Knee Anatomy

A Brief Review

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To understand knee problems, you must know the anatomy of this most complex joint. This usually calls for repeated trips to the anatomy laboratory to dissect and study knee anatomy. As it is impossible for us to share the dissection with you physically, we are providing the following drawings and photographs as a brief review for your continued research and study. This article will concentrate on structures about the knee that have clinical importance and will not attempt to be a comprehensive review of knee anatomy.

The knee is usually viewed as consisting of the tibiofemoral and patellofemoral joints. The tibiofemoral joint is divided into medial and lateral compartments. The following information is organized according to the structures found in either compartment.

STRUCTURAL FOUNDATION

The osseous portions of the knee are the femur, tibia, patella, and fibula (Fig. 1). The distal end of the femur has a medial and a lateral condyle, each of which has a distinct shape that corresponds to the shape of the tibial plateau (Fig. 2). The shape of these condyles is important in the movement of the tibia on the femur. The proximal end of the tibia flares to create a plateau with medial and lateral sections divided by the tibial spine (Fig. 3). The menisci deepen the contour of these plateaus to provide a good “seat” for the corresponding femoral condyles (Fig. 4). This added depth is extremely important because the lateral femoral condyle and lateral tibial plateau are both somewhat convex.

EXTENSOR MECHANISM

The extensor, or quadriceps femoris, mechanism consists in part of six muscles (the rectus femoris, the vastus intermedius, the vastus lateralis, the vastus medialis longus, the vastus medialis obliquus, and the articularis genu), one tendon (the quadriceps femoris), and the patellar ligament (often referred to as the patellar tendon) (Fig. 5). The patella (the largest sesamoid in the body) is a critical component of the

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Fig. 1. Osseous anatomy of the knee.

Fig. 2. Distal femoral topography.

Fig. 3. The surface of the intercondylar notch of the femur and the tibial spine providing bony stability, much like a horseback rider straddling a horse.
extensor mechanism: its location allows greater mechanical advantage for the extension of the knee. The direction of pull exerted on the patella by the muscles provides for a great amount of dynamic stability of the patella. The articulating surface of the patella consists of five areas (Fig. 6).

The extensor mechanism includes still other structures. The fat pad lies beneath the patellar tendon as it runs from the inferior patellar pole to the tibial tubercle. The patellofemoral and the patellotibial ligaments, thickenings in the extensor retinaculum that covers the anterior portion of the knee, stabilize the patella. The prepatellar bursa lies between the skin and the anterior surface of the patella. The infrapatellar bursa lies deep to the patellar tendon but in front of the infrapatellar fat pad. These two bursae are subject to inflammation caused by trauma (primarily to the prepatellar) and by overuse (infrapatellar). Other bursae are present about the anterior, medial, and lateral portions of the knee.

The synovial membrane of the knee develops from three separate pouches. Seams from this fusion are present in the synovial membrane. These seams are termed plicae and are somewhat inconstant in nature. The plica usually courses medially beneath the extensor mechanism and runs distally along the medial patella border across the medial femoral condyle, finally attaching to the fat pad (Fig. 7). Because the synovial membrane of the knee is large, in fact the largest synovial membrane in the body, it obtains needed support from the articularis genu during movements of the knee.
MEDIAL COMPARTMENT

The medial compartment of the knee is supported by a portion of the extensor retinaculum (Fig. 8). Other muscles of the thigh aid in dynamic stability of the knee. Ligamentous stability of the knee involves several planes of motion, as explained in another article in this series (Classification of the Knee Instability). Dynamic stabilization is of the utmost importance when dealing with individuals who have knee instability. The pes anserinus group (sartorius, gracilis, and semitendinosus muscles) crosses the posterior medial area of the joint and attaches to the anterior medial part of the tibia at the level of the tibial tubercle. The adductor magnus muscle attaches to the femoral condyle at the adductor tubercle. The semimembranosus muscle with its five branches is an important medial stabilizer of the knee. Fibers from these branches support the posterior capsule and the posteromedial capsule and attach to the medial meniscus as well as to the tibia. The muscular attachment to the medial meniscus pulls the meniscus posteriorly from the joint as the knee flexes (Fig. 9).

The medial meniscus is intimately attached to the capsular ligaments at its periphery. Thus these capsular ligaments are divided into the meniscofemoral and meniscotibial ligaments (Fig. 10). These capsular ligaments lie deep to the tibial collateral ligament, which originates at the medial femoral epicondyle and courses distally and attaches beneath the pes anserinus group on the tibia.

A superior view of the tibia (Fig. 11) shows the capsular ligaments. The medial capsular ligaments are longitudinally divided into three groups. The anterior third is seen anteromedially. The middle third provides stability through its thickened structures. The posterior third is often referred to as the posterior oblique ligament and is important in controlling anteromedial rotatory instability.

The posterior cruciate ligament is also included in the medial compartment (Fig. 12). It is often referred to as the “main stabilizer” of the knee and is composed of posteromedial and anteromedial bundles.
The tension within each bundle varies as the knee moves from flexion to extension. The posterior cruciate ligament tightens as the tibia internally rotates on the femur. Its origin is on the intercondylar surface of the medial femoral condyle and its insertion is on the fovea of the tibia.

LATERAL COMPARTMENT

Lateral compartment structures of the knee are somewhat analogous to the medial compartment structures. Muscular support is provided by the iliotibial band and iliotibial tract (these structures are divided by their orientation according to the intermuscular septum). These structures attach anterolaterally into Gerdy's tubercle (Fig. 13). The biceps femoris has two heads that attach as shown in Figure 13. The popliteus muscle originates on the lateral femoral condyle and inserts on the posterior, medial edge of the tibia. Its insertion forms an important structure as it reinforces the posterior third of the lateral capsular ligament.

The fibular collateral ligament overlies the lateral capsular ligaments (Fig. 14). The lateral capsular ligaments attach to the lateral meniscus (Fig. 14) in much the same way that ligaments attach to the medial meniscus. These lateral ligaments are divided into the meniscofemoral and meniscotibial sections of the lateral capsule. The anterior third of the lateral capsule provides little static support. The middle third of the lateral capsular ligaments is responsible for providing support against anterolateral rotatory instability. The posterior lateral third of the lateral compartment is supported by the arcuate complex (Fig. 15). The complex is composed of the fibular collateral ligament, the popliteus tendon, the posterior third of the capsular ligament, and the arcuate ligament.

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Also included in the lateral compartment is the anterior cruciate ligament. One of its three bundles is the anteromedial bundle, originating posteriorly and superiorly on the medial surface of the lateral femoral condyle and inserting on the medial aspect of the intercondylar eminence of the tibia. More anteriorly and distally is the posterolateral bundle on the medial surface of the lateral femoral condyle, which inserts lateral to the midline of the intercondylar eminence. The intermediate bundle is between these two bundles (Fig. 16). The tension on the bundles is altered as the knee moves from flexion to extension. The function of the anterior cruciate ligament is still unknown. It has become apparent that it is an important stabilizer of the knee. Its structure allows for several different areas of stability and whether to repair it after injury is controversial.

SUMMARY

This article provides a basis for understanding the anatomy involved in knee disorders and was directed toward structures of clinical importance. The osseous portions of the knee were discussed in relation to muscular actions. The soft tissue components about the knee were described in relation to the osseous components that divide the knee into medial and lateral compartments. This article is to serve to introduce this special issue, giving the clinician a greater understanding of the interaction between structure and function rather than a comprehensive view of knee anatomy.

REFERENCES