The evaluation and management of cartilage lesions affecting the patellofemoral joint

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Published online: 8 February 2013
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Abstract Patellofemoral chondral lesions are unique and difficult-to-treat entities often affecting a young and active patient population. Recent advances in our understanding of cartilage injuries, surgical techniques, and surgical technology have provided treatment options for symptomatic patients with lesions of the patellofemoral compartment. A number of surgical treatment options are available, including surgical microfracture, autologous or juvenile chondrocyte implantation, osteochondral autograft transfer, and osteochondral allograft implantation. Management decisions are based on a number of patient- and lesion-related factors in an effort to relieve pain, restore function, and preserve the patellofemoral articulation. The present article reviews the evaluation and management of cartilage injuries affecting the patellofemoral joint.

Keywords Patellofemoral · Chondromalacia · Osteochondral lesion · ACI · Osteochondral autograft · Osteochondral allograft

Introduction

Lesions to the articular cartilage of the knee are a common problem and can be difficult to effectively manage due to the poor intrinsic potential for spontaneous healing present

within the tissue [1, 13]. While our understanding of articular cartilage structure, biochemistry, and biomechanics has significantly improved, chondral lesions still pose a problem for both the patient and the treating surgeon. Chondral lesions of the patellofemoral joint can be especially challenging to successfully treat, due to the complex biomechanical environment present and the significant forces experienced within this compartment during weight-bearing activity.

Chondral lesions of the patellofemoral joint may arise following traumatic or instability events or as secondary injuries developing in the setting of abnormal joint loading. Left untreated, cartilage defects affecting the patella or trochlea alter the normal distribution of weight-bearing forces and may predispose patients to the development of osteoarthritis [1]. Recent advances in our understanding of focal chondral lesions, surgical techniques, and surgical technology have provided treatment options for symptomatic patients with cartilage lesions of the patellofemoral compartment. The present article reviews the evaluation and management of cartilage injuries affecting the patellofemoral joint.

Anatomy and biomechanics of the patellofemoral joint

The patella is the largest sesamoid bone in the body. It is a flat triangular bone and functions to direct forces of the quadriceps, protect the deeper knee joint anatomy, and protect the quadriceps tendon from frictional forces [2, 3]. The patella has a rounded base, proximally to which the quadriceps tendon is attached. Distally, the patella narrows to a pointed end, which attaches to the patellar ligament. Anteriorly, the patella is convex, with a roughened surface for tendinous attachments [3]. Posteriorly, the patella is covered by thick hyaline cartilage. This articular surface also has a midline ridge that is congruous with the trochlear groove. The distal 25 % of the patella's undersurface is nonarticulating.

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The articular surface of the patella is divided into two large facets, medial and lateral. These are then divided into several subfacets that vary from person to person. The lateral facet is generally concave, with two transverse ridges that separate upper, middle, and lower thirds of the articular surface [2]. Facet morphology can be classified into one of three groups on the basis of the Wiberg classification scheme. Type 1 patellae have concave medial and lateral facets and are equal in size. This makes up 10 % of patella morphology. Type 2 patellae have a flat or convex medial facet that is much smaller in size than the lateral facet. This makes up 65 % of patella morphology. Type 3 patellae have a convex medial facet that is slightly smaller than the lateral facet. This is seen in 25 % of patellae [2, 4].

The femoral trochlea is a 5.5-mm-deep groove in the distal aspect of the femur that intimately articulates with the patella. The lateral facet is larger and extends more proximally and anteriorly than the medial facet. The trochlear groove is covered by a 2- to 3-mm-thick cartilage cap, which tends to be thinner medially. Functionally, the trochlea provides a lateral buttress to lateral subluxation of the patella, starting at approximately 15°–20° of knee flexion [2–4].

Patellar contact area changes with increasing knee flexion. In general, the contact area reaches a maximum at 90° of knee flexion and moves proximally on the patella from extension to 90° flexion. At 90° flexion, the proximal aspect of the patella is in contact with the femoral trochlea. As the knee flexes beyond 90°, the patellofemoral contact area decreases, and the tendofemoral contact area increases. Contact pressure is the ratio of the contact area and the patellofemoral joint reaction force. Force increases from extension to 90° of flexion at a greater rate than contact area increases. The maximum compressive pressures occur at 60°–90° of flexion [5].

Epidemiology of patellofemoral chondral lesions

Chondral lesions of the knee are a common problem in the active patient. In a study of 31,000 consecutive knee arthroscopies, Curl et al. reported that 63 % of patients had a chondral defect evident intraoperatively, irrespective of the surgical indication [6]. In a similar study of 1,000 consecutive knee arthroscopies, Hjelle et al. found that 61 % of their patients had chondral or osteochondral lesions present, 19 % of which were focal [7]. While the majority of these lesions were found on the medial femoral condyle (58 %), chondral lesions affecting the patella were the second most common, present in 11 % of cases [7, 8]. In a cohort of patients with patellar instability, Nomura et al. demonstrated that 37 of 39 patients (95 %) with acute lateral patellar dislocations treated surgically were found to have chondral or osteochondral lesions affecting the patella [9].

Presentation and physical exam

Patients with patellofemoral cartilage injuries typically present with activity-related anterior knee pain and intermittent swelling and may report mechanical symptoms, including catching with knee flexion. They will often describe a dull aching pain in the anterior knee, especially after sitting for prolonged periods of time (“movie theater sign”) [10]. Activity-related pain is associated with knee flexion, including ascending or descending stairs [11]. Occasionally, patients will present with patellar instability (acute vs. chronic) and a history of traumatic subluxation or dislocation [12]. In addition, patients could have sharp intermittent pain that could be representative of an unstable chondral lesion.

Physical examination should focus on assessment of conditions that could predispose the patient to patellar instability or excessive patellofemoral contact pressures. It is important to first examine the patient while he or she is standing to assess overall varus or valgus alignment. It is important to assess patellar position, which could shed light on femoral version and tibial rotation. Malalignment and large quadriceps angles secondary to knee valgus or a wide pelvis and patellar position such as patella alta are risk factors for patellofemoral chondral lesions [13–15].

A sitting exam is then performed, observing patella position, tibial torsion, vastus medialis obliquus atrophy, and knee range of motion. Crepitus and patellar tracking can be evaluated while a patient’s knee is put through a range of motion. Typically, crepitus and pain in early flexion represent distal patellar pathology.

Supine exam is then performed focusing on the presence of an effusion, decreased quadriceps or gastrocnemius flexibility, and the presence of patellar apprehension with applied laterally directed stress at 30° of knee flexion, which may be a clue to patellar instability.

Imaging

Initial imaging for patients with suspected patellofemoral chondral injuries begins with standard standing anteroposterior radiographs of bilateral knees to assess for the presence of osteoarthritis, fractures, or other lesions. Bilateral tunnel views give insight into femoral condylar disease, including osteochondritis dissecans, and a clearer assessment for the presence of osteoarthritis. Lateral radiographs of the knee may reveal patella alta or baja as determined by the relative relationship of the distal pole of the patella to the osseous density of the intercondylar notch represented by Blumensaat’s line [16] or through the Insall-Salvati method, which is the ratio of the length of the patella tendon to the greatest diagonal length of the patella, with normal being

between 0.8 and 1.2 [17]. The last view in the standard series is the patellar or merchant view. This is performed with the knee flexed to 45°, with the plate positioned distal to the knee, providing an axial view of the patellofemoral compartment, which shows the relative congruence of the patella to the femoral trochlea in addition to patellar tilt, subluxation, and/or the presence of patellofemoral arthrosis [12, 18, 19].

Computed tomography (CT) has become a useful modality for addressing patellofemoral conditions and can give insight into the relationship of the tibial tubercle to the trochlear groove, an important parameter in assessing patients with a history of patellar instability. To determine the tibial-tubercle–trochlear-groove distance (TT–TG), a line is drawn connecting the most posterior aspect of the subchondral bone of each posterior femoral condyle. A second line is then drawn that extends from the nadir of the osseous femoral trochlea perpendicular to the posterior condylar line. A third line is then drawn from the most anterior aspect of the tibial tubercle perpendicular to the posterior condylar line. The linear distance between the two lines subtended from the tibial tubercle and femoral trochlea is measured in millimeters [19–23]. Another technique for determining TT–TG, which has been adopted by many as imaging programs become more sophisticated, uses a double superimposed image of the trochlear groove and tibial tubercle, which has been shown to be equally valid to the original description of TT–TG measurement [23]. Interobserver and intraobserver reliability for TT–TG measurements were shown to be 97 %–98 % and 91 %–97 %, respectively [24, 25•]. In a study of 60 asymptomatic knees by Alemparte et al., the mean TT–TG distance was determined to be 13.6 mm, with a range of ± 8.8 mm. In other studies, asymptomatic patients were found to have TT–TG values ranging from 10 to 12.7 mm. It is generally accepted now that TT–TG values <15 mm are considered normal, while values >20 mm are considered abnormal [26].

Magnetic resonance imaging (MRI) has been shown to be as efficacious as CT scanning with respect to evaluating the TT–TG distance and has the added benefit of assessing the soft tissues, including the status of the articular surface and the underlying subchondral bone [27, 28]. In a study by Wilcox et al., MRI was shown to have an interobserver reliability of 91 % and an intraobserver reliability of 96 % in calculating TT–TG distance. Various MRI sequences have been developed to provide important information regarding the presence of articular cartilage injuries, in addition to allowing for the calculation of ventral height, trochlear depth, sulcus angle, and lateral inclination. Additionally, T2 images can identify defect-associated bone marrow edema lesions and help determine defect depth.

Nonsurgical management

Basic nonsurgical management is used as an initial treatment modality to treat chondral lesions of the patellofemoral joint for at least 6 months [30]. It is usually best for patients without significant pain and those without mechanical symptoms related to a loose chondral or osteochondral fragment [10]. Nonsteroidal anti-inflammatory medications, intra-articular corticosteroid injections, and hyaluronic acid viscosupplementation can be used as needed to relieve inflammation and pain. Activity modification to avoid exacerbating symptoms and weight loss may also help [31]. In addition, strengthening of muscles crossing the knee through formal physical therapy helps absorb physiologic loads and may improve patient symptoms. In a study by Chiu et al., patellofemoral pain improved with isometric and isokinetic weight training focusing on quadriceps strengthening [32•].

Surgical management

Surgical management is entertained when a patient has persistent and functionally limiting symptoms despite an adequate trial of nonoperative treatment. Surgical options depend on the lesion size, depth, location, and status of the underlying subchondral bone. Surgical options vary from straightforward to complex and are strongly dependent of the patient's expectations and goals for recovery.

General indications for surgery include young, active patients (less than 50 years old) with severe discomfort related to a deep focal chondral or osteochondral lesion. The knee must be stable and within normal alignment. Lesions appropriate for surgical management are typically larger than 0.5 cm². Contraindications to surgery are obesity and chronic inflammatory diseases. Relative contraindications include malalignment and ligamentous laxity (both of which can be treated at the time the chondral defect is addressed) [33•].

Microfracture, autologous chondrocyte implantation (ACI), DeNovo juvenile chondrocyte implantation, osteochondral autograft transfer, and osteochondral allograft transplant are considered cartilage restoration procedures for the patellofemoral joint. Tibial tubercle osteotomies—specifically, advancement or anteromedialization procedures—are the mainstay in realignment procedures and are often combined with cartilage restoration to unload the treated lesion site. Patellofemoral replacement is an arthroplasty option for patients with more diffuse disease affecting both the patella and/or trochlea and can be used as a salvage procedure. Each procedure carries with it a specific set of indications, challenges, and outcomes specific to the unique environment of the patellofemoral joint.

Cartilage restoration

Microfracture

Microfracture, as first described by Steadman, is indicated for small ($1\text{--}4\text{ cm}^2$) full-thickness cartilage defects and involves debridement of cartilage within the lesion down to subchondral bone and using specially designed awls to create perforations in the subchondral bone plate. Penetration of the subchondral bone plate within the lesion leads to bleeding and subsequent fibrin clot formation, filling the defect and covering the exposed bony surface. Pluripotent, marrow-derived mesenchymal stem cells then migrate into the clot and promote the formation of a fibrocartilaginous repair tissue [34–36]. In a study of 68 patients with an average of 11.3 years follow-up status postmicrofracture, Steadman et al. found significant improvement in pain and knee function at final follow-up [37]. Of the patients assessed in this follow-up study, 20 lesions were noted to be in the trochlea, and 8 were noted to be in the patella.

Microfracture has the best results in young patients (<40 years old) with small lesions of the femoral condyles. Technically, microfracture of patellar chondral lesions can be difficult secondary to trouble obtaining a perpendicular angle of approach arthroscopically. Additionally, the outcomes following microfracture tend to decline with time. In a recent systematic review of the clinical efficacy of microfracture in the treatment of articular lesions of the knee, Mithoefer et al. demonstrated that the procedure resulted in symptomatic improvement during the first 24 postoperative months in all 28 studies included in the analysis [38•]. However, 7 studies in this review reported deterioration of functional outcomes in 47 %–80 % of patients between 18 and 36 months postmicrofracture. Some authors attribute this decline to incomplete defect fill and poor integration with the surrounding normal articular cartilage following microfracture, while others point to the inferior wear characteristics of the fibrocartilaginous repair tissue resulting from marrow stimulation [38•, 39–43].

Autologous chondrocyte implantation

ACI, as originally described by Brittberg et al., employs tissue-engineering techniques with cell-based therapy to regenerate cartilage by harvesting a native cartilage biopsy specimen from a non-weight-bearing portion of the knee (intercondylar notch or periphery of the condyle). Chondrocytes are isolated, expanded in culture, and reimplanted into the lesion during a second-stage procedure. The indications for ACI include a symptomatic full-thickness chondral defect or a shallow osteochondral unipolar lesion. ACI is considered a first-line surgical treatment in large lesions ($>4\text{ cm}^2$) and is a useful secondary treatment for patients

with persistent symptoms following treatment with an alternate method.

Outcomes of ACI in the patellofemoral compartment have had mixed results. Of the 23 patients in Brittberg's initial study, 7 had patellar-based lesions, and of those, 2 had excellent results (28 %), 3 had good results, and 2 had poor results [44]. Pascual-Garrido et al. reported a statistically significant improvement in patients treated with isolated ACI on the basis of several functional scoring systems and patient satisfaction. In a follow-up by Brittberg, 81 % of his patients had good-to-excellent results at 2 years, and 83 % at 5–11 years follow-up [45].

ACI performed in conjunction with an unloading tibial tubercle osteotomy (AMZ) has shown better results, with significant improvements in functional outcomes and patient satisfaction (Fig. 1) [46•]. Peterson et al. reported that among patients with isolated patellar lesions, 65 % had a satisfactory outcome with ACI alone, but when the procedure was performed in combination with an AMZ, 85 % had good-to-excellent results [47]. ACI in combination with AMZ has been shown to have superior outcomes, as compared with ACI alone, with 86 % of patients having good-to-excellent results following the combined procedure versus 55 % of the patients treated with ACI alone [48•, 49, 50].

Particulated juvenile cartilage allograft (DeNovo)

Particulated juvenile cartilage allograft (DeNovo) is a relatively new technique for filling chondral defects about the knee with hyaline-like cartilage. Theoretical advantages of DeNovo over ACI is that it uses allograft, which does not limit the amount of implantable material; juvenile chondrocytes are more metabolically active, thereby producing more extracellular matrix; and the procedure can be performed in a single-stage [51•]. The current indications for DeNovo are limited but tend to be similar to those for ACI. Lesions should be $1\text{--}5\text{ cm}^2$ in size, with minimal to no associated subchondral bone edema [51•].

Outcome studies following juvenile chondrocyte implantation are currently sparse. In a case report by Bonner et al. of a 36-year-old male 2 years post-op following DeNovo treatment of a patellar chondral lesion, the authors described clinical and functional improvement in addition to radiographic improvement with defect fill and a decrease in subchondral bone edema as seen on MRI [52]. In a study by Farr et al., clinical outcomes were evaluated following DeNovo implantation in 9 patients showing significant improvement in functional outcome scores at the 12- and 18-month follow-up time points [53•]. More work must be done to better define expected outcomes following juvenile chondrocyte implantation and to better understand the indications for this procedure.

Fig. 1 Autologous chondrocyte implantation and tibial tubercle osteotomy used to treat a 29-year-old female with persistent pain, swelling, and mechanical symptoms related to a patellar chondral lesion that had failed a prior attempt at surgical microfracture

Osteochondral autograft transfer

Osteochondral autograft transfer (OATS) is a treatment used to address full-thickness cartilage defects by preserving hyaline cartilage and using native osteochondral “plugs” from non-weight-bearing portions of the joint. The benefit of using autograft is that there is no risk of immunologic reaction. It also allows for a one-stage technique to fill a chondral defect with hyaline cartilage, with consistent integration and bony healing [31]. Disadvantages of OATS include donor site morbidity, especially for larger treated lesions, in addition to persistent gaps at the lesion/autograft interface.

Hangody et al. reported their results for OATS for weight-bearing portions of the knee. They found that 92 % of patients treated for femoral condylar lesions had good-to-excellent results, while patellar lesions had only 79 % good-to-excellent results in a 10-year follow-up with 3 % donor site morbidity [54]. In a study by Bentley et al., however, results were not as promising. As compared with ACI with good-to-excellent results at 88 %, OATS had only 69 % good-to-excellent results for all chondral lesions of the knee. Of the patients in this study, 5 had patellar lesions treated with osteochondral autograft transfer, and all 5 had poor postoperative outcomes [55].

The indications for OATS include a small- to medium-sized (1–4 cm²), full-thickness chondral or osteochondral defect. The joint must be ligamentously stable without malalignment [56•]. Harvest sites have been described for

several non-weight-bearing zones in the knee, including the medial and lateral margins of the trochlea, the intercondylar notch, and the posterior femoral condyles. In a study by Garretson et al. assessing patellofemoral contact pressures in cadaveric knees, it was found that the medial trochlea had the lowest contact pressures, followed by the distal lateral trochlea, and that these two areas could provide desirable donor grafts [57]. In a study by Thaunat et al., the posterior femoral condyles were assessed for their suitability as donor sites for osteochondral autograft transfer. It was found that while the articular thickness was comparable to other articular surfaces, the difficulties of obtaining perpendicular plugs make this approach less desirable [58•].

Little has been written about patellar lesions treated with OATS. OATS is considerably more challenging and complicated for patellar lesions because of the difficulty of correctly matching the surface concavity and convexity of the patellofemoral articulation, and the donor grafts typically lack the articular thickness of the native patella [26]. Little consensus has been established as to the best way to approach treating patellofemoral lesions with OATS, but the technique remains a viable option for smaller lesions with involvement of the underlying subchondral bone.

Osteochondral allograft transplantation

Considered a salvage procedure, osteochondral allograft transplantation can be used to treat large (>4 cm²), focal chondral, or osteochondral lesions. This can be performed as a single-staged procedure and is useful for patients who have failed treatment with another cartilage repair technique. Concerns associated with fresh allograft implantation include donor availability and the risk for infection and/or immunogenic reaction.

In a large retrospective study focusing on patellofemoral chondral lesions by Jamali et al., 18 patients (20 knees) underwent osteochondral allograft implantation, of which 15 had their entire patella resurfaced, while the remaining 3 had an average of a 7.1 cm² cylindrical plug implanted. The results of this study showed that 15 of the 20 knees had successful results, with 4 excellent results, 8 good results, and 3 fair results. Five failed and went on to further allografting, total knee arthroplasty (TKA), or arthrodesis. Twelve knees treated successfully were also evaluated radiographically, with 10 having no or mild patellofemoral arthrosis at the time of the last postoperative follow-up [59].

Realignment/unloading procedures

Originally described by Fulkerson et al., anteromedialization of the tibial tubercle (AMZ) is designed to decrease the Q-angle to a more normal central position and/or correct the TT–TG distance for cases of patellar instability and unload the

patellofemoral compartment in the setting of cartilage restoration surgery [50, 60]. The goal of medialization of the tibial tubercle is to restore a normal TT–TG distance while allowing the anteriorization of the tubercle to unload the contact forces seen in the patellofemoral compartment. In a study by Cohen et al., patellofemoral contact pressure was shown to significantly decrease with anteromedialization [61].

AMZ has been shown to have good results in appropriately selected patients. In a study by Pidioriano et al., patients undergoing AMZ had better outcomes when lesions were located in the lateral facet or distal pole of the patella. Patients had poor outcomes with medial lesions or central trochlear lesions [29]. In a study by Carofino et al. examining the outcome in older active patients (mean age of 55), it was found that 12 of 19 patients had good-to-excellent outcomes [62].

Potential complications associated with tibial tubercle osteotomy include nonunion at the osteotomy site, painful hardware requiring later removal, and iatrogenic overloading of the proximal and medial aspects of the patellar articular surface.

Patellofemoral arthroplasty

Patellofemoral arthroplasty (PFA) has been performed for the treatment of patellofemoral arthritis for approximately 30 years. Much controversy surrounds this procedure, since outcomes have been inconsistent and the indications for its use are narrow [63]. Currently, debate is present over the use of PFA or TKA for isolated patellofemoral arthritis, especially in the younger patient population. PFA is a salvage procedure for severe chondrosis, arthrosis, and failed attempts at cartilage restoration [64•].

Indications for PFA include patients with isolated severe patellofemoral chondrosis (Outerbridge III or IV), osteoarthritis, or posttraumatic arthritis with severely affected activities of daily living. In addition, patients should have attempted and failed other nonoperative and operative interventions, including patellofemoral unloading procedures [64•]. The optimal patients are those with patellofemoral dysplasia but no evidence of maltracking [63, 64•, 65]. Contraindications to PFA include patients with inflammatory arthritis and chondrocalcinosis [63]. Controversy over the ideal age exists currently, with many advocating for its use in patients under 60 years old [65].

The rationale for the use of PFA is that of a compartment-sparing prosthetic resurfacing procedure that focuses on extensor mechanism conservation [64•]. The challenge of PFA is to help patients with isolated patellofemoral arthritis who are young and would thus anticipate a revision of a TKA, if performed. The idea is that this is a midterm procedure that can be converted to a TKA if necessary [63]. Controversy over outcomes, however, has made PFA less popular in recent years. Historically, rates for good-to-

excellent results have been reported to range from 45 % to 96 %, with revision rates reported to be 20 %–25 % [64•].

Many of the outcome failures stem from progression of medial and lateral compartment osteoarthritis, which is seen in the vast majority of cases, or component maltracking. In a study of the Avon PFA, Ackroyd et al. reported that there was progression in 20 % of patients at 5-year follow-up, but only 4 % needed a revision procedure [66]. Patellar clicking, subluxation, and blocks to extension were reported in as high as 18 % of treated patients [67]. Over the years, the PFA designs have improved, including more anatomic geometry and improved cement and polyethylene, which can reduce patellar maltracking and reduce failure due to component-related issues [68, 69•]. Outcome studies show similar functional results between PFA and TKA [70].

Postoperative rehabilitation

Postoperative rehabilitation protocols used for the available cartilage restoration techniques of the patellofemoral joint vary depending on whether a concomitant tibial tubercle osteotomy is performed. Generally, if cartilage surgery is performed in isolation, patients are allowed to bear weight as tolerated immediately after the procedure in a hinged brace locked in extension. In the setting of an AMZ, patients are made to touch weight bearing for 6 weeks.

Patients start using a continuous passive motion (CPM) machine immediately postoperatively, initially set from 0° to 30° for the first 3 postoperative weeks. CPM and range of motion work with the physical therapist then progresses on as tolerated, with goals of 90° of flexion by 6 weeks and 120° of flexion by 8 weeks.

From 12 to 24 weeks postoperatively, the patient is weight bearing as tolerated, and rehabilitation is focused on achieving normal gait mechanics with slow to moderate speed treadmill exercises. In addition, light balance and proprioceptive exercises are begun.

Return to impact activities varies depending on the repair technique utilized. Patients undergoing microfracture or an osteochondral implantation typically return to unrestricted activity at 6 months, while those treated with a cell-based repair are kept out of athletics until 12–18 months.

Authors' approach

At our institution, the management algorithm for cartilage lesions of the patellofemoral joint centers on both patient factors and lesion factors. Surgical intervention is considered for young (<40 years of age) active patients with continued functionally limiting symptoms despite a trial of nonoperative care.

Small ($<2\text{ cm}^2$) well-contained lesions of the patella and trochlea are considered candidates for microfracture or OATS. We base the treatment decision on the defect's location and its appearance on MRI. For trochlear lesions in which underlying subchondral bone marrow edema is present, we prefer to treat the osteochondral injury with an OATS, while a surface lesion without associated bone marrow edema can be treated with microfracture. Small lesions of the patella are treated with microfracture as a first-line option.

Larger lesions ($>2\text{ cm}^2$) or those who fail an attempt at a prior microfracture are treated with a cell-based cartilage repair (ACI or DeNovo) in the absence of underlying subchondral bone marrow edema or osteochondral allograft if significant bone marrow edema is present. We tend to perform an associated tibial tubercle osteotomy (AMZ) to unload the patellofemoral compartment for all ACI/DeNovo cases in the patellofemoral compartment.

Articular cartilage injuries occurring in the setting of patellar instability are worked up with an MRI to allow for calculation of a TT–TG distance. Abnormal TT–TG distances are corrected with a tibial tubercle osteotomy (plus or minus a medial patellofemoral ligament reconstruction) to allow for stabilization of the patella, while simultaneously unloading the compartment protecting the cartilage repair site.

Conclusion

Patellofemoral chondral lesions are a unique and difficult-to-treat entity. Much has been done to better characterize and manage this condition. For patients with persistent and functionally limiting symptoms, despite an adequate trial of non-operative management including anti-inflammatory medication, intra-articular corticosteroid injections and physical therapy surgical intervention are indicated. A number of surgical treatment options are available, including microfracture, autologous or juvenile chondrocyte implantation, osteochondral autograft transfer, and osteochondral allograft implantation. The determination of which surgical treatment is appropriate is based on lesion characteristics, including size, depth, location, and the status of the underlying subchondral bone. Recent data have demonstrated that combining cartilage restoration procedures with an unloading/realigning tibial tubercle osteotomy improves outcomes by decreasing the contact loads experienced by the lesion site following repair.

To date, the data assessing the outcomes of the surgical management of patellofemoral cartilage injuries are limited. Continued research is necessary to help identify an ideal treatment algorithm for patients affected by this complex pathology.

Disclosure No potential conflicts of interest relevant to this article were reported.

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