E-39 - Modality Insight on the Anterior Cruciate

2026 Spring Symposium

Abstract

The anterior cruciate ligament (ACL) is a 1- to 1.5-inch-long fibrous tissue that connects the tibia to the femur, providing a major contribution of stability to forward, backward, and rotational movements. Many have reported hearing a popping sound upon injury, followed by pain and loss of movement. Physicians employ multiple imaging modalities for diagnosis, treatment, and recovery such as X-ray and MRI for the anterior cruciate ligament. As devastating an injury this can be, treatment includes full ligament replacement using arthroscopic reconstructive surgery with a tissue graft. Visualization is vital in all three of the mentioned steps to post recovery success, improving operative procedures and rehabilitation outcomes.

Keywords: magnetic resonance imaging (MRI), anterior cruciate ligament (ACL)

Modality Insight on the Anterior Cruciate

Introduction (Level 1)

The anterior cruciate ligament is one of the four major ligaments running diagonally through the knee center and plays a significant role in knee joint stability. The fibrous ligament connects the femur to the tibia and limits anterior to posterior movements between the tibia and femur, as well as rotational forces from movements such as cutting and jumping. Many of these movements involved make athletes a prime target for injury due to the sheer load put onto the knee joint. According to the medical data from Maria Casado (2019), "Football, baseball, basketball and skiing account for 78% of the anterior cruciate ligament injuries" (Para 1). Female athletes are especially vulnerable to this type of injury at rates as stated by Maria Casado (2019), "Female athletes have a 4 to 6 times higher risk than men to suffer this kind of injury. Several factors, anatomical as well as hormonal, biomechanical or related to neuromuscular control, are the cause of the predominance of the lesion in women" (Para 4). The impact of an ACL injury includes decreased knee stability, reduced mobility, and impaired sport performance, often leading to arthritis if not treated. This paper will examine the anatomy and mechanism of ACL injuries, and the comparative roles that X-ray and MRI play in diagnosis and repair of those injuries.

Discussion (Level 1)

Anatomy of the ACL (Level 2)

The anterior cruciate ligament is an important intra-articular ligament of the knee that can tear at any age from newborn to one hundred years of age. It originates from the postero-medial aspect of the lateral femoral condyle and inserts into the anterior intercondylar area of the tibia.

The ligament runs oblique through the intercondylar notch and crosses the posterior cruciate ligament. According to Radiopedia (2025), “The anteromedial bundle is responsible for the posterior translation of the femur at 30 degrees flexion, and the posterolateral bundle resists hyperextension and prevents posterior translation of the femur in extension” (para 4).

The synovial membrane around the ACL contains small blood vessels inside it, supplying blood to the ligament. However, this blood supply is not evenly distributed, with the upper proximal part of the ACL receiving more blood than the lower distal side. An anatomical factor that plays into the poor healing of the ligament would be the front surface of the ACL, that lacks blood vessels located along the anterior edge of the intercondylar fossa (Physiopedia, Irarrázaval S et al, 2017). The anatomy of the ACL proves healing difficult with a lack of blood supply, justifying replacement as the main line of treatment.

Mechanism of ACL Injuries (Level 2)

Researchers have identified two main causes of ACL injuries that occur through both contact and non-contact mechanisms. Non-contact injuries account for most cases, particularly in athletic populations. According to Boden et al. (2000) and Griffin et al. (2000) reported that approximately 70% of ACL injuries occur without contact, usually during landing or rapid changes in direction with the knee close to full extension. Direct strikes to the knee seemed to have caused less ACL injuries rather than self-imposed injuries due to landing or twisting upon one’s own ACL.

Comparative Roles of Imaging Modalities in Diagnosis, Repair, and Rehab (Level 2)

X-ray (Level 3)

ACl tears can be diagnosed with the help of imaging services. X-ray is not necessarily a key identifier in visualizing soft tissue, so it alone cannot diagnose an ACL tear, but it can show

indirect signs of an ACL injury. X-rays use high energy waves that pass through the body and create images based on tissue density wavelengths that allow them to pass through the body. As x-rays travel through the body, some of their energy particles called photons are absorbed while others continue to pass through. Dense structures such as bone absorb more photons and appear white, while less dense structures such as tissue and air absorb less photons, creating a darker image (Asrt.org, 2020). X-rays cannot show the anterior cruciate ligament. They are mainly used to check for bone injuries, such as fractures. While X-rays do not provide information about ligament damage, they are helpful in deciding if further imaging, such as an MRI, is needed. According to Wing hung (2022) and his research team, "On radiography, there are several indirect signs that could raise suspicion of underlying ACL injury. Avulsion fracture of ACL at the tibial insertion or femoral origin can be found on radiographs but is better defined by computed tomography (CT)[14,15] (Figure 1A and B). Avulsion fracture of lateral tibial rim (Segond fracture) (Figure 2) is commonly associated with an ACL tear[16-18] and is classically due to avulsion fracture of the iliotibial band though the term has also been applied when there is avulsion of the fibular collateral ligament"(para 8).

(Display of tibial insertion avulsion fracture) National Library of Medicine https://pmc.ncbi.nlm.nih.gov/articles/PMC3302044/#B14

Magnetic Resonance Imaging (Level 3)

Magnetic Resonance Imaging is the preferred method to diagnose a suspected ACL injury. MRI works by placing a patient in a strong magnetic field, where a radiofrequency pulse is applied causing atoms to move out of alignment. When the MRI pulse is stopped, atoms return to their normal position and data is collected on the atom's movement. With the help of computers these signals are collected and used to make an image of atoms that were moved (Asrt.org, 2020). The ability of MRI to visualize soft tissue is the reason why it is preferred imaging. Soft tissue such as ligaments, cartilage, surrounding structures such as menisci can help doctors to see if the ACL was partially or completely torn. The scan would take 45 to 60 minutes, and the patient would be placed in a supine position, foot first into the scanner. The affected knee would be placed in a knee coil which would boost the scan to the part of interest. MRI gives Doctors answers within an hour whether surgery is necessary, if the ligament is partially or completely torn, with the scan being at or more than 90% accurate.

(Visualization of ACL tear) National Library of Medicine https://pmc.ncbi.nlm.nih.gov/articles/PMC3302044/#B14

Conclusion (Level 1)

The anterior cruciate ligament is one of the most important structures in the body, which is important to daily life. With most injuries coming from athletes, symptoms seem to uniformly be from full knee extension and a twisting motion leading to a popping sensation according to the study presented by Boden and Griffith. Women have a higher predisposition to ACL injuries due to biomechanical factors and a higher incidence rate compared to men; however, ACL tears can occur in individuals of any gender. X-ray and MRI are the two main studies used to find and diagnose a torn anterior cruciate ligament. X-ray imaging can identify fractures and avulsion injuries at ligament attachment sites, while MRI allows detailed evaluation of ACL tear severity and associated soft-tissue injuries that may occur at the same time. Together, X-ray and MRI provide a well-established and effective approach to the evaluation of ACL injuries, allowing for correct diagnosis, proper treatment planning, and improved patient outcomes with current imaging technology.

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