The case:

A 47-year-old healthy and active man injured his right knee the preceding day while working as a physical therapist. The patient presented with an antalgic gait, a 2+ effusion, and lateral joint line tenderness. Radiographs showed no bony abnormalities. An MRI was ordered.

Figure 1: Coronal (A) and sagittal (B) fast spin echo proton density images of the right knee.

Your diagnosis?
Diagnosis:

Lateral Femoral Condylar Shear Injury

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The magnetic resonance imaging (MRI) study demonstrated a lateral femoral condylar shear injury with a large loose body in the anterior intercondylar notch. No bony component was observed because the sheared fragment was all articular cartilage. A small lateral meniscal tear was also documented, but no cruciate or collateral ligament damage was observed. Arthroscopic surgery was recommended to treat this injury.

CLINICAL FINDINGS IN SHEAR INJURIES

Shear injuries are caused by any force causing slippage between a pair of contiguous articulated parts in the direction that parallels the plane they contact and are often the result of sports-related injuries. This contradicts other mechanisms of injury, such as compressive and avulsion forces.

Signs and symptoms of femoral cartilage injury include immediate pain and swelling of the affected area, joint effusion, and difficulty weight bearing. Hemarthrosis may occur in 5% to 10% of young, active patients with chondral shear injuries, and significant joint swelling may present within the first 4 to 6 hours after injury. When the cartilage defect becomes dissociated, patients often describe joint movement difficulty or locking or catching caused by the loose body.

Patients may also describe feeling their knee giving way.

IMAGING

Performing imaging on patients with suspected cartilage shear injuries typically begins with knee radiographs. Lesions confined to the non-mineralized cartilage will only reveal a joint effusion or hemarthrosis and soft tissue swelling. Magnetic resonance imaging (MRI) is the imaging test of choice for assessing the size and depth of cartilage shear defects and for identifying the location of any displaced fragments for the surgeon (Figure 1).

High-resolution imaging with dedicated surface coils and high-strength magnets assesses whether the lesions extend to the tidemark (at the junction between the mineralized and non-mineralized cartilage) or involve the mineralized cartilage or deeper subchondral bone. Most lateral femoral condylar shearing fractures result from acute lateral patellar dislocation relocation syndrome. The current case lacks the classic injury pattern involving the anterolateral aspect of the lateral femoral condyle, medial aspect of the patella, and lateral retinaculum. This case study’s cartilage defect involves both the weight-bearing and non-weight-bearing portions of the femur and is located too medially to be consistent with prior patellar dislocation.

TREATMENT

The treatment of patients with focal femoral chondral lesions depends on the size of the lesion, any associated malalignment, meniscal deficiency and ligament insufficiency, and whether the patient is a high-demand patient.

Microfracture is a single-stage procedure that is ideally suited for small, well-contained, Outerbridge grade III–IV cartilage lesions usually <2.5 cm. Microfracture operates on the principle that small induced osteochondral or subchondral insults cause the release of pluripotential stem cells from the bone marrow, filling the defect with a blood clot. This clot eventually transforms into fibrocartilage, which is denser but not as durable as hyaline cartilage.

Most clinical studies of the outcomes after microfracture show improvement in knee
function in 70% to 90% of patients. Larger defects can be treated with osteoarticular transfers (either autologous or cadaveric) and autologous cartilage transplantation procedures.

All 3 options were discussed with the patient to treat this lesion. The patient underwent arthroscopic removal of the 2×1.5-cm cartilaginous fragment (Figure 2) microfracture of the condylar defect (Figure 3), and a partial lateral meniscectomy. Postoperatively, the patient used a constant passive motion machine 8 hours per day for 6 weeks. He maintained nonweight-bearing status for 6 weeks, then progressed to partial weight bearing for an additional 2 weeks, with the use of a lateral unloading brace for 3 months.

Physical therapy including strengthening did not begin until 8 weeks postoperatively. The patient progressed well postoperatively, with resolution of swelling and return to full range of motion. The patient was pain-free and returned to all normal activities after his 6-month postoperative follow-up MRI.

**Postoperative Imaging**

In the early postoperative setting, the fibrocartilage generated by microfracture tends to appear thin and indistinct. Between 1 and 2 years postoperatively, the tissue should have filled the original defect and be well-defined and smooth on MRI. The signal intensity of the cartilage on MRI can vary after a microfracture procedure. Reparative fibrocartilage tends to be hypointense compared with native cartilage due to the matrix being less organized and the increased mobility of water. As the fibrocartilage matures, the signal intensity should decrease on fluid-sensitive sequences, and the subchondral bone marrow edema-like signal should also improve over time (Figure 4).

Abnormal findings indicative of incomplete or failed treatment include persistent bone marrow edema-like signal changes, incomplete filling of the defect with thin and irregular repair tissue, and exposed subchondral bone. Cartilage mapping sequences are also useful in evaluating the integrity of postoperative cartilage with a color-coded map of T2-weighted values, where longer values are indicative of more disorganized repair tissue.

Various studies have shown different results regarding the long-term success of microfracture surgery. In a notable study, Von Keudell et al followed 15 patients who underwent microfracture of isolated knee cartilage defects with MRIs. Imaging studies obtained at least 18 months postoperatively were correlated with clinical scores, with suboptimal results. Of 13 patients, 1 showed good cartilage repair on postoperative...
Figure 4: Fibrocartilage regeneration 5 months after microfracture of lateral femoral condylar full-thickness cartilage defect. Coronal (A) and sagittal (B) fast spin echo proton density fat-suppressed images showing complete filling of the prior defect by fibrocartilage (arrowheads) that is nearly isointense to the native hyaline cartilage.

MRI, whereas 2 had moderate and 10 had poor repair on imaging studies.

OTHER SURGICAL OPTIONS

Although microfracture surgery was performed for our patient, several other treatment modalities are available for palliation, repairation, and restoration of cartilaginous shear injuries. Simple removal of the cartilage fragment and debridement of the defect margins is a palliative measure in a smaller lesion. Reparative techniques include direct repair and several techniques aimed at recruitment of pluripotential cells from marrow stromal cells.²,⁵

If the cartilage defect involves a portion of subchondral bone, direct fixation may be used to restore a congruent surface with viable articular cartilage. With this technique, the osteochondral fragment is reduced and internally fixated to allow for healing. In addition, autologous mesenchymal stem cells can be implanted directly into the cartilage defect without having to penetrate the subchondral bone.⁵

Restorative techniques, such as osteochondral grafting, are intended to replace articular cartilage and subchondral bone as a single unit. Autologous chondrocyte implantation is another option for cartilage repair.³

In this procedure, arthroscopic cartilage samples are harvested from a nonweight-bearing area of the knee and are grown in a laboratory for 4-6 weeks until a sufficient amount to replace the deficit in the articular cartilage is available. The patient then undergoes a second open surgery in which chondrocytes are injected into the defect and covered with a membrane that is attached with suture and fibrin glue.

Matrix-associated autologous chondrocyte transplantation is a 1-step procedure used in combination with microfracture, in which a collagen scaffold membrane is cut into the shape of the original defect and secured to the cartilage defect using fibrin glue or suturing.⁹,¹⁰

PROGNOSIS

Despite varying long-term results, microfracture surgery is considered a good first-line procedure because it is a cost-effective, short procedure with low morbidity and does not prevent the application of other cartilage repair procedures in the future.⁴ Factors decreasing the efficacy of microfracture include older age, obesity, and cartilage lesions >2.5 cm. A high likelihood of symptoms returning within 2 years of the operation exists and repeat surgery may be needed. The effectiveness of cartilage growth after microfracture surgery is believed to be dependent on the patient’s bone marrow stem cell population. Some studies suggest that increasing the number of stem cells increases the chances of success.

As with any arthroscopic procedure, bleeding, infection, and risk of thromboemboli are risks of microfracture surgery. One of the main long-term complications of the surgery is the recurrence of cartilage degeneration. This is because fibrocartilage is not as durable and stiff as natural hyaline cartilage, subjecting it to increased deformation under physiological loading. Over time, this can cause mechanical failure of the repaired tissue, leading to decreased range of motion, increased stiffness of the knee, and recurrence of cartilage degeneration.¹⁰

REFERENCES


