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 by articular cartilage which thickens peripherally. The cavity faces obliquely ______, ______, ______.

Femoral head: ______ surface 3/4 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

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**

(see Fig)

Normal: 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).

(Quadriceps angle)


typically ~ _?_ > is considered high

**Neck-to-Shaft Angle**

Coxa vara angle < 125°

Normal angle ≥ 125°

Coxa valga angle > 125°

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 vs varus vs abduction vs 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 text.

Normal angle of torsion is ~ 12°. If > 12° condition is called and tends to make the distal end of the 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 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.

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

Kinematics

3 planes: Flex-ext - Sagittal
Ab-Add - Frontal
Int/Ext - Transverse

1. Flexion: Ext.
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) Max flexion ~ 90°

Max Ext. few degrees late in stance, as opposite foot hits "contralateral HS"


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., Karp, R.C., & Clarkson, B.H. (1963). Walking patterns in healthy-old men. J Gerontol, 24, 169-178.