

MR and Internal Derangement

Dan L. Hobbs, M.S.R.S., R.T.(R)(CT)(MR), is an associate professor in the department of radiographic science at Idaho State University in Pocatello.

Knee pain is a common reason for patient visits to a physician office.¹ Cluette² suggests common causes of knee pain, including arthritis, ligament injuries, cartilage injuries, meniscal tears, patellar tendonitis, chondromalacia patella, Bakers cyst, bursitis, Osgood-Schlatter disease, osteochondritis dissecans and gout. Certainly there are other causes; the job of imaging professionals is to facilitate the diagnosis of such ailments.

In the past, plain film radiography was used as the first imaging modality to aid the evaluation of the painful knee; however, today plain films are used primarily

to evaluate joint space narrowing and for major trauma events. Positions for these cases include the traditional posteroanterior (PA) projections and lateral positions. Additionally, joint space narrowing is demonstrated by weight-bearing knee studies such as the Rosenberg method.³ Because of the many soft tissue structures within the knee, it is impossible to adequately evaluate the knee joint with plain radiographs. In fact, "[O]ver the past 15 years, magnetic resonance (MR) imaging has become the premier, first-line imaging study that should be performed in the evaluation of the painful knee."⁴

This article describes some of the soft tissue components of the knee joint. Injury occurs when these structures become damaged, usually with resultant tendon, cartilage or ligament tears. Traumatic injury can be a major cause of knee problems, but damage can also be attributed to physiological processes such as gene mutations. Furthermore, this article defines internal derangement and concludes with an example of a torn meniscus demonstrated by the use of MR imaging.

Anatomy of a Breakdown

A host of culprits reside in the knee joint that can cause pain. They include cartilage wear and tear, muscle dexterity, bone erosion and deterioration, tendon and ligament damage, inflammation and gene mutations.⁵ Each of these conditions can be a cause for concern and can lead to pain, damage and arthritis. For example, cartilage can deteriorate as a consequence of injury or excessive wear and tear. The result is bone to bone contact resulting in erosion and damage. Similarly, as tendons and liga-

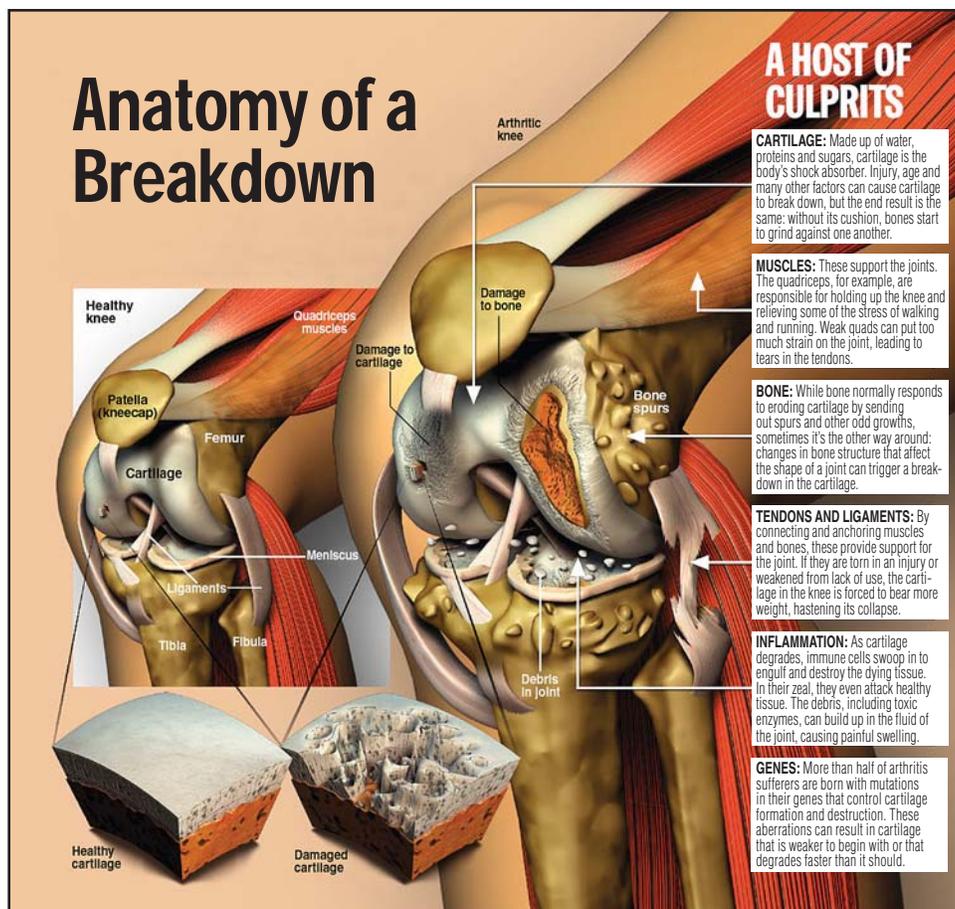


Fig. 1. Anatomy of a breakdown. This diagram shows the anatomical components of the knee, the mechanisms that cause injury and several processes that may result in pain to the joint itself. (Diagram by Joe Lertola. Reprinted with permission from: Time magazine, December 9, 2002 issue, posted December 1, 2002.)

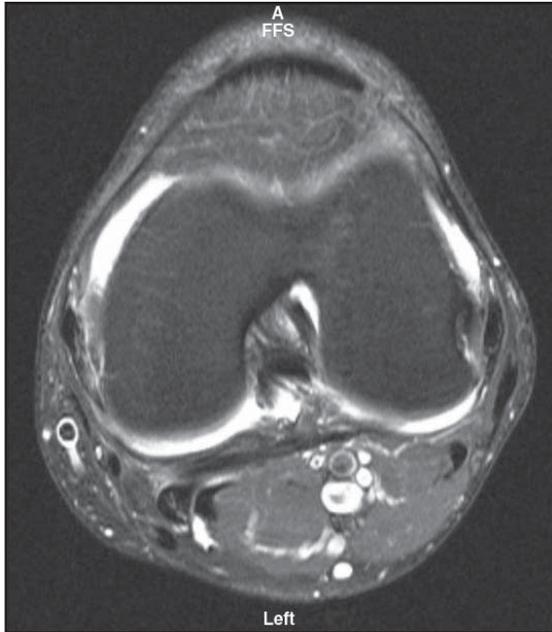


Fig. 2. Axial localizer. This image was used to prescribe the sagittal and coronal images. (Image courtesy of Owen Bartschi, R.T.(R)(MR), Idaho Medical Imaging, Pocatello, Idaho.)

ments become weakened or torn, the cartilage of the knee is forced to bear more weight, resulting in injury or even collapse of the joint. Regardless of the mechanism of injury, osteoarthritis often is a common result; what's more, recent studies⁶ have shown that osteoarthritis is influenced not only by mechanical processes, but that biochemical and genetic factors also play a role. Thus, "...researchers have discovered an array of biochemical messages that are traded between bones, muscles and other parts of the body and play a key role in keeping joints healthy."⁵ Consequently, there are myriad reasons, ranging from injury to genetic predisposition, that cause knee-related problems. (See Fig. 1.)

Incidence of Traumatic Injury and IDK

It is interesting to note that in the United States trauma to the knee accounts for almost 3 million visits to an outpatient or emergency department each year.⁷ Of this 3 million, "[t]he MCL [medial collateral ligament] is the most frequently injured ligament in the knee. [However], ACL [anterior cruciate ligament] damage causes the highest incidence of pathologic joint instability."⁷ Accordingly, the abbreviation IDK



Fig. 3. Lateral meniscus. Conventional, proton density-weighted sagittal view of the knee. The lateral meniscus forms 2 triangles with points facing each other. Regular-sized arrows denote the anterior and posterior horns, small arrow denotes normal patellar tendon and the arrowhead denotes normal quadriceps tendon. (Image courtesy of Owen Bartschi, R.T.(R)(MR), Idaho Medical Imaging, Pocatello, Idaho.)

is used to describe an internal derangement of the knee. This term is used any time there is a problem that involves the normal functioning of the ligaments or cartilage of the knee joint. In fact, Resnick and Sartoris state that "[i]nternal derangement of the knee represents a common medical problem with significant patient morbidity..." They then go on to state that, "Magnetic resonance (MR) imaging has proved to be a reliable method and, in many instances, has replaced arthrography in the evaluation of internal derangement of the knee."⁸ Today, MR is the primary imaging modality used in the diagnoses of IDK.

MR Methods

To demonstrate a derangement on MR, a series of images should be performed in several orthogonal planes. Crues et al⁹ suggests that "[t]he knee must be scanned in the axial, coronal and sagittal planes using thin sections (3 to 5 mm thick) with a combination of T1- and T2-weighted techniques, including at least one T2-weighted image with fat suppression." Likewise, Bontrager¹⁰ discusses the value of some of these sequences. He suggests that T1-weighted images are useful for

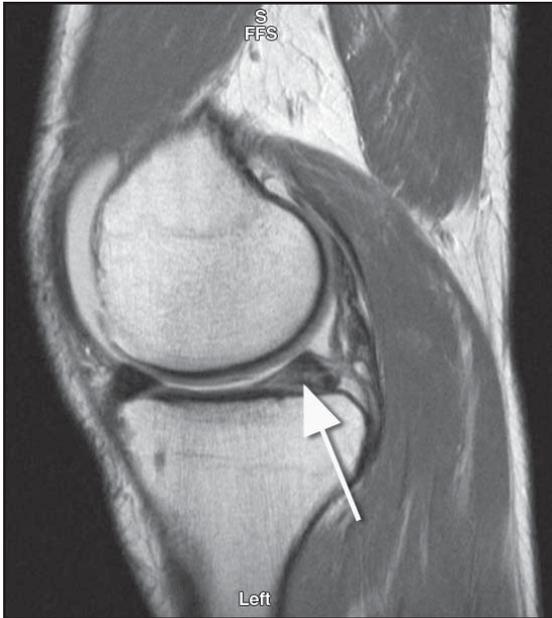


Fig. 4. Medial meniscus. Arrow denotes a moderate-sized horizontal tear of the medial meniscus. (Image courtesy of Owen Bartschi, R.T.(R)(MR), Idaho Medical Imaging, Pocatello, Idaho.)

showing internal derangements of the articular cartilages and tendons. Likewise, he suggests that T2-weighted images are helpful to distinguish inflammation and edema around the ligaments and tendon tears.¹⁰

Case Study

A 56-year-old male patient was evaluated for chronic left knee pain that he had experienced for the past 2 years. After appropriate screening, he was placed in a

1.5-T magnet scanner (Espree, Siemens AG, Munich, Germany). After placement of the knee coil, the patient was positioned in the bore of the magnet; an axial localizer was then performed. (See Fig. 2) This was followed by a complete multiplanar MR series, which consisted of sagittal and coronal T1-weighted, proton density-weighted and fat saturation sequences.

When evaluating the sagittal images, the anterior and posterior horns of the menisci appear as triangular densities in the center of the knee in both the lateral and medial compartments. The menisci are somewhat broadened on each end and taper to a pointed triangular shape toward the center of the image. The lateral meniscus in the sagittal sequence is intact and normal in appearance and shape. (See Fig. 3) On the other hand, the medial meniscus demonstrates irregularities in the posterior aspect of the body. (See Fig. 4.) This defect can be best seen on images that have narrow meniscal windows. (See Fig. 5.)

Technologists should be aware that tears of the menisci sometimes do not appear on either the coronal or sagittal views, as they are only seen when they are perpendicular to the plane of the slice. Thus, Bradley states that “tears running oblique[ly] to the coronal and sagittal planes may well be visualized only by a notch on the articular surface.”⁴ Even without this notch, a normal-appearing MR may be inconclusive. The terminology used to describe this condition would be “false negative.” In other words, the MR image was normal in appearance; however, unseen pathology was present in the patient’s knee. This type of scenario may be cause for knee arthroscopy.

Lastly, in the case presented, a coronal image shows irregular densities in the medial meniscus. (See Fig. 6.) Also, the radiologist reported irregularity and partial loss of the articular cartilage covering the medial femoral condyle and posterior medial tibial plateau. It is interesting to note the normal appearance of the posterior cruciate ligament. (See Fig. 7.)

Discussion

IDK can be traumatic in origin and can be caused by a variety of reasons. Regardless of the cause, MR is the preferred imaging modality for evaluating knee pain. Obtaining a good MR scan is important in identifying IDKs. The orthopedic surgeon uses the scan to base therapeutic decisions. Additionally, the

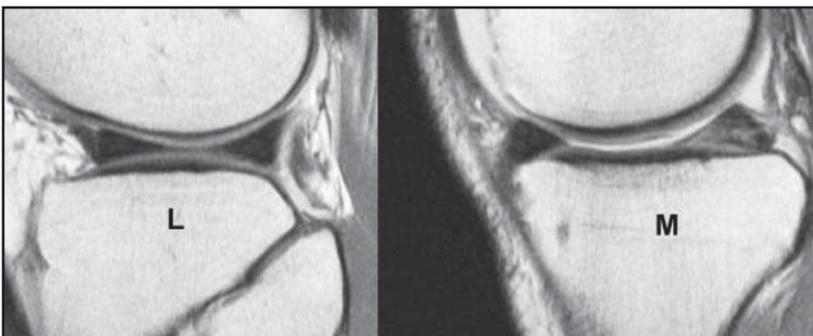


Fig. 5. Narrow windows better demonstrate the menisci. Medial meniscus (M) with the associated tear involving the posterior horn and the intact lateral meniscus (L). (Image courtesy of Owen Bartschi, R.T.(R)(MR), Idaho Medical Imaging, Pocatello, Idaho.)



Fig. 6. Coronal image. Arrow denotes irregular densities in the medial meniscus. (Image courtesy of Owen Bartschi, R.T.(R)(MR), Idaho Medical Imaging, Pocatello, Idaho.)



Fig. 7. Posterior cruciate ligament. Arrow denotes normal posterior cruciate ligament. (Image courtesy of Owen Bartschi, R.T.(R)(MR), Idaho Medical Imaging, Pocatello, Idaho.)

examination can be indispensable in diagnosing IDKs as it can detect abnormalities of the soft-tissue structures that cannot be seen on plain radiographs.

The study should be performed in several orthogonal planes with a combination of T1- and T2- weighted techniques to capitalize on extracting the most information possible. The images presented in this article show an example of a torn medial meniscus. Perhaps some of these thoughts will come to mind the next time you are asked to perform an MR examination of the knee. ♦

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