

Management of Chondral Injuries Associated With Patellar Instability

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The treatment of cartilage injuries secondary to patellar instability is multifactorial. These factors include the time frame of patellar instability, the pathoanatomic factors, the extent of symptoms, and the size and location of the cartilage injury. The chondral or osteochondral injury which occurs with acute patellar instability is managed with either reduction and internal fixation or removal. The treatment of the patellar instability component is controversial in the acute setting, especially when there is no need for an osteochondral surgery. In such cases, patellar dislocations are treated nonoperatively. However, if the patient is indicated for surgery for treatment of osteochondral fracture and intra-operatively the medial patellofemoral ligament (MPFL) remains pathologically lax and presents with a discrete MPFL injury site, there is the option of acute repair.

Chondral injury associated with recurrent patellar instability may be subdivided into 2 overlapping groups: (1) chondral damage resulting from the instability episodes (distal medial region of the patellar and/or lateral proximal region of the lateral femoral condyle) and (2) chondrosis secondary to the chronic lateral tracking of the patella (chronic patellar subluxation) from patholaxity of the MPFL (lateral chondrosis to patella and trochlea in addition to the injuries sustained from the actual instability episodes). The treatment is based on the patient's chief complaints and the unique underlying pathoanatomy. Many of these patients will have one or more predisposing factors, such as patella alta, trochlear dysplasia, patholaxity of the MPFL and an excessively lateral position of the tibial tuberosity. Therefore, the key to managing this patient population is to address each patient's specific pathoanatomy, which by definition will include addressing the MPFL patholaxity. The goals are to stabilize the patella, normalize patellofemoral contact area and/or forces, and then restore the articular cartilage based on relevant symptoms. As of this writing, treatment options in the United States include debridement, marrow stimulation, osteochondral auto and allograft, autologous chondrocyte implantation, and the use of particulate articular cartilage.

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Acute patellar instability accounts for approximately 2%-3% of all knee injuries.¹ Harilainen et al have reported that patellar instability is the second most common cause of traumatic hemarthrosis of the knee after anterior cruciate ligament tears.² Patellar instability is more common in females than males and risk factors for instability include patellar alta, trochlear dysplasia, excessive lateral tibial tuberosity position, genu valgum, generalized ligamentous laxity, quadriceps atrophy, external tibial torsion, and increased femoral anteversion.

The typical mechanism for acute traumatic lateral patellar dislocation is internal body and/or femoral rotation with the knee in early flexion and a fixed foot. This creates functional valgus alignment resulting in a lateral force vector, which results in the dislocation. Osteochondral injury in patients

with acute patellar dislocation occurs in anywhere from 0% to 68% of patients depending on the cited study and their respective definition of osteochondral fracture.^{1,3} Nomura et al, while describing patellar cartilage changes after first time dislocation noted a 95% incidence of chondral damage, with the damage ranging from cracks or fissures to osteochondral fractures.³ However, when limited to clinically relevant osteochondral injuries there is consensus that a useful number to consider when evaluating this patient population is approximately a 20% incidence of osteochondral fracture.

Chondral injuries in patients with recurrent patellar instability are also frequent with up to 95% of patients exhibiting chondral damage.⁴ The extent of chondral injury in patients with chronic patellar instability may be less severe than patients with acute patellar dislocations, especially if the force required to dislocate the patella is less, for example, the subset of recurrent patellar dislocators with trochlear dysplasia and patellar alta. Approximately 20% of these patients will have chondral defects involving the subchondral bone with the majority exhibiting fissuring or partial thickness defects.⁴

Pathophysiology

The pathophysiology of cartilage injuries in acute patellar instability occurs as a shear injury either during the dislocation event or during the relocation of a lateral dislocation. The most common cartilage injury occurs to the medial facet of the patella and the lateral aspect of the proximal lateral femoral condyle. Magnetic resonance imaging (MRIs) in these patients show bone bruising or osteochondral fractures of the medial patellar facet and the lateral most aspect of the lateral femoral condyle (primarily nonarticular).^{5,6}

More recently, the cartilage injuries to the lateral femoral condyle have gained recognition. In these patients, MRI studies demonstrate cartilage injuries that include the midlateral weight-bearing aspect of the lateral femoral condyle.⁷ Because the knee is typically flexed slightly during the initial dislocation and with the quadriceps pulling the patella laterally, these lesions occur more posteriorly than what one would expect; that is, they typically begin at the level of the notch roof and not at the lateral trochlea. The shearing of the lateral femoral cartilage occurs as the lateral facet of the patella forcibly strikes the lateral femoral condyle.

Chondral injury associated with recurrent patellar instability may be subdivided into 2 overlapping groups: chondral damage resulting from the instability episodes (distal medial region of the patellar and/or lateral proximal region of the lateral femoral condyle) and chondrosis secondary to the chronic lateral tracking of the patella (chronic patellar subluxation) from patholaxity of the medial patellofemoral ligament (MPFL) (lateral chondrosis to patella and trochlea in addition to the injuries sustained from the actual instability episodes). Additionally, patients with chronic patellar instability often have predisposing mechanical factors, such as generalized ligamentous laxity, dysplasia, patellar alta, excessive femoral anteversion or tibial external torsion, excessive valgus alignment, or an excessively lateral tibial tuberosity. These factors often result in an environment in which less

force is necessary to dislocate the patella. Nomura et al have shown that most of the cartilage abnormalities are fissuring and fibrillation of the patella at the medial facet in this patient population.⁴ Watanabe et al have shown reduced levels of glycosaminoglycan concentrations in both the medial and lateral facets in patients with chronic patellar dislocations compared with healthy subjects.⁸ Cartilage abnormalities of the trochlea or femoral condyle in patients with recurrent instability have been poorly documented. Lateral patellofemoral (PF) lesions tend to occur in proportion to the chronicity of the problem and the degree of lateral maltracking due to MPFL patholaxity, trochlear dysplasia, and an excessive lateral position of the tibial tuberosity.

Diagnosis

Any patient who sustains an acute first-time traumatic dislocation should be suspected of having a cartilage injury until proven otherwise. Typically, patients are young, athletic and were involved in a noncontact twisting injury to the affected knee. Patients commonly report that their "knee cap came out of place" and often describe it as the knee giving way while they were pivoting. Pain is often relieved once the patient goes down to the ground, extends the leg causing the patella to reduce spontaneously. As previously mentioned, approximately 20% of patients with initial traumatic patellar dislocation will have a chondral or osteochondral fracture. The clinical presentation in these patients is often dramatic with extensive swelling, hemarthrosis, and difficulties with ambulation. Depending on the timing of initial presentation, patients can relate mechanical symptoms of catching, locking, or loss of range of motion if the osteochondral fracture has displaced and floating in the knee as a loose body.

The examination for patients thought to have had a patellar instability episode begins with a standard lower extremity and detailed knee examination with added emphasis on patellar-specific areas. Generalized ligamentous laxity is also documented as patients who are ligamentously lax are far less likely to have cartilage abnormalities.⁹ Concomitant ligamentous injuries may be present and will be detected during the general knee evaluation. During the focus on the PF aspects of the knee, inspection of the sites of ecchymosis may help determine which structures have been injured. Similarly, palpation of the medial structures, specifically over the patellar and femoral attachment sites of the MPFL, vastus medialis oblique, and adductor and retinacular structures is important.¹⁰ The laxity of the patellar soft-tissue restraints is measured with respect to the number of quadrants the patella is able to displace laterally at 0° and 20°-30°. The presence of crepitus might indicate an unstable osteochondral fracture, but is a very soft sign. Additionally, in the acute setting, apprehension to lateral patellar displacement classically confirms the diagnosis. In patients who have a large effusion or hemarthrosis and cannot tolerate an examination, we recommend aspiration for diagnostic and therapeutic reasons. Bloody effusions in addition to fatty globules can alert the surgeon to the presence of an osteochondral fracture. Infu-

sion of lidocaine after aspiration is helpful in anxious patients to allow a more detailed examination.

Radiographic evaluation is discussed in detail in this issue in *Evaluation and Imaging of the Patellofemoral Joint Disorders*. Chondral fractures are obviously not visible on plain radiographs and even osteochondral injuries may be missed (Fig. 1).⁹ Occasionally, a sliver of bone in the notch or suprapatellar pouch will indicate that the osteochondral fracture has become a loose body. Radiographic evaluation in the chronic setting specifically focuses on the evaluation for patellar height, trochlear morphology, and measurement of the tibial tuberosity to trochlear groove distance using computed tomography scans or MRI. The specific parameters related to these measures are discussed in this issue in the chapter on *Tibial Tuberosity Osteotomies*.

We recommend MRI in virtually all patients who have an acute patellar dislocation to evaluate for potential cartilage injuries unless the clinical examination is consistent with a very low-energy dislocation and there is minimal effusion. Even an MRI can fail to detect some cartilage injuries, unless a high suspicion for these injuries is maintained and cartilage specific sequences are requested.⁵ Historically, classic findings on MRI included bony edema in the medial facet of the patella and the nonarticular lateral portion of the lateral femoral condyle (Figs. 2 and 3). Fragment stability is assessed by the presence of fluid tracking underneath the fragment.

Classification

Chondral injuries are divided between osteochondral or chondral pathology. It is very important to distinguish between these 2 groups, as it has clinical implications on healing potential. Pure chondral fractures have poor intrinsic capability to heal due to poor vascularity and acellular ultrastructure.^{11,12} Osteochondral fractures, in contrast, have the ability to heal as with any cancellous bone fracture. In patients who have an acute patellar dislocation and osteochondral or chondral fracture, we classify these as stable or unstable based on the MRI findings. The Berndt and Harty classification¹³ as modified by Anderson¹⁴ et al is useful to determine stability despite its primary use as a classification for osteochondral dissecans of the talus. Stage I lesions have increased bone marrow edema with subchondral trabecular

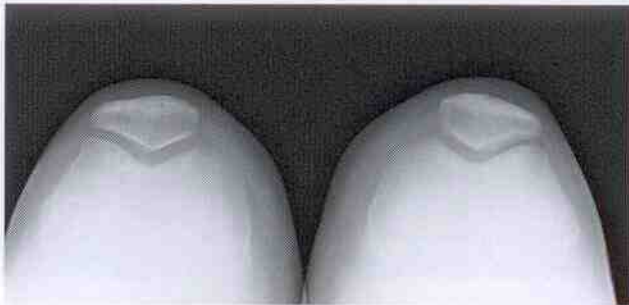


Figure 1 Merchant view of the patella showing no obvious osteochondral fracture or loose body. Occasionally, a fracture fragment will be visible in between the patella and trochlea.



Figure 2 Sagittal T2-weighted MRI showing an osteochondral fracture of the medial facet of the patella with associated effusion and subchondral edema and/or signal after an acute patellar dislocation.

compression with an intact cartilage surface. Stage IIa lesions are defined as intact cartilage with a subchondral cyst, whereas stage IIb lesions have an incomplete separation of the osteochondral fragment with 1 edge separated and 1 edge attached. Stage III lesions are complete fractures with fluid around an undetached, nondisplaced osteochondral fragment. This is best determined on the T2 images. Stage IV

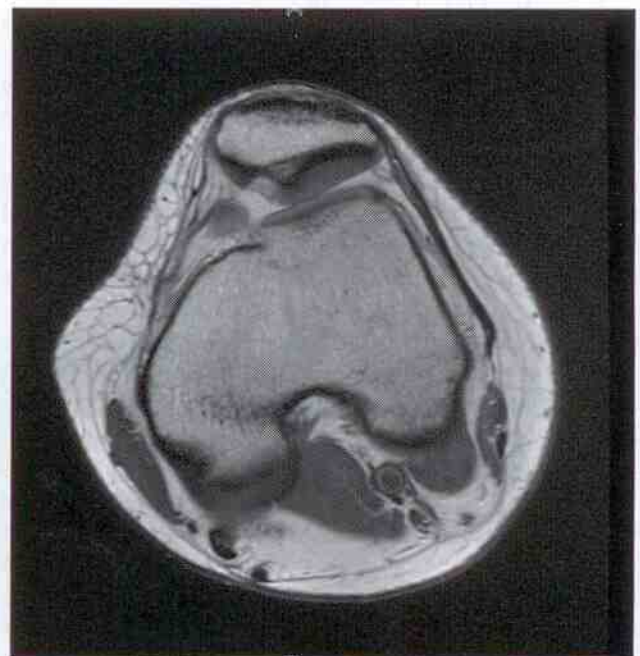


Figure 3 Axial T1-weighted MRI showing a chondral defect of the medial facet of the patella after an acute patellar dislocation.

Table 1 Outerbridge and International Cartilage Restoration Society Scoring Comparison

Score	Modified Outerbridge Classification System	International Cartilage Restoration Society Classification
Grade 0	Normal	Normal
Grade I	Cartilage with softening and swelling	Nearly normal: superficial lesion Superficial lesion grading A: Soft indentation B: Superficial fissures and cracks
Grade II	Partial thickness defect (<50% loss of cartilage thickness)	Abnormal: lesions extending down to <50% of cartilage depth
Grade III	Fissuring to level of subchondral bone, (>50% loss of cartilage thickness)	Severely abnormal: cartilage defect Cartilage defect grading A: Extending down >50% of cartilage depth B: Down to calcified layer C: Down to but not through the subchondral bone D: Blisters are included
Grade IV	Exposed subchondral bone	Severely abnormal: penetrating subchondral bone Subchondral bone penetration grading A: Penetrating subchondral bone but not full diameter B: Subchondral bone, full diameter

lesions have a completely displaced osteochondral fragment. Stage I-II lesions are considered stable, whereas stage III and IV lesions are considered unstable.

Patients who do not have an osteochondral or chondral fracture are classified using the International Cartilage Restoration Society or modified Outerbridge classification.¹⁵ These 2 classifications are somewhat similar, but the International Cartilage Restoration Society allows for more precise classification to the lesion grade, region, and dimensions. Table 1 shows a comparison of the 2 grading scales.¹⁶

Acute Management

The management of patients with acute chondral injuries after patellar dislocation is driven by patient symptoms, extent of chondral injury, and physical examination. Patients who have had an acute patellar dislocation with an unstable osteochondral or chondral fracture are always managed surgically. This as a semi-urgent surgical indication as the goal is to prevent any further damage to the cartilage or subchondral bone that may later prevent a successful surgical repair. In these patients, the patellar instability is treated conservatively unless there is marked patholaxity of the MPFL on examination after fixation of the fragment. In that instance, primary MPFL repair at the site of the tear is performed. Management of the MPFL is fully described in the chapter on *Medial Patellofemoral Ligament Reconstruction* in this issue.

Patients who have a stable osteochondral or chondral fracture (rare) or bony edema and/or chondromalacia as seen on MRI are treated conservatively after initial patellar dislocation. Stefancin et al in a systematic review of patients with an acute first-time dislocation recommended conservative non-operative treatment in such individuals.¹ We treat patients with soft-tissue protection for a short period using a patellar stabilization brace that provides a medial patellar displacement force on the lateral aspect of the patella. We transition

these patients quickly to a supervised physical therapy program to encourage range of motion, quadriceps, and proximal core strengthening with advances in weight-bearing as tolerated.

Acute Management of the Articular Cartilage

Patients with an acute patellar dislocation and an osteochondral fracture require semi-urgent surgical arthroscopic or open reduction and internal fixation or removal when the fragment characteristics prevent repair (Figs. 4 and 5). Strict attention is paid to the status of the cartilage, especially on the patella, trochlear, and lateral femoral condyle. As Sanders et al pointed out, the damage to the lateral femoral condyle can



Figure 4 Arthroscopic picture showing a small chondral defect of the medial patellar facet after an acute patellar dislocation. This patient had a small loose body in the medial gutter that was removed and no symptoms resulted from the small chondral defect.



Figure 5 Arthroscopic picture showing a large osteochondral defect after an acute patellar dislocation resulting in a large loose body, which necessitated an open reduction and internal fixation.

be posterior, and thus the knee should be flexed to determine the extent of cartilage damage.⁷ Any softening, or fissuring at the site of cartilage fracture is probed to document stability of the fragments. If the osteochondral or chondral fracture is unstable, it will have displaced either to the notch, gutter, or the suprapatellar pouch (Fig. 6). Characteristics that suggest good healing potential of the fragment include a wafer of bone on the back of the cartilage fracture (no matter how small), size and/or contour match to the recipient bed, healthy appearing cartilage, and a clot at the base of the fracture. If surgery is undertaken acutely within 2-3 weeks, this portends a more likely successful outcome. Osteochondral fractures with smooth edges, chondral hypertrophy, and no bony wafer are less likely to be amenable to successful reimplantation and are excised. Depending on the size and location of the defect, microfracture is often performed, especially in patients who present with defects on the weight-bearing portion of the lateral femoral condyle. Smaller lesions



Figure 6 Arthroscopic picture showing a loose body in the lateral gutter. This loose body resulted from an acute patellar dislocation.

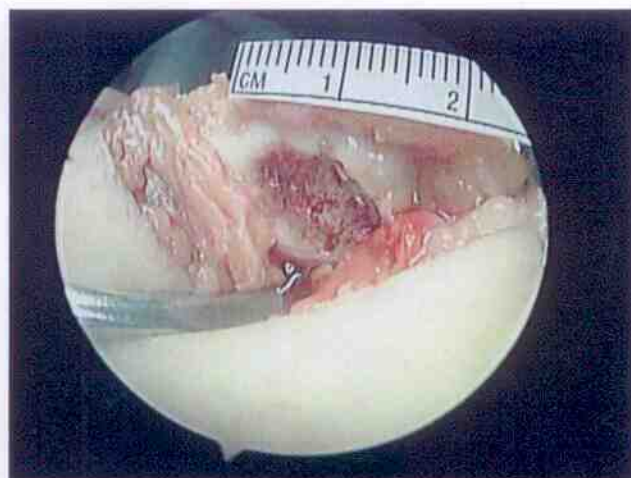


Figure 7 Picture of the medial facet of the patella after preparation of the osteochondral fracture bed showing good bleeding bone to facilitate repair.

with or without bone loss, especially those on the inferior medial portion of the medial facet off the weight-bearing surface are simply debrided. In addition, increased age is also considered a risk factor for failure, with younger patients having a greater probability of healing. However, there is no strict age limit where excision vs. repair is indicated and all fragments that can be technically fixed are repaired.

The goal in the treatment of osteochondral fractures is to restore a smooth articular surface (ie, patellar osteochondral fractures typically need open reduction). If the fragment is unstable but partially attached, the fragment is reflected in a "trap door" manner and clot debris is removed to ensure an anatomic reduction. In addition, this debridement results in a bleeding bed, which greatly increases the healing potential. The fragment is placed back in its bed ensuring a congruent reduction of the articular surfaces. A small diameter K-wire may be used to provisionally hold the fragment in place. Large fragments are then secured with interfragmentary technique using metal or bioabsorbable screws (Arthrex BioCompression Screw, Arthrex, Inc, Naples, FL). Less commonly, bioabsorbable pins may be used, but they lack the desired compression that aids in fracture healing (Figs. 7 and 8). Smaller fragments often times only accommodate 1 fixation point and greater protection during the postoperative period is emphasized. In the setting of open fixation, incisions are placed appropriately nearest to the defect or in a position to allow for potential future surgical approach to the MPFL.

Pure chondral fractures may remain problematic as the pure cartilage lesion does not heal. Factors that dictate treatment in these patients include the size and location of the fracture fragment, thickness of the cartilage fragment, and the status of the surrounding (remaining) cartilage. The bed is also probed to determine the status of the cartilage, and presence of any exposed bone. If the fracture fragment is smaller than 1 cm², we typically recommend excision. If there is any remaining irregular cartilage in the bed or margins of the

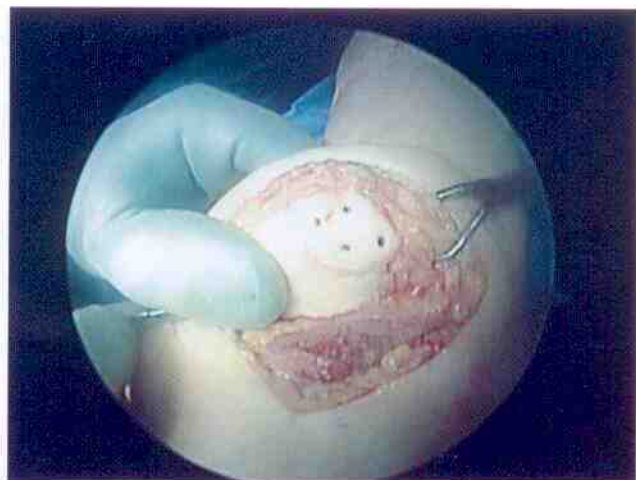


Figure 8 Picture of the medial facet of the patella after open reduction and internal fixation of an osteochondral fracture. The fragment in this patient was so large that it accommodated 4 pins for fixation.

fracture fragment, it is excised and debrided until the surrounding cartilage is stable and healthy upon probing.

Chronic Management

The treatment algorithm for patients with chronic patellar instability and chondral abnormalities is based on the patient's symptoms and complaints. In the chronic setting, patients commonly complain of recurrent and disabling patellar instability and in between these instability episodes they may also have symptoms related to their chondral abnormalities. Specifically, patients are queried as to the degree or magnitude of pain between instability episodes. If the "between episode pain" is negligible, only the patellar instability is treated. However, if there are recurrent effusions associated with moderate discomfort when ascending or descending stairs, the cartilage injury is assessed for single-stage treatment at the time of the patellar stabilization operation. If pain is a coprimary complaint, then articular cartilage treatment is discussed and performed in a single or staged fashion with the instability treatment. A complete discussion of the treatment for patellar instability is included in the chapter entitled *Medial Patellofemoral Ligament Reconstruction* in this issue, but some general decision-making principles must be considered given the complexity of this problem and the fact that some symptomatic chondral injuries may possibly be managed with a Fulkerson tibial tubercle anteromedialization osteotomy alone without formal treatment of the chondral defect.¹⁷

Management of the MPFL

In the chronic setting, the primary lesion is patholaxity of the MPFL. In general, the function of the MPFL is largely important during the first 30° of knee flexion. The decision for MPFL repair vs. reconstruction is based on the integrity of the medial soft-tissue restraints. MRI can preoperatively help to evaluate the quality of the MPFL tissue. If the MPFL has healed with good quality tissue, but it is pathologically lax,

then a case may exist for shortening this medial restraint to provide a medial checkrein for the patella. In contrast, if the tissues are inadequate, MPFL reconstruction would be more suitable. In the setting of patella alta or trochlear dysplasia, an even greater dependence on an intact functioning MPFL exists.

Tibial Tubercle Surgery

Managing chronic recurrent instability with pain related to the chondral defect is often performed in conjunction with a tibial tubercle osteotomy (TTO) and is discussed in detail in the *Tibial Tuberosity Osteotomies* chapter in this issue.

Management of the Articular Cartilage Pathology

Overview

The PF compartment can be approached through traditional portals. Common to all techniques is establishing the exact dimensions and grade of the lesion. A curette and shaver are used to create vertical walls and clear the base of the lesion. If the lesion(s) is large and the level of pain and dysfunction due to the chondral injury is significant, then an optional approach is to stage the definitive treatment. That is, first to fully assess all contributing pathologies and document the chondral lesions to allow for subsequent planning for large osteochondral allografts or obtain a cartilage biopsy for subsequent autologous cultured chondrocytes (ACI). The cartilage restoration would be performed in combination with appropriate management of the MPFL and correction of other comorbidities. An exception to this treatment sequence is a patient with distal lateral patellar lesions, as they may respond to tuberosity surgery alone. Then, the first stage would be MPFL reconstruction in combination with a traditional TTO as described by Fulkerson with subsequent observation of the patellar chondral lesion—noting once again that many of these patients will significantly improve without definitive articular cartilage repair.^{17,18}

Arthroscopic Debridement and Microfracture

Arthroscopy is performed to evaluate unstable cartilage areas. In these instances, unstable cartilage flaps are removed to create a stable and vertical wall. If there is exposed bone or grade III chondrosis, microfracture may be used as a first-line treatment. It can be difficult to debride and microfracture the patella as it is important to remain perpendicular to the surface during the microfracture technique. Occasionally, a small lateral arthrotomy is used to more accurately manage these defects. The specifics of the microfracture technique have been described previously.^{19,20}

These less invasive techniques may be useful in patients with recurrent effusions and low levels of pain in between instability events. However, in patellar lesions the long-term results are guarded as outlined by Kreuz et al.²¹ Therefore, at the time of these first-line treatments, in patients with larger lesions, a case can be made to harvest an articular cartilage biopsy from the intercondylar notch should the future need arise for more definitive cartilage treatment with an ACI.²²

