BIOMECHANICS OF HIP JOINT

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INTRODUCTION

- The hip joint, or **coxofemoral joint,** is the articulation of the acetabulum of the pelvis and the head of the femur
- diarthrodial ball-and-socket joint
- three degrees of freedom:

1. flexion/extension in the sagittal plane
2. abduction/adduction in the frontal plane
3. medial/lateral rotation in the transverse plane

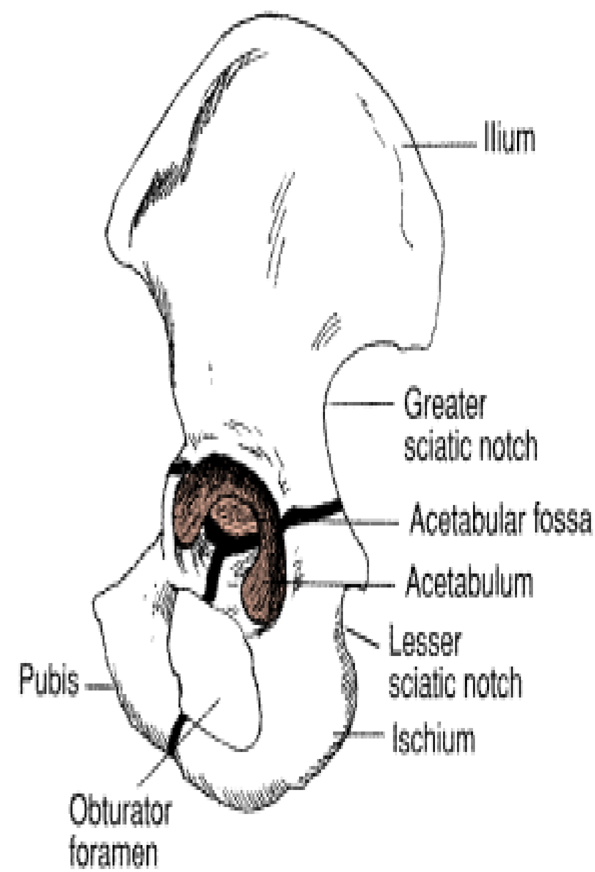
- The primary function of the hip joint is to support the weight of the head, arms, and trunk **(HAT)** both in static erect posture and in dynamic postures such as ambulation, running, and stair climbing.

STRUCTURE OF THE HIP JOINT

✓ **Proximal Articular Surface**

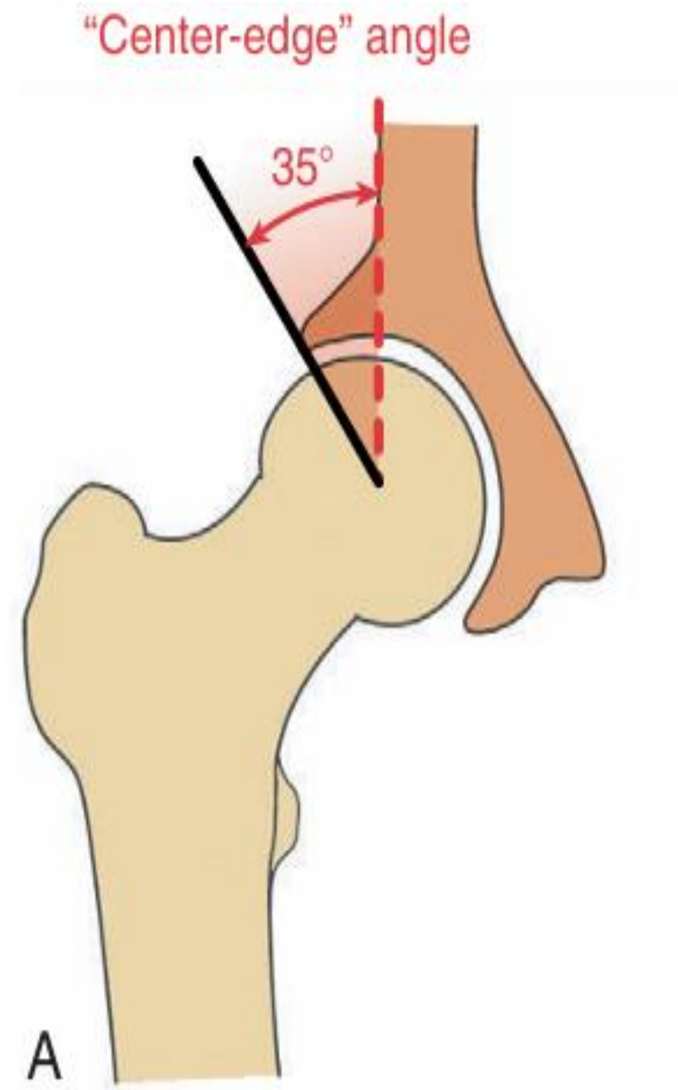
➢ **Acetabulum**

- Articulation-the cuplike concave socket acetabulum which is located on the lateral aspect of the pelvis bone.
- The periphery of acetabulum is covered by hyaline cartilage. This helps to distribute the pressure evenly.
- The transverse acetabular ligament make an fibro osseous tunnel through which blood vessels pass



- The opening of the acetabulum is approximately laterally inclined 50°
- anteriorly rotated (anteversion) 20°
- and anteriorly tilted 20° in the frontal, transverse, and sagittal planes, respectively

- Acetabular depth can be measured as the **center edge angle of Wiberg.**
- Angle formed by**, Line through center of femoral head** and **a line connecting center of femoral head to bony edge of acetabulum.**
- **Normal range- 35 degree**



- **lower central-edge angle reduces the acetabular coverage of femoral head.**
- This reduced coverage increases the risk of dislocation and, reduces the contact area within the joint.
- Increase joint pressure (force/area) .Over many years of walking, this scenario may lead to hip osteoarthritis, with degeneration of the acetabular labrum

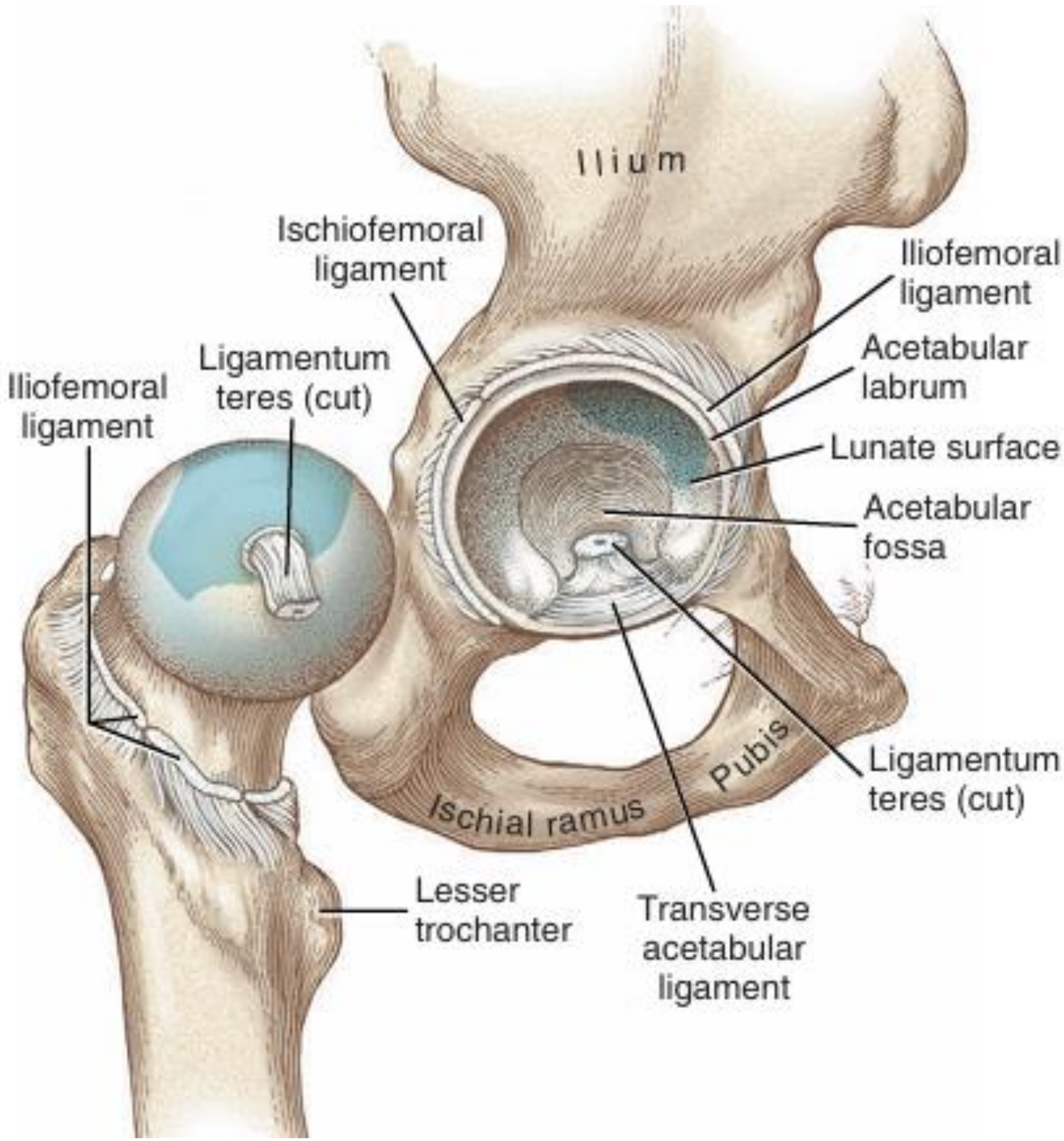
➢ Acetabular labrum

- The entire periphery of the acetabulum is rimmed by a ring of wedge-shaped fibrocartilage called the acetabular labrum
  - ✓ Deepens the socket,
  - ✓ increases the concavity of the acetabulum, grasping the head of the femur to maintain contact with the acetabulum
  - ✓ It enhances joint stability by acting as a seal to maintain negative intra-articular pressure
  - ✓ Also provide proprioceptive feedback

- ✓ **Distal articular surface:**
- ✓ **<u>femoral head</u>**

- The articular surface of the femoral head forms **two thirds of a sphere** and is more circular than the acetabulum.
- The depression at midpoint of femoral head is **fovea** ,where the ligamentum teres attached.

- The ligamentum teres (also known as the ligament to the head of the femur):
- It is a tubular sheath of synovial-lined connective tissue that runs between the transverse acetabular ligament and the fovea of the femoral head .


Ilium
Ischiofemoral ligament
Iliofemoral ligament
Acetabular labrum
Lunate surface
Acetabular fossa
Ligamentum teres (cut)
Iliofemoral ligament
Ligamentum teres (cut)
Pubis
Ischial ramus
Lesser trochanter
Transverse acetabular ligament

ANGULATION OF THE FEMUR

- There are two angulations made by the head and neck of the femur in relation to the shaft

➢ Angle of inclination occurs in the **frontal plane between an axis through the femoral head and neck and the longitudinal axis of the femoral shaft**

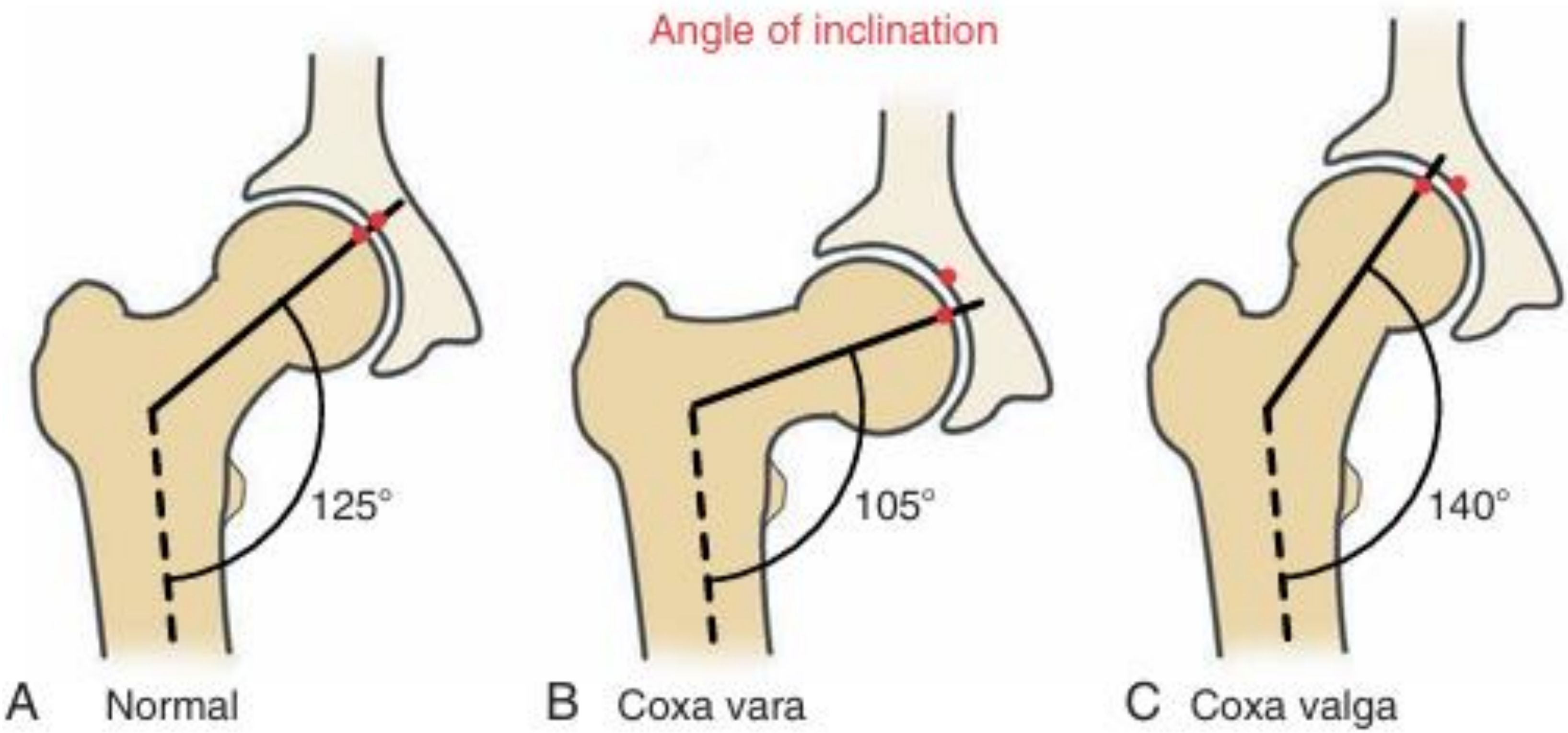
➢ Angle of torsion occurs in the **transverse plane** between **an axis through the femoral head and neck and an axis through the distal femoral condyles**

1.ANGLE IF INCLINATION OF FEMUR

- The angle of inclination of the femur approximates **125°**
- Normal range from **110° to 144°**.
- At birth this angle measures about 140 to 150 degrees. Primarily because of the loading across the femoral neck during walking, this angle usually reduces to its normal adulthood value of about 125 degrees.

- With a normal angle of inclination, the greater trochanter lies at the level of the center of the femoral head.
- In **womens angle of inclination is smaller** than men because of greater width of female pelvis

- A pathological increase in the medial angulation between the neck and shaft is called coxa valga
- A pathological decrease is called coxa vara


Angle of inclination
125°
105°
140°
A Normal
B Coxa vara
C Coxa valga

- Coxa vara increases the congruency because of decreased angle between neck and shaft of femur .

- In coxa valga, contact of femoral head with acetabulum is reduced. It decreases stability of hip joint.

Increased angle bring **vertical weight bearing line closer to the shaft of the femur**

Reduction in force across the femoral neck

Reduces density of lateral trabecular system.

- Both coxa vara and coxa valga can lead to abnormal lower extremity biomechanics altered muscle function,and gait abnormalities

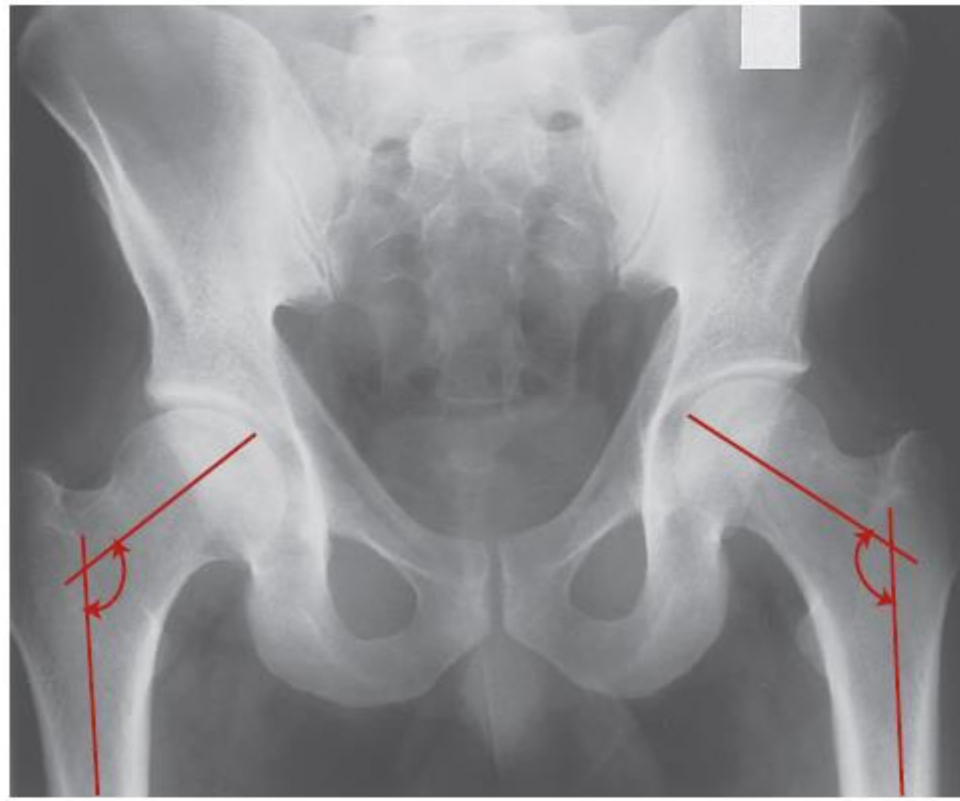


Figure 10–5 The axis of the femoral head and neck forms an angle with the axis of the femoral shaft called the *angle of inclination*. In this adult subject without impairments, the angles are slightly less than 130°, with a couple of degrees of variation from side to side.

2.ANGLE OF TORSION OF THE FEMUR

- The angle of torsion of the femur can best be viewed by looking down the length of the femur from top to bottom.
- An axis through the femoral head and neck in the transverse plane will lie at an angle to an axis through the femoral condyles with the head and neck torsioned anteriorly with regard to the femoral condyles

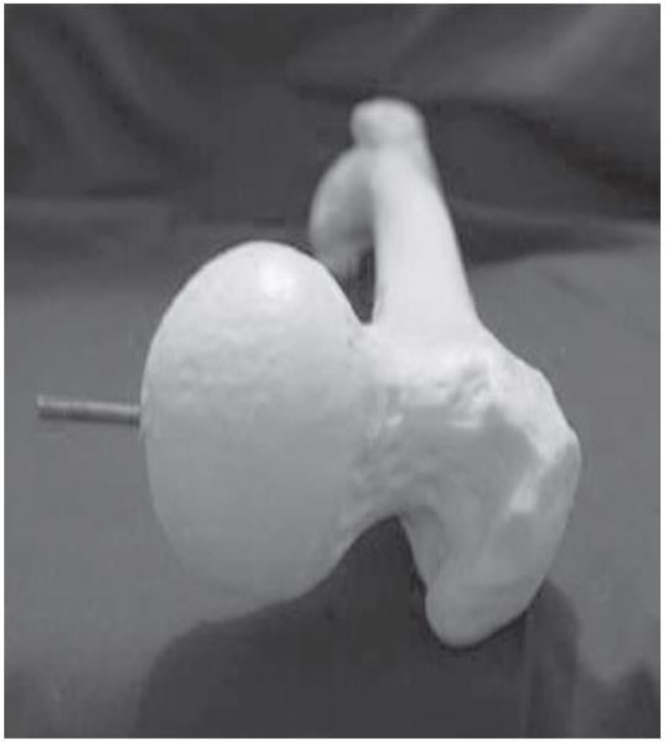


Figure 10–7 A line parallel to the posterior femoral condyles and a line through the head and neck of the femur normally make an angle with each other that averages 10° to 20° in the adult without impairments. The femoral head and neck are in torsion anteriorly (medially) with respect to the femoral condyles.

- Normal angulation
  - in males -15
  - in females-18
  - infants -30-40

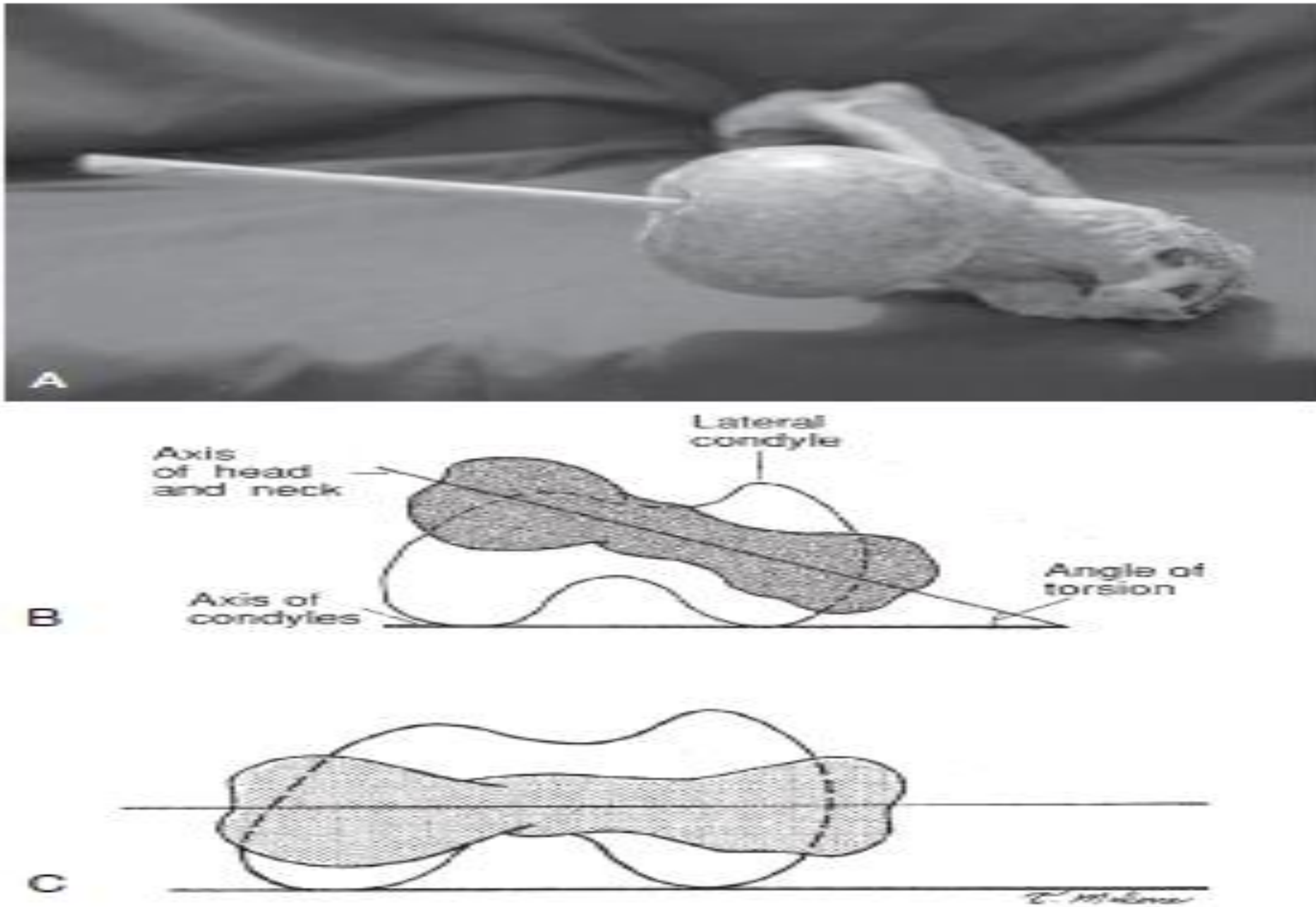


Figure 10–8 Angles of torsion in a right femur. **A.** An angle of torsion within normal limits. **B.** A pathological increase in the angle of torsion is called anteversion. **C.** A pathological decrease in the normal angle of torsion is called retroversion.

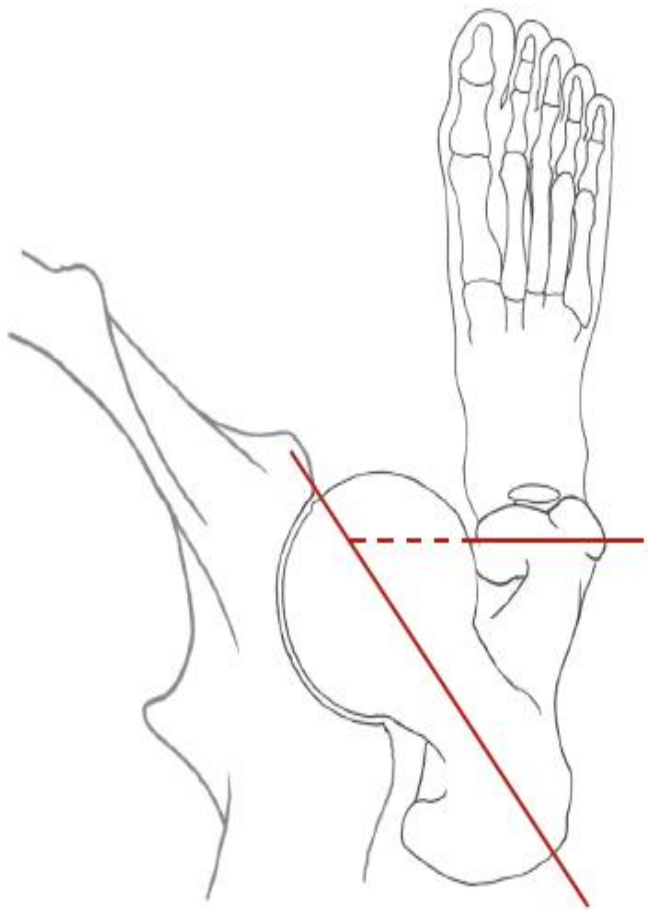
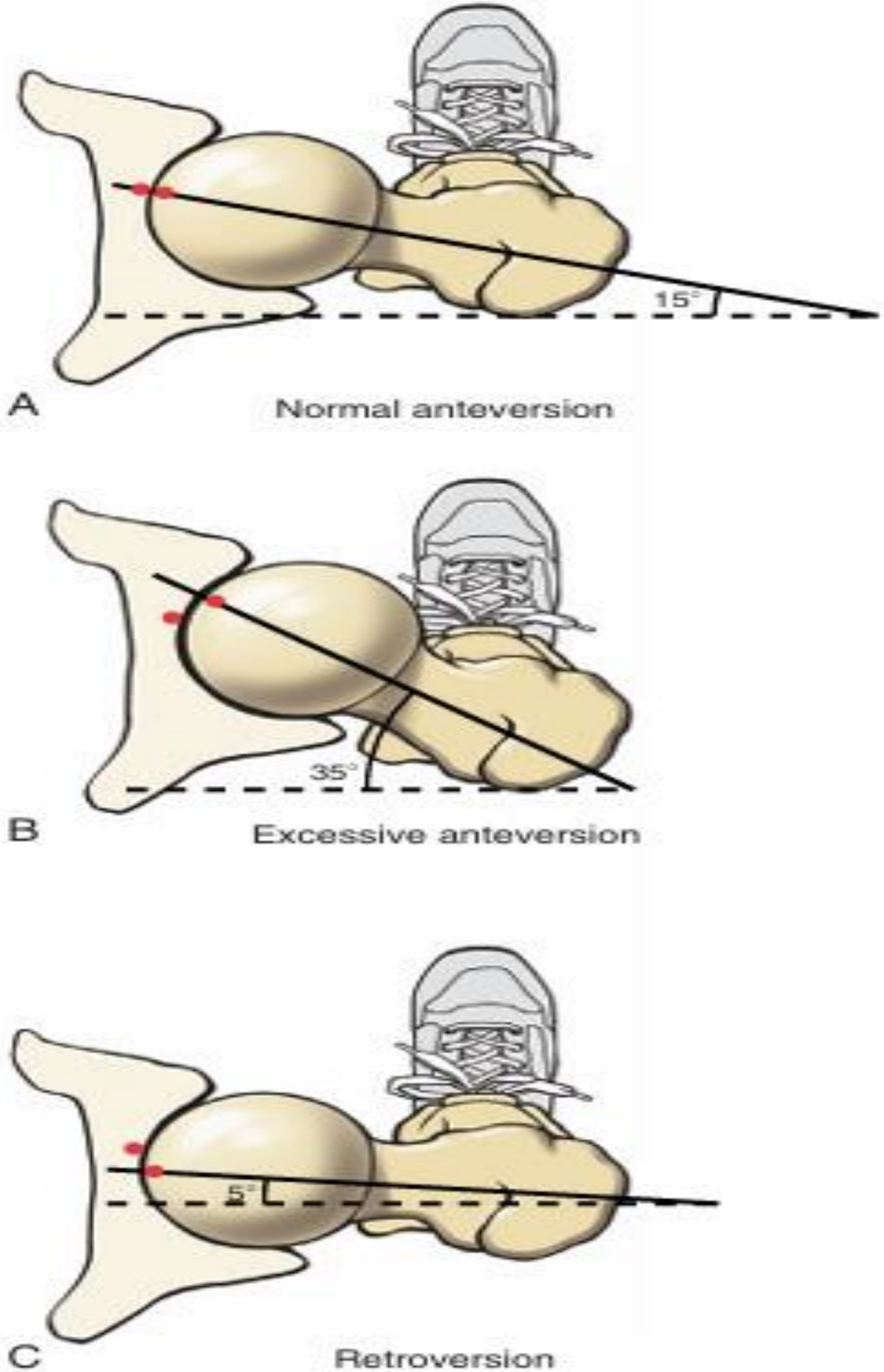
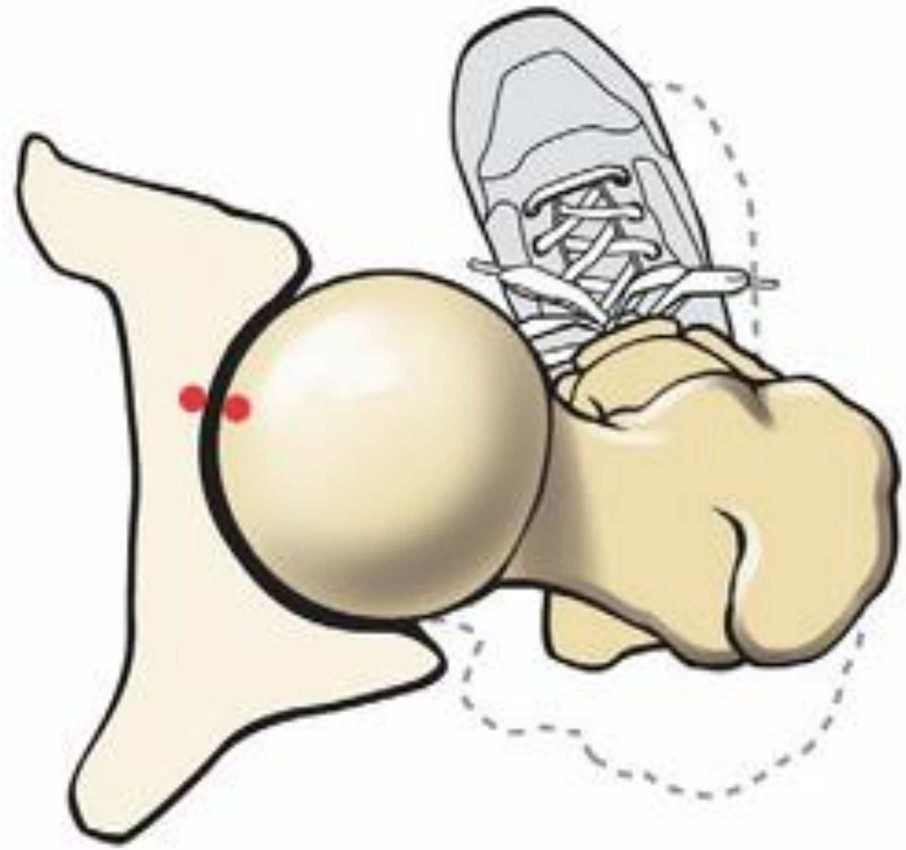


Figure 10–9 In the supine position with the femoral condyles parallel to the supporting surface, the anteverted femoral head is exposed anteriorly. Lateral rotation will be limited, but medial rotation is relatively excessive.

- Normally, as viewed from above, the femoral neck projects about 15 degrees anterior to a medial-lateral axis through the femoral condyles.
- This degree of torsion is called normal **anteversion .**
- Torsion significantly greater than 15 degrees is called **excessive anteversion**.
- Torsion significantly less than 15 degrees is called **retroversion**


15°
A
Normal anteversion
35°
B
Excessive anteversion
5°
C
Retroversion

- Excessive anteversion may be associated with an abnormal gait pattern called **"in-toeing."**
- **Individual internally rotate hip in case of excessive anteversion to align hip optimaly during standing/ walking and display intoeing.**
- Excessive femoral anteversion of 25 to 45 degrees is common in persons with cerebral palsy



B Excessive anteversion with “in-toeing”

ARTICULAR CONGRUENCE

- In the neutral or standing position, the articular surface of the femoral head remains exposed anteriorly and somewhat superiorly

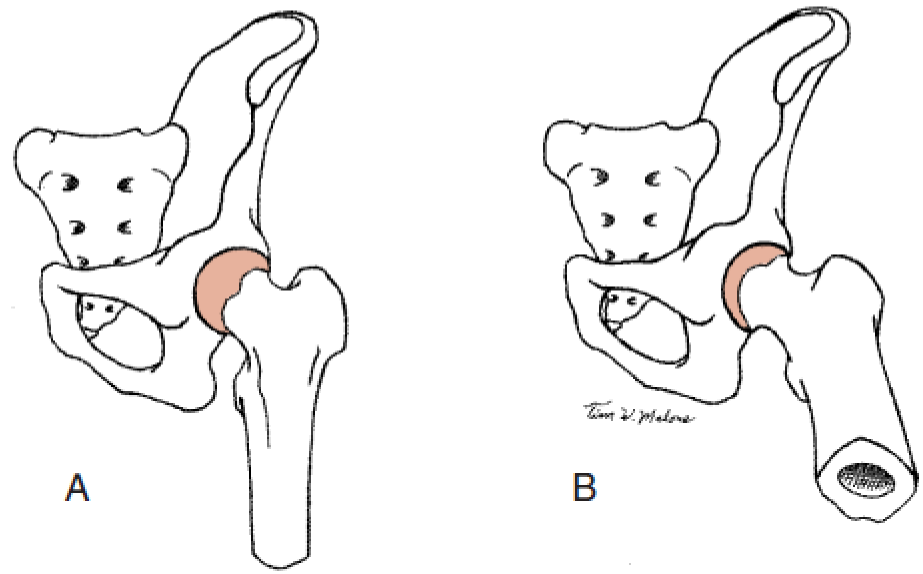
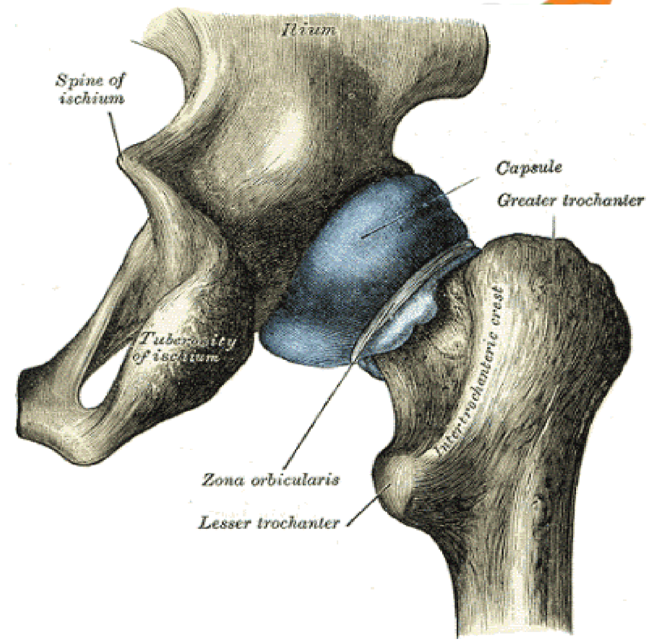


Figure 10–11 In the neutral hip joint, articular cartilage from the head of the femur is exposed anteriorly and, to a lesser extent, superiorly. Maximum articular contact of the head of the femur with the acetabulum is obtained when the femur is flexed, abducted, and laterally rotated slightly.

- Maximum Articular contact between the femur and the acetabulum is obtained by a combination of flexion, abduction, and slight lateral rotation

HIP JOINT CAPSULE



Contribute joint stability

Capsule- irregular, dense fibrous structure with longitudnal and oblique fibers.

capsule

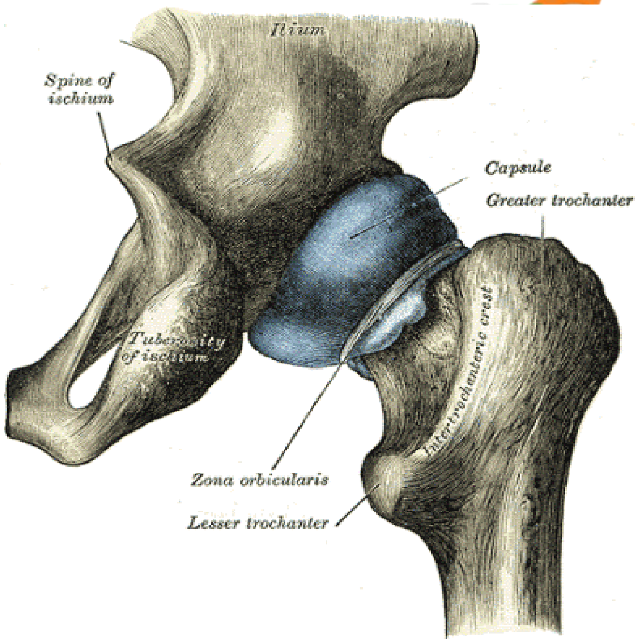
- Circular fibers(Zona orbicularis)
- Longitudnal fibers

- Zona orbicularis:
- forms tight ring just below the femoral head.
- Primary stability of hip joint during distractive force.

- Capsule is thicker- anterosuperiorly- where greatest stress occurs.
- Thin-and loose- posteroinferiorly.
- Capsule covers femoral head and neck but not the greater and lesser trochanter.
- Deep inside the capsule carries blood vessels

HIP JOINT CAPSULE

- Both joint capsule and ligamentum teres provide stability of the hip joint during distractive forces



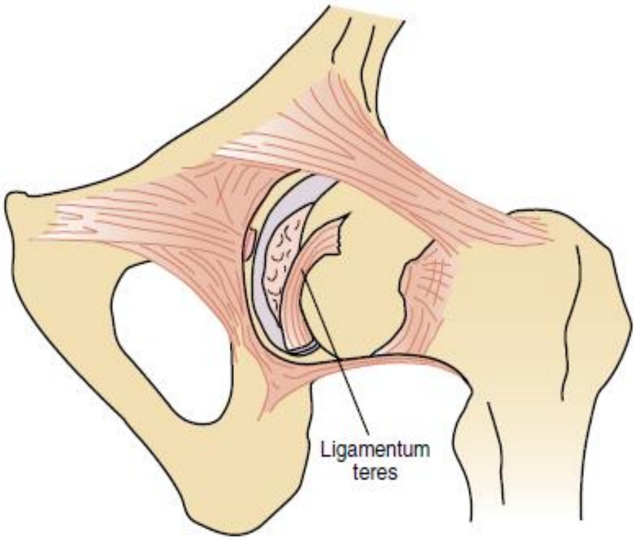


Figure 10–13 Anterior view of a right hip shows the centrally located ligamentum teres arising from the fovea on the femoral head. The joint capsule and other structures have been removed.

HIP JOINT LIGAMENTS

- Iliofemoral ligament(Y ligament of Bigelow)
- Pubofemoral ligament
- Ischiofemoral ligament

<u>Iliofemoral ligament</u> <u>(Y ligament/</u> **<u>ligament of bigelow).</u>**

- From anterior inferior iliac spine to inter trochanteric line with 2 slips.
- Taut in hip hyper extension.

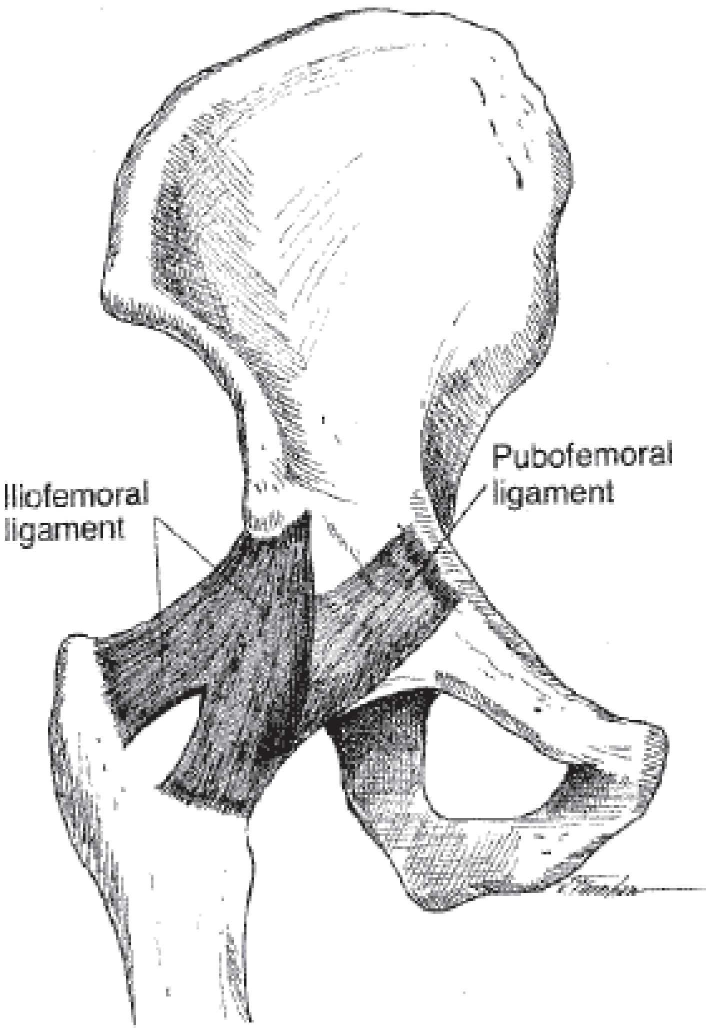


Figure 10–14 Anterior view of the right hip joint shows the two bands of the iliofemoral (Y) ligament and the more inferiorly located pubofemoral ligament.

- **Pubofemoral ligament:**
- From superior pubic ramus to anerior and inferior rim of the acetabulum.
- Taut in hip abduction and hyperextension.

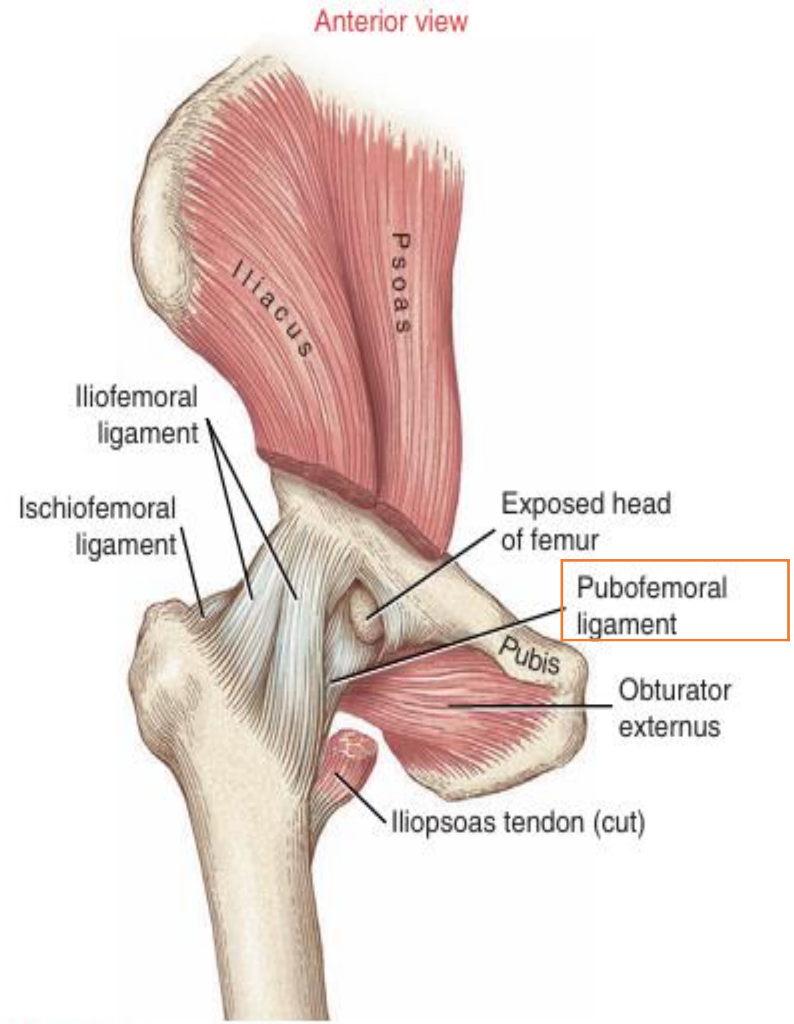


FIGURE 12-14. The anterior capsule and ligaments of the right hip. The iliopsoas is cut to expose the anterior side of the joint. Note that part of the femoral head protrudes just medial to the iliofemoral ligament. This region may be covered by a bursa.

- Ischiofemoral ligament:
- From posterior and inferior rim of the acetabulum to greater trochanter of femur.
- Taut in hip full internal rotation and hyperectension

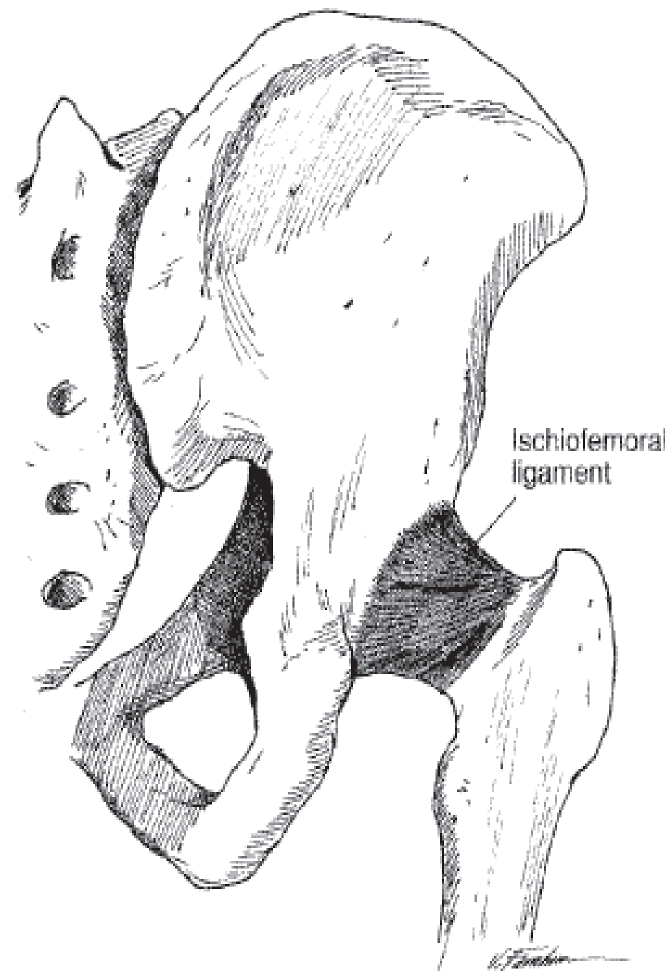


Figure 10–15 Posterior view of a right hip joint shows that the spiral fibers of the ischiofemoral ligament are tightened during hyperextension and therefore limit hyperextension.

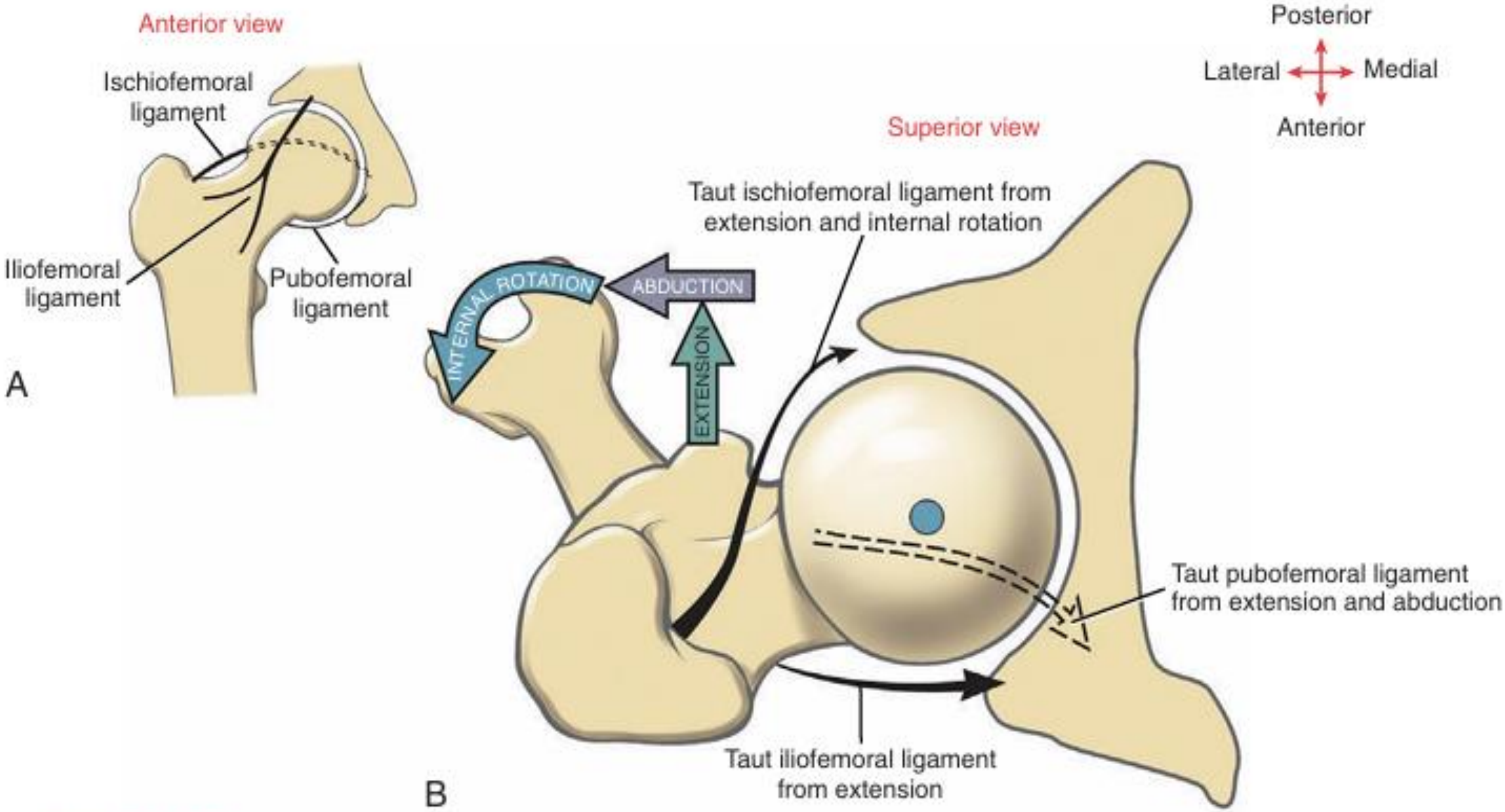


FIGURE 12-17. **A,** The hip is shown in a neutral position, with all three capsular ligaments identified. **B,** Superior view of the hip in its close-packed position (i.e., fully extended with slight abduction and internal rotation). This position elongates at least some component of all three capsular ligaments.

STRUCTURAL ADAPTATIONS TO WEIGHT BEARING

- In standing at least half the weight of the HAT passes down through the pelvis to the femoral head, whereas the ground reaction force (GRF) travels up the shaft.

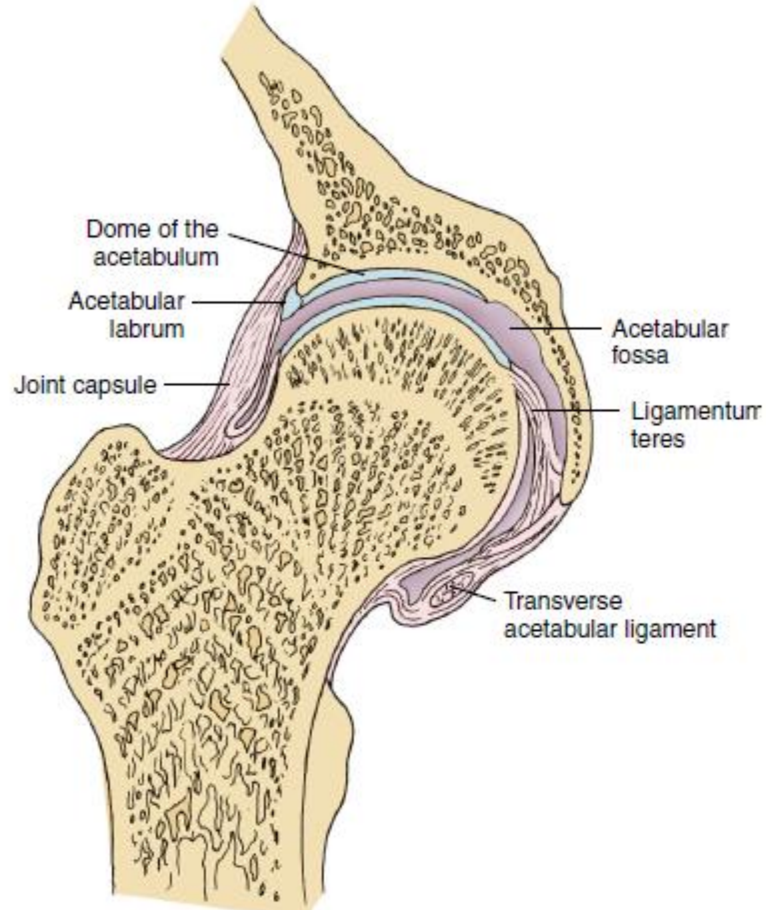


Figure 10–16 The trabeculae of the femur line up along lines of stress in the cancellous bone and can be seen on cross-section.

- These two forces, nearly parallel and in opposite directions, create a force couple with a moment arm
- (MA) equal to the distance between the superimposed body weight on the femoral head and the GRF up the shaft.
- These forces creates a compressive force near medial side and tensile force near lateral side.

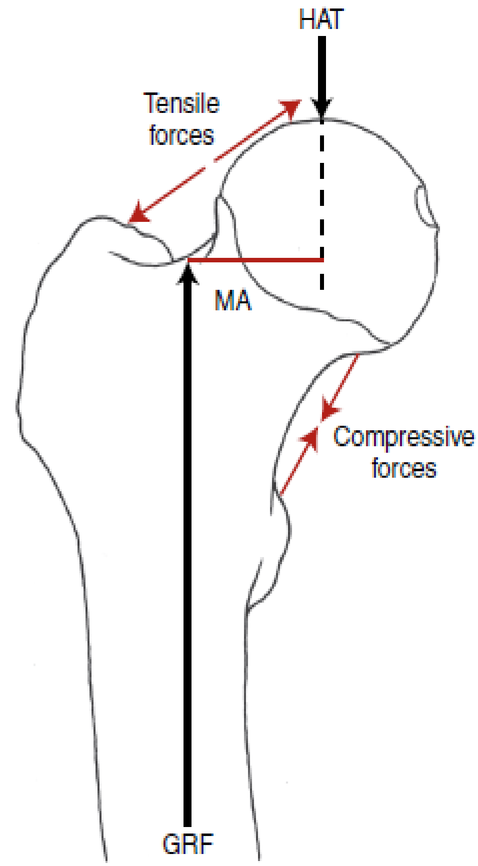


Figure 10–17 The weight-bearing line of the head, arms, and trunk (HAT) loads the head of the femur, whereas the ground reaction force (GRF) comes up the shaft of the femur, resulting in a force couple that creates a bending moment, with a moment arm (MA) that is dependent on the length and angle of the neck of the femur. The bending moment creates tensile stress on the superior aspect of the femoral neck and compressive stress on the inferior aspect.

Trabecular system

- It is the calcified plate of tissue within the cancellous bone.
- Function is to accommodate the mechanical stress and strains created by transmission of forces between femur and pelvis.

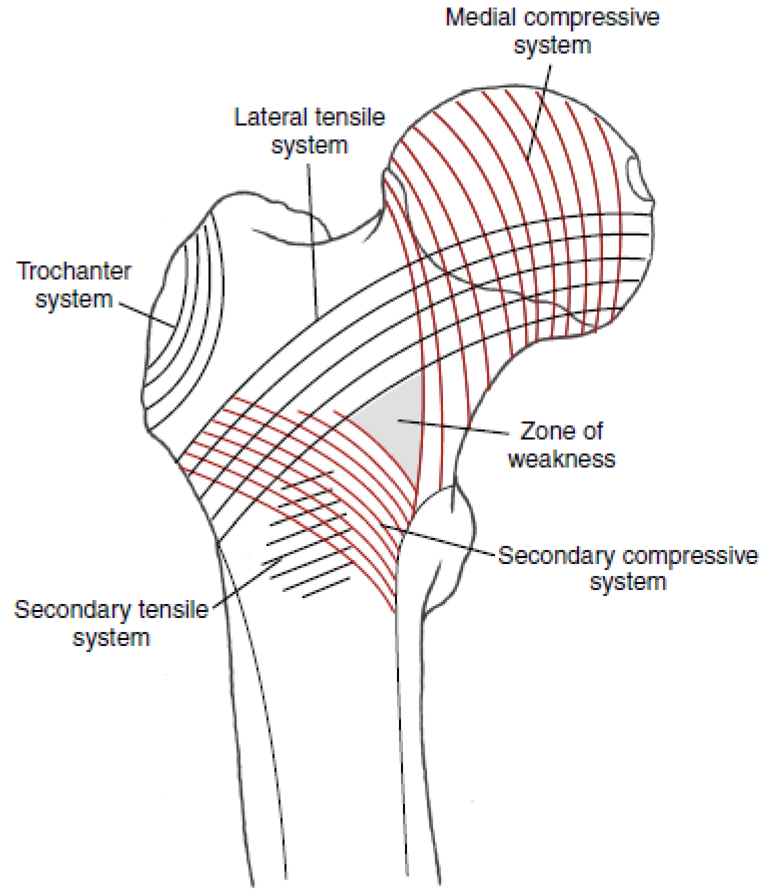


Figure 10–18 Two major (the medial compressive and lateral tensile) trabecular systems show the primary transmission of forces. Additional lines of stress are evident at the secondary compressive and tensile systems and at the trochanteric system.

Trabecular system

- The medial (compressive) trabecular system
- The lateral (tensile) trabecular system
- Accessory (secondary) trabecular systems
- zone of weakness

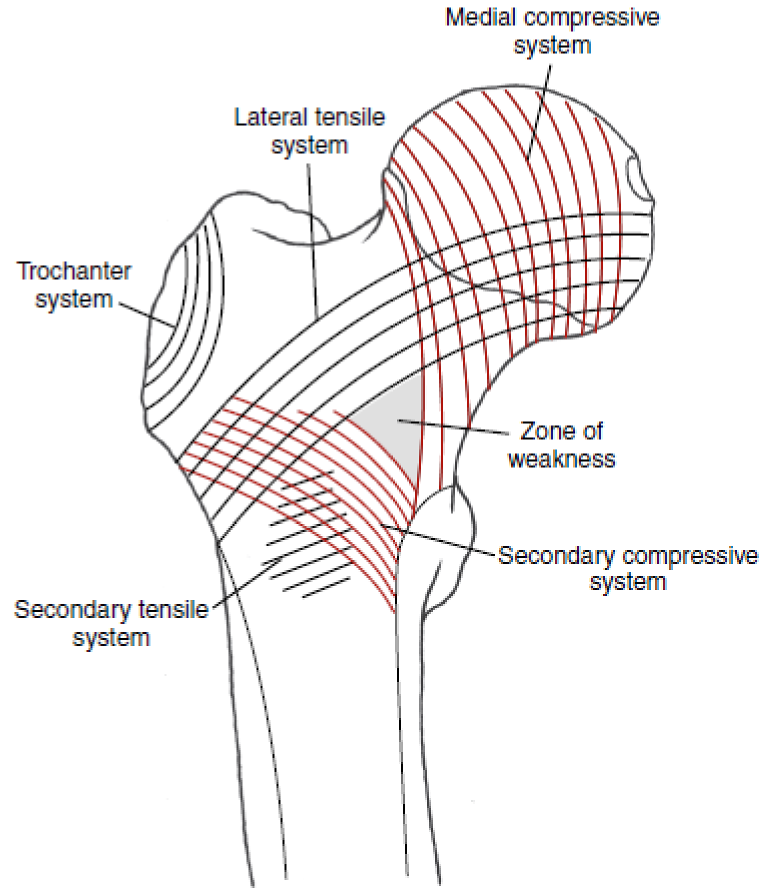


Figure 10–18 Two major (the medial compressive and lateral tensile) trabecular systems show the primary transmission of forces. Additional lines of stress are evident at the secondary compressive and tensile systems and at the trochanteric system.

- Medial trabecular system:
- From medial cortex of upper femoral shaft to superior aspect of femoral head.
- It is oriented along the vertical compressive force through the hip joint.
- Lateral trabecular system:
- Arise from lateral side of upper femoral shaft crossing the medial side, to the inferior aspect of head of femur.

- The area in which trabecular system cross each other at right angles are area that offer greater resistance to stress and strain.
- Zone of weakness:
- Area that is suspectable to bending forces ,risk of fracture.

- The forces of HAT and the ground reaction force that act on the articular surfaces of the hip joint and on the femoral head and neck also act on the femoral shaft

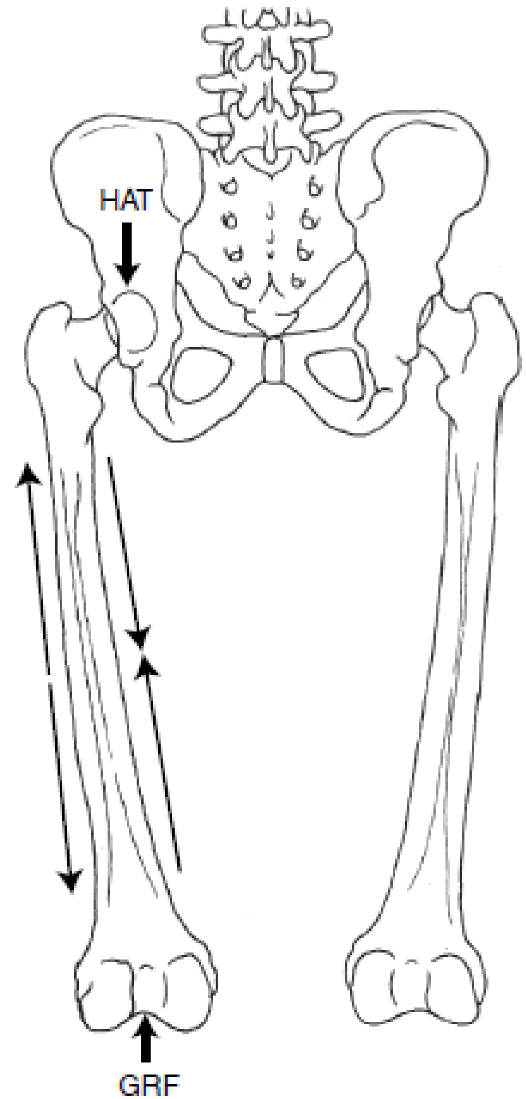
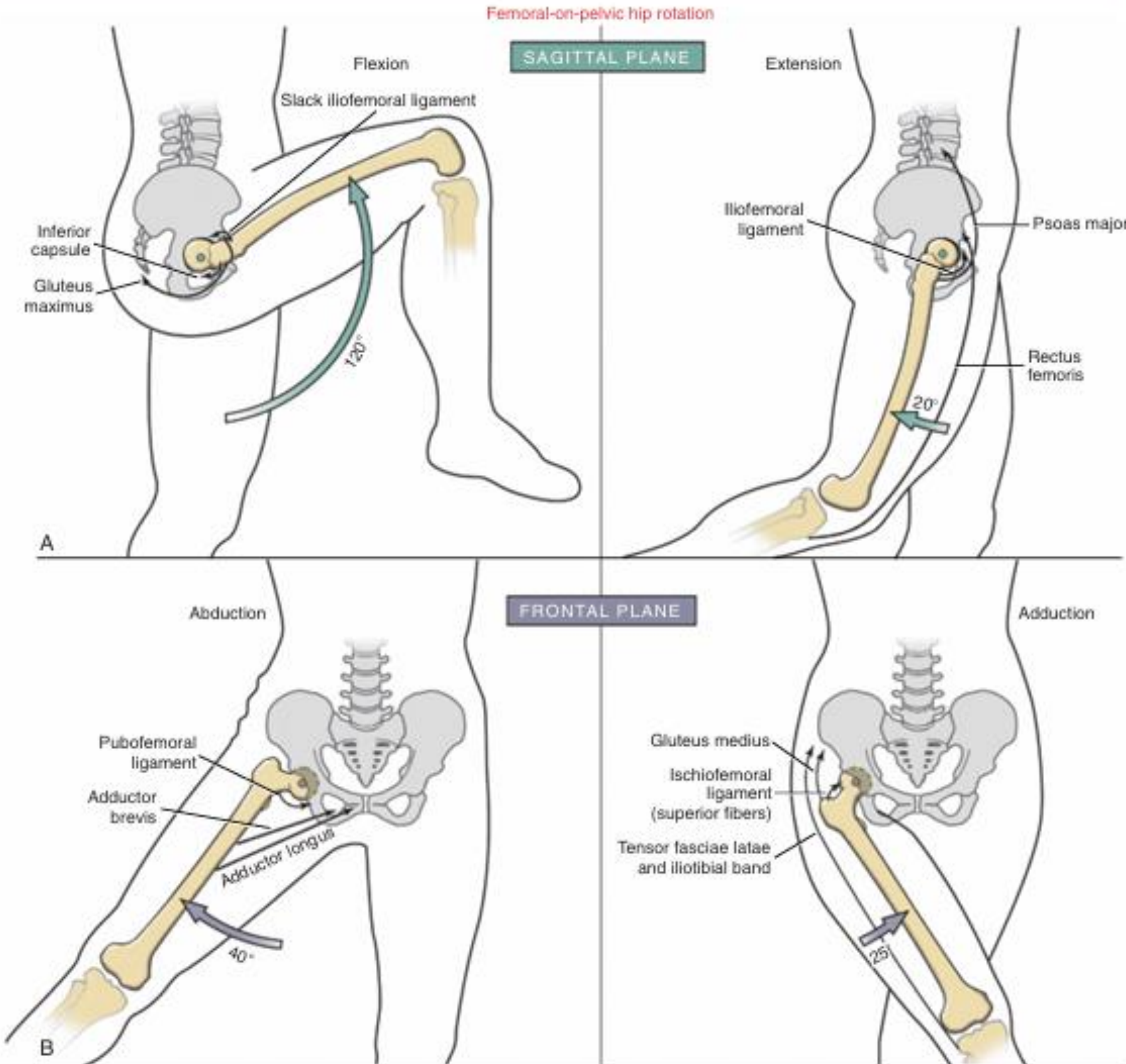


Figure 10–19 The weight-bearing line (HAT) from the center of rotation of the femoral head and the ground reaction force (GRF) causes a bending force on the shaft of the femur that results in compressive forces medially and tensile forces laterally.

Osteokinematics

(a) Motion of femur on acetabulum:

- Flexion/ extension
- Abduction/ adduction
- Medial/ lateral rotation.



Femoral-on-pelvic hip rotation
SAGITTAL PLANE
Flexion
Slack iliofemoral ligament
Inferior capsule
Gluteus maximus
120°
A
Extension
Iliofemoral ligament
Psoas major
Rectus femoris
20°
FRONTAL PLANE
Abduction
Pubofemoral ligament
Adductor brevis
Adductor longus
40°
B
Adduction
Gluteus medius
Ischiofemoral ligament (superior fibers)
Tensor fasciae latae and iliotibial band
25°

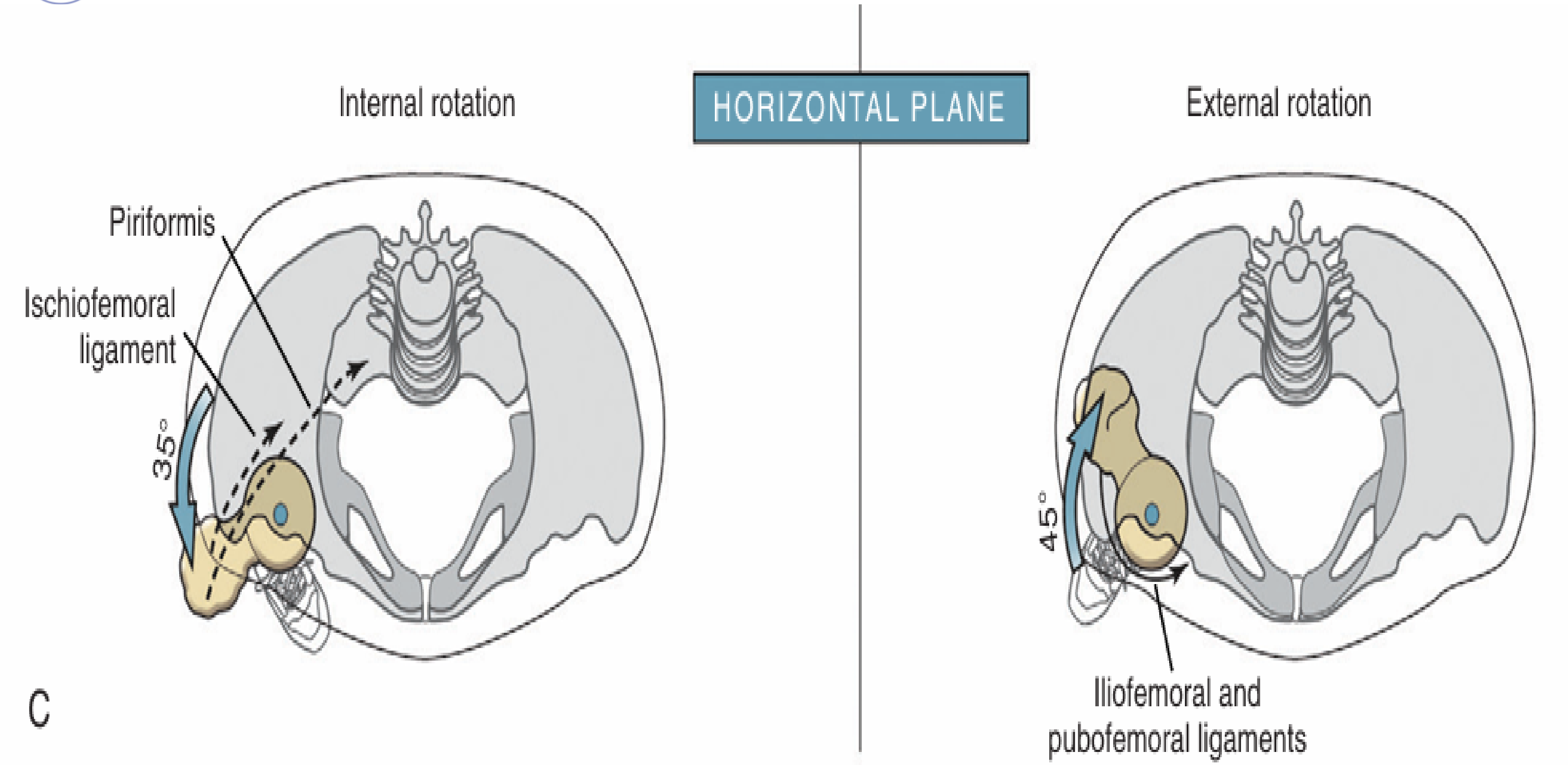
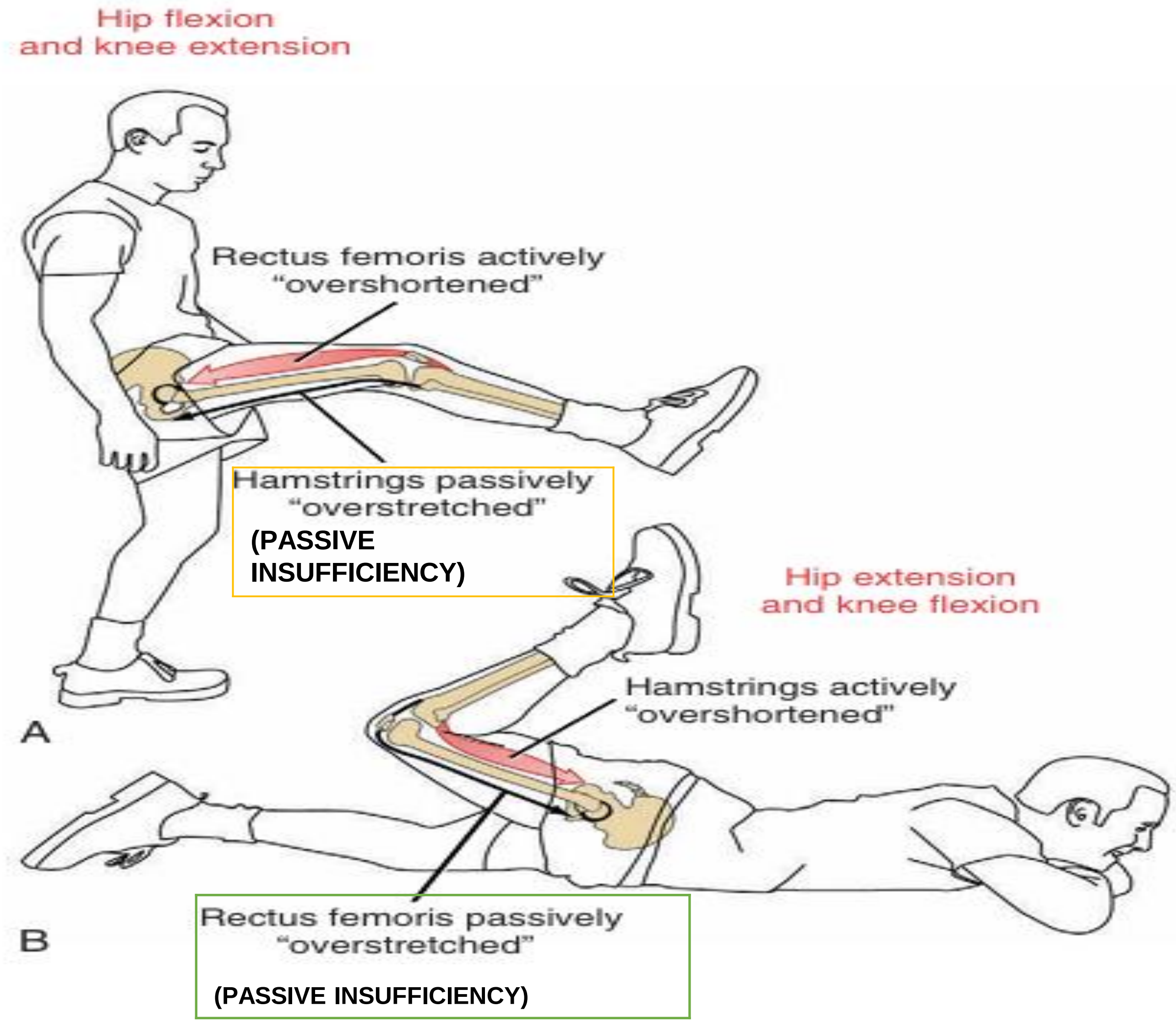


FIGURE 12-20. The near maximal range of *femoral-on-pelvic* (hip) motion is depicted in the sagittal plane **(A)**, frontal plane **(B)**, and horizontal plane **(C)**. Tissues that are elongated or pulled taut are indicated by straight black or dashed black arrows. Slackened tissue is indicated by a wavy black arrow.

- Flexion of hip, with **knee flexed- 0-120 degree.**
- Flexion of hip **with knee extended – 0-90 degree.**
- **With knee flexed the ROM is reduced because of the passive insufficiency of hamstrings.**

- **Extension of hip with knee flexed- ROM is less,** because of passive insufficiency of two joint **rectus femoris muscle.**
- Extension of hip with knee extended increased ROM.


Hip flexion
and knee extension
Rectus femoris actively
"overshortened"
Hamstrings passively
"overstretched"
(PASSIVE
INSUFFICIENCY)
A
Hip extension
and knee flexion
Hamstrings actively
"overshortened"
Rectus femoris passively
"overstretched"
(PASSIVE INSUFFICIENCY)
B

- Abduction 45-50 degree – limited by 2 joint gracilis.
- Adduction- 20-30 degree – limited by tensor fascia lata and IT band.
- Internal and external rotation- ranges from 42-50 degree.

Osteokinematics

(b) Motion of pelvis on femur

- Whenever the hip joint is weight-bearing, the femur is relatively fixed, and motion of the hip joint is produced by movement of the pelvis on the femur

➢ **Anterior and Posterior Pelvic Tilt**

- sagittal plane
- coronal axis
- Posterior pelvic tilt- brings the symphysis pubis up and the sacrum of the pelvis closer to the femur.
- Anterior pelvic tilting - moves the anterior superior iliac spine anteriorly and inferiorly and the inferior sacrum moves farther from the femur

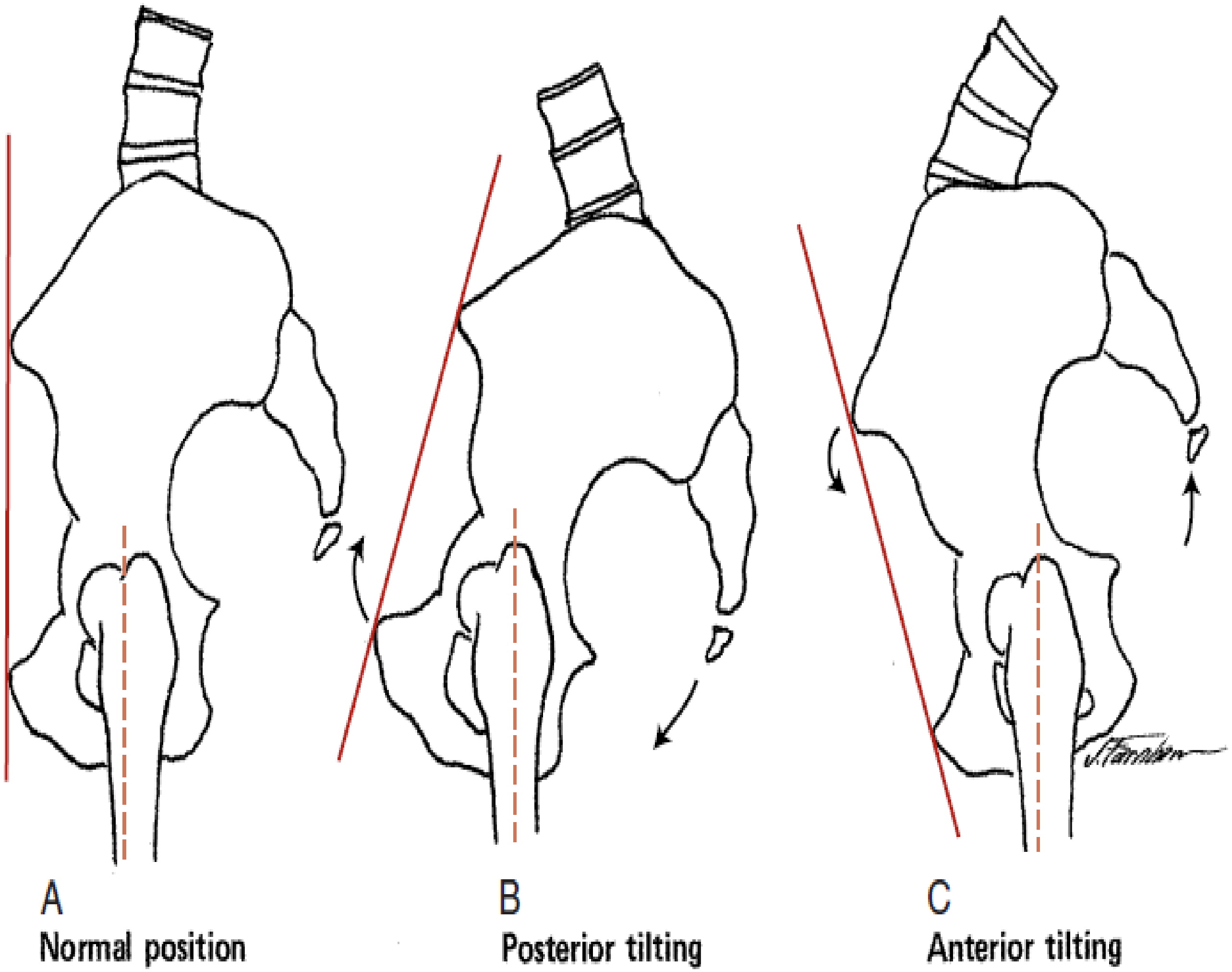


Figure 10–20 Flexion and extension of the hip occurring as tilting of the pelvis in the sagittal plane. **A.** The pelvis is shown in its normal position in erect stance. **B.** Posterior tilting of the pelvis moves the symphysis pubis superiorly on the fixed femur. The hip joint extends. **C.** In anterior tilting, the anterior superior iliac spines move inferiorly on the fixed femur. The hip joint flexes.

➢ <u>**Lateral Pelvic Tilt**</u>

- Lateral pelvic tilt is a frontal plane motion.
- anteroposterior axis
- In the normally aligned pelvis, a line through the anterior superior iliac spines is horizontal

- <u>In lateral tilt of the pelvis in unilateral stance:</u>
- one hip joint (e.g., the left hip joint) is the pivot point or axis for motion of the opposite side of the pelvis (e.g., the right side) as that side of the pelvis elevates (pelvic hike) or drops (pelvic drop).

- If a person stands on the left limb and hikes the pelvis, the left hip joint is being abducted because the medial angle between the femur and a line through the anterior superior iliac spines increases.
- If a person stands on the left leg and drops the pelvis, the left hip joint will adduct because the medial angle formed by the femur and a line through the anterior superior iliac spines will decrease

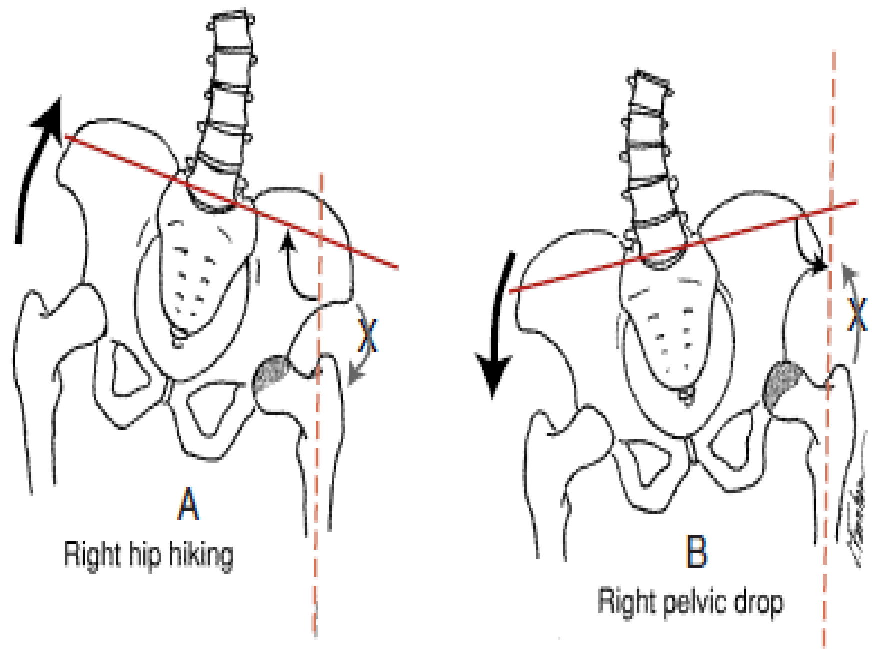


Figure 10–21 Lateral tilting of the pelvis around the left can occur either as hip hiking (elevation of the opposite side of the pelvis) or as pelvic drop (drop of the opposite side of the pelvis). **A.** Hiking of the pelvis around the left hip joint results in left hip abduction. **B.** Dropping of the pelvis around the left hip joint results in left hip joint adduction. Although it is visually tempting to name the direction of lateral tilt by the motion of the side of the pelvis *nearest* the hip (gray arrows that are "crossed out"), this is incorrect.

➢ Lateral Shift of the Pelvis

- With **pelvic shift,** the pelvis cannot hike; it can only drop.
- If the pelvis is shifted to right the left side of the pelvis will drop , the right hip will be adducted and left hip will be abducted.

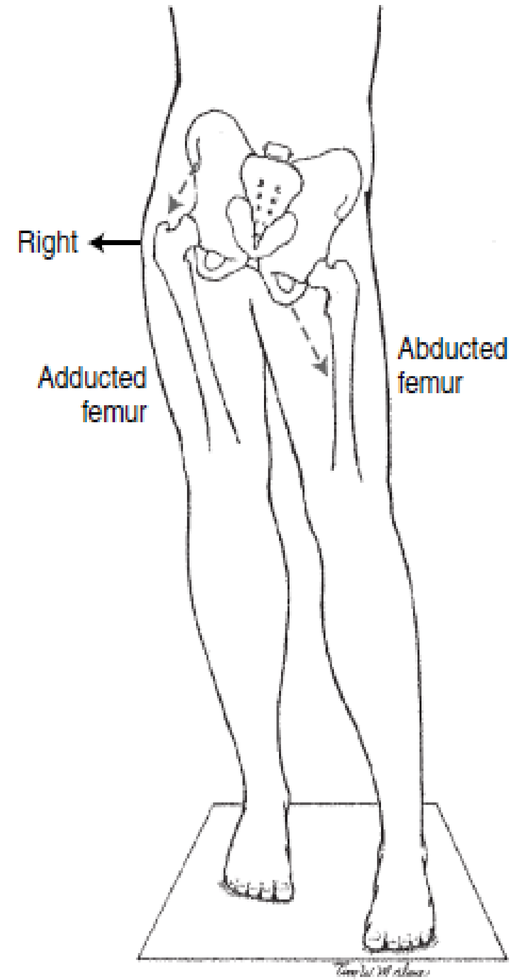


Figure 10–22 When the pelvis is shifted to the right in bilateral stance, the right hip joint will be adducted and the left hip joint will be abducted. To return to neutral position while continuing to bear weight on both feet, the right abductor and left adductor muscles work synergistically to shorten and shift the weight back to center.

- Forward and Backward Pelvic Rotation:
- Pelvic rotation is motion of the entire pelvic ring in the transverse plane around a vertical axis.

- Forward (anterior) rotation of the pelvis occurs in unilateral stance when the side of the pelvis opposite to the weight-bearing hip joint moves anteriorly from the neutral position.
- Forward rotation of the pelvis produces medial rotation of the weight-bearing hip joint

- **Backward (posterior) rotation of the pelvis** occurs when the side of the pelvis opposite the weight-bearing hip moves posteriorly
- Backward rotation of the pelvis produces lateral rotation of the supporting hip joint

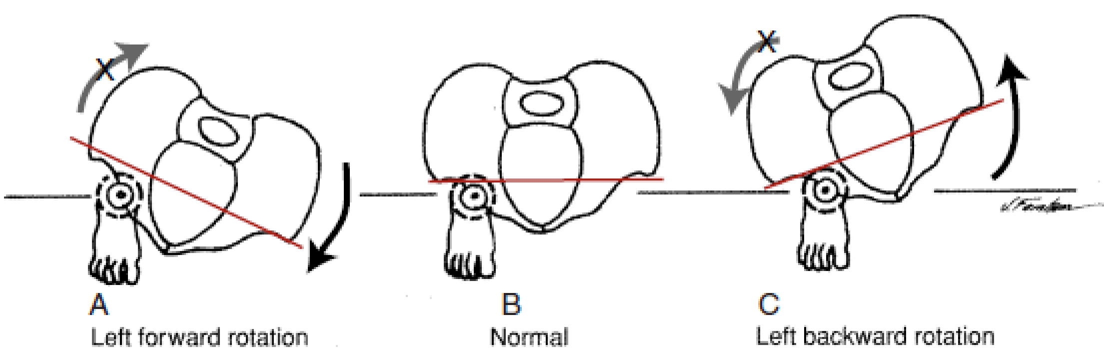


Figure 10–23 A superior view of rotation of the pelvis in the transverse plane. **A.** Forward rotation of the pelvis around the right hip joint results in medial rotation of the right hip joint. **B.** Neutral position of the pelvis and the right hip joint. **C.** Backward rotation of the pelvis around the right hip joint results in lateral rotation of the right hip joint. The reference for forward and backward rotation is the side *opposite* the supporting hip, although the eye often erroneously catches the opposite motion of the pelvis on the same side (gray crossed-out arrows).

Coordinated Motions of the Femur,Pelvis, and Lumbar Spine

➢ Pelvifemoral Motion

- When the femur, pelvis, and spine move in a coordinated manner to produce a larger ROM than is available to one segment alone, the hip joint is participating in what will predominantly be an open-chain motion termed pelvifemoral motion.
- Also been referred to as pelvifemoral rhythm

▫Moving the head and arms through space

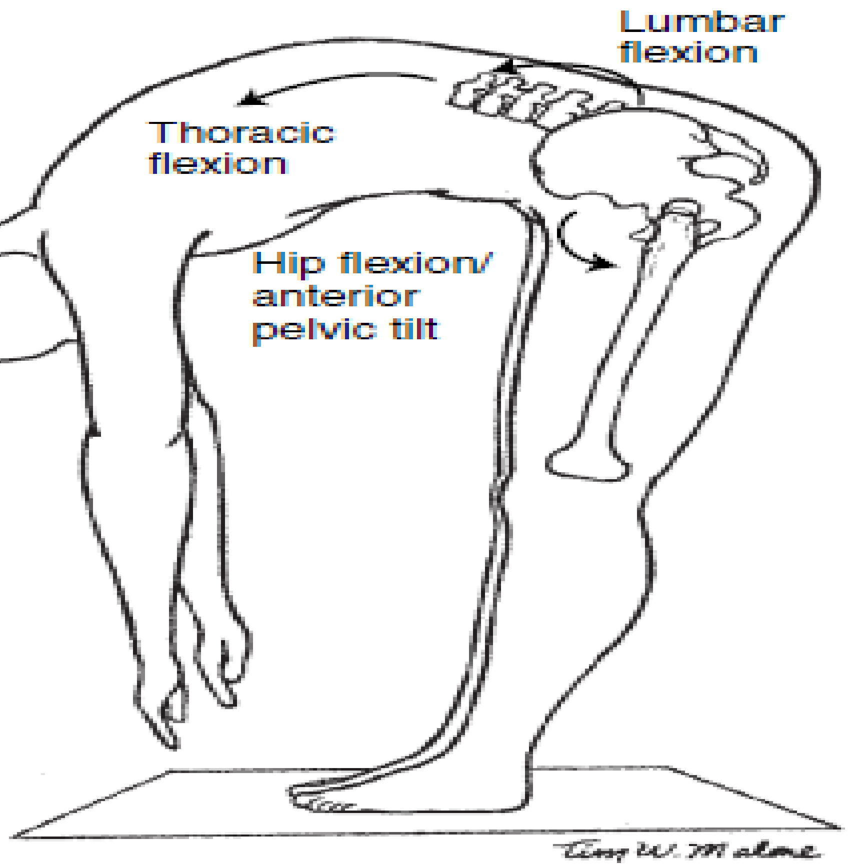


Figure 10–25 Pelvifemoral motion can increase the range of forward flexion of the head and arms by combining hip flexion, anterior pelvic tilt, and flexion of the lumbar spine. This combination permits the hands to maximize the reach toward the ground.

- ❑Moving the foot through space

- ✓When a person is lying on the right side, the left foot may be moved through an arc of motion approaching 90°
- ✓The abducting limb is in an open chain

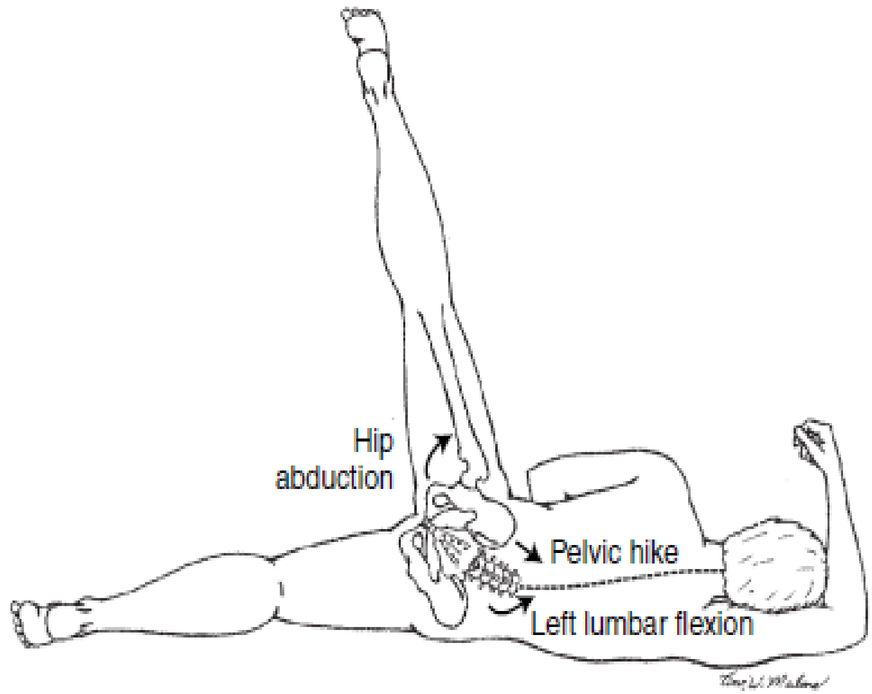


Figure 10–26 Pelvifemoral motion increases the range through which the foot can be moved in space by combining left hip abduction, lateral pelvic tilt (left hike), and flexion of the lumbar spine to the left.

- Compensatory motions of the lumbar spine that accompany given motions of the pelvis and hip joint in a functional closed chain

Table 10-1 Relationship of Pelvis, Hip Joint, and Lumbar Spine During Right Lower Extremity Weight-Bearing and Upright Posture

PELVIC MOTION	ACCOMPANYING HIP JOINT MOTION	COMPENSATORY LUMBAR SPINE MOTION
Anterior pelvic tilt	Hip flexion	Lumbar extension
Posterior pelvic tilt	Hip extension	Lumbar flexion
Lateral pelvic tilt (pelvic drop)	Right hip adduction	Right lateral flexion
Lateral pelvic tilt (pelvic hike)	Right hip abduction	Left lateral flexion
Forward rotation	Right hip medial rotation	Rotation to the left
Backward rotation	Right hip lateral rotation	Rotation to the right

HIP JOINT FORCES AND MUSCLE FUNCTION IN STANCE

- **Bilateral Stance**

- The line of gravity falls just posterior to the axis for flexion/extension of the hip joint
- In the frontal plane during bilateral stance, the superincumbent body weight is transmitted through the sacroiliac joints and pelvis to the right and left femoral heads
- joint axis of each hip lies at an equal distance from the line of gravity of HAT
- The gravitational moment arms for the right hip(DR) and the left hip (DL) are equal

- Because the body weight (W) on each femoral head is the same (WR = WL), the magnitude of the gravitational torques around each hip must be identical
- **WR X DR =WL X DL**
- The gravitational torques on the right and left hips occur in opposite directions.
- The weight of the body acting around the right hip tends to drop the pelvis down on the left (right adduction moment), whereas the weight acting around the left hip tends to drop the pelvis down on the right (left adduction moment)

- These two opposing gravitational moments of equal magnitude balance each other, and the pelvis is maintained in equilibrium in the frontal plane without the assistance of active muscles

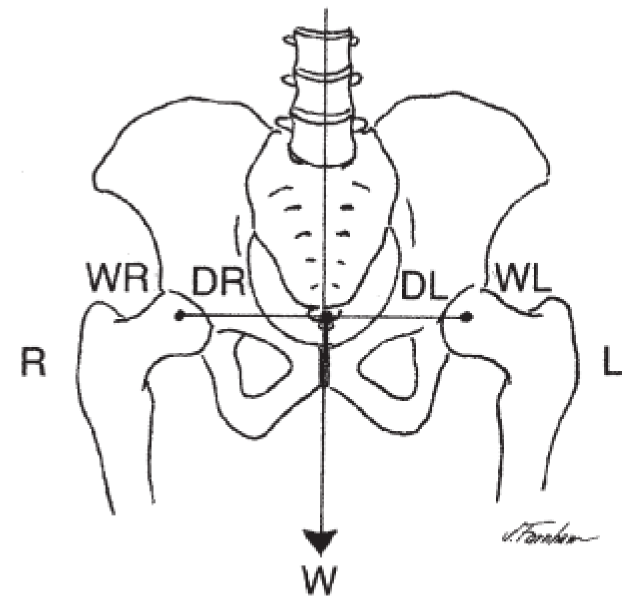


Figure 10–30 An anterior view of the pelvis in normal erect bilateral stance. The weight acting on the right hip joint (WR) multiplied by the distance from the right hip joint axis to the body's center of gravity (DR) is equal to the weight acting at the left hip joint (WL) multiplied by the distance from the left hip to the body's center of gravity (DL). Therefore, WR × DR = WL × DL.

Unilateral stance

- The left leg has been lifted from the ground and the full superimposed body weight (HAT) is being supported by the right hip joint.
- The weight of the non-weightbearing left limb that is hanging on the left side of the pelvis must be supported along with the weight of HAT by right hip joint.
- Of the one-third of the portion of body weight found in the lower extremities, the non-weightbearing limb must account for half of that, or one sixth of the full body weight

- The magnitude of body weight (W) compressing the right hip joint in right unilateral stance, therefore, is

- Right hip joint compressionbody weight =[2/3 x W] + [1/6 x W]= 5/6 x W

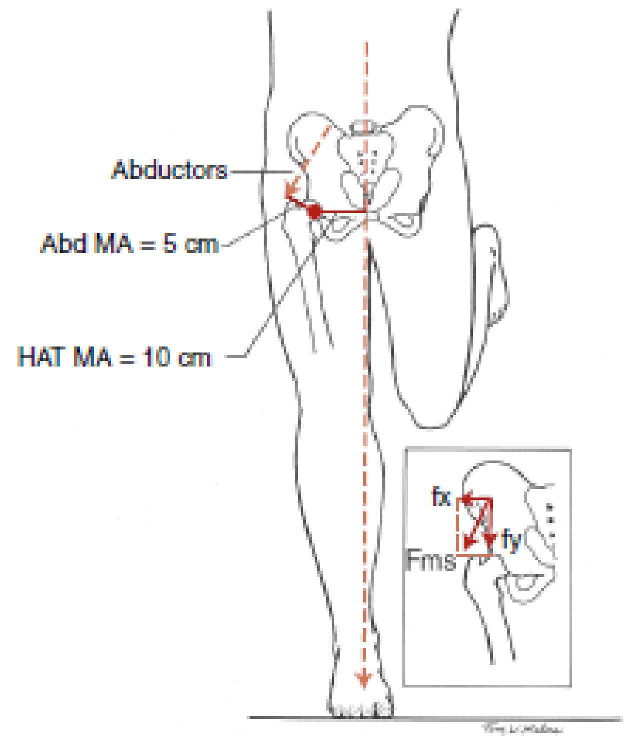


Figure 10–31 In right unilateral stance, the weight of HAT acts 10 cm from the right hip joint. The 10-cm moment arm slightly underestimates the location of the LoG because it does not account for the weight of the hanging left limb. The hip abductors have a moment arm of approximately 5 cm. Inset. The pull of the abductors (F_{ms}) on the horizontally oriented pelvis will resolve into a parallel component (Fx) that will pull the acetabulum into the center of the femoral head and a perpendicular component (Fy) that will pull the pelvis down on the superior aspect of the femoral head, as well as pull the ilium closer to the femur, producing a hip abduction torque.

- The force of gravity acting on HAT and the nonweightbearing left lower limb (HATLL) will create an adduction torque around the weight-bearing hip joint
- Gravity will attempt to drop the pelvis around the right weight-bearing hip joint axis.
- The abduction countertorque will have to be supplied by the hip abductor musculature
- The result will be joint compression or a joint reaction force that is a combination of both body weight and abductor muscular compression.

➢ Compensatory Lateral Lean of the Trunk

- the compensatory lateral lean of the trunk toward the painful stance limb will swing the line of gravity closer to the hip joint, thereby reducing the gravitational moment arm
- It does reduce the gravitational torque

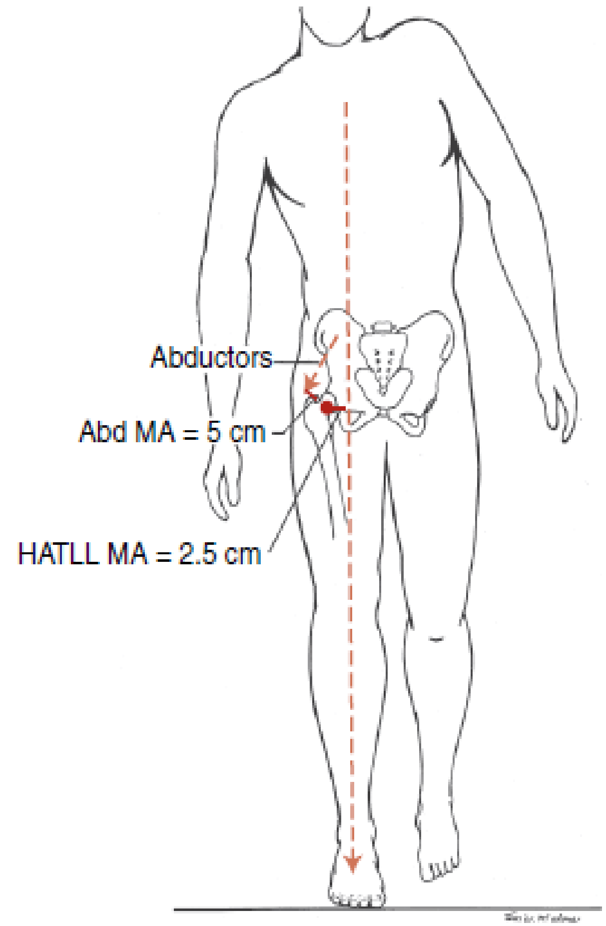


Figure 10–32 When the trunk is laterally flexed toward the stance limb, the moment arm of HATLL is substantially reduced (e.g., 2.5 cm, in comparison with 10 cm with the neutral trunk), whereas that of the abductors remains unchanged (e.g., 5 cm). The result is a substantially diminished torque from HATLL and, consequently, a substantially decreased need for hip abductor force to generate a countertorque.

➢ Use of a Cane Ipsilaterally

- Body wt passes mainly through cane

➢ Use of a Cane Contralaterally

- Cane assists the abductor muscles in providing counter torque

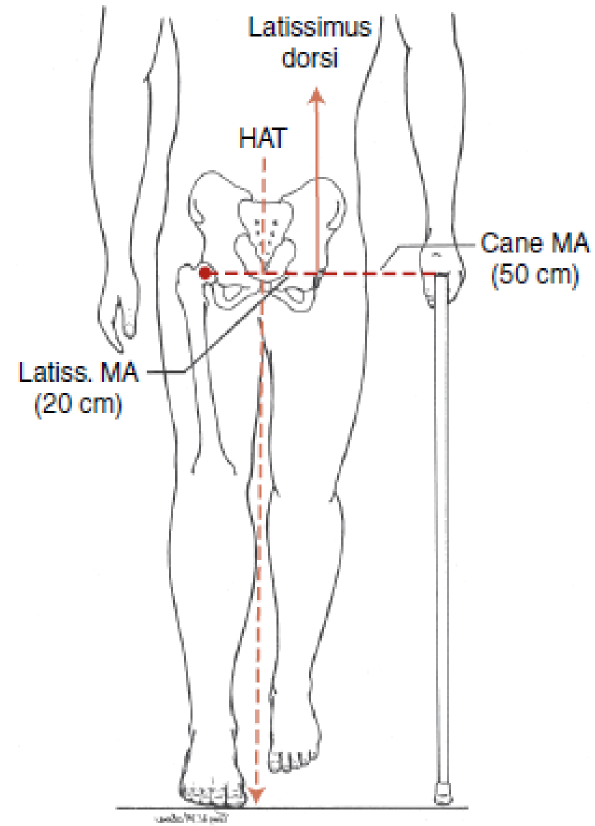


Figure 10–33 When a cane is placed in the hand opposite the painful supporting hip, the weight passing through the right hip is reduced, and activation of the left latissimus dorsi provides a countertorque to that of HATLL and diminishes the need for a contraction of the right hip abductors. The moment arm (MA) of the cane is erroneously estimated to be 50 cm, whereas the moment arm of the more relevant latissimus dorsi is estimated to be 20 cm.

➢ Pathological Gaits

- When a lateral trunk lean is seen during gait and is due to hip abductor muscle weakness, it is known as a gluteus medius gait
- If the same compensation is due to hip joint pain, it is known as an antalgic gait
- If lateral lean and pelvic drop occur during walking, the gait deviation is commonly referred to as a Trendelenburg gait

Femoroacetabular Impingement

➢ **Cam impingement**

- Pistolgrip deformity of the femoral neck

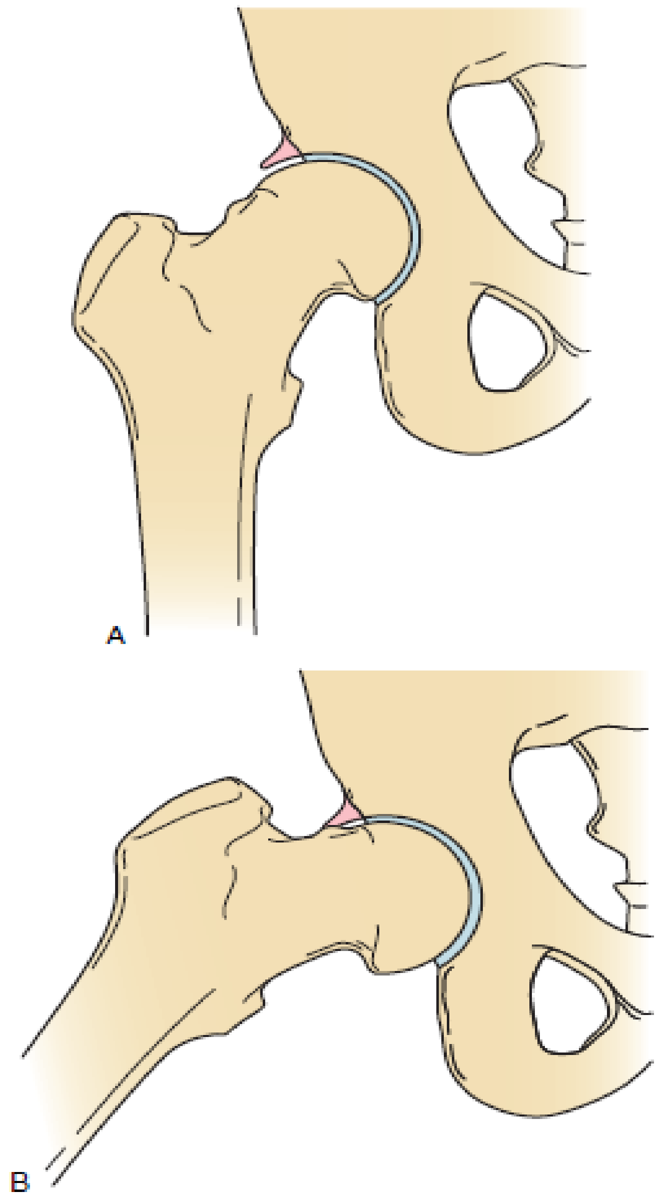


Figure 10–34 Cam impingement occurs as a result of an abnormal widening of the femoral neck (A) that leads to the abutment of the anterior superior labrum and the articular cartilage of the acetabulum during flexion or abduction of the hip (B).

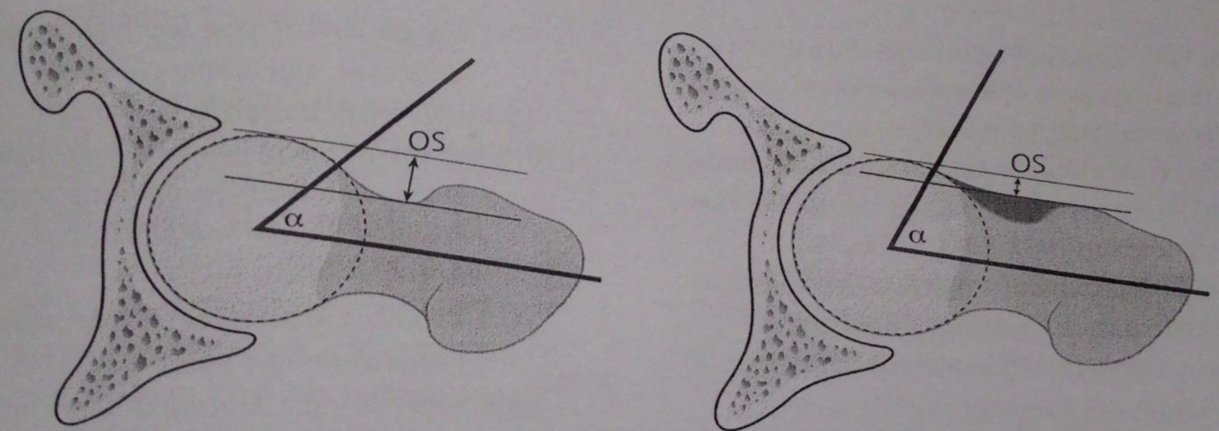


Figure 95.11 Radiographic abnormalities seen on axial imaging of the hip in cam-type femoroacetabular impingement. (a) Normal hip with α angle <55° and normal head–neck offset (OS). The α angle is the angle subtended between a line drawn from the centre of the femoral head along the long axis of the neck, and a line from the centre of the femoral head to the point where the neck protrudes anterior to a best fit circle drawn over the femoral head, i.e. the point where asphericity begins. OS is the difference between the anterior radius of the femoral head and the anterior radius of the femoral neck; less than 7 mm is abnormal. (b) Abnormal hip with an anterior neck bump demonstrating an increased α angle and reduced OS.

➢ **Pincer impingement**

- caused by aberrations of the acetabulum

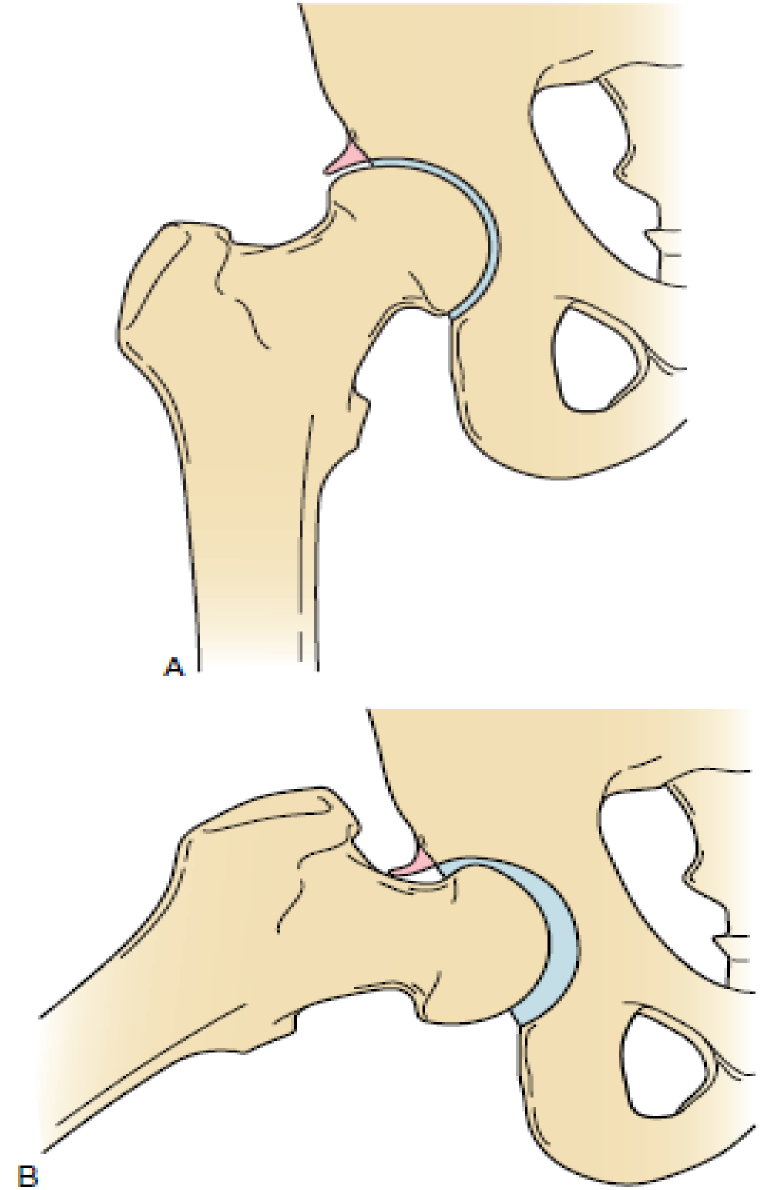


Figure 10–35 Pincer impingement occurs as a result of an overcoverage of the acetabulum on the femoral head (A), causing compression of the superior labrum between the acetabular rim and the femoral head-neck junction with flexion or abduction (B).

- Movements
- Flexion : chiefly by psoas major, iliacus

  assisted by rectus femoris and sartorius

- Adductor longus assists in early flexion following full extension
- Extension : gluteus maximus and the hamstrings.
- Abduction : gluteus medius and minimus

assisted by sartorius,tensor fasciae latae and piriformis

- Action is limited by adductor longus,pubofemoral ligament and medial band of ilio femoral ligament

- Adduction : by adductor longus, adductor brevis and adductor fibers of adductor magnus
- Lateral rotation : piriformis, obturator internus and externus, superior and inferior gemelli and quadratus femoris
  - assisted by the gluteus maximus
- Medial rotation : the anterior fibers of the gluteus medius and gluteus minimus, tensor fasciae latae
- Piriformis muscle was a lateral rotator at 0° of hip flexion but a medial rotator at 90° of hip flexion