

ANATOMY OF THE KNEE

Injuries to the knee are very common. The anatomy of the knee has been studied extensively. This section will attempt to cover major aspects of knee anatomy.

BONY ANATOMY:

A knee joint proper consists of three bones: the femur, the tibia and the patella. The two major articulations within the knee are the tibiofemoral and patellofemoral joints.

Tibiofemoral Articulation:

This portion of the knee joint is made by the articulation of the upper thighbone (femur) with the lower leg bone (tibia). The end of the femur has two rounded structures known as the femoral condyles. The lateral femoral condyle is on the outside part of the knee while the medial femoral condyle is on the inside. The medial condyle is larger and more symmetrical than the lateral condyle.

Between the two condyles is an area known as the intercondylar notch. This area houses the femoral attachments of the cruciate ligaments. The anterior cruciate ligament (ACL) originates from the lateral side of the notch and the posterior cruciate ligament (PCL) attaches to the medial side. The roof of the notch is generally rounded but in some patients the notch has a triangular, stenotic configuration that may place them at risk for injuring the ACL.

The upper end of the tibia is formed by the medial and lateral tibial plateaus. Two tibial spines are located in the central portion between the tibial plateaus and these help contribute to stability of the knee. The ACL inserts on the tibia in this area.

The tibial tubercle is located past the knee joint in the front part of the knee. This serves as the attachment site for the patellar tendon which connects the kneecap to the lower leg bone.

Motion of the tibiofemoral joint is complex. The knee does not move as a simple hinge but there is a complex combination of gliding and rolling of the femur on the tibia.

Patellofemoral Articulation:

The patella (kneecap) lies within the strong thigh muscle known as the quadriceps. The cartilage on the undersurface of the kneecap is the thickest in

the human body. The kneecap glides up and down on the front surface of the femur bone as the knee flexes and extends.

In some patients, the kneecap tends to slip towards the outside of the knee. These patients may have difficulty with kneecap dislocations or with pain which affects the knee joint.

NEUROVASCULAR ANATOMY:

Blood Supply to the Knee:

The blood supply of the knee is derived from branches of several arteries, including the descending genicular artery, the medial and lateral superior genicular, the medial and lateral inferior genicular arteries, the middle genicular artery, and the anterior and posterior recurrent arteries. All these branches come together about the knee and help supply the knee joint proper.

Blood Supply to the Menisci:

The blood supply of the medial and lateral menisci originates predominantly from the lateral and medial genicular arteries. Anatomic studies have shown that the degree of vascular penetration is 10 to 30% of the width of the medial meniscus and 10 to 25% of the width of the lateral meniscus. The central portions of the meniscus do not have a direct blood supply. As a result, tears that occur away from the periphery of the meniscus are unlikely to heal, even with surgical treatment.

Blood Supply to the Cruciate Ligaments:

The blood supply to the ACL and PCL ligaments originate from branches of the middle genicular arteries primarily. The blood supply to the ligaments is primarily of soft tissue origin. The connection of the ligament to bony structures does not appear to contribute significantly to the vascular schema.

MENISCI:

The menisci are C-shaped discs of fibrocartilage that occupy the space between the condyles of the femur and the tibial plateaus. These are the structures that are commonly thought of when someone experiences "torn cartilage." The menisci deepen the surfaces of the tibia to allow it to receive the condyles of the femur. The peripheral border of each meniscus is thick and is attached to the fibrous capsule of the knee joint. The central border tapers to a thin, free edge.

Medial Meniscus:

The medial meniscus is a semi-circular structure which is wider toward the back of the knee than toward the front. The anterior horn of the medial meniscus is attached to the tibial plateau, just in front of the area where ACL attaches. The anterior often "drops off" the tibial plateau with the majority of its insertion sitting below the knee joint itself. The posterior horn of the medial meniscus is firmly attached to the tibia in the back of the knee near the attachments of the lateral meniscus and the PCL.

Lateral Meniscus:

The lateral meniscus is almost circular and covers a larger portion of the lateral tibial plateau when compared to the amount of medial meniscus covering the medial tibial plateau. The lateral meniscus is approximately the same width in both the front and back. The anterior horn of the lateral meniscus attaches to the tibia in front of the intercondylar eminence in association with the ACL. The lateral meniscus is more loosely attached to the joint capsule than the medial meniscus.

On occasion, the lateral meniscus may be "discoid". In this case, rather than tapering centrally, the meniscus occupies the entire space between the tibia and femur. Patients who have discoid meniscus may complain of audible "snaps" during flexion and extension of the knee.

Functional Anatomy:

When the knee bends, the menisci move toward the back of the knee. As the knee straightens, they move toward the front of the knee. The menisci act as "shock absorbers" and reduce the force per unit area on the proximal tibia. Loss of meniscal tissue increases stresses on the joint surface and predisposes the development of osteoarthritis. In addition, the presence of the menisci may provide some stability to the knee in cases where the ligaments are deficient.

CRUCIATE LIGAMENTS:

Ligaments are structures which connect one bone to another bone. The ligaments primary importance of the knee are the anterior cruciate (ACL), posterior cruciate (PCL), medial collateral (MCL) and lateral collateral (LCL) ligaments. Each of these ligaments serves to attach the upper leg bone (femur) with one of the two lower leg bones (tibia or fibula).

Anterior Cruciate Ligament:

The anterior cruciate ligament attaches from the lateral aspect of the intercondylar notch of the femur to a point further toward the front of the knee on the intercondylar eminence of the tibia. The ACL is the primary restraint against forward motion of the lower leg bone on the upper leg bone.

If the ACL is torn, the knee will often become unstable with episodes in which the knee "gives out." The result of these giving away episodes can be damaging to the meniscal cartilage, as well as to the joint surfaces themselves. Eventually, patients with recurring episodes of given away often develop osteoarthritis.

Posterior Cruciate Ligament:

The PCL runs from the inside part of the intercondylar notch on the femur to a point on the back of the upper surface of the tibia. The PCL is the primary restraint against backward motion of the lower leg bone (tibia), on the upper leg bone (femur). Many patients can tolerate an injury to the PCL and function fairly well. However, some patients will develop problems with osteoarthritis and require reconstruction of the PCL if it is damaged.

ANTERIOR ASPECT OF THE KNEE: QUADRICEPS MECHANISM

The four muscles that make up the quadriceps mechanism are the largest muscle unit in the body. The muscles comprising the quadriceps are the rectus femoris, vastus lateralis, vastus intermedius, and vastus medialis. All these muscles attach to the kneecap and function as a unit in the knee.

The medial and lateral patellar retinacula are extensions of the quadriceps tendons. In some patients, the lateral retinaculum may bind the kneecap down causing pain and contributing to instability. In these patients, releasing the retinaculum will help reduce pain.

MEDIAL ASPECT OF THE KNEE:

The medial aspect (inside portion) of the knee has been described by Warren and Marshall as being comprised of three basic layers. For our purposes, layer two contains the superficial medial collateral ligament (MCL) which is the most important in understanding the function of the knee. The superficial MCL is the primary restraint in preventing the knee from bending inward. The MCL also helps to prevent abnormal rotation and forward movement of the knee.

Injuries of to the MCL can often be treated nonsurgically. With severe injuries, an extended period in a brace may be required.

LATERAL AND POSTEROLATERAL ASPECTS OF THE KNEE:

The anatomy of the lateral and posterolateral aspects of the knee is very complex. The anatomy can be described in three layers, as on the medial side. However, the structures on the lateral aspect of the knee are often thin and poorly defined.

Prominent structures on the lateral (outside) aspect of the knee include the iliotibial band, the biceps femoris, the lateral collateral ligament, and the popliteus muscle.

The iliotibial band is the continuation of a muscle that begins at the hip and runs to attach to the tibia approximately three to four inches past the knee. In runners, the bursa between the iliotibial band and the tibia may become inflamed. The biceps femoris muscle is one of the hamstring tendons. It attaches to the smaller of the lower leg bones (fibula) and helps support the knee from bending outward.

The lateral collateral ligament runs from the outside portion of the lateral femoral condyle to the head of the fibula. The LCL is very important in preventing outward bending of the knee.

The popliteus muscle lies deep to the calf musculature and sits on the back of the upper portion of the tibia. From here, it has a complex insertion to the femur, lateral meniscus, and fibular head. The popliteus is also important in preventing abnormal rotation and outward bending of the knee.