.

Limited Range of Motion- Parents may have difficulty putting on a nappy because the hips can't fully spread.

Pain - Pain is normally not present in infants and young children with hip dysplasia, but pain is the most common symptom of hip dysplasia during adolescence or as a young adult.

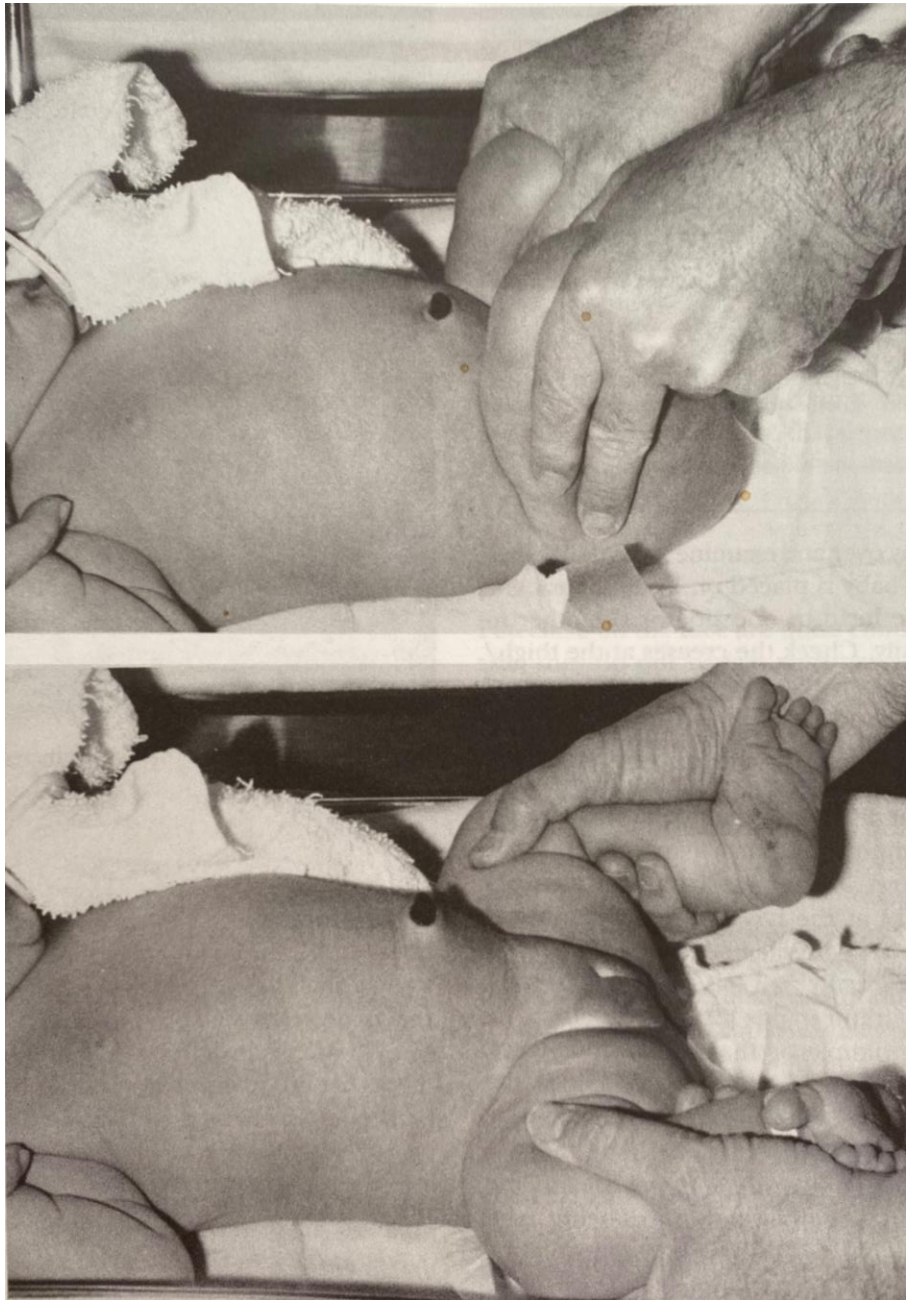


Hip Dysplasia of newborn

- Asymmetrical external rotation & Abduction
- Uneven skin folds thighs & buttocks
- If bilateral, normal skin folds
- Leg length discrepancy
- Un-eveness in knees: lower side is dislocated (3/12+ Galeazzi's or Allis test)

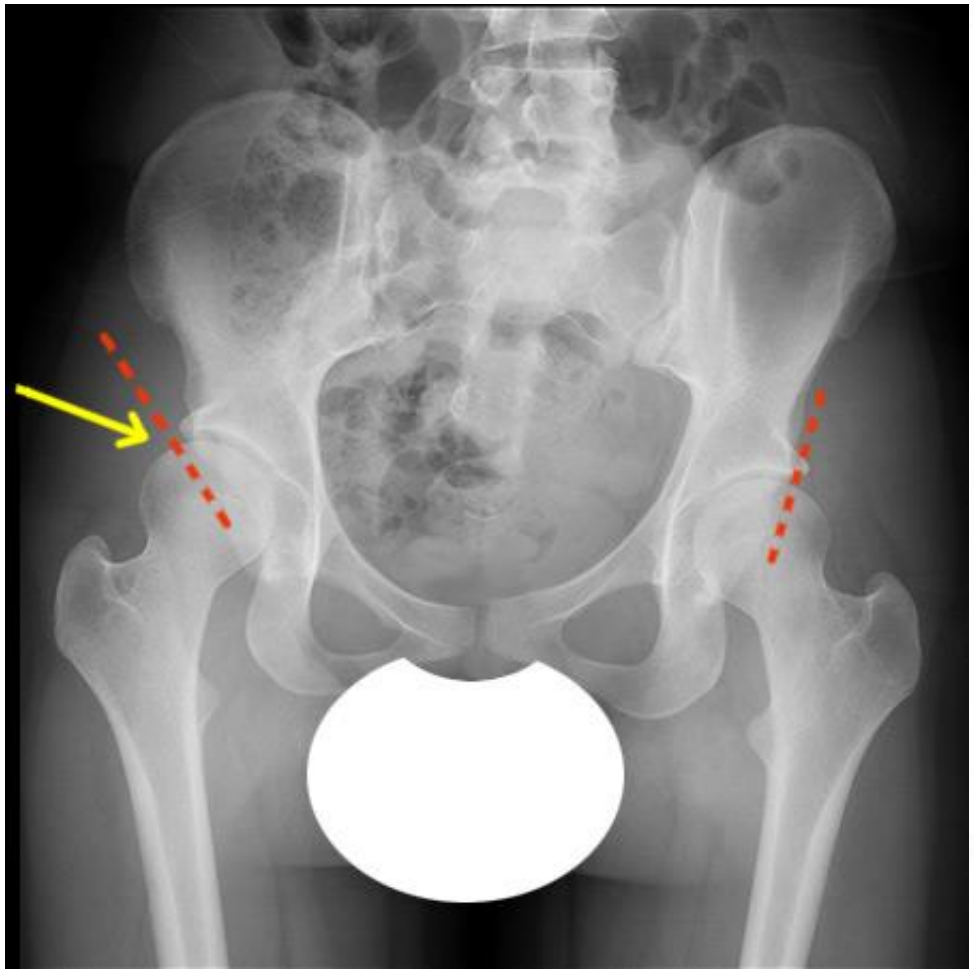
Testing for Dysplasia & Dislocation

- Supine Knees & Hips flexed 90 degrees
- Thigh held with forefingers along lateral shaft femur, middle fingers on greater trochanter & thumb medially on femoral triangle
- Adduct femora fully, then gently abduct from position of full adduction so knees come to lie laterally on bed
- During abduction, push GT medially with fingers
- If during any of above, there is a click, resistance, spasm or discomfort of adductors, assume dislocated or dislocatable hip > orthopaedic assessment



(Goldbloom, Paediatric Skills)

Hip Dysplasia Adult Untreated Hip Neuromuscular disease



Right Hip Dysplasia: Yellow

Red: Lack of acetabular coverage compared to left healthy hip

Hip Dysplasia

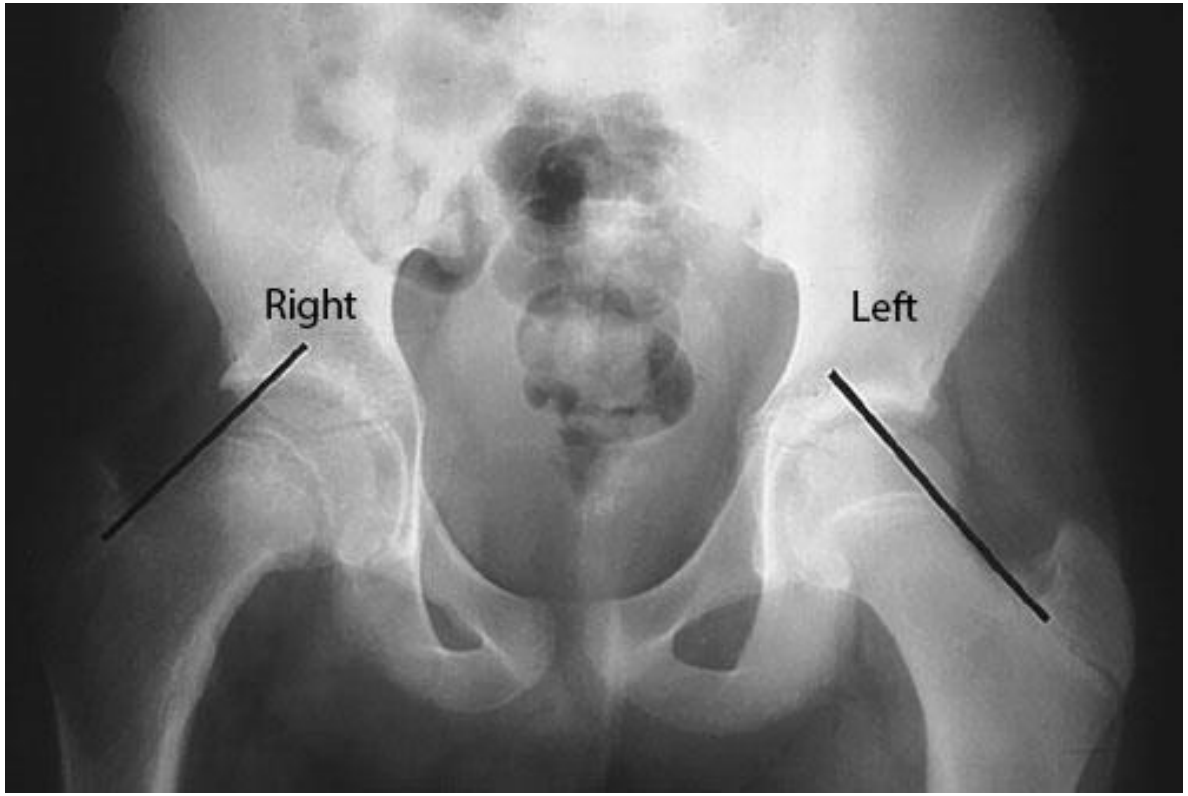
Left Hip Slightly out of socket but returns to it when legs held apart: Principle of TTT is to hold the hip in joint until stable

Dislocation of left hip

Stability in Flexed position

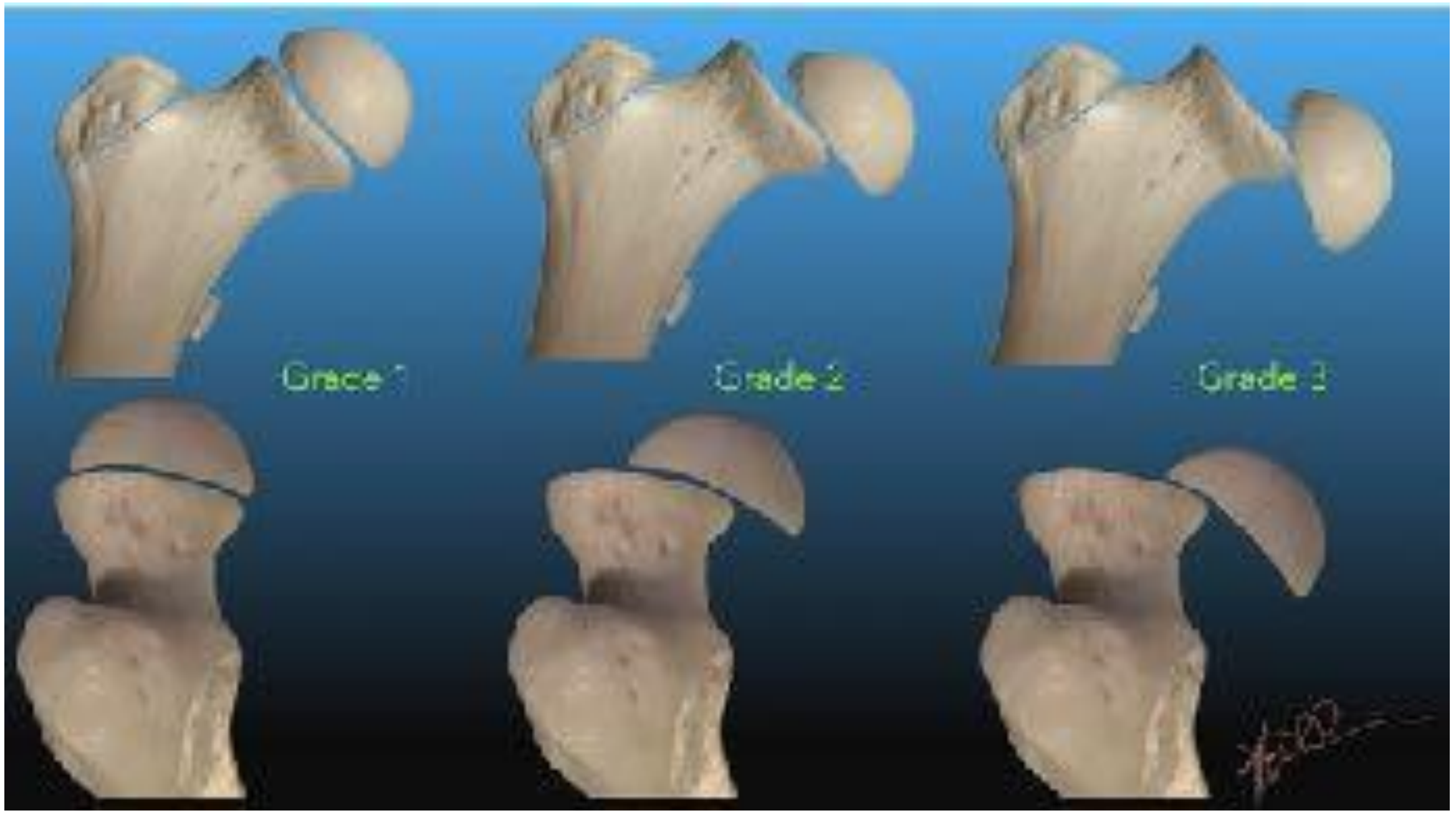
Pavlik Harness – Fabric splint

Slipped capital femoral epiphysis



- Most common Hip Disorder in Adolescents
- Obesity, endocrine disorders
- Rapid growth spurt
- Posterior, inferior & medial displacement of the femoral epiphysis, on the AP view, more obvious to the frog leg.

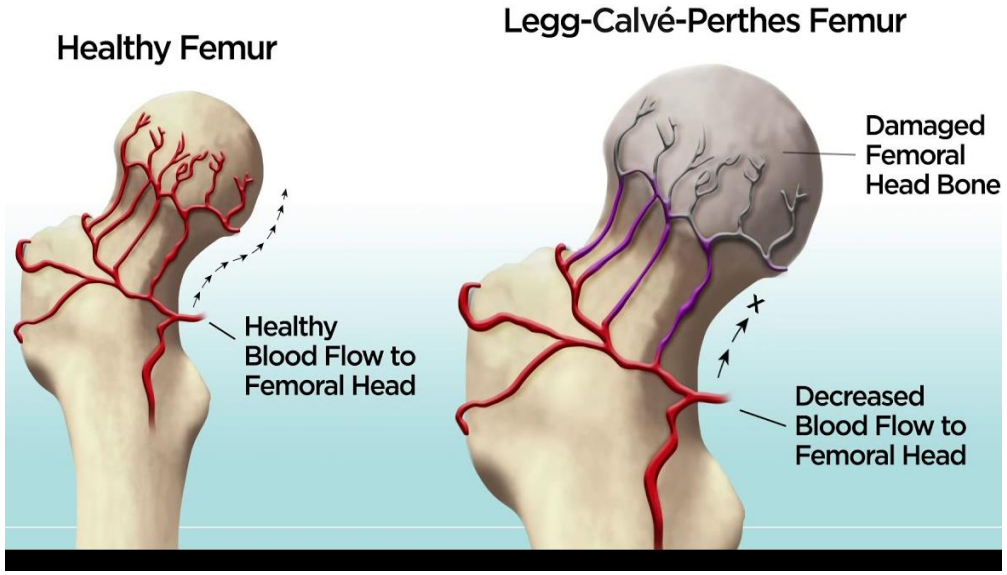
Dynamic Chiropractic; June 18, 2007, Vol. 25, Issue 13


Grade 1
Grade 2
Grade 3

Legg-Calve-Perthes' disease

- Head head ossifies with increased demand on vascular supply
- Inadequate blood supply/venous drainage > Changes in femoral epiphysis
- Insidious onset ?No pain since immature somato-sensory system
- Flexion contracture hip with external rotation, Stands tilted
- Pain, limping & limited movement of the hip joint
- Avoid high impact activities, until hip joint heals.
- Most children recover from Perthes' disease, but it 2 + years for bone to regrow & return to “normal”

Perthes' disease



- Uncommon
- 3-11 yoa, Boys 4 -5 X Girls
- Bilateral 10 – 12 % cases
- Trauma, Genetics 2-20%
- Vascular supply:

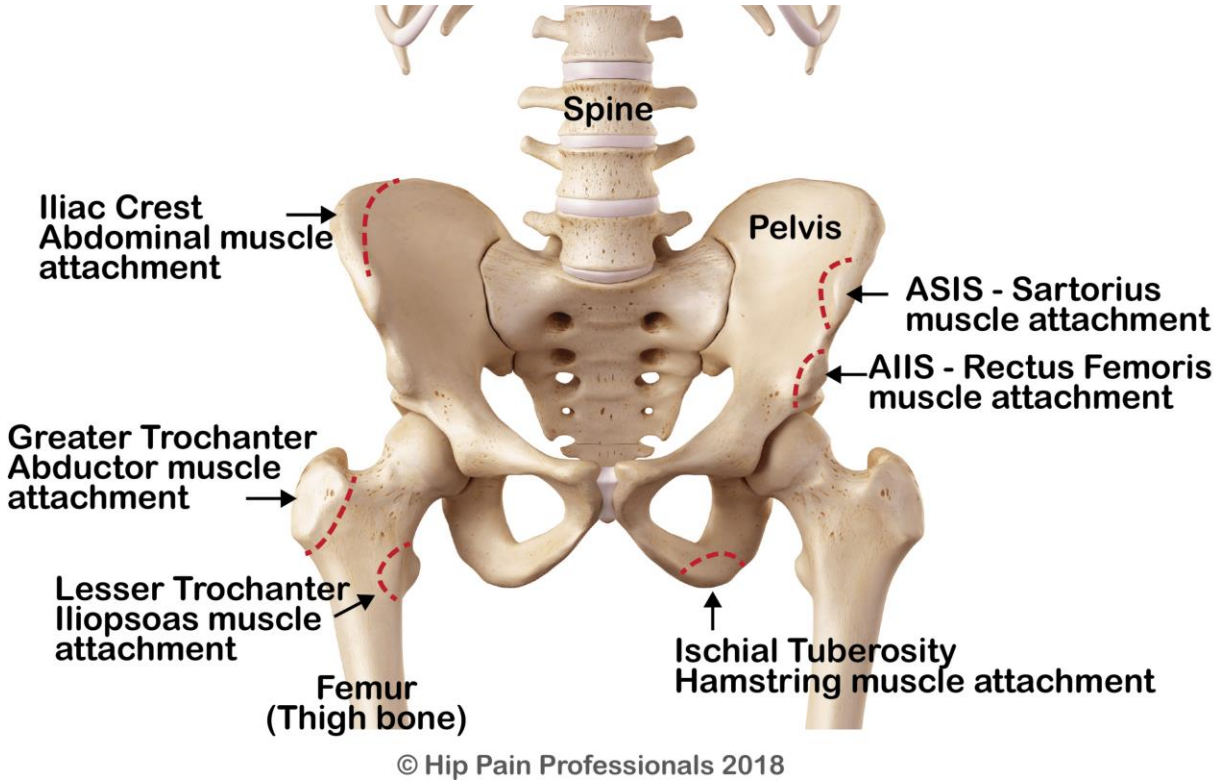
Reduced Venous drainage in head > increased intra-ossous pressure

- Final Diagnosis by xray.

Signs & Symptoms of Perthes' disease

- Occasional limp in the earlier stages
- Stiffness & Reduced range of movement in the hip joint
- Pain in the knee, thigh or groin on weight bearing
- Pain on moving hip joint
- Thinner thigh muscles
- Shorter leg leading to uneven leg length
- Worsening pain & Limping with progression of time

“Growing pains” around hip & pelvis: Children & Adolescents



- Young children around thighs & calves - muscular
- Apophysitis: Traction of muscles pulling on bony growth centres
- Pain experienced locally at the area of muscle attachment but can radiate around area
- Tenderness at muscle attachment for most sites.
- Pain is usually worse following activity: eases with rest

Growth centres (apophyses) red > Apophysitis & Avulsion fracture sites

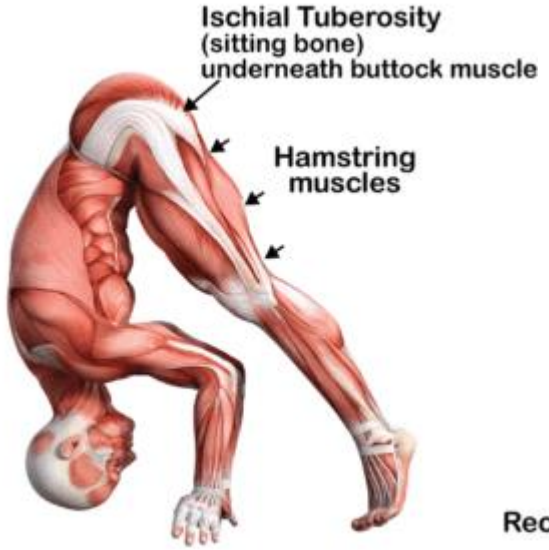
Apophysitis

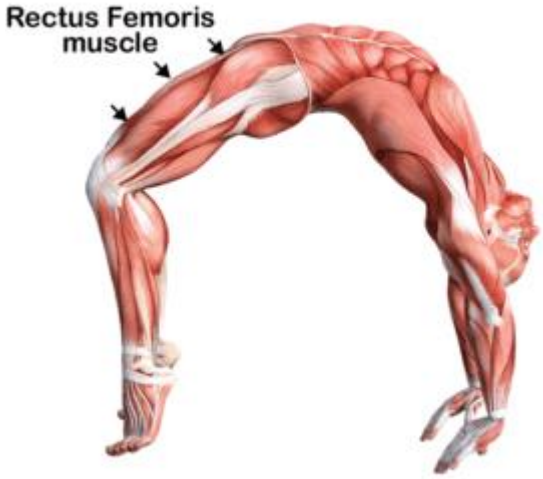
- Long bones growing faster than muscles - “growing pains”
- Relatively tight muscles “tug” on growth zones in immature pelvis & femur: ‘traction apophysitis’

- Factors related to the development of apophysitis:

- Muscle tightness – eg shortened hamstring muscles placing greater loads on apophysis at ischial tuberosity
- Rapid growth spurts – intermittent during adolescence; symptoms recur during or just post growth spurt as muscles relatively short compared to newly lengthened bones

Apophysitis – underlying factors



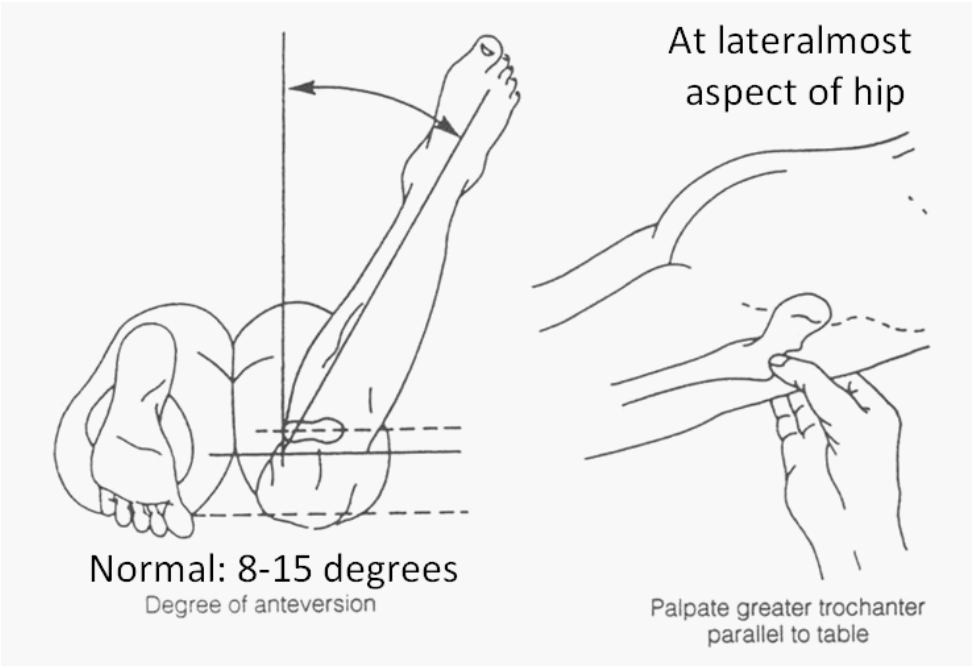


- Males – Growth is in more rapid spurts
- High activity levels > Places repetitive loads on growth plates
- Type of activity – Rapid acceleration & deceleration sports & large ranges of hip movement, eg soccer & gymnastics, place greater load across hip & pelvic growth centres

Other Differentials

- Child with pain & restricted hip movement
- Infection - osteomyelitis
- Juvenile Rheumatoid arthritis
- Tumours

Femoral Anteversion Assessment



- Trochanteric prominence angle (Craigs test).
- Prone, hip neutral – stabilise sacrum with forearm, palpate GT whilst passively IR hip, until most prominent portion of GT reaches its most lateral position
- Measure angle between tibial shaft & line perpendicular to table