Biomechanics of the Hip Joint

Anatomical considerations

Hip is a "ball & socket" joint - composed of _____ (socket) and _____ (ball). It is a very stable joint allowing a large range of motion in 3 planes. (Fig)

Acetabulum: _____ surface covered w/ articular cartilage which thickens peripherally. The cavity faces obliquely _____, _____, & _____

Femoral head: _____ surface 2/3 sphere with cartilage covering the surface, thickest on medial central surface and thinnest toward the periphery. This design results in different strengths and stiffnesses in different regions of the femoral head. This reflects the need to transmit differing stresses to different parts of the femur from the

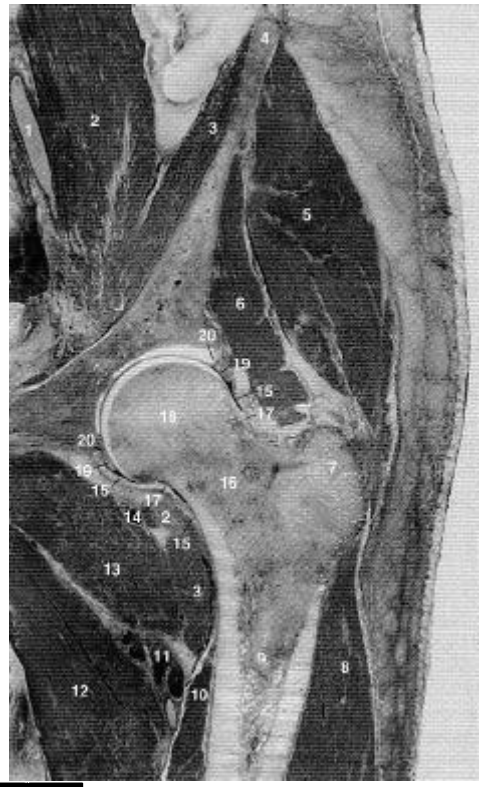


FIG. 8-1

The hip joint (front view) 1. External iliac artery. 2. Psoas major muscle. 3. Iliacus muscle. 4. Iliac crest. 5. Gluteus medius muscle. 6. Gluteus minimus muscle. 7. Greater trochanter. 8. Vastus lateralis muscle. 9. Shaft of femur. 10. Vastus medialis muscle. 11. Profunda femoris vessels. 12. Adductor longus muscle. 13. Pectineus muscle. 14. Medial circumflex femoral vessels. 15. Capsule of the hip joint. 16. Neck of femur. 17. Zona orbicularis of capsule. 18. Head of femur. 19. Acetabular labrum. 20. Rim of acetabulum. *Reprinted with permission from McMinn, R.H. & Huchings, R.H.R. (1988).* Color Atlas of Human Anatomy *(2nd ed., p. 302). Chicago: Year Book Medical Publishers, Inc.*

acetabulum through the femoral head to the femoral neck. The joint force is usually considered to act on the ____ portion of the femoral head.

Femoral Neck

_____ (angle of inclination)

(see Fig)

Normal: ___ coxa valga > ___

Coxa vara < ___ range of values ____

Women tend to have somewhat smaller angle than men.
As you get older, the angle tends to decrease

Why is femur designed this way?

This arrangement places femoral shaft away from the pelvis laterally – this allows a greater freedom of motion.

This arrangement also increases the moment arm of the hip abductor muscles (e.g. gluteus medius).

Q angle (quadriceps angle)

Q angle

typical ~ _ ?

women tend to have slightly greater Q angles than men (related to wider pelvis)

> _ is considered high

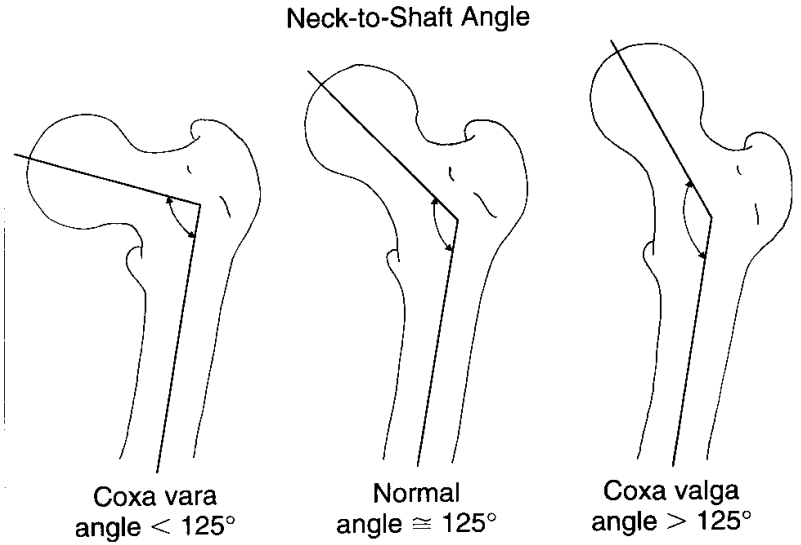
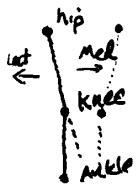


FIG. 8-4

The normal neck-to-shaft angle (angle of inclination of the femoral neck to the shaft in the frontal plane) is approximately 125°. The condition in which this angle is less than 125° is called coxa vara. If the angle is greater than 125°, the condition is called coxa valga.

Valgus & varus vs abduction & adduction

: the distal end of a segment is _____ lateral to the proximal end of a segment (expressed relative to a line created by the long axis of the next proximal segment) [For hip joint valgus = abduction]



_____ is just the opposite - like adduction

Angle of anteversion (_____)

(see Fig) also see attached figure from another text

Normal angle of torsion is ~ 12°

If > 12° condition is called _____ and tends to make the distal end of femur rotate medially (excessively) compared to the proximal end. This tends to show up in gait as an "internally rotated femur" in order to keep the femoral head securely in the acetabulum.

If < 12° : condition is called _____ and just the opposite occurs - the distal end of femur tends to be externally rotated during gait in order to keep femoral head secure in acetabulum.

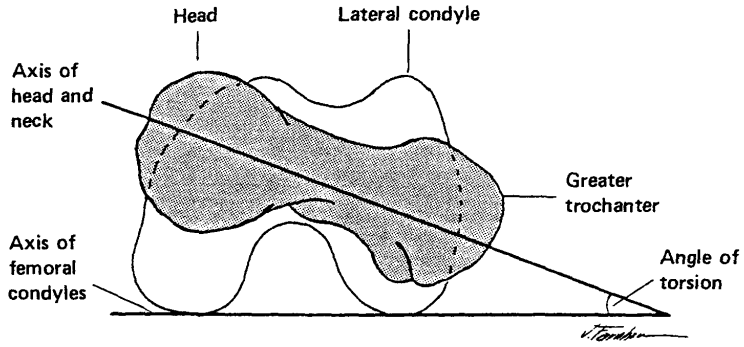


FIGURE 8-5. The drawing shows the normal angle of torsion of a right femur.

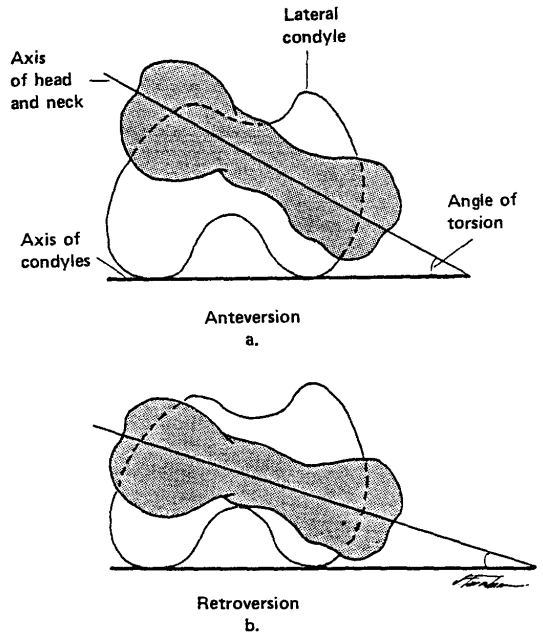


FIGURE 8-6. Abnormal angles of torsion in a right femur. a. A pathologic increase in the angle of torsion is called *anteversion*. b. A pathologic decrease in the normal angle of torsion is called *retroversion*.

Internal composition of femoral neck
(see Fig)
Cancellous bone within proximal femur tends to be organized into two basic systems: _____
and _____
These systems reflect the internal (cancellous bone) organization of the ~~trabecular bone~~ system.
The _____ is important in supporting the joint force which is directed parallel to this structure. Note that the epiphyseal plates at the proximal end of femur run perpendicular to this structure
_____ - believed to resist compressive forces produced by contraction of gluteus medius muscle.
Over all - cortical bone forms a shell around femoral neck, thin superiorly and thickening inferiorly.
Problem: with aging the cortical bone tends to thin out and inner cancellous bone gets resorbed also. This increases

FIG. 8-6

Roentgenogram of a femoral neck showing the medial and lateral trabecular systems. The thin shell of cortical bone around the superior femoral neck progressively thickens in the inferior region.

the risk of femoral neck fractures. Perhaps much of this thinning of bone is linked to inactivity.

Kinematics

ROM 3 planes: Flex-ext – sagittal
Ab-Ad – frontal
Int/Ext Rot – transverse

1. Flexion: Ext.
2. Abduction Add.
3. Int. rot. Ext.

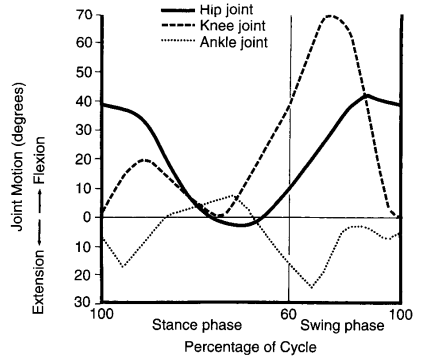
↳ (These rotations are facilitated when hip is flexed. Soft tissues restrict this somewhat when hip is extended or hyperextended.)

Gait Studies – Murray (1967) see Fig
Max flexion ~40° just prior to ipsilateral heel strike (HS)
Max Ext. "few degrees" late in stance as opposite foot hits "contralateral HS"

Trends: Fig
As one gets older step length decreases
ROM of hip knee ankle also decrease
} Sagittal plane

Stance phase: Add + int. rot
Swing Abd + ext rot

Frontal Plane
Johnson / Smidt (1969) Fig
Transverse Plane
} total range of motion in both planes



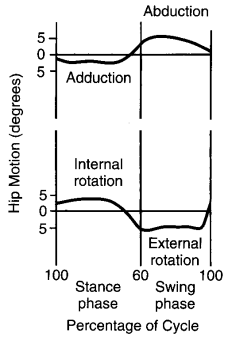


FIG. 8-8

A, Range of hip joint motion in the sagittal plane for 30 normal men during level walking, one gait cycle. The ranges of motion for the knee and ankle joints are shown for comparison. Adapted from Murray, M.P. (1967). Gait as a total pattern of movement. *Am J Phys Med, 46,* 290. **B, A typical pattern for** range of motion in the frontal plane (*top*) and transverse plane (*bottom*) during level walking, one gait cycle. *Adapted from Johnston, R.C. & Smidt, G.L. (1969). Measurement of hip-joint motion during walking. Evaluation of an electrogoniometric method.* J Bone Joint Surg, 51A, *1083.*

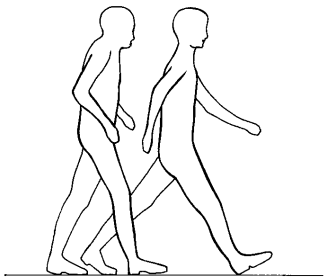


FIG. 8-9

Differences in the sagittal body positions of older men (*left*) and younger men (*right*) at the instant of heel strike. The older men showed shorter strides, a decreased range of hip flexion and extension, decreased plantar flexion of the ankle, and a decreased heel-to-floor angle of the tracking limb; they also showed less dorsiflexion of the ankle and less elevation of the toe of the forward limb. *Reprinted with permission from Murray, M.P., Kory, R.C., & Clarkson, B.H. (1969). Walking patterns in healthy old men.* J Gerontol, 24, *169–178.*

End Hip Notes Part 1

Continued in Part 2 (separate handout)