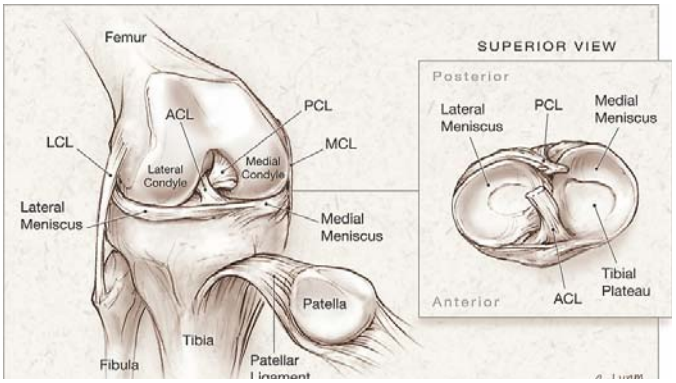
ANATOMY



Type of joint

Knee: modified hinge or condyloid

Patello-femor joint:is a saddle joint

Locking mechanism

Rotation pivots on the Lateral condyle and the medial condyle glides backwards
It occurs around the ACL
Vastus medialis locks the joint and the popliteus muscle unlocks the knee joint

Movement occurs

Flexion and extension occurs above the meniscus [0-130º]
Rotation of the knee occurs below meniscus

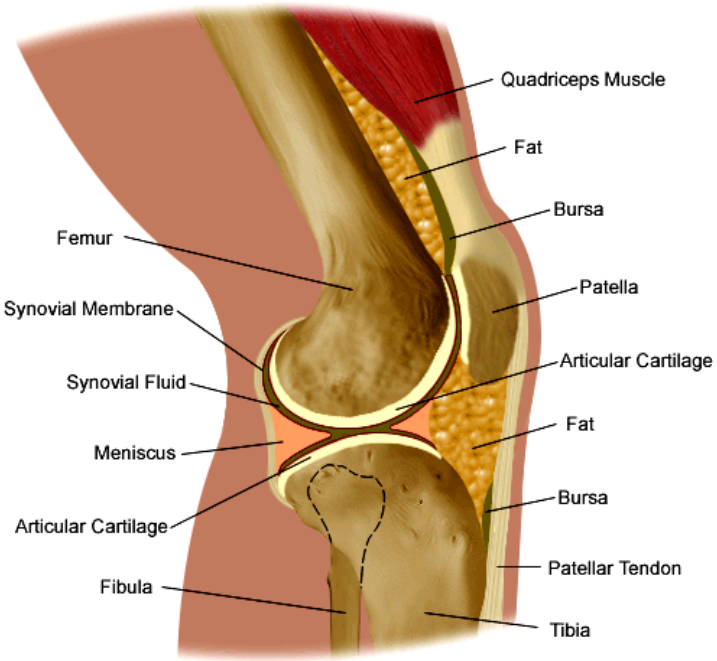
Nerve supply

1.Femoral nerve supplies the knee joint through 3 muscular branches to quadriceps [vastus medialis, intermedius and lateralis]

2. Sciatic nerves through a direct genicular branches

3. Obuturator Nerve through it's posterior division through middle genicular artery

Anatomy of the Knee



Bursae

4 Anterior bursae

Suprapatellar bursa
Prepatellar bursa
Superficial and deep infrapatellar bursa

2 Medial bursae

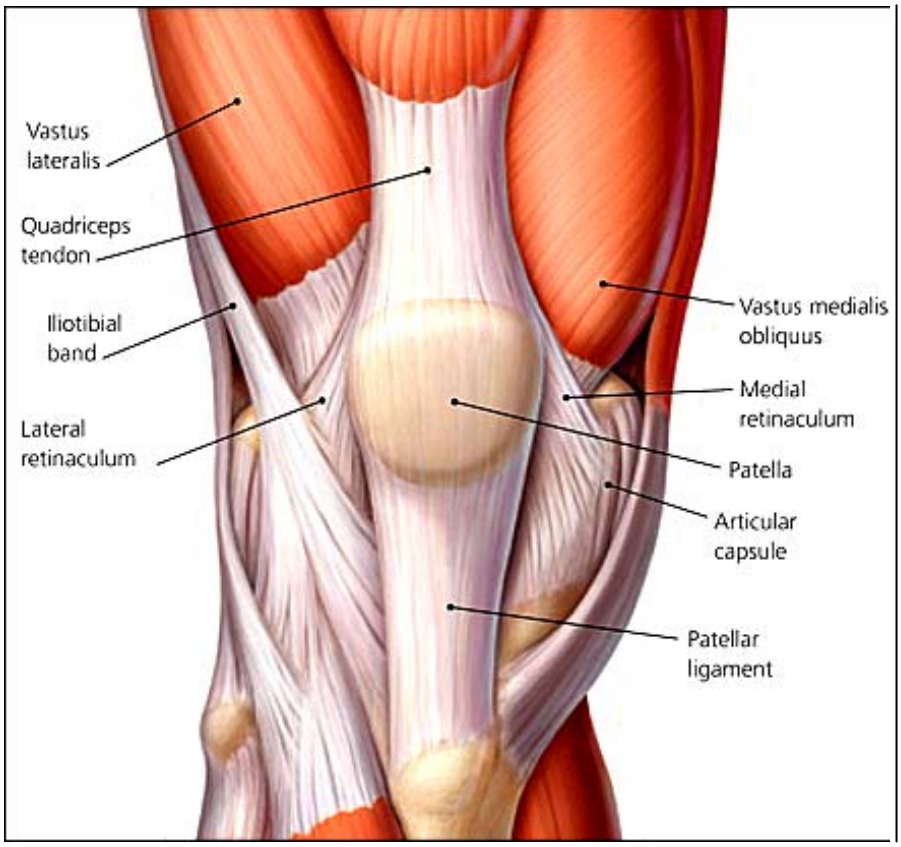
Between MCL and Pes anserinus
Between MCL and Semimembranous and capsule

2 Lateral bursae

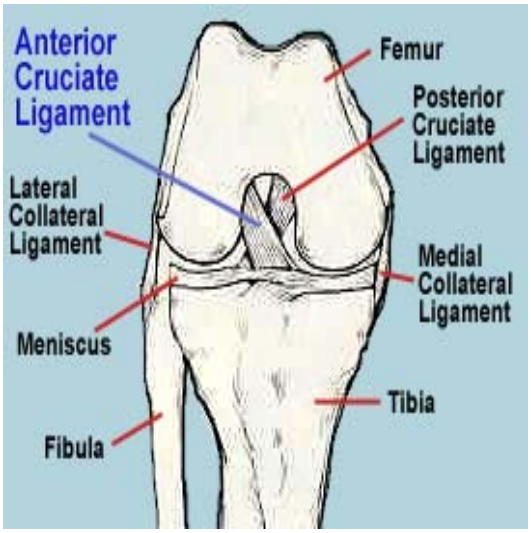
Between Lateral collateral ligament and biceps tendon
Between Popliteus and Capsule

4 Posterior bursae

2 Between lateral and medial gastrocnemius and joint capsule
1 Between Semimembranous and Medial Gastrocnemius
1 Popliteus and back of the tibia (synovial extension)



ACL [Anterior cruciate ligament]



Intra-articular and extrasynovial ligament

Length and width: 30-40 mm x 11mm
Fibers rotate by 90° between its attachments

Tibial attachment is anterior and stronger than femoral.
Femoral attachment is to the medial side of the lateral femoral condyle

Anterior fibres: blend with Anterior horn of the lateral Meniscus

2 bundles Anteromedial [tight in flexion]
Posterolateral [tight in extension]

When the knee is extended, the ACL is a relatively flat, ribbon-like ligament composed of many parallel fibers.
Blood Supply Middle Genicular Artery

Nerve supply Golgi tendon receptors

Load to failure 1700N [Normal walking 170N; Running 500N]

Strain rate plays a role in the location of ligament failure

High strain rate Midsubstance tears [common]
Low strain rate Avulsion from tibial attachment [seen in children with tibial eminence fracture]

Tension in cruciate ligament

Tension is constant in all position. This is due to different fibers in the ACL experience different tension from flexion and extension and the whole ligament is not in constant state of tension.

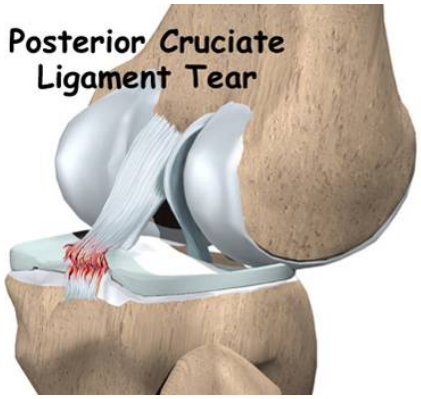
Function of ACL

1. ACL Carries loads throughout flexion
2. Normally it carries small load ie., 500 N [fails at 2500 N]
3. Highest loading of ACL is during quadriceps powered extension moving from 40° flexion
4. Tunes roll back with PCL. 4 bar linkage
5. Prevents anterior translation
6. Important for rotational instability

ACL VS MCL

	MCL	ACL
Macroscopic	Extra-articular;Flat; uniform	Intra-articular; varied
Collagen	Fibres are parallel Densely packed	Varied and Nonparallel Less fibers
Electron Micro	Mean fibril diameter is larger	Is smaller
Elastic Modulus Tensile strength	2 fold more than ACL 110 MPa	Less than MCL 70 MPa (Medial bundle)
Healing	Heals. No surgery required	Always need surgery

Posterior cruciate ligament [PCL]



Intra-articular and extrasynovial ligament

Its mean length is 38 mm and mean width 13 mm

2 bundles Anterolateral [larger and 85%]
Posteromedial bands

Anterolateral band is tight in flexion and lax in extension while the posteromedial bundle is tight in extension and lax in Flexion

Division of PCL increases in the Patellofemoral joint forces. This may lead to Patello-femoral arthritis.

Medial structures of the knee

3 layers: Superficial, middle and deep layers

Grouped: into anterior, middle and posterio third

	Anterior	**Middle**	**Posterior**
Superficial	Fascia	Fascia	Layer of fascia
Middle	None	Superficial MCL	Posteromedial capsule
Deep	None	Deep MCL	Posteromedial capsule

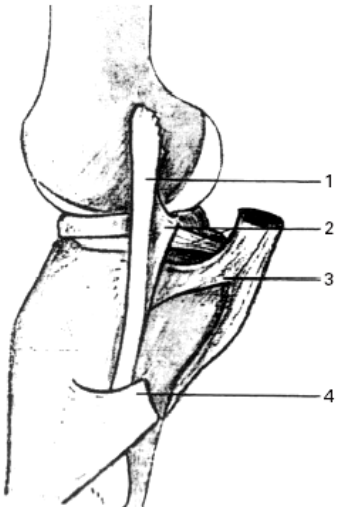
3 important medial ligamentous structure

1. Superficial MCL

Femur attachment: 1cm anterior and distal to Adductor tubercle
Tibia attachment: Under Pes Anserinus [6 cm distal to the joint]

Fibers are grouped into

a. Anterior fibers Parallel fibers
b. Posterior fibers Oblique
Posterior oblique ligament



2. Deep MCL

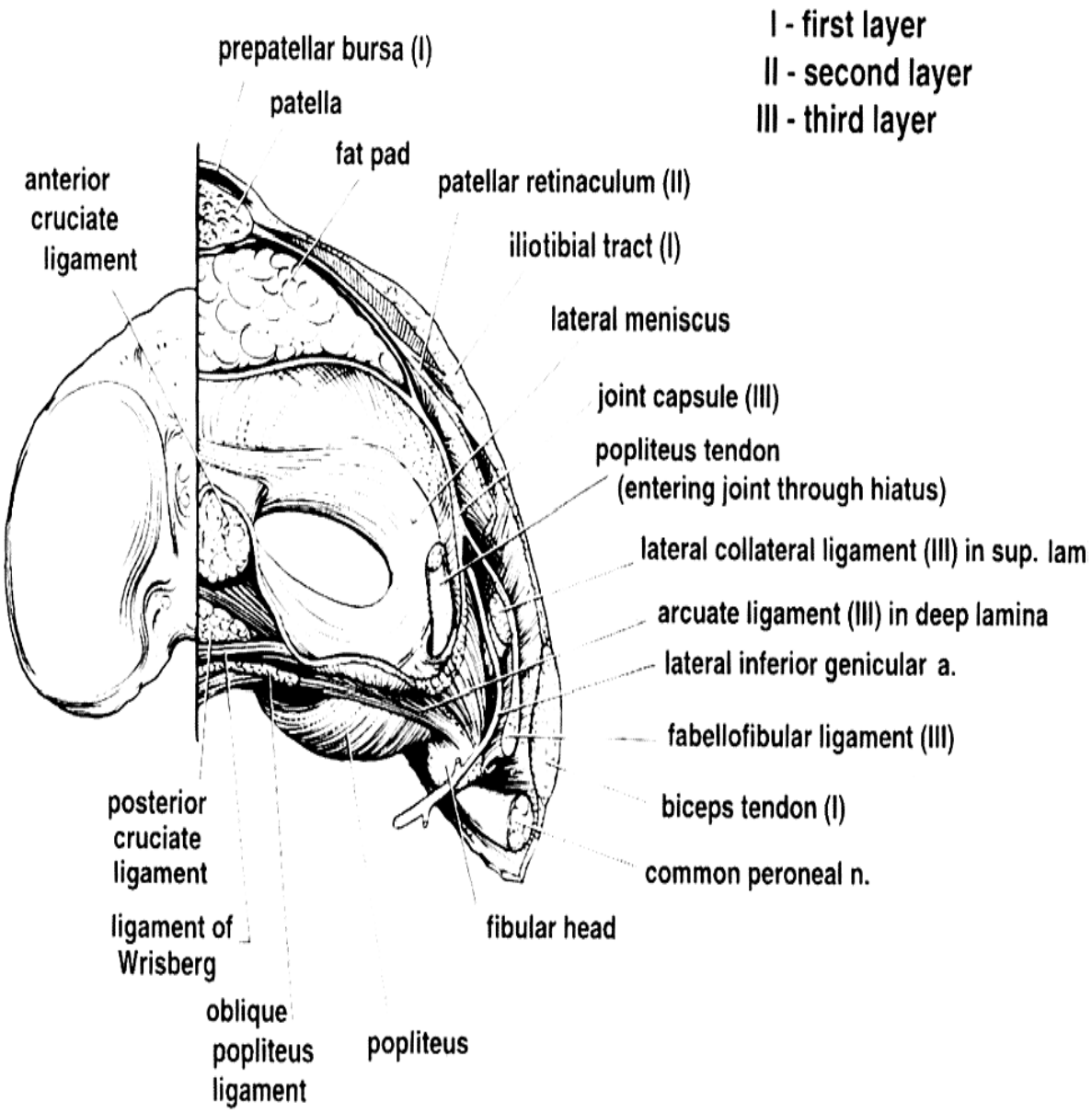
Femur: Femur just below Superficial
Tibia: close to the articular margin

3. Posteromedial capsule
Blending of superficial and deep MCL and Semimbranous extension
Posterior oblique ligament probably not distinct and is as above

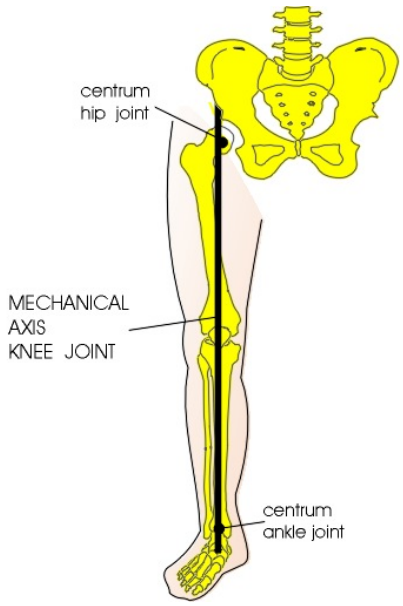
Appears to dynamically stabilised by Semimembranous

Lateral structures of the knee [Seebacher]

I layer Biceps Femoris; Iliotibial band
II layer Quadriceps retinaculum; Patellofemoral ligament
III layer Superficial: Lateral collateral ligament; Fibulo-fabellar ligament
Deep: Coronary ligament, Arquate ligament, Popliteo-fibular ligament


I - first layer
II - second layer
III - third layer
prepatellar bursa (I)
patella
fat pad
anterior cruciate ligament
patellar retinaculum (II)
iliotibial tract (I)
lateral meniscus
joint capsule (III)
popliteus tendon (entering joint through hiatus)
lateral collateral ligament (III) in sup. lam
arcuate ligament (III) in deep lamina
lateral inferior genicular a.
fabellofibular ligament (III)
biceps tendon (I)
common peroneal n.
fibular head
posterior cruciate ligament
ligament of Wrisberg
oblique popliteus ligament
popliteus

III. BIOMECHANICS



a. Anatomic and mechanical axis

Mechanical axis: Centre of the hip to the centre of the ankle
Anatomic axis of femur is approx 6 degrees of valgus from mechanical axis or 9 degrees of valgus from vertical axis
Anatomic axis of tibia is 3 degrees of varus from mechanical axis

Lines that intersect the tibia and the femur intersect at knee 6

Posterior slope in the tibial plateau is 9 º

2. The "screw home mechanism

Rotation between the tibia and femur occurs automatically between full extension (0^o) and 20^o of knee flexion.
External rotation of the tibia on femur during full extension is Obligatory external rotation

This occurs because of differential radii. Medial femoral larger than lateral (by 17mm). At full extension, medial tibial plateau has to cover more distance and this causes external rotation of the tibia.

This screw home: very stable and both Cruciates are tight and very minimal movement occurs between tibia and femur

1.During knee extension
The tibia glides anteriorly on the femur.

2.During the last 20 degrees of knee extension
Anterior tibial glide persists on the tibia's medial condyle because its articular surface is longer in that dimension than the lateral condyle's.

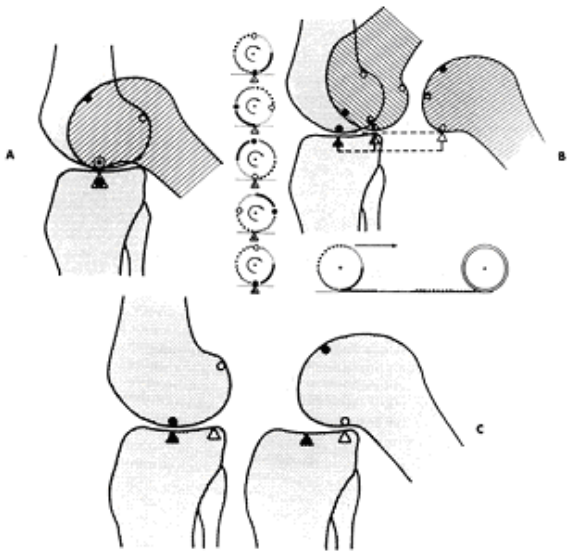
3.Prolonged anterior glide
On the medial side produces external tibial rotation, the "screw-home" mechanism

c. Sliding and rolling

With 0-15 º of flexion: [Rolling prominent]
Sliding::Rolling is 1:2

With 15 º-130 º of flexion: [Sliding prominent]

Sliding::Rolling is 4:1



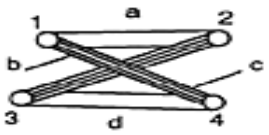
From kinematics studies,

Flexion and extension do not occur about a fixed transverse axis of rotation but rather about a constantly changing center of rotation (polycentric rotation).

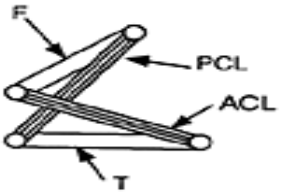
Motion is therefore achieved by a complex coupled mechanism in which the femoral condyles simultaneously glide and roll back on the tibial plateaus

D. 4 Bar linkage

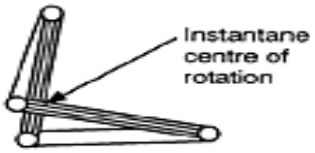
4 Bars ACL, PCL, Femur: Roof of the intercondylar notch, Tibia intercondylar eminence



(a) Straight leg



(b) 45 degrees bent



(c) 90 degrees bent

Relation to Femoral link

Extension: ACL is parallel to the Femoral link
Flexion PCL is parallel to the femoral link.

Isometry Only Some fibers in ACL and PCL is isometric during any ROM.

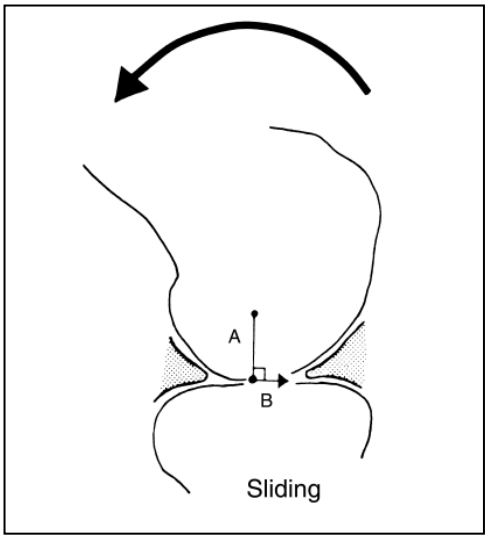
With flexion and extension

None of the length of bars changes with movement but angle between ACL and PCL changes.

e. Instant centre

Centre is at the intersection of ACL and PCL. Therefore do not produce moment .

Line from instant centre to tibifemoral contact point forms perpendicular to the tangential to the tibia.



f. Movement

Normal range 0-140º

Functional range -3 to 120 º

Walk : Heel strike 15 º flexion

Sprint: Heel strike 30 º

Swing 60 º

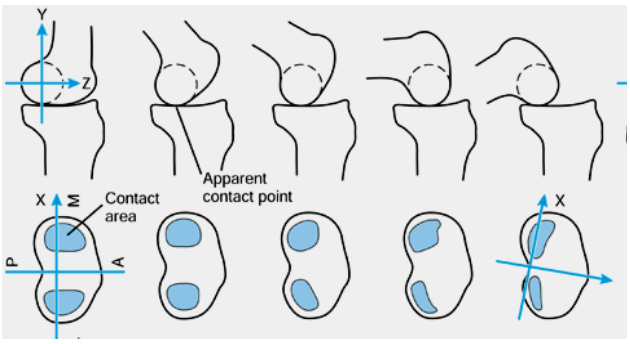
Getting in and out of chair 115 º

Climbing stair 90 to 100 º

g. Primary joint restraints

	Primary	**Secondary**
Anterior	ACL	Deep MCL
Posterior	PCL	Posterolateral complex
Varus	LCL	Posterolateral complex
Valgus	MCL	Cruciates
Internal Rotation	MCL	ACL
External Rotation	LCL & posterior complex	PCL

H. Posterior roll back



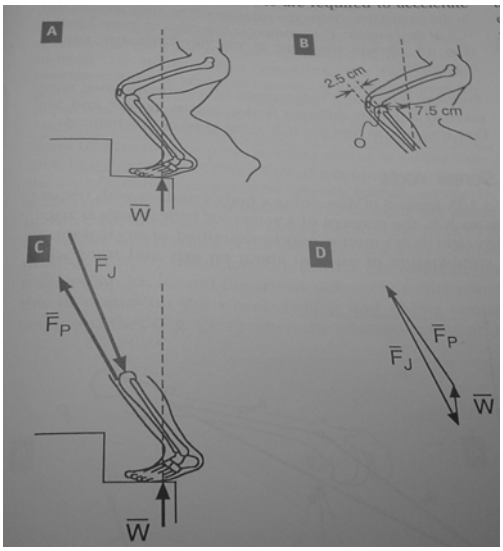
On knee flexion, both femoral condyles roll back. This is due to four bar linkage.

PCL retaining supposed favour normal roll back

Roll back: increases maximum knee flexion.

And it increases patello-femoral moment arm

1**I. Tibio-femoral force**



- Moment: Fq x 2.5 = W x 7.5 ie., Fq=3 x W

- Sum of Forces: F q+ Fj+ Fw = 0

Fq = Quadriceps force; Fj = Joint reaction force