HIP COMPLEX

Synopsis :-

* Introduction
* Structure & func of hip Joint
* Force & muscle func in stance
  - => Unilateral stance
  - => Bilateral stance
* Clinical consideration. (Pathology)

Introduction :-

* The hip Joint is also called as coxofemoral / femoroacetabular Joint.
* The articulation of acetabulum of pelvis & head of femur is to form hip Joint.
* This is a ball & Socket variety
* It is a Synovial joint.
* The articulating two segments form a diarthrodial

ball & Socket joint with three degrees of freedom.

=> Flexion / Extension → Sagittal plane.

=> Abduction / Adduction → frontal Plane.

=> Med / lat rotation → Transverse Plane.

Structure & function of Hip Joint :-

Structure :-

Proximal articular surface;

* The cuplike concave socket of the hip joint is called acetabulum.

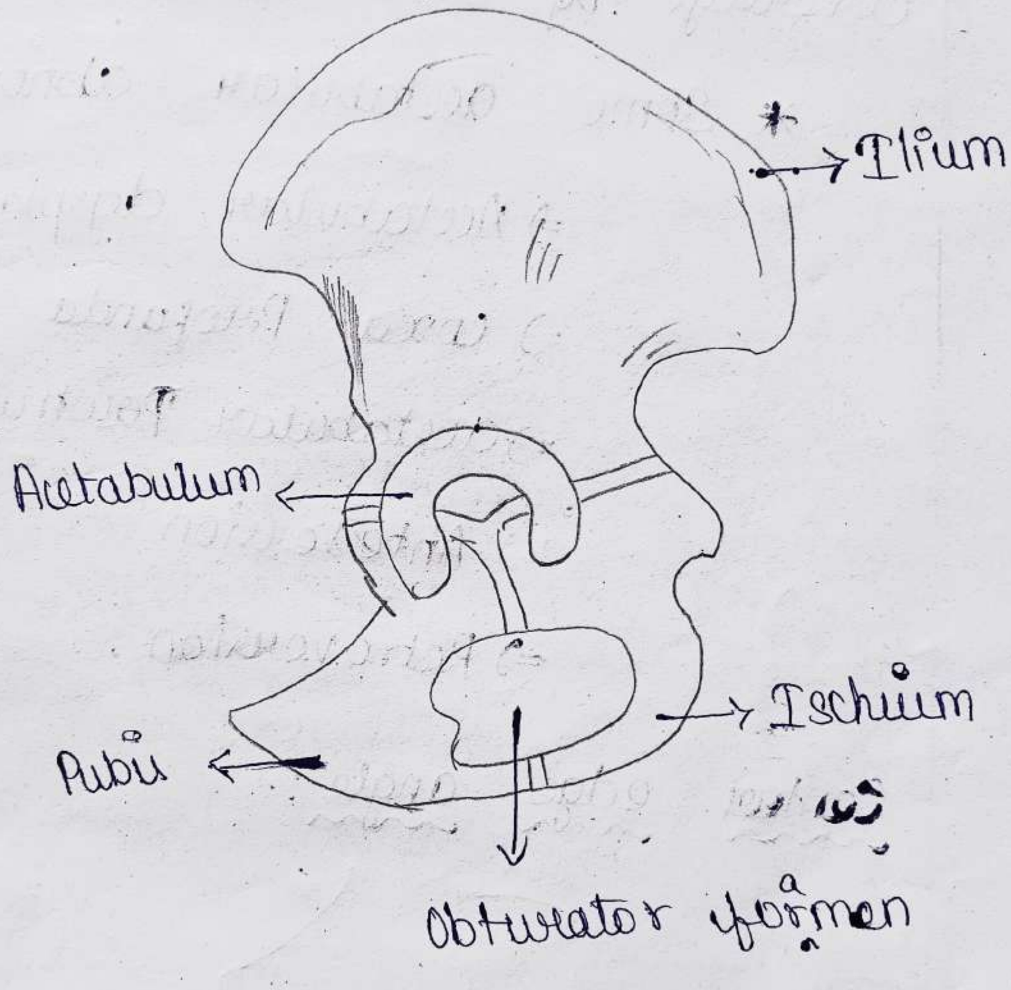
* It is located on the lateral aspect of the innominate or os coxa.

* Three bone form the pelvis:

=> Ilium

=> Ischium

=> pubis



Acetabulum :-

* It is Appearing to be Spherical Only the upper margin of the Acetabulum has a true circular Contour.

* The ~~Opening~~ articular surface area of the acetabulum tends to

be smaller in women than it is in men.

* Normal func of hip Joint requires optimal femoral head coverage by the acetabulum.

* Some acetabular abnormalities

=> Acetabular dysplasia

=> Coxa Profunda

=> acetabular Protrusio

=> Anteversion

=> Retroversion.

Angle of wiberg

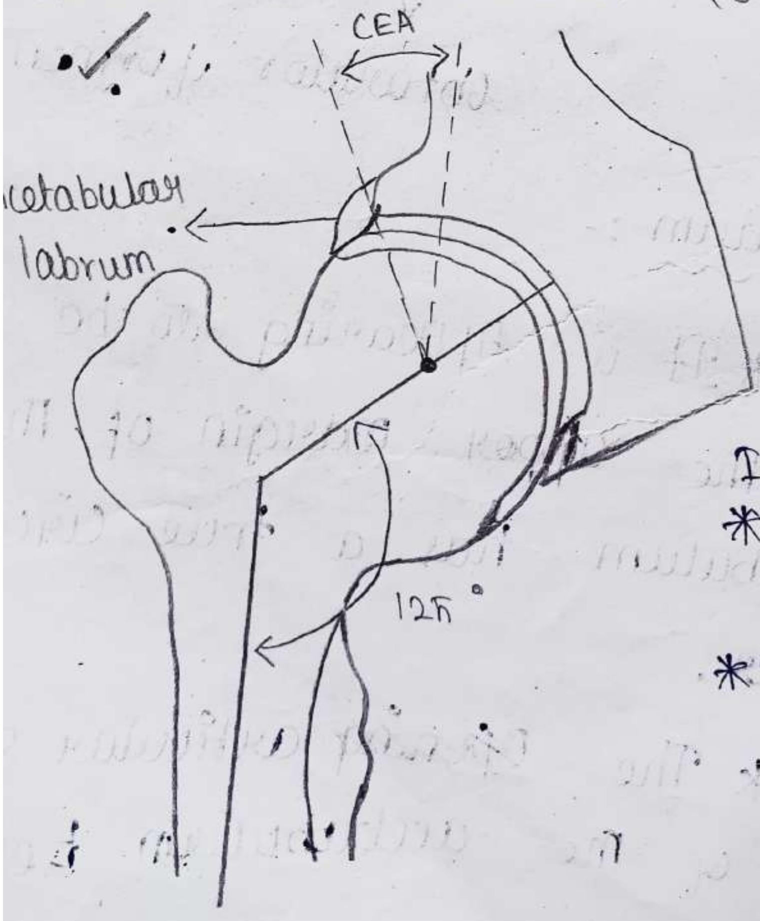
Center edge angle :- (Before acetabulum) dysplasia

definite -> 16 less

normal -> 16-25

Possible -> 25 <

Normal value -> 5



If ∠le ↑,
* Anteversion acetabular

* If ∠le ↓,
Retroversion of acetabulum

⇒ The ∠le b/w the center of head of femur & edges of the acetabulum

⇒ ∠le is less in male & high in females

⇒ Normal (18.5° – 21.5°)

Acetabular labrum :- ✓

* The acetabular labrum is a ring of wedge-shaped fibrocartilage attached to the outer periphery of the acetabulum.

In there region the ligament are present;

⇒ Fibrous capsule

⇒ Ligamentum teres

⇒ Anterior ligament

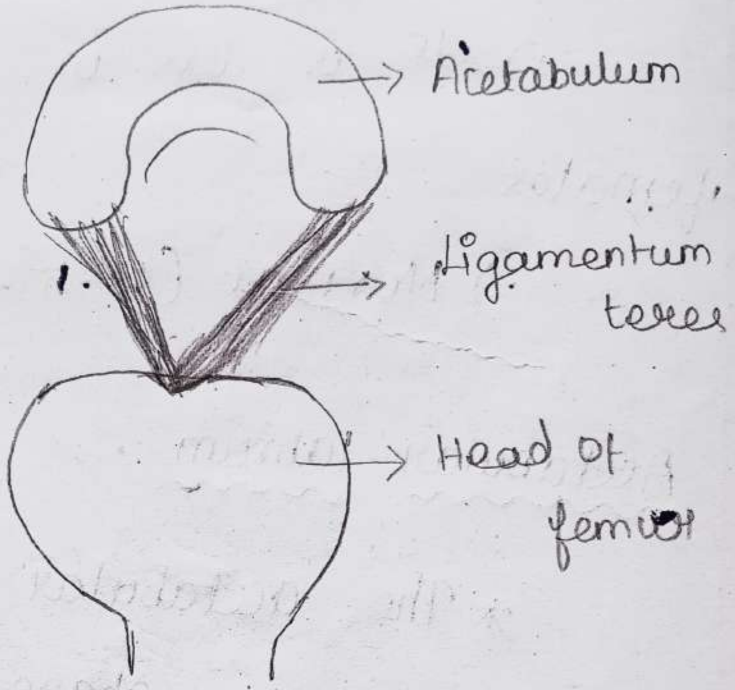
⇒ Posterior ligament.

Ligamentum teres :-

* It is a Δ^{le} shaped ligament

* This is a thick ligament

(because of large amount of vascular bundles)



* Transverse acetabular ligament is consider as a continuation of the acetabular labrum.

* Histologically, it is predominantly ligamentous but contain cartilaginous cell believed to withstand compressive load.

Distal Articular surface :-

* Head of the femur is a rounded hyaline cartilage covered surface.

* Femoral shape & dimension

can be variable even in bone of the same overall size.

* The fovea is not covered with articular & is the point at ~~the~~ which the ligamentum teres is attached.

* The femoral head is attached which in turn is attached to the shaft of the femur b/w the greater & lesser trochanter.

Angulation of Femur :- ✓

⇒ Two angulation is made by the head & neck of the femur in relation to the shaft.

=) The angles are,

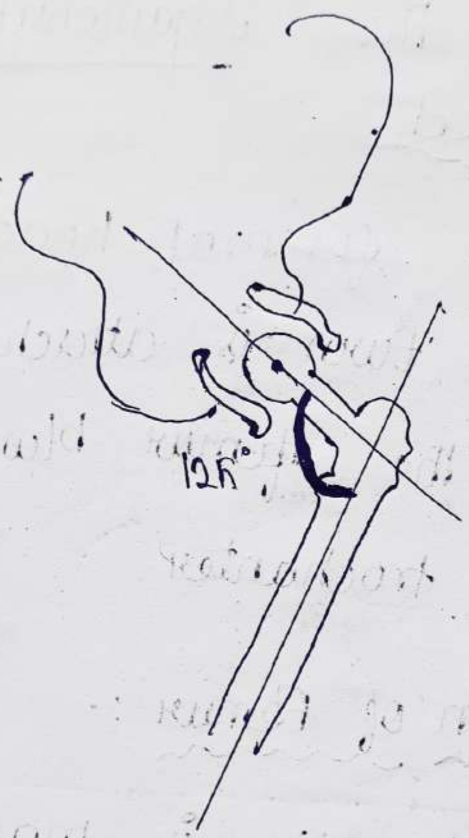
* Angle of inclination

* Angle of torsion.

Angle of inclination :- ✓

* An imaginary line passes through the center of the head & through the

the neck and then draw a line from the shaft of the femur then it may an angle called "angle of inclination".



=> The angle of inclination is approximately 125°.

=> Normal value (110° to 144°) in adult.

=> In women, the AOI is smaller than men, owing to the greater width of female pelvis.

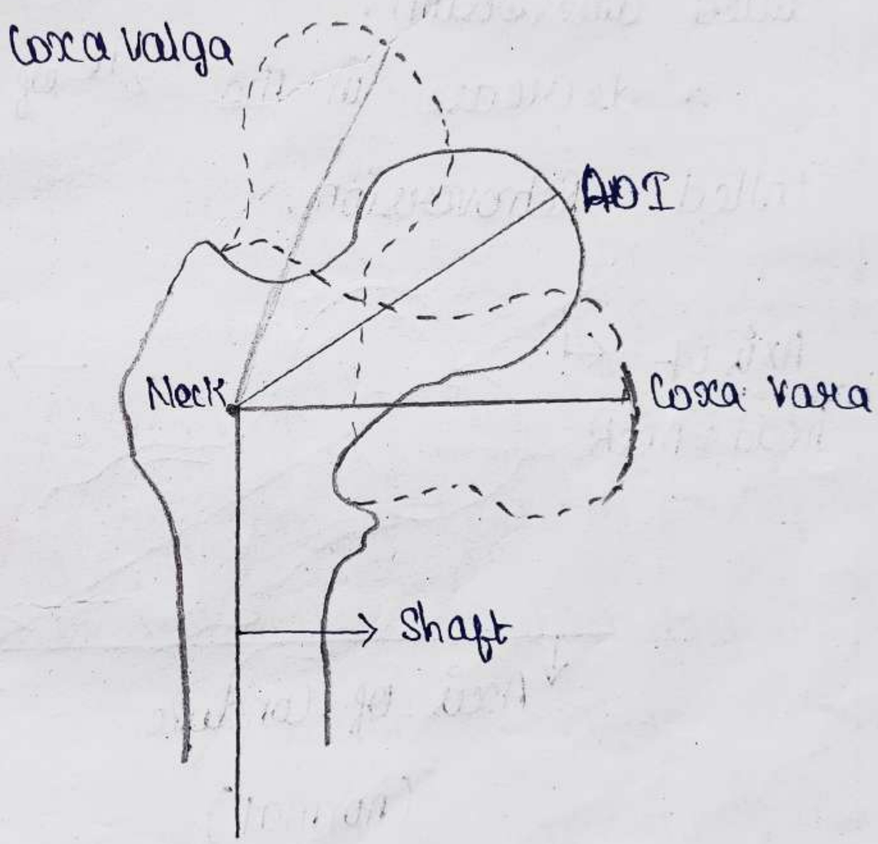
Pathology,

* Greater medial angulation b/w

the neck & shaf is called Coxa valga
(greater than normal)

* smaller angle is called Coxa vara.
(lesser than normal $\angle^{le}$)

* Coxa valga & Coxa vara can lead to abnormal lower extremity biomechanics, altered (m) func, gait abnormality.



Angle of Torsion of the femur

⇒ An axis through the femoral head & neck in the transverse plane will lie at an $\angle^{le}$ to an axis through the femoral condyle, with the head & neck torsioned anteriorly with regard to an angle through the femoral condyles

* The ∠^le of torsion ↓ with age.

* In the adult, the normal angle of torsion is considered to be 10-20°.

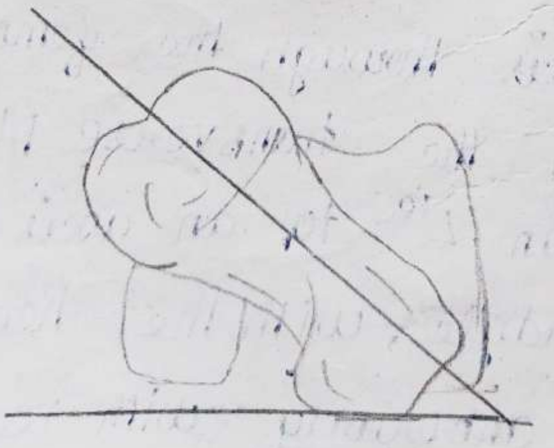
Pathology,

* Increase in the angle of torsion is called anteversion.

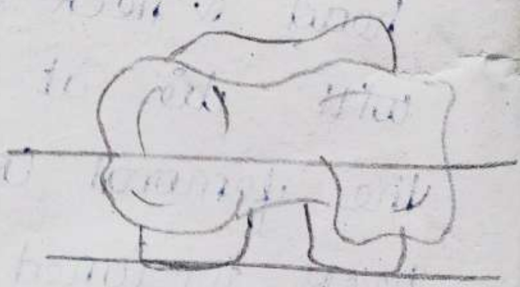
* decrease in the ∠^le of torsion is called Retroversion.

(normal)

Pathologically,



Ante version
>15°



Retroversion
<15°

Articular Congruence

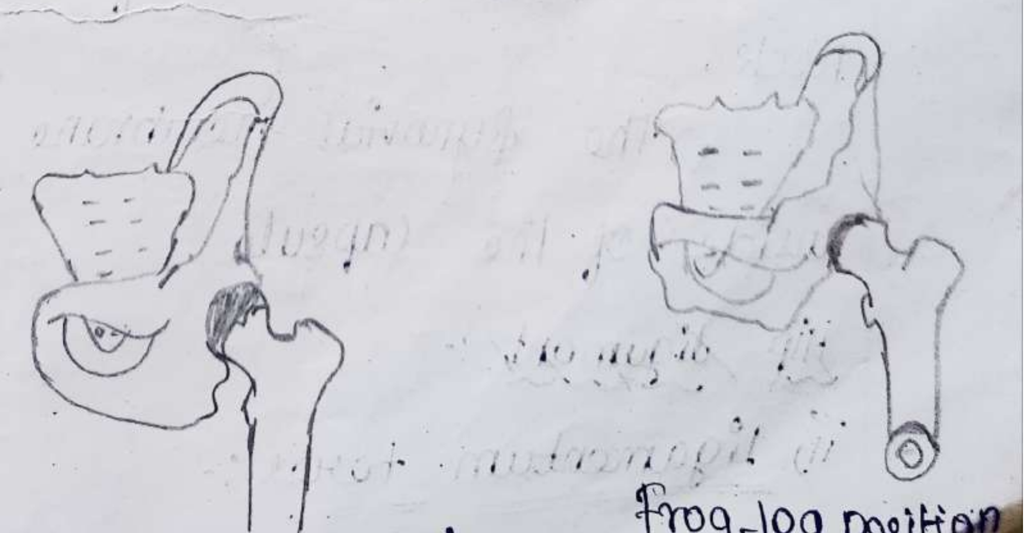
* The hip Joint is Considered to be a Congruent Joint.

* The Shape of the hip Joint helps to ↓ the Peak Contact Stress.

* There is Substantially more articular Surface on the Head of the femur than there is on the acetabulum.

eg → In neutral / Standing position, the articular surface of femoral head remains exposed anteriorly & Superiorly.

⇒ The acetabular Contact b/w the femur & the ∠le of torsion of femoral head exposes a substantial amount of the femoral head's articular Surface anteriorly



Neutra Hip Joint, Standing

Frog-leg position

* Articular contact b/w the femur & actebulum can be ↑ in normal non-weight bearing hip Joint by a cominatio n of flexion, abduction & slight lat rotation

* This position is called frog-leg Position

Hip Joint ligament :- X

Name

i) Joint Capsule :-

=) The hip Joint capsule is a substantial contributor to joint stability

=) The capsule cover the femur head & neck like a cylindrical sleeve & attaches to the base of the femoral neck.

=) The synovial membrane lines the inside of the capsule.

~~Hip ligament~~ :-

ii) Ligamentum teres :-

* It is an intra- articular but extra synovial accessory joint structure

* It is a triangular band.

=) Two anterior ligament are,

* Iliofemoral ligament

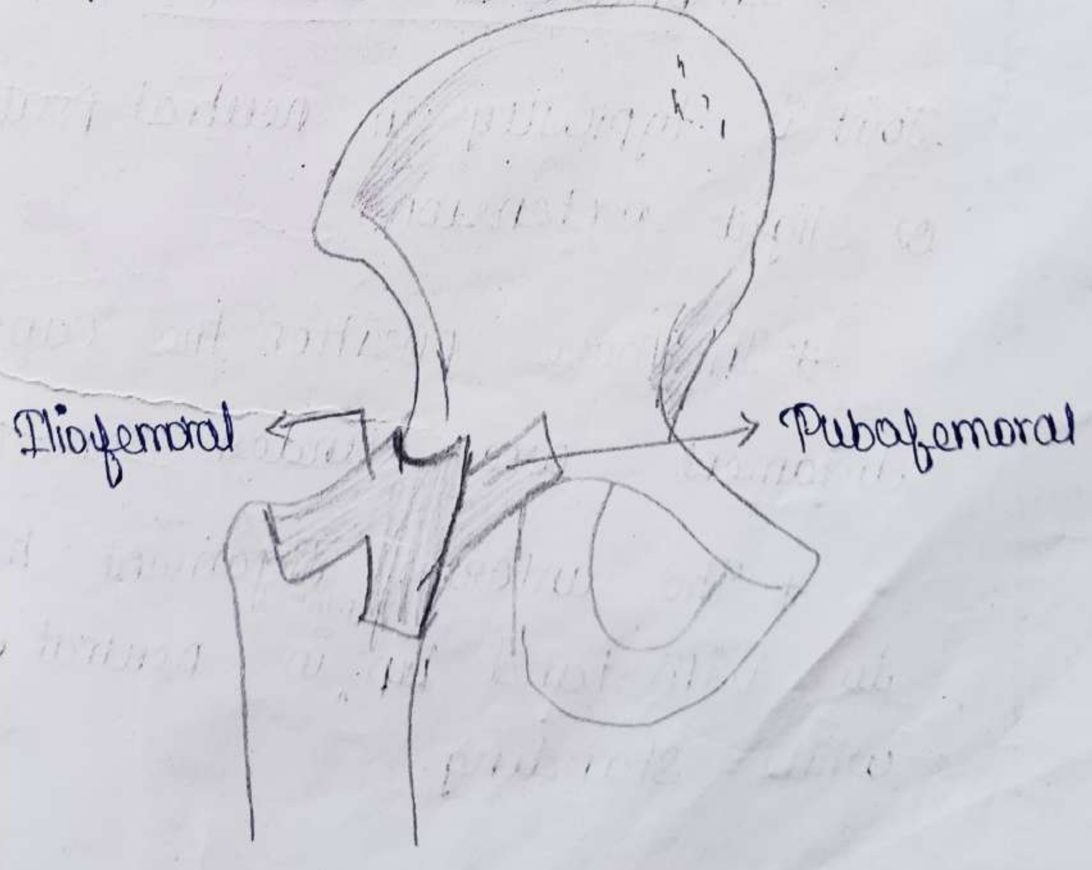
* Pubofemoral ligament

=) One posterior ligament is

* The ischiofemoral ligament.

i) Iliofemoral → Y ligament of Bigelow

* It is a fan shaped ligament & resembles an inverted letter Y.



ii) <u>Pubofemoral ligament</u> :-

=) The band of the iliofemoral & the pubofemoral ligament form a Z on the anterior capsule.

iii) <u>Ischiofemoral ligament</u> :-

* The IF ligament attaches to the Post surface of the acetabular rim & the acetabulum labrum.

* The anterior ligaments are stronger than IF (2)

* In <u>bilateral stance</u>, the hip Joint is typically in neutral position or slight extension.

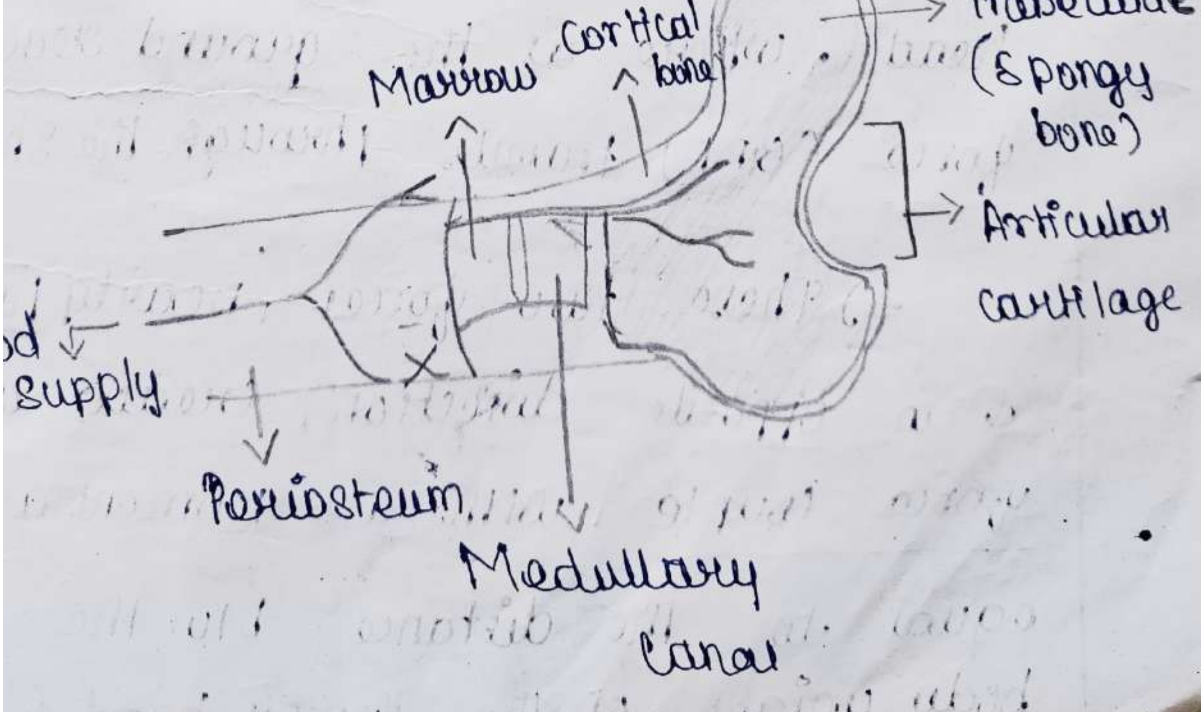
* In these position the capsule & ligament are under some tension

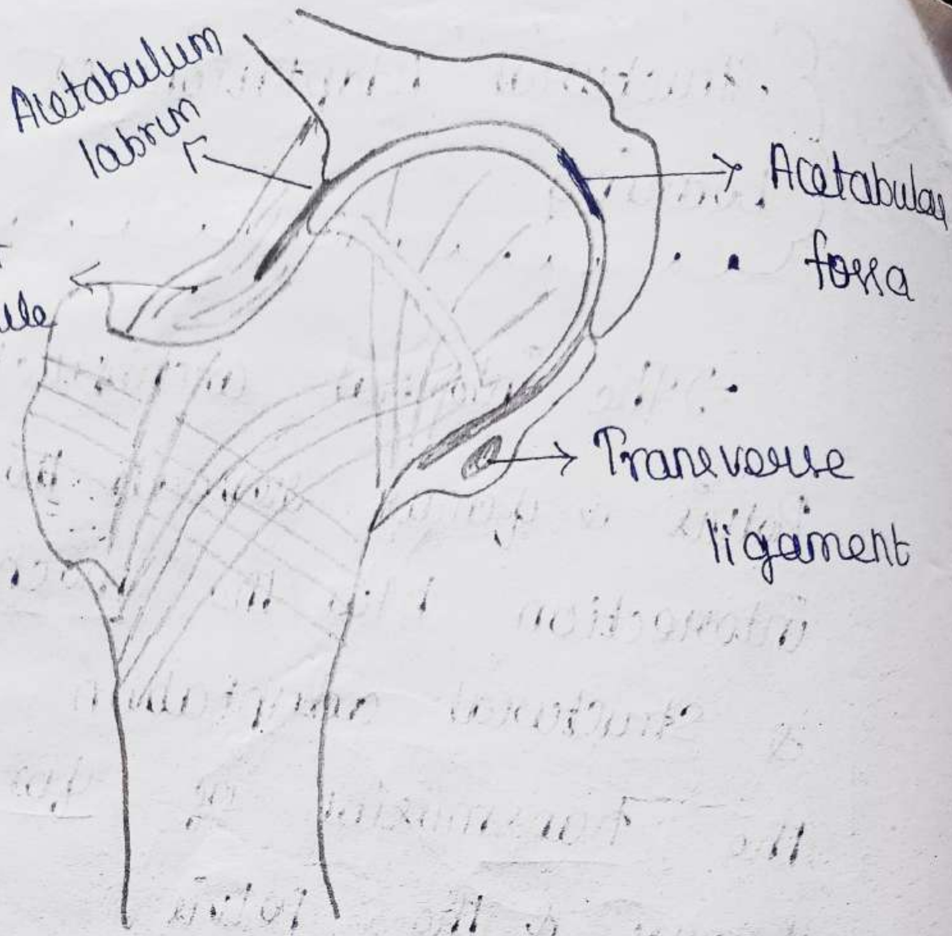
* The anterior ligament helps to withstand hip Joint in neutral while standing.

Structural Adaptations of weight-bearing

⇒ The internal architecture of the Pelvis & femur reveals the remarkable interection b/w the <u>mechanical stress</u> & <u>structural adaptation</u> created by the <u>transmission</u> of <u>forces</u> b/w the femur & <u>the Pelvis</u>.

⇒ The <u>trabeculae</u> (calcified plate of tissue within the cancellous bone) line up along lines of stress & form systems that normally adapt to stress requirement.



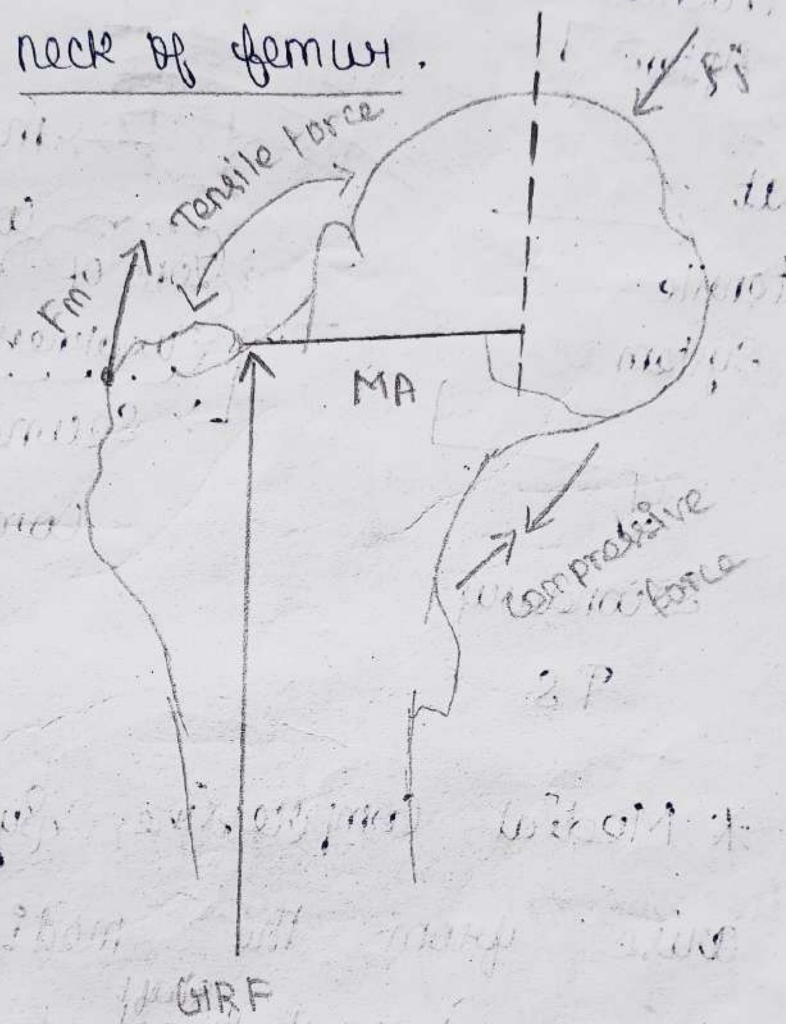


Lines of stress in the cancellous bone

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

⇒ These two forces, nearly parallel & in opposite direction, create a force couple with a moment arm equal to the distance b/w the body weight on the femur head & GRF up the shaft.

* These force create a bending moment (or shear force) across the neck of femur.

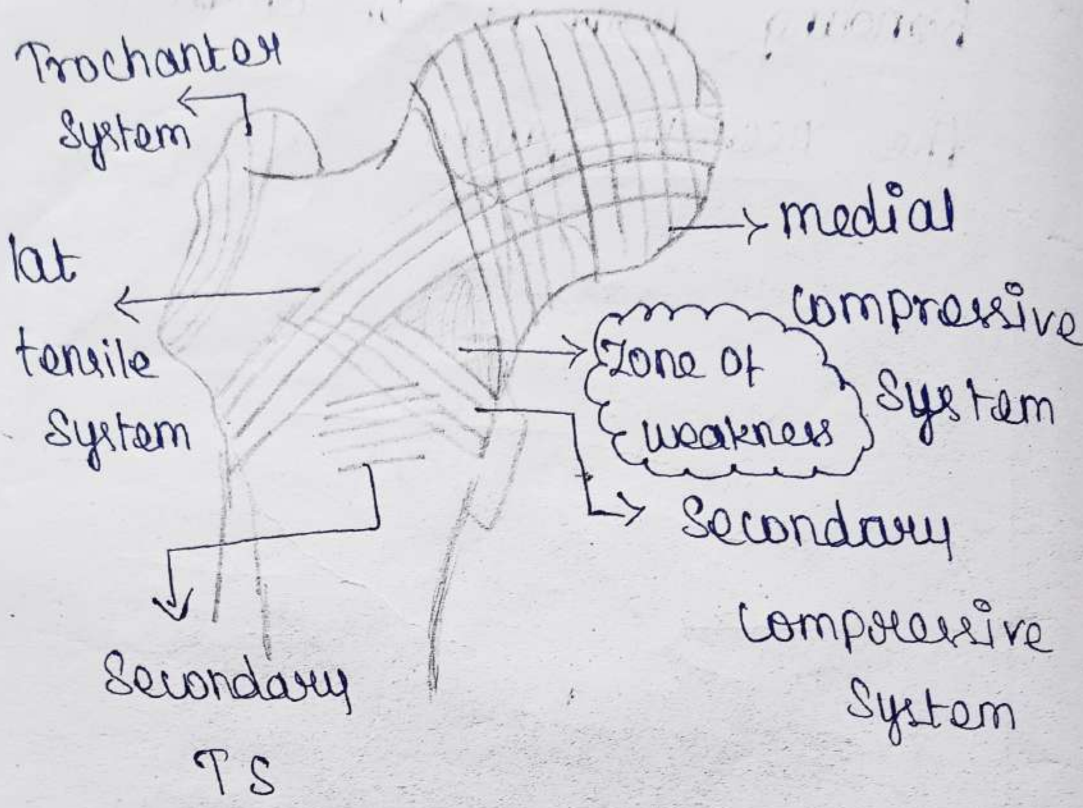


=) The bending stress creates a tensile force on the superior aspect of the femoral neck & a compressive stress on inferior aspect.

Trabecular system :-

=) A complex set of force prevents the rotation & resist the shear force that the force couple cause; among these forces are

The structural resistance of "2 major & 3 major trabecular" system



* Medial Compressive System (MCS) arise from the medial cortex of upper femoral ~~bound~~ shaft & radiates through the cancellous bone to cortical bone of sup ~~hea~~ aspect of femoral head.

* The medial system is oriented along vertical (longitudinal) compressive force passing through the hip joint.

⇒ lateral trabecular (tensile system) from of the femur arises from the lat cortex of upper femoral shaft & crossing the medial system, terminate in cortical bone on inf aspect of head of femur.

⇒ The lat. TS is oblique & may develop in response to parallel (shear force) of the weight of HAT & GRF.

⇒ The two accessory trabecular system of one is considered as compressive & other is tensile

⇒ Another secondary trabecular system is confined to the trochanteric area of femur.

⇒ The area in which the trabecular system crossing are considered as the area is ~~having~~ resistance to stress & strain

⇒ There is an area in the femoral neck in which the trabeculae are relatively thin & do not cross each other.

* This zone of weakness has less reinforcement & thus more potential for failure.

Weight bearing Surface

* The primary weight-bearing surface of the acetabulum / dome of acetabulum is located on the superior portion of lunate surface

* In the normal hip, the dome lies directly over the center of rotation of the femoral head.

* The dome shows the greatest prevalence of degenerative changes in acetabulum.

* The primary weight bearing area of the femoral head is

Correspondingly, its superior portion.

=) The force of HAT & GRF that act on the anterior surface of hip joint & femoral head, neck also act on shaft.

=) The femoral shaft is not vertical but lies at angle that varies considerably among individuals.

=) The vertical loading on the oblique femur result in bending stresses in the shaft.

=) The medial cortical bone in the shaft must resist compressive stresses, where as the lat cortical bone must resist tensile stresses

{Functions of Hip Joint} :-

=) Motion of the femur on the acetabulum

* The movement of Convex femoral head with the Concavity of acetabulum moves through its three degrees of freedom

=) flexion / extension.
=) Abduction / adduction
=) Medial / lat rotation.

Movement of Hip Joint — femoral head

=) Motion of the pelvis on the femur

* whenever the hip Joint is weight bearing, the femur is relatively fixed & motion of the hip Joint is produced

=) Ant & post pelvic Tilt
=) Lat pelvic tilt
=) Ant & post pelvic rotation.

Ant & posterior Pelvic tilt :-

=) These movement are in Sagittal plane around the Coronal axis

* Ant & post pelvic tilting on the pelvis fixed femur produce hip flexion & extension.

* During the hip flexion movement the ~~hip~~ ASIS is anteriorly moved & inferiorly this is called anterior PT

* During the hip extension movement the ASIS is moves posteriorly & superiorly.

Lateral Pelvic tilt :-

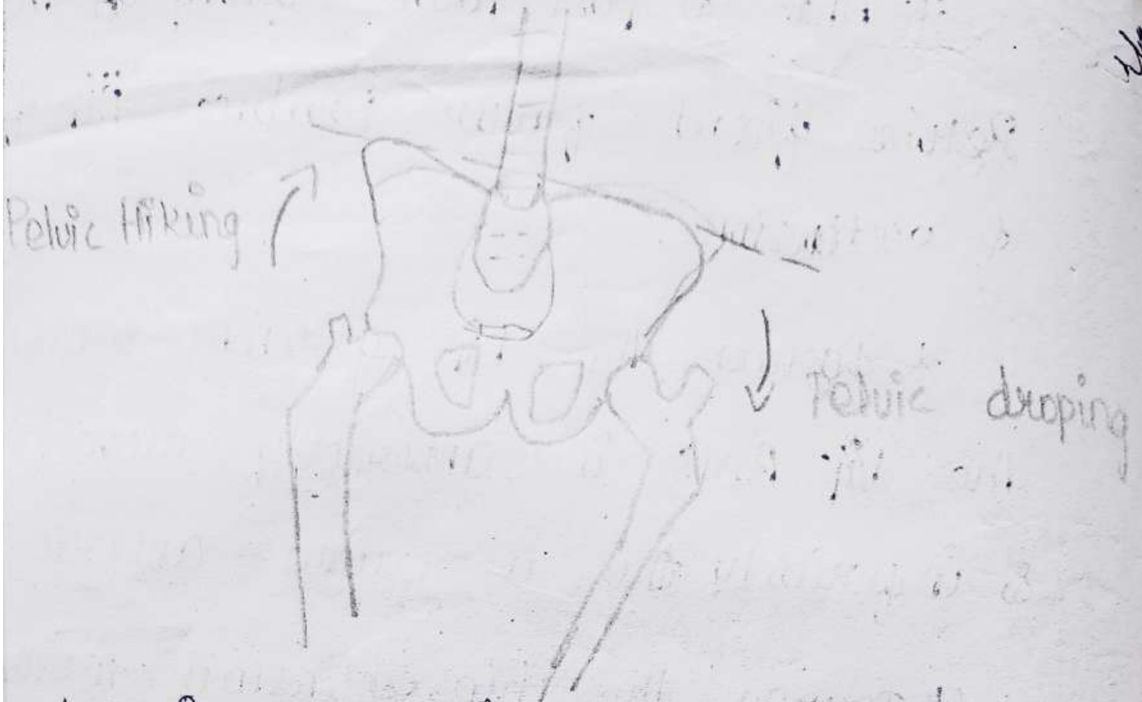
* These movement is in frontal plane around anteroposterior axis.

* The lat tilt in unilateral stance, axis for the motion of the opposite side of the pelvis as it elevates or drops

⇒ Elevates (Pelvic hiking)

⇒ Droping (pelvic drop)

* During Hip abduction & adduction the lateral Pelvic tilt is occur.



Anterior & posterior pelvic rotation

=) These movement is in transverse Plane around vertical axis.

Co-ordinated movements of femur, pelvis & lumbar spine

* when the Pelvis moves on a relatively fixed femur, there are 2 Possible out come to consider.

* There are open & closed chain response

Hip Joint movements	Femoral Distal end	Head of femur	Acetabular movement	Pelvis	Sacrum	lumbar
Flexion	Moves anteriorly	Glides post articular surface	Ant gliding on the HOF	Ant tilt	Counter nutation	Lumbar flexion (Lordosis ↓)
Extension	Moves Posteriorly	Glides Ant	Post Gliding	Post tilt	Nutation	Extension
Abduction O.K	Moves lat	Glides med	lat Glide	Same side Hiking	Neutral / no movement takes place	Same side lat flexion
Abduction C.K	Moves lat	Glides med	lat Glide	Same side droping		Same side lat extension
Adduction O.K	Moves med	Glides lat	Med Glide	Same side droping	Neutral / No movement takes place	Same side lat extension
Adduction C.K	Moves med			Same side Hiking		Same side lat flexion
Med rotation	Medially rotate	rotate lat / Glide lat on the Posterior surface of Acetabulum	Med Glide on Post surface of acetabulum	No movement	No movement	No movement
Lat rotation	Laterally rotate	Glide med on the Posterior surface of Acetabulum	lat Glide on PSOA	" "	" "	" "

{Force & (m) Function in Stance}.

Bilateral Stance :-

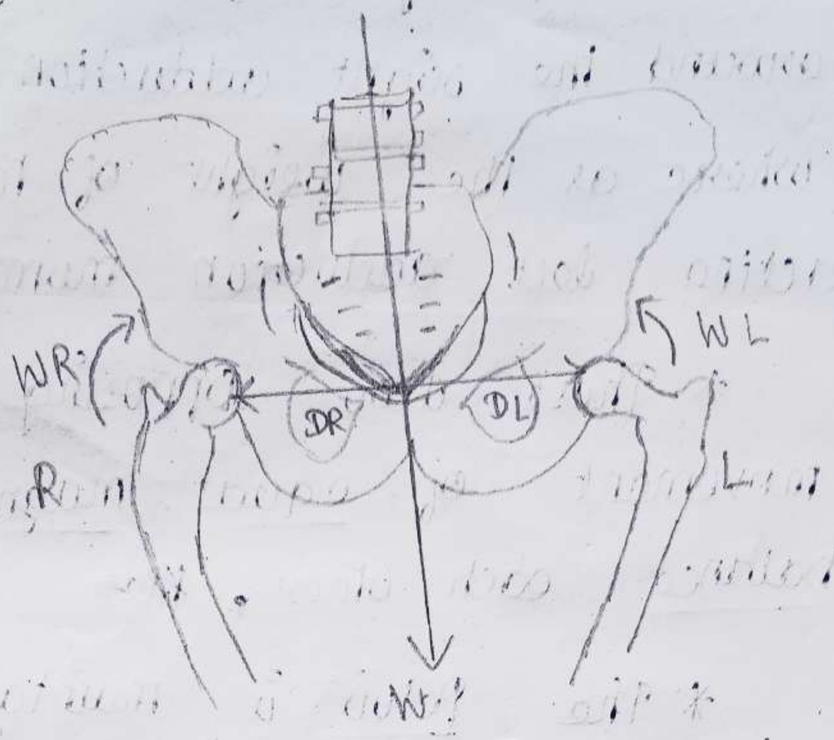
* In erect bilateral stance, both hips are in neutral / slight hyperextension & weight is evenly distributed b/w both legs.

* The LOG falls Just posterior to axis for flexion / extension of hip Joint.

* The posterior LOG creates an external extension moment of force around the hip that tends to posterior tilt the pelvis on the femoral head.

* In the frontal plane during BS, the body weight is transmitted through the sacroiliac Joint & pelvis to the right & left femoral heads.

* Hypothetically, weight of the HAT should be distributed, so that each femoral head receives approximately half of the weight



* The Joint axis of each hip lies at an equal distance of LOG at HAT; that is the gravitation moment arm for the right hip (DR) & left Hip (DL) are equal

$$DR = DL$$

⇒ Because the body weight (W) on each femoral head is Same, the magnitude of gravitational Torque around each hip must be identical (WR = WL) : [WR × DR = WL × DL]

⇒ The gravitational torque on the right & left hips, Occur in opp. direction

* The weight of the body acting around the right adduction movement, where as the equal to weight of the body acting left adduction moment.

* These two opposing gravitational movement are of equal magnitude balance each other,

* The Pelvis is maintained in equilibrium in frontal plane without the assistance of active (m).

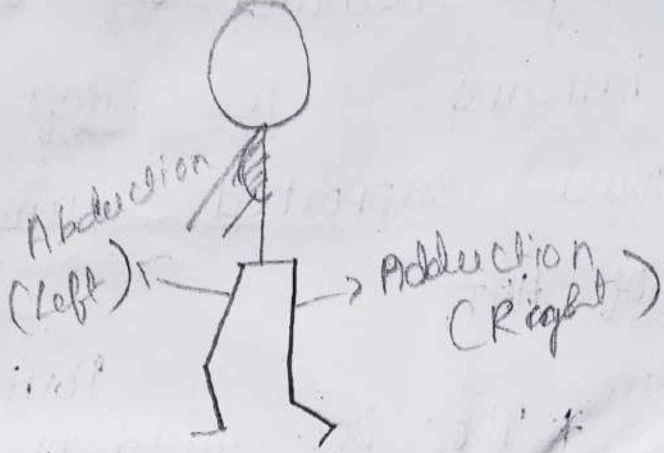
* When bilateral stance is not symmetrical, the frontal plane (m) activity will be necessary to either control the side-to-side motion / return to symmetrical stance.

eg->

* The Pelvis is shifted to the right, resulting in relative adduction of the rip hip & abduction of left hip.

* To return to neutral, the abductors of right hip (m) contraction would be expected.

* However the Contraction of left hip adductor would also be expected.



* In the absence of adequate hip abductor function, the adductor can contribute to stability - Only in bilateral stance.

Unilateral stance.

* The left leg has been lifted from the ground & the body weight is being supported by right hip Joint.

* Rather than the sharing Compressive force of body weight with the left limb, The right hip Joint must carry the full burden

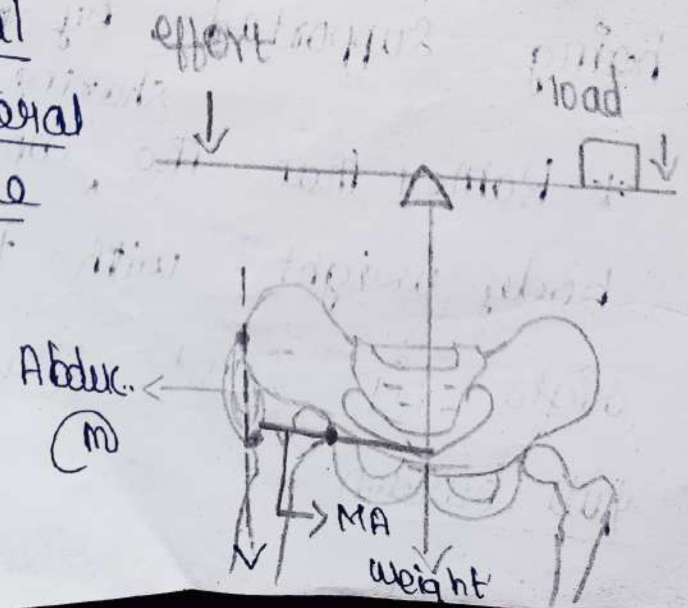
* In addition, weight of the non-weight bearing left limb that is hanging on the left side of pelvis must supported along with the weight of HAT.

* The One-third Portion of the body weight found in lower extremities – (non-supporting limb is half, One Six of the full body weight)

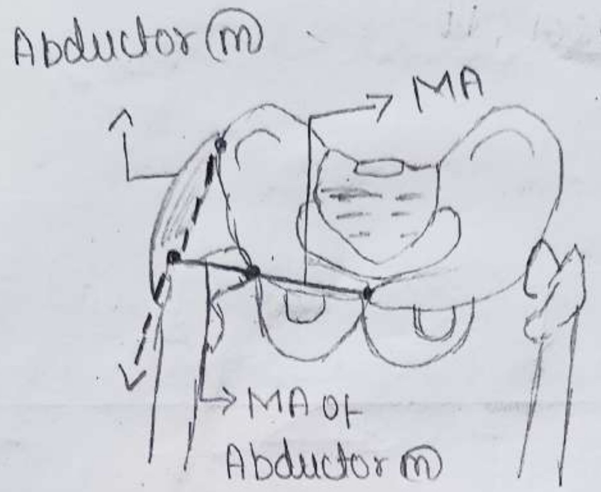
* The magnitude of the body weight is compressing the right Joint in right unilateral stance.

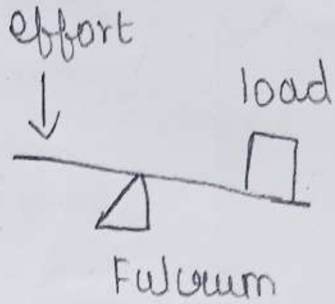
DR Joint Compression $= \left[\frac{2}{3} \times W + \frac{1}{6} \times W\right]$

<u>Normal unilateral Stance</u>



load $= 5/6 \times W$





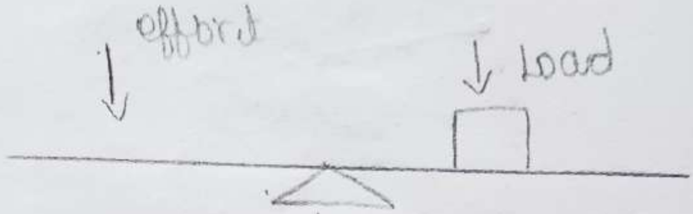
Abduction Torque is created, Pelvis will drop to Contro(=)lateral side.

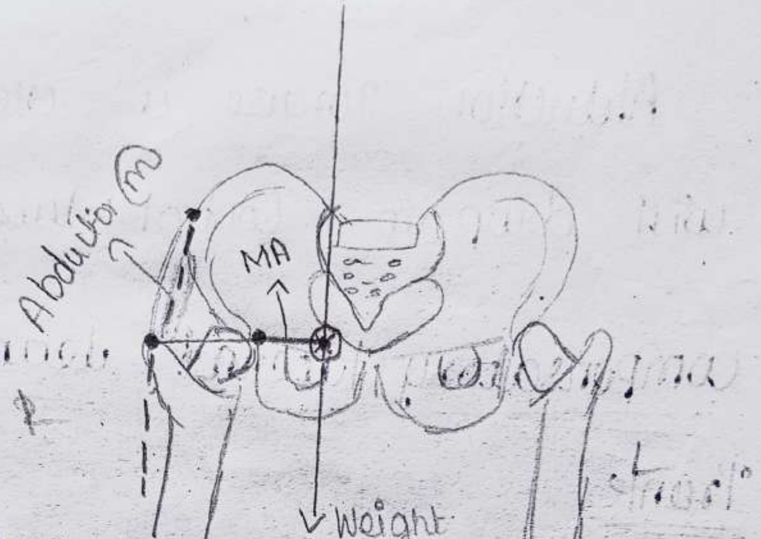
Factors:-

Compensatory lateral lean of the Trunk

⇒ Gravitational torque at the pelvis is the product of the body weight & distance that the LOG lies from the hip Joint axis. τ = F × MA

⇒ If there is a need to reduce the Torque of gravity & the MA of the gravitational force can be reduced by laterally leaning the trunk over the Pelvis towards the side of pain.

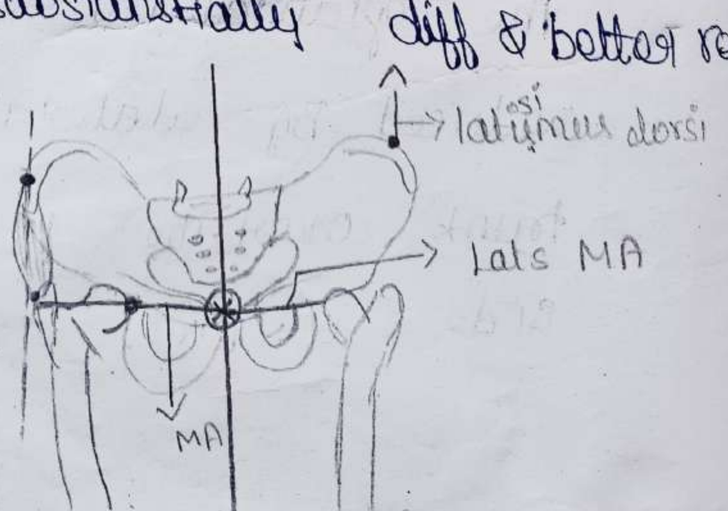


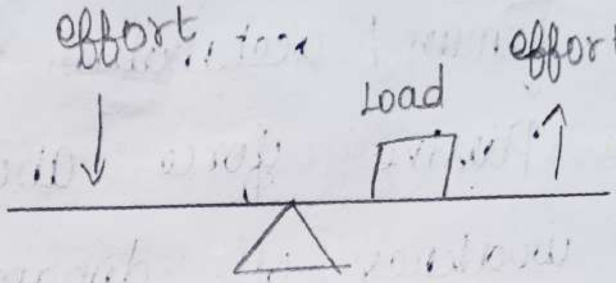


__Use of a cane__ __Ipsilaterally__, (15% of weight to cane)

* Pushing downward on a cane held in the hand on the (same) side of the pain it should reduce the body weight by amount of downward thrust.

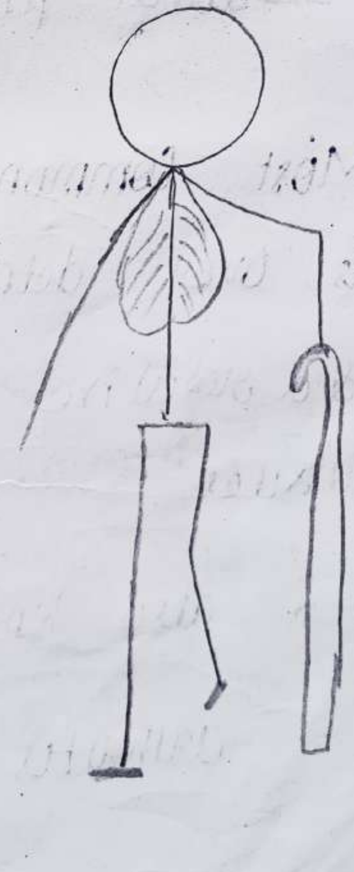
* Moving the cane to the opp. hand produces substantially diff & better result





<u>Use of a cane contralaterally</u> :- (15% of weight cane.

* When a cane is moved to the Side of opp. The pain / weak, the reduction of HATLL is the Same as it is when the cane is used on the Same side as Painful area.



Hip Joint Pathology :-

* small changes in the biomech of the femur / acetabulum can result in ↑ in Passive force above normal levels / in weakness of dynamic joint stabilizers.

conditions are,

⇒ femoro acetabular impingement
⇒ Arthrosis
⇒ Fracture
⇒ Bony abnormalities of femur.
⇒ Labral Pathology.

Arthrosis :-

⇒ Most common painful condition of hip is over deterioration of articular cartilage & a relative changes in articular tissues.

⇒ It is also knowns as OA, degenerative arthritis.

Fracture :-

* The bony components must also be of sufficient strength to withstand the force that are acting around through the hip Joint.

* The result of bending force across the femoral neck may fracture

* Normally, the trabecular system are capable of resistance the bending force, but abnormal ↑ in the force or weaking of bone can lead to bony failure.

* The failure site is Zone of weakness

* The femoral neck failure is uncommon for child / young adult.

Bony Abnormalities of femur :-

⇒ COXA Vara

⇒ COXA Valga

Femoroacetabular Impingement :-

⇒ FemAI is described as the dysfunctional abutment of the proximal femur and the acetabulum.

⇒ The result of such impingement cause pain & lead to progessive degenerative changes in the hip joint, specifically the labrum.

<u>types</u>

* Cam impingement
* Pincer impingement.