KNEE COMPLEX

DR. DIGVIJAY SHARMA

DEPARTMENT OF PHYSIOTHERAPY

U.I.H.S

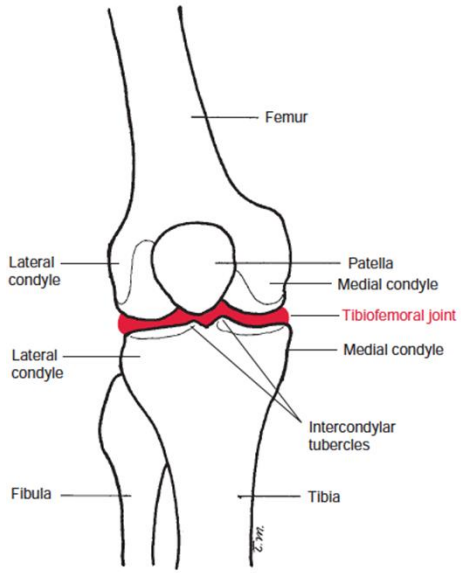
KANPUR

Knee Complex

The knee complex is similar to the elbow complex in that flexion and extension of knee produces a functional shortening and lengthening of the extremity.

The knee complex is composed of two distinct articulation located within a single joint capsule-

1. Tibiofemoral joint
2. Patellofemoral joint



Patellofemoral Joint

Structure of Tibiofemoral Joint –

It is the articulation between distal femur and proximal tibia.

It is a double condyloid joint with 2° of freedom.

i. Flexion and Extension occurs in sagittal plane around a coronal axis.

ii. Medial and lateral rotation occurs in a transverse plane and vertical axis.

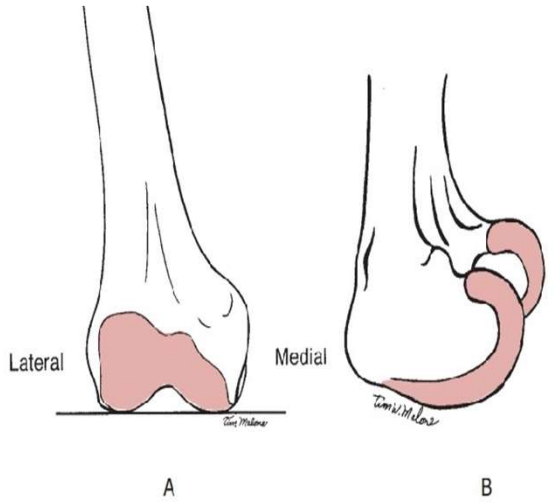


Figure 11-1 ■ **A.** Because of the obliquity of the shaft of the femur, the lateral femoral condyle lies more directly in line with the shaft than does the medial condyle. The medial condyle is more prominent, however, which results in a horizontal distal femoral surface despite the oblique shaft. **B.** The anteroposterior convexity of the condyles is not consistently spherical, having a smaller radius of curvature posteriorly.

Femoral articular surface-

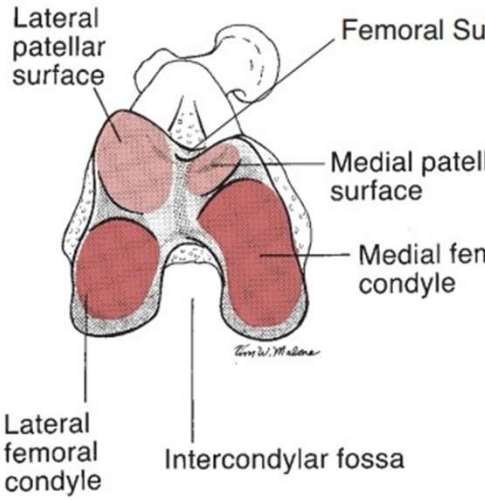
The large medial and lateral condyle on the distal femur form the proximal articulation surface of the knee joint.

The 2 condyles are separated by the **intercondylar notch** or fossa through most of their length but are the joint anteriorly by an asymmetrical, shallow, saddle shaped groove known as *patellar groove* or surface.

The patellar surface is separated from 2 articular surface by 2 slight groove that runs obliquely across the condyles.

The shaft of femur is angled in such a way that the femoral condyles do not lies immediately below femoral head but somewhat medial.

The articular surface is also not as long as the articular surface of medial condyle.



▲ **Figure 11-2** ■ The patellar surface (shaded li separated from the femur's tibial articular surface (sh pink) by two slight grooves that run obliquely across t The medial femoral condyle is longer than the lat condyle; the lateral lip of the patellar surface is larger tha lip of the patellar surface.

Tibial articular surface –

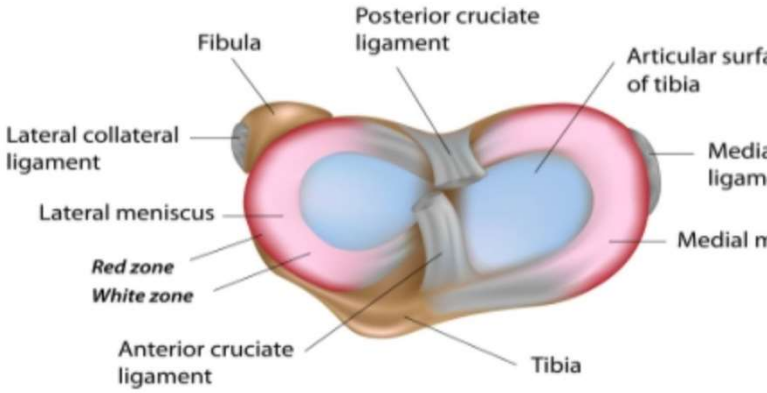
The articular surface on the tibia that corresponds to the femoral articulating surface are two concave asymmetrical medial and lateral tibial condyle or plateaus.

The proximal tibia is enlarged as compare to the shaft and overhangs the shaft posteriorly.

The articulating surface of the medial tibial condyle is 50% larger than that of the lateral condyle and the articular cartilage of medial tibial condyle is “3 times thicker”.

The 2 tibial condyles are separated by a roughened area and 2 bony spines known as intercondylar tubercle.

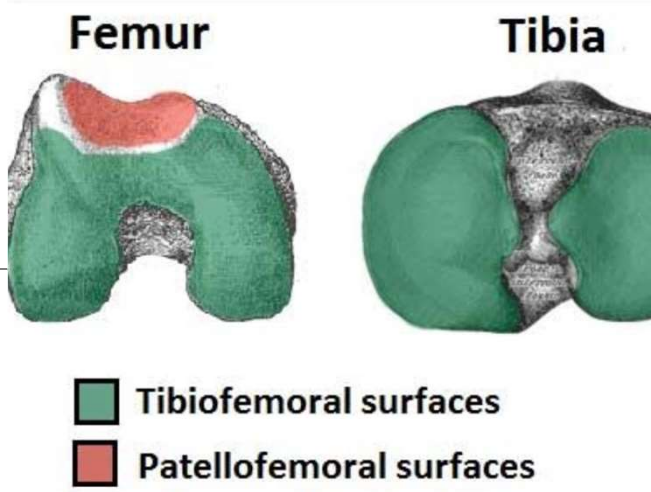
These tubercle becomes lodged in intercondylar notch of the femur during knee extension.

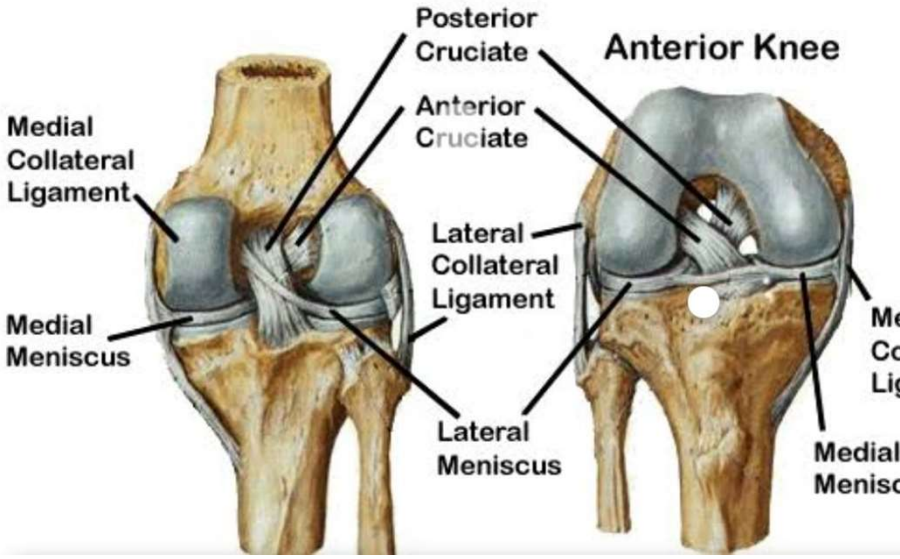


Tibiofemoral articulation-

When the large articular condyle of femur are placed on shallow concavity of tibial condyle, the incongruency of knee joint is evident.

So, the articular incongruence at the knee is accompanied by an accessory joint structure that enhances congruency and assist in balance between mobility and stability needed by joint. Each of the condyle of knee joint has its own accessory joint structure together known as menisci of the knee.





Menisci-

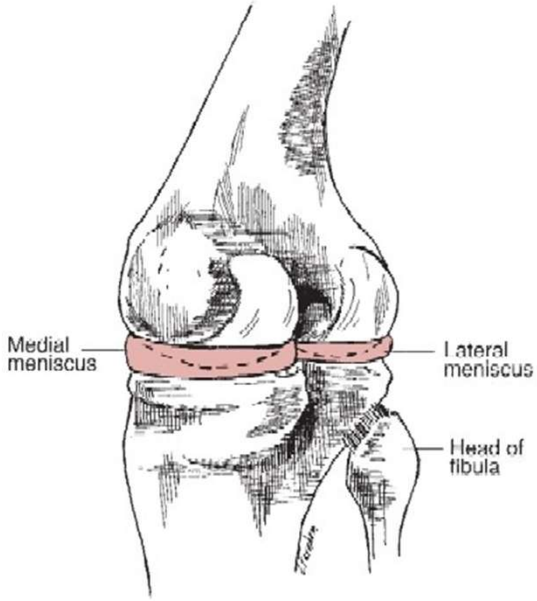
These are 2 asymmetrical fibrocartilaginous joint disc and are located on the tibial condyles.

The medial meniscus is a semicircle, the lateral meniscus is four-fifth of ring.

Both menisci are open towards the intercondylar area, thick periphery and thin centrally, forming concavities into which the respective femoral condyles can sit.

The wedge shaped menisci increases the joint congruence and play an important part in distributing weight bearing force, in reducing friction between joint segments and serving as shock absorber.

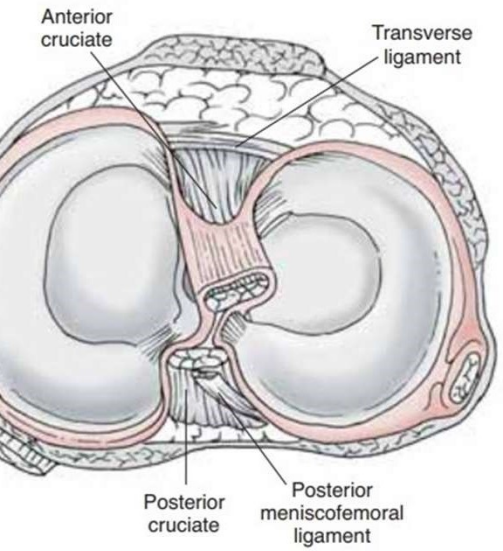
The menisci have multiple attachments to surrounding structures, some common to both while some are unique to each .



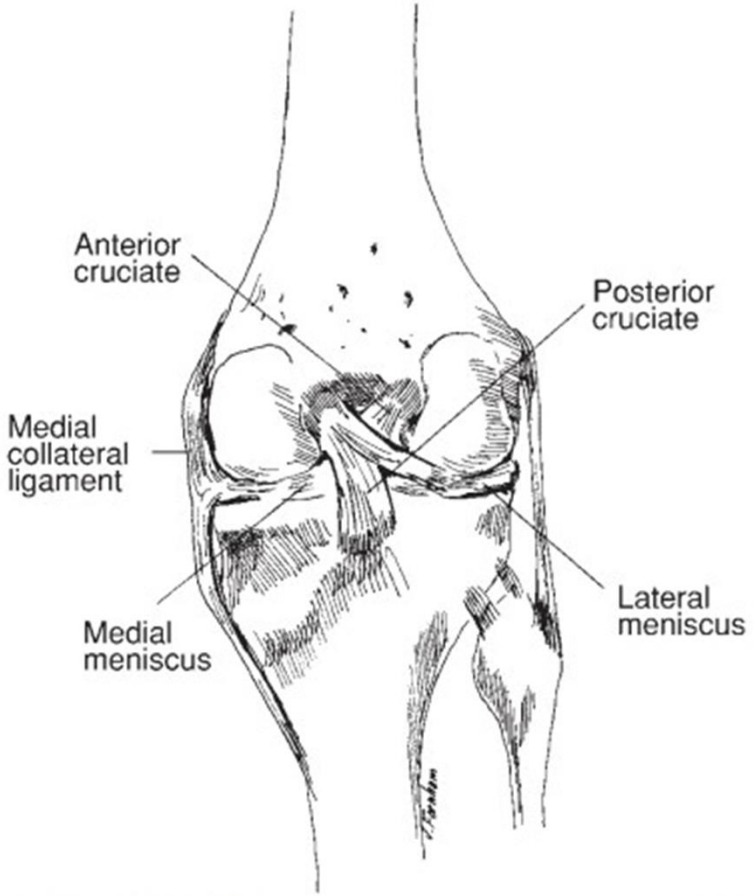
▲ **Figure 11-8** ■ A posteromedial view of an extended right tibiofemoral joint, showing the menisci tightly interposed between the femur and the tibia. The dotted lines indicate the wedge shape of the menisci and show how the menisci deepen and contour the tibial articulating surface to accommodate the femoral condyles.

Meniscal Attachments-

ATTACHMENTS	MEDIAL AND LATERAL MENISCI	
ORIGIN	Intercondylar tubercles of the tibia Tibial condyle via coronary ligaments Patella via patellomeniscal or patellofemoral ligament. Transverse ligaments. Anterior cruciate ligament	
	MEDIAL MENISCUS	**LATERAL MENISCUS**
UNIQUE	Medial collateral ligament semitendinosus	Anterior and posterior meniscofemoral ligament Posterior Ligaments Popliteus muscle



◀ **Figure 11-9** ■ Structure of the menisci. A superior view of the menisci illustrates differences in size and configuration between the medial and lateral menisci. The medial meniscus is C-shaped, whereas the lateral meniscus is shaped like a nearly complete ring or circle. The location of the attachments of the ACL and PCL on the tibial plateau are also shown.



▲ **Figure 11-10** ■ The medial meniscus is attached to t
medial collateral, anterior cruciate, and posterior cruciate ligamen
The lateral meniscus is also attached to the posterior cruciate li
ment (the joint capsule has been removed for visualization).

Physiological Valgus –

- Long axis of femur and tibia forms on the angle of 185° to 190°medially to create the physiological valgus at knee joint.
- An increase in normal physiological valgus that is more than 195 medially is an abnormal condition and known as genu valgum or knock knee.
- An decrease in medial tibiofemoral angle or normal physiological valgus that is 180 or less is known as Genu Varum or Bow knees.

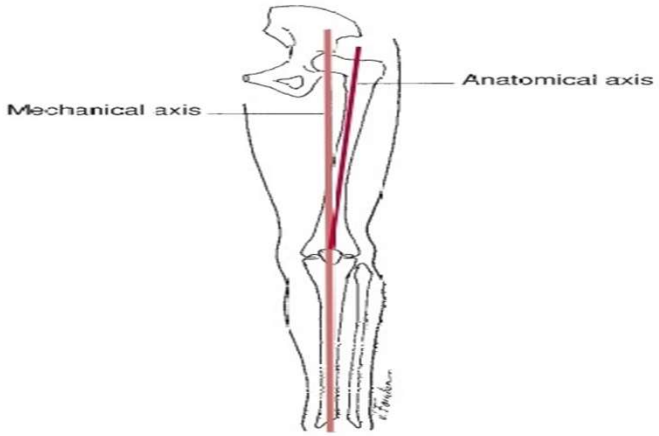


Figure 11–5 ■ The anatomic axes of the femur and t result in a normal physiologic valgus angulation of approxima 185°. The mechanical axis (weight-bearing line) of the lower extr ity passes from the center of the hip to the center of the ankle j and, in a neutrally aligned limb, results in weight-bearing forces are distributed about equally between the medial and lateral cond of the knee joint.

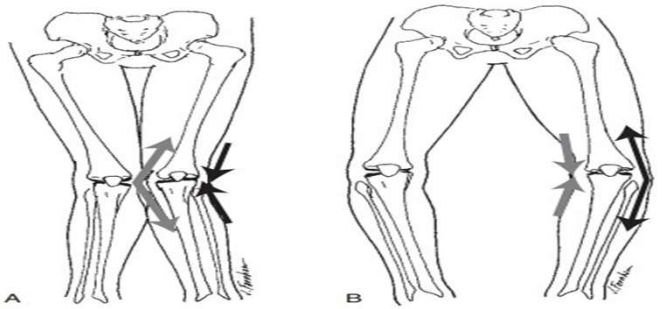
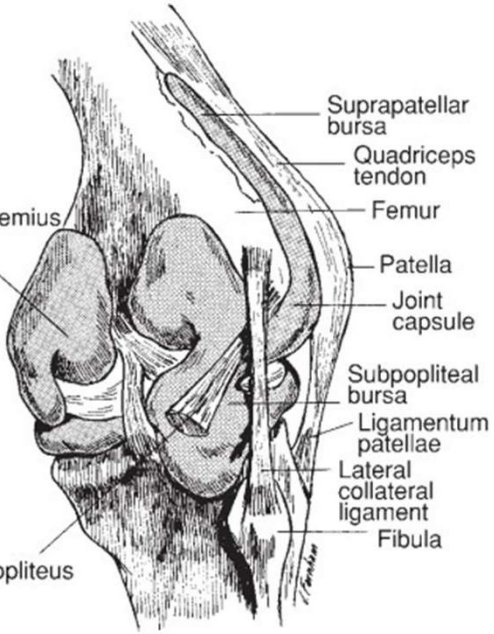


Figure 11–7 ■ A. An increase in the normal tibiofemora angle results in genu valgum, or "knock knees." Arrows on the latera aspect of the left tibiofemoral joint indicate the presence of com pression forces, whereas the arrows on the medial aspect indicate th presence of distraction (tensile) forces. B. A decrease in the norma tibiofemoral angle results in genu varum, or "bow legs." Arrows o the lateral aspect of the left tibiofemoral joint indicate the presenc of distraction (tensile) forces, whereas arrows on the medial aspect o the joint indicate the presence of compression forces.

nt Capsule –



11-12 ■ This view of the posterolateral aspect of the (with the fibrous outer layer of the capsule removed) plex course of the synovial layer of the knee joint cap- the related bursae.

- The joint capsule that encloses the tibiofemoral and patellofemoral joint is large, completely attached and lax wit several recesses.
- Posteriorly the capsule is attached proximally to the posterior margins of the femoral condyles and intercondylar notch and distally to the posterior tibial condyle.
- Medially and laterally the capsule begins proximally above the femoral condyles to continue distally to the margins of the tibial condyle.
- Anteriorly the patella, the tendon of the quadriceps muscle superiorly, and patellar ligament inferiorly complete the anterior portion of the joint capsule.
- Anteromedially and anterolaterally expansions from the vastus medialis and vastus lateralis muscle completes the capsule.

Synovial Lining-

The intricacy of the fibrous layer of the knee joint capsule is surpassed by it's synovial line, the most extensive and involved in the body. The synovium adheres to the inner wall of the fibrous layer except posteriorly where the synovium invaginates anteriorly following the contour of the femoral intercondylar notch.

Some of the important bursae of the knee joints are following-

Suprapatellar bursa

Prepatellar bursa

Deep infrapatellar bursa

Superficial infrapatellar bursa

Ligamentum mucosum.

Knee joint ligament-

Collateral ligament-

- Medial collateral ligament-
- Lateral Collateral ligament-

Cruciate Ligament

- Anterior Cruciate ligament
- Posterior Cruciate ligament

The knee joint capsule is reinforced by a number of ligaments that play an important part not only in knee joint stability but also in mobility.

Medial collateral ligament-

The medial collateral ligament attaches to the medial aspect of the medial femoral condyles sloping anteriorly to insert into medial aspect of proximal tibia.

The posterior medial fibres of the ligament blend with fibres of the joint capsule and some fibre extend medially to attach the medial meniscus.

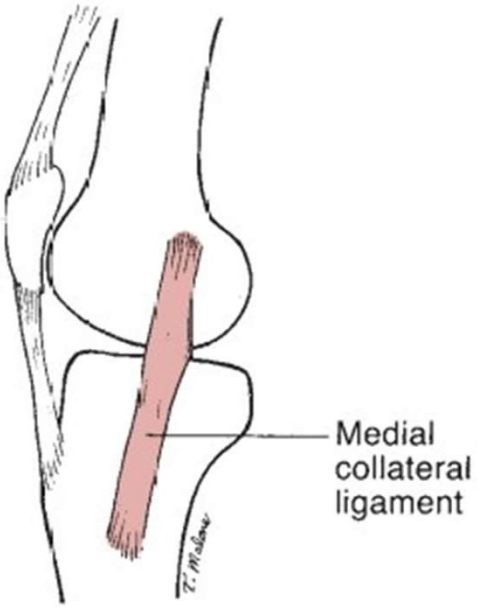
The MCL resist valgus stresse across the knee joint specially on extended knee.

Lateral collateral ligament-

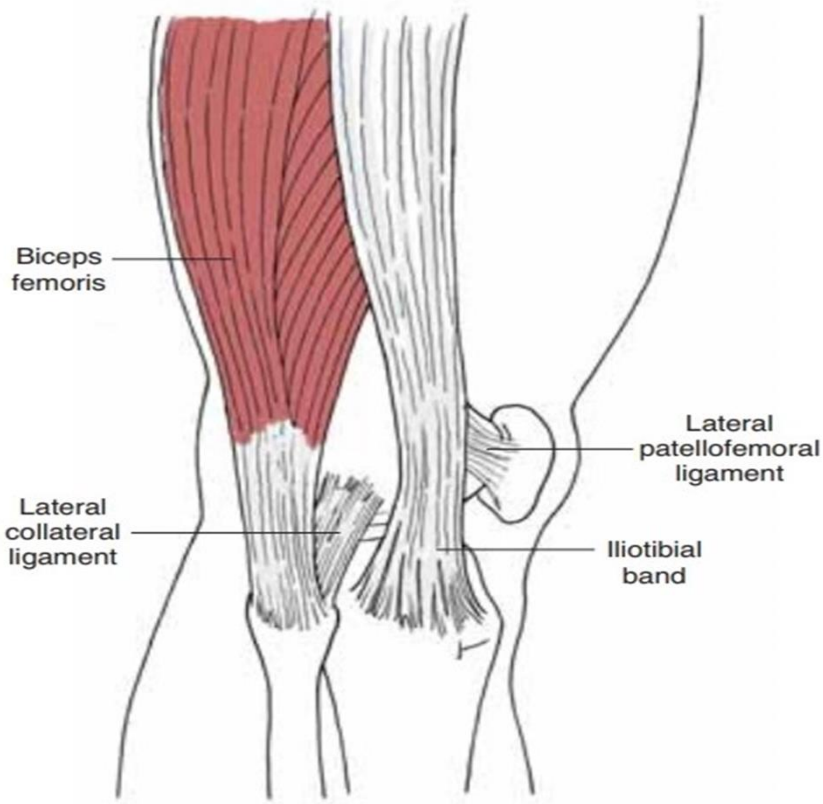
The lateral collateral ligament or fibular collateral ligament is strong cord like structure extending from the lateral femoral epicondyle and attaching posteriorly to the head of fibula.

Both collateral ligament are taut in full extension and therefore help resist in hyperextension of the knee joint.

The MCL resist valgus stresses and LCL resist varus stresses across the knee joint.



▲ **Figure 11–15** ■ The superficial portion of the medial collateral ligament (MCL) runs inferiorly from the medial femoral condyle to the anteromedial tibial condyle.



▲ **Figure 11–16** ■ Lateral collateral ligament joins the biceps femoris muscle in a common attachment to the fibular head, whereas the iliotibial band is also attached distally to the anterolateral tibia.

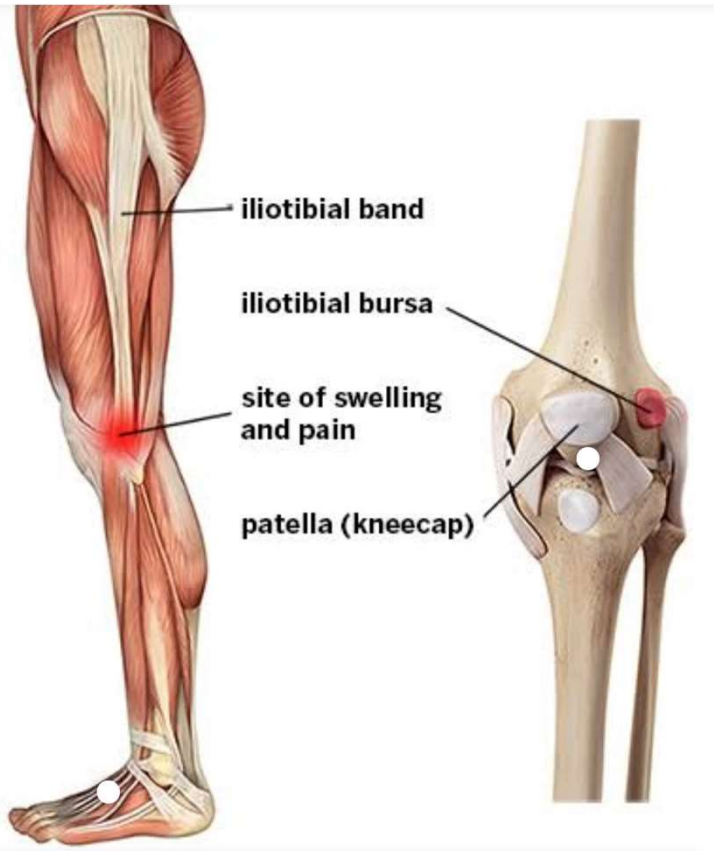
Iliotibial band-

The iliotibial tract / band is formed by-

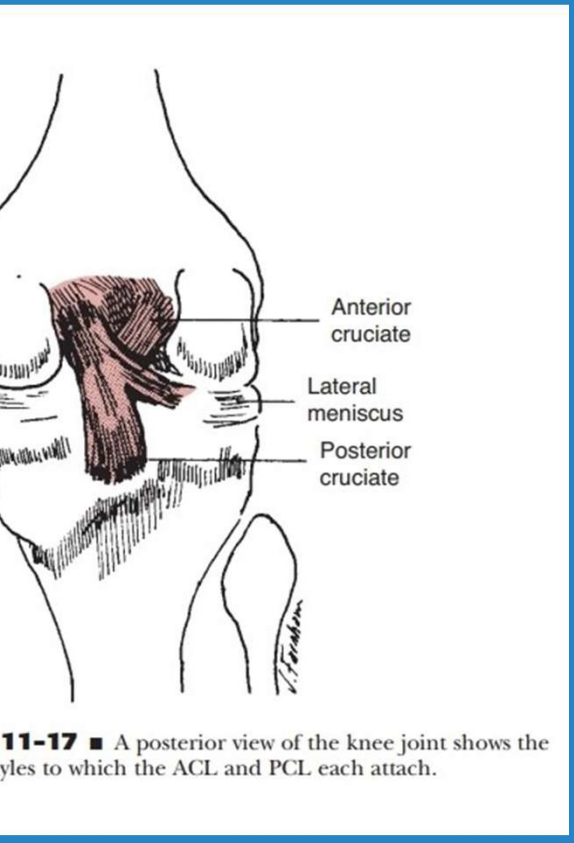
Proximally from the fascia investing the tensor fascia Lata, the Gluteus Maximus and the Gluteus Medius muscles.

The IT band continues distally to attach to the Linea aspera of the femur via the lateral intravascular septum and insert into the lateral tubercle of the tibia.

Reinforcing the anterolateral aspect of the knee joint. The IT band appears to be constantly taut regardless of the position of hip and knee joint.



uciate ament-



11-17 ■ A posterior view of the knee joint shows the yles to which the ACL and PCL each attach.

Anterior cruciate ligament and posterior cruciate ligament ar centrally located within the articular capsule but lie outside the synovial cavity.

These ligament named according to the tibial attachment.

(I) ACL

The ACL arising from anterior aspect of tibia passes under th transverse ligament and extend superiorly and posteriorly to attach to the posterior part of the inner aspect of lateral femoral condyle.

(ii) PCL

The PCL runs superiorly and somewhat anteriorly from its posterior tibial origin to attach to the inner aspect of the medial femoral condyle.

It is shorter and lesser oblique than ACL.

The ACL is generally considered the primary restrained to anterior displacement of the tibia on the femoral condyle.

The PCL is primarily restrained to the posterior displacement of tibia beneath the femur.

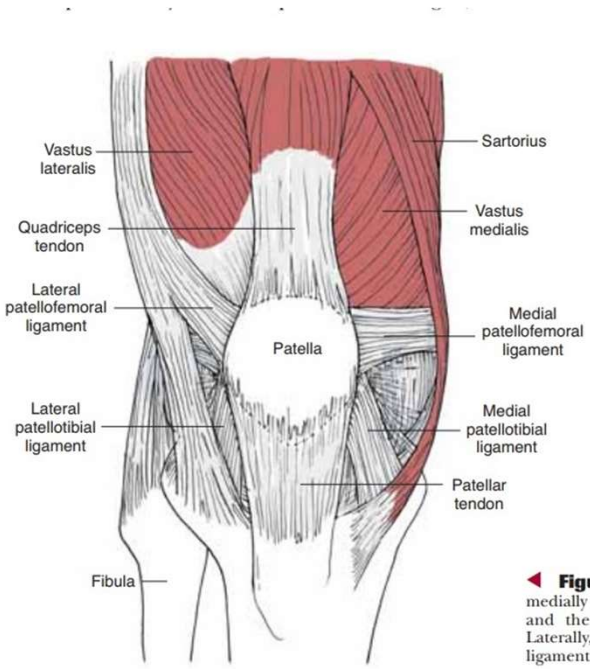


Figure 11-14 ■ The extensor retinaculum is reinforced medially by the transversely oriented medial patellofemoral ligament and the longitudinally oriented medial patellotibial ligament. Laterally, the lateral patellofemoral ligament and lateral patellotibial ligament help resist an excessive medial glide of the patella.

Posterior capsular ligament –

The posteromedial aspect of the capsule is reinforced by **oblique popliteal ligament** and posterolateral aspect of capsule is reinforced by **arcuate popliteal ligament** .

These ligament plays an important role in checking Varus and valgus stress respectively in the extended knee and in providing secondary strength to other tibial motions.

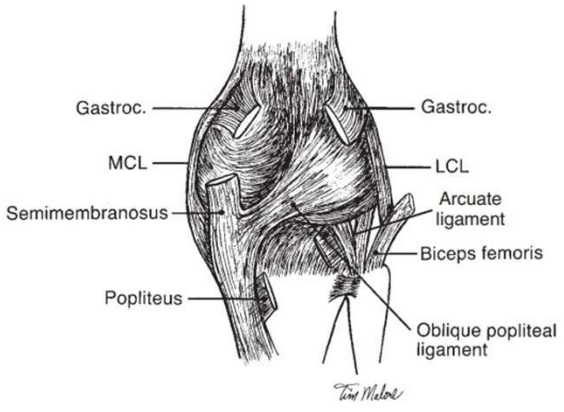


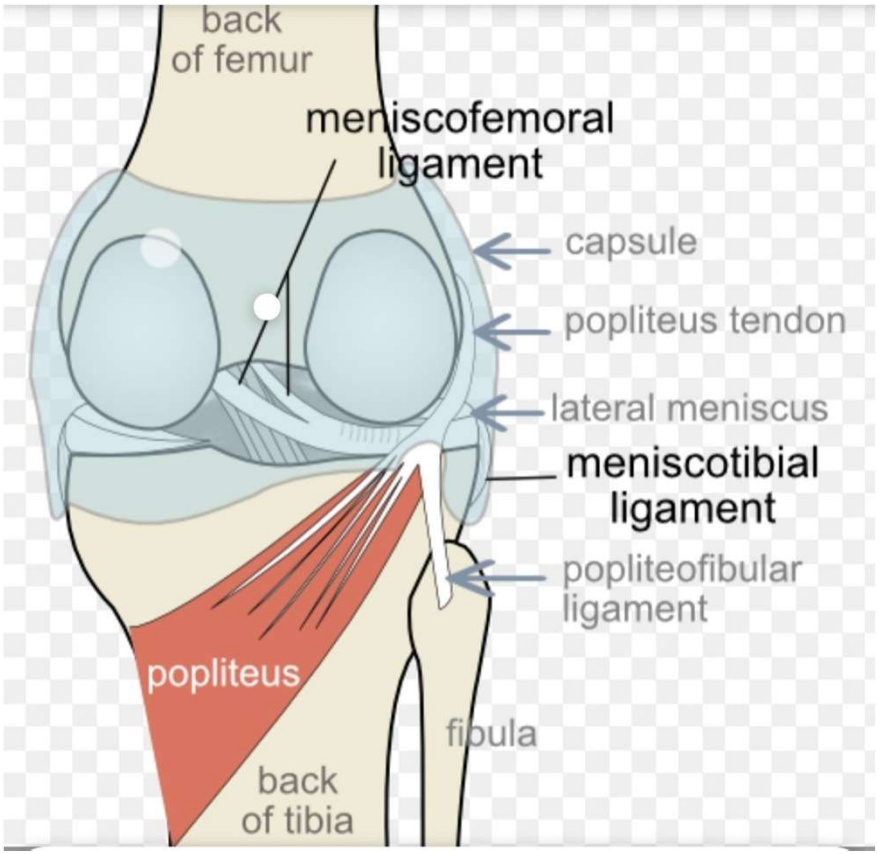
Figure 11-21 ■ A view of the posterior capsule of t knee joint shows the reinforcing oblique popliteal ligame Also seen are the collateral ligaments (MCL and LCL), t arcuate ligament, and some of the reinforcing posterior m culature (semimembranosus, biceps femoris, medial and l eral heads of the gastrocnemius, and the upper and lo sections of the popliteus muscles). The medially located p terior oblique (POL) muscle is not shown because it lies sup ficial to the other medial capsular structures.

Meniscofemoral ligament –

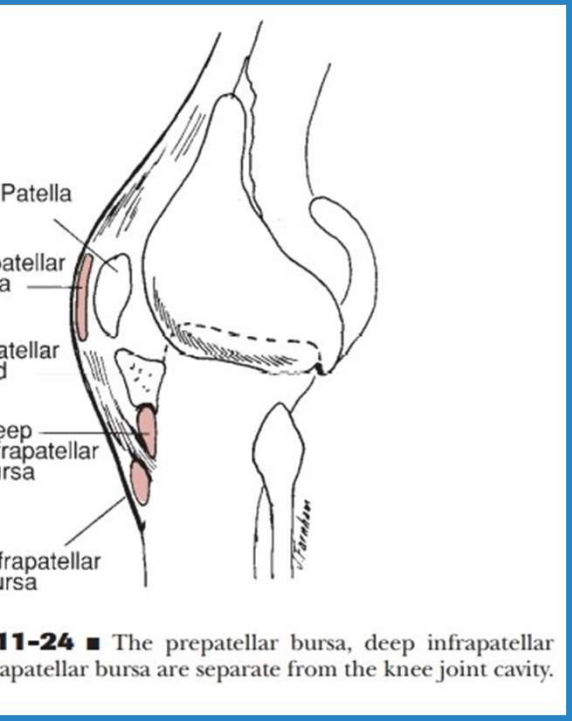
The 2 meniscofemoral ligament arise from the posterior horn of the lateral meniscus and insert on the lateral aspect of the medial femoral condyle near the insertion side of PCL.

The ligament that runs anterior to the PCL is called **anterior meniscofemoral ligament or ligament of Humphrey** and that runs posterior is called **posteriomeniscus femoral ligament or ligament of wrisberg** .

These ligament work in conjunction with the popliteus muscle and become taut during femoral lateral rotation and may prevent posterior translation of the tibia.



IEE JOINT URSAE –



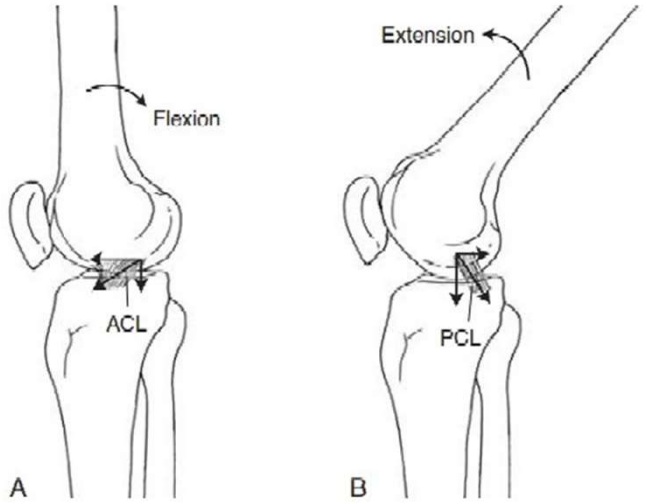
11-24 ■ The prepatellar bursa, deep infrapatellar apatellar bursa are separate from the knee joint cavity.

- The extensive ligamentous apparatus of the knee joint and large excursion of bony segment set up substantial frictional forces between muscular, ligamentous and bony structures.
- However, numerous bursae prevent or limit such degenerating forces.
- These are suprapatellar , sub popliteal , and gastrocnemius bursas .
- Several other bursae are pre-patellar, deep infrapatellar , subcutaneous infrapatellar bursae.

KNEE JOINT FUNCTION –

OSTEOKINEMATICS –

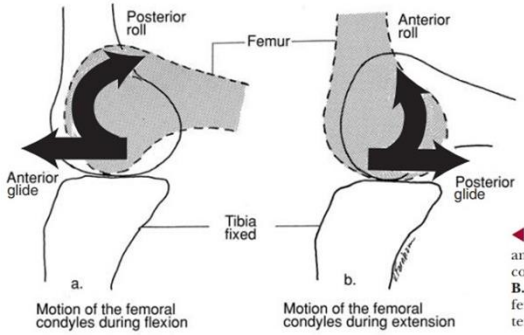
- The primary motion of knee joint are flexion / extension and to a lesser extent medial and lateral rotation .
- In weight bearing, the femur moves over tibia to bring out the flexion and extension while in non weight bearing the tibia moves over the femur .
- The rotation which is axial in nature can be carried out at 90°flexed knee, there will be medial and lateral rotation measuring 30° and 40° respectively.



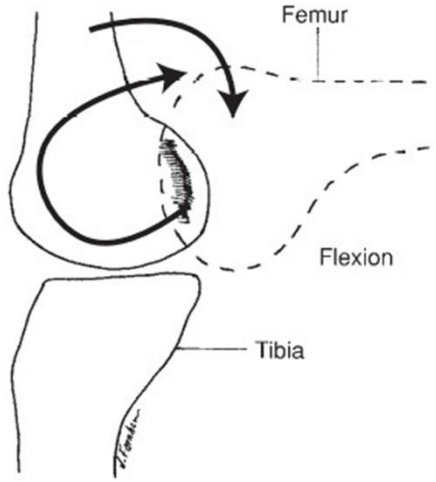
▲ **Figure 11-27** ■ **A.** In flexion of the femur, posterior rolling of the femoral condyles creates tension in the "rigid" ACL that results in an anterior translational force imposed by the ACL on the femur. **B.** In extension of the femur, anterior rolling of the femoral condyles creates tension in the "rigid" PCL that results in a posterior translational force imposed by the PCL on the femur.

Arthrokinematics –

- In weight bearing from flexion to extension the femur starts rolling over the tibia posteriorly followed by the sliding of femur posteriorly and then both movement together till the desired moment is achieved.
- From extension to flexion the femur slides first then rotates and then simultaneous movement takes place.
- In non weight bearing the flexion and extension, the rolling and sliding takes place in posterior direction and from extension to flexion in anterior direction.



◀ **Figure 11-26** ■ **A.** A schematic representation of rollir and gliding of the femoral condyles on a fixed tibia. The femor condyles roll posteriorly while simultaneously gliding anterior **B.** Motion of the femoral condyles during extension. Th femoral condyles roll anteriorly while simultaneously gliding po teriorly.



▲ **Figure 11-25** ■ Schematic illustration of pure rolling of the femoral condyles on a fixed tibia shows the femur rolling off the tibia.

Locking and Unlocking of knee joint-

- The locking mechanism of knee joint is also called **screw home mechanism** or phenomena.
- The medial femoral condyle is larger and lower than the lateral femoral condyle.
- The medial tibial condyle is larger to compensate femoral condyle.
- In weight bearing when flexed femoral condyle starts moving on fixed tibial condyle, the rolling and sliding movement takes place.
- There is anterior rolling and posterior sliding of femoral condyle occurs to keep the joint congruent.
- During extension when the femur is at 30° of flexion, the lateral condyle which is relatively shorter stops its rolling and gliding.

Locking-

- As the extension force is continuous the femur will keep on extending on medial condyle.
- The medial condyle will go for sliding and rolling.
- This movement causes the rotation of medial femoral condyles medially over medial tibial condyle around a relatively fixed lateral condyle.
- When last 5° of extension is left the rotation of femur is more dominant.
- At the same time vastus medialis pulls the patella medially to fit into the femoral joint so the further movement is not possible and knee is locked .
- So vastus medialis is known as muscles of locking at knee joint.

Unlocking-

The flexion will start only when the knee is unlock.

The unlocking will take place only when the medial femoral condyle will rotate laterally over the medial tibial condyle.

After 30° flexion the rotation will not occur and there will be posterior rolling and anterior sliding.

The rotation of femur is initiated by popliteus muscle, so it is known as muscle of unlocking of knee joint.

In non-weight bearing when Tibia is moving, the lateral rotation of tibia take place for locking and medial rotation of tibia for unlocking.

PATELLOFEMORAL JOINT-

Patella is a primarily an anatomically eccentric pulley and mechanism to reduce friction between the Quadriceps tendon and femoral condyles.

The patella has ability to slide on femoral condyles while remains sitted between them.

In full knee extension, patella sits on anterior surface of distal femur.

With knee flexion, patella slides distally on femoral condyles, sitting itself between the femoral condyles.

In full flexion, patella sinks into the intercondylar notch.

The sagittal plane motion of the patella is called Patellar Flexion.

Knee extension reverse the sliding of the patella and bring it back to the patella surface of the femur known as patellar extension.

Patellofemoral articular surfaces –

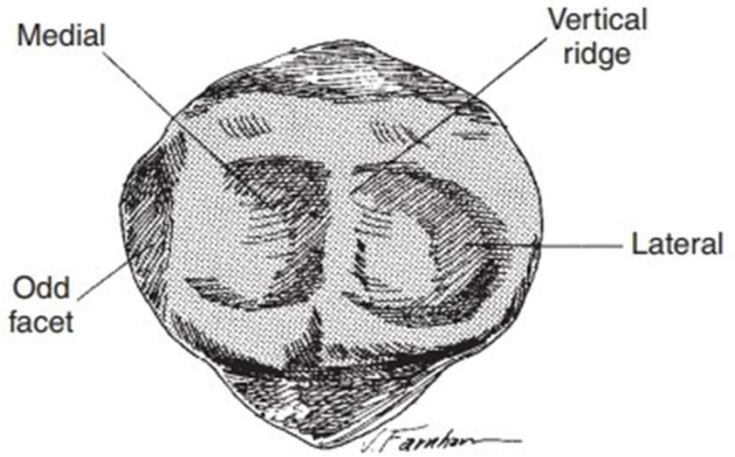
The triangularly shape patella is distinguished by being the largest sesamoid bone in the body.

Patellofemoral joint is least congruent joint in the body.

The total articular surface of the patella is much smaller than the femoral trochlear surface.

The posterior surface of patella is covered by articular cartilage and divided by a vertical ridge into approx. equal size medial and lateral patellar facets.

Medial facet is smaller than lateral patellar facet.



▲ **Figure 11-39** ■ Articulating surfaces on the posterior aspect of the patella.

At least 30% of patella also have second vertical ridge toward the medial border, separating the medial facet from extreme medial edge known as **odd facet of Patella.**

The femoral surfaces are concave side to side but convex top to bottom.

The lateral facet is slightly more convex than medial surface and has highly developed lip than medial surface.

The angle formed by medial and lateral facets has been found to average - 138° but varies individually – (116° - 151°).

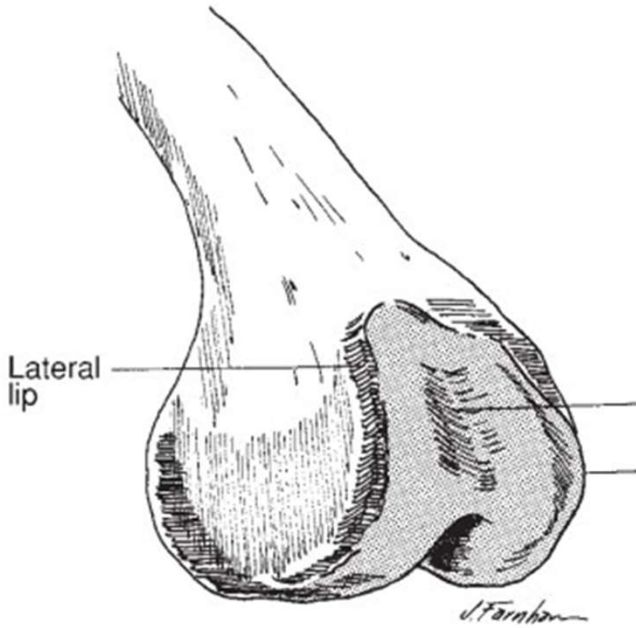
Patellofemoral joint congruence –

In fully extended or neutral knee the patella lies on the femoral sulcus.

Patella in neutral / extended knee has little or no contact with femoral sulcus beneath it.

The first consistent contact of patella is made at 10°–20° of flexion on inferior margin of patella across both medial and lateral facets.

With increase in flexion, area of contact increase and shifts from distal to proximal.



▲ **Figure 11-40** ■ Articulating surfaces on the
Note the well-developed lateral lip on the lateral aspe
lating surface.

By 90° of knee flexion, all portion of patella have experienced some contact except the odd facet.

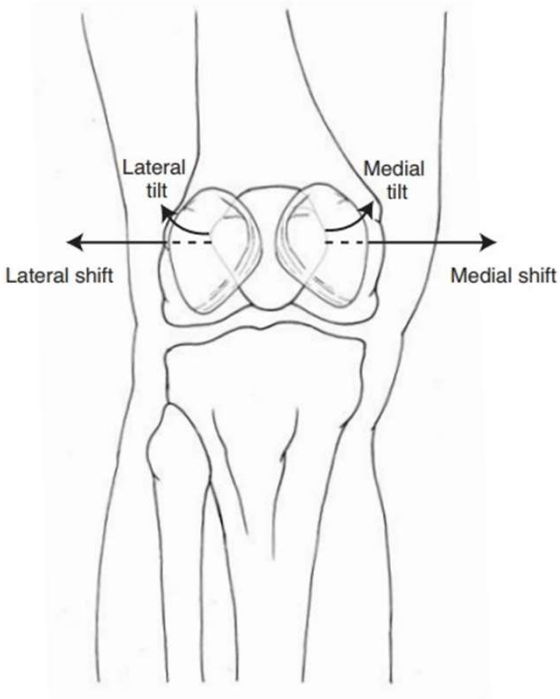
As flexion continues past 90° the medial facet enters the intercondylar notch, odd facet achieves contact for first time.

At 135° of flexion, contact is on the lateral and odd facets, with medial facets completely out of the contact.

Patellofemoral motion –

Patellar motion -

1. Medial and lateral patellar tilt
2. Medial and lateral rotation of patella
3. Medial and lateral patellar shift



▲ **Figure 11-42** ■ Patellar motions with respect to the femur. Medial/lateral shift is named on the basis of the direction in which the patella is moving; medial/lateral tilt is named for the direction toward which the anterior surface of the patella is moving.

Medial and Lateral Patellar Tilt-

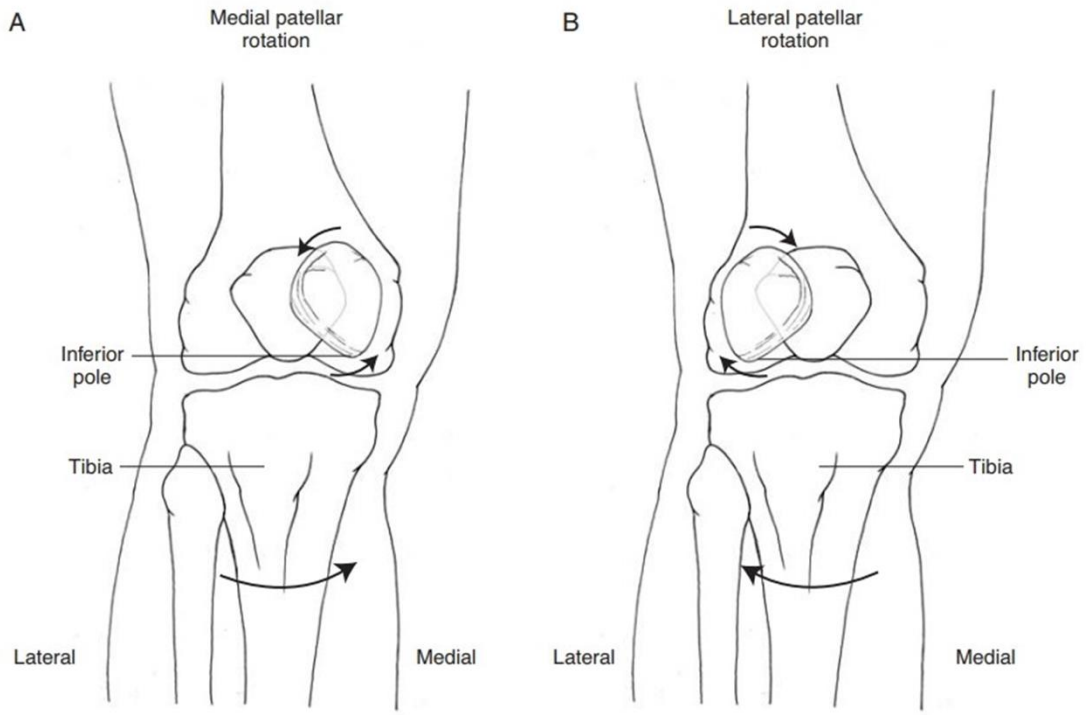
The tilting motion helps the patella accommodate to some of the asymmetry of the femoral condyle when it travels down the femur during the knee flexion.

The tilting of the patella on the medial sides is called Medial patellar tilt (0°-30°) and tilting on lateral side is called lateral patellar tilt (20°-30°).

Medial and lateral rotation of patella-

In medial rotation of patella the inferior pole of the patella follow medial rotation of tibia, while femur rotate laterally on the tibia .

In lateral rotation of the patella the inferior patellar pole remain laterally with the tibia as the femur rotate medially on the tibia.



▲ **Figure 11-43** ■ **A.** Medial rotation of the patella. The inferior pole of the patella follows the tibial tuberosity during medial rotation of the tibia. **B.** Lateral rotation of the patella. The inferior pole of the patella follows the tibial tuberosity during lateral rotation of the tibia.

Patellar Shift-

The mediolateral translation the patella undergoes during knee joint movement is referred as patellar shift .

Shifting on the medial side is known as **medial patellar shift.**

Shifting on the lateral side is known as **lateral patellar shift.**

Lateral shift = 7.5 – 10 mm

Medial shift = 9.6 mm (approx.)

Q-angle or Quadriceps angle-

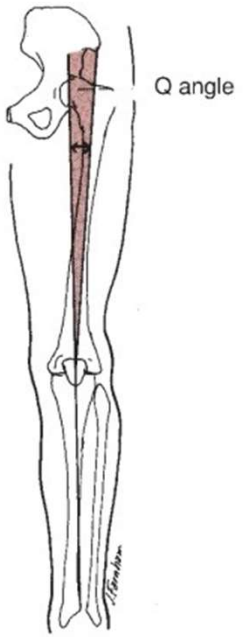
The Q-angle is the angle between a line connecting the ASIS to the mid point of patella and the extension of line connecting the tibial tubercle to the mid line of patella.

The net effect of pull of quadriceps and patellar ligament is commonly assessed clinically using Q-Angle of knee.

An angle of 10°-15° measured with the knee either in full extension or slightly flexed is considered to be normal.

Females have a little bigger Q angle due to the larger pelvis.

A Q-angle of 20° or more is considered to be abnormal, creating excessive lateral forces on the patella that may lead patella to pathological changes.



▲ **Figure 11–47** ■ The Q-angle is the angle between a line connecting the anterior superior iliac spine to the midpoint of the patella and the extension of a line connecting the tibial tubercle and the midpoint of the patella.

THANK YOU