Autologous Chondrocyte Implantation and Anteromedialization for Isolated Patellar Articular Cartilage Lesions

5- to 11-Year Follow-up

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Background: Isolated chondral lesions of the patella are particularly challenging to treat, and long-term studies of treated isolated patellar lesions are limited. Previous short-term studies have reported favorable outcomes of autologous chondrocyte implantation (ACI) of the patella and/or trochlea, with a trend toward improvement when anteromedialization (AMZ) of the tibial tubercle was performed with the procedure.

Hypothesis: Autologous chondrocyte implantation with concomitant AMZ for symptomatic isolated patellar lesions provides functional and symptomatic improvement in patients at a minimum 5-year follow-up.

Study Design: Case series; Level of evidence, 4.

Methods: Patients with failed primary treatment of isolated patellar full-thickness articular cartilage defects and patellofemoral malalignment who were treated with ACI and AMZ of the tibial tubercle at least 5 years prior were contacted for final postoperative outcome scores. Outcome scales including the International Knee Documentation Committee (IKDC), Lysholm, modified Cincinnati Knee Rating System, and 12-item Short Form Health Survey (SF-12) scores were assessed at baseline and final follow-up.

Results: Of 27 eligible patients, 23 (25 knees) were available for assessment at a mean follow-up of 7.6 years (range, 5.1-11.4 years). Significant improvements from baseline to final follow-up were observed in the IKDC score (from 42.5 to 75.7; \( P < .0001 \)), modified Cincinnati Knee Rating System score (from 3.0 to 7.0; \( P < .0001 \)), Lysholm score (from 40.2 to 79.3; \( P < .0001 \)), and SF-12 score (physical component score: from 41.2 to 47.6; \( P = .002 \); mental component score: from 48.1 to 60.7; \( P = .0001 \)). Most patients (83%; 19/23) rated their surgery as good or excellent. The overall reoperation rate was 40% (10/25) largely because of periosteal hypertrophy (33%). One patient failed at 5.9 years postoperatively and underwent patellofemoral arthroplasty.

Conclusion: Combined ACI and AMZ resulted in significant improvements in symptoms and function with a low incidence of adverse events in patients with isolated symptomatic patellar chondral defects after a mean follow-up of more than 7 years.

Keywords: anteromedialization (AMZ); autologous chondrocyte implantation (ACI); articular cartilage; chondral lesion; knee; patellofemoral; patellar tracking

Articular cartilage injuries are commonly seen in orthopaedic clinics, and because articular cartilage does not have the ability to self-regenerate, it does not usually heal without surgical intervention. Although focal cartilage defects may lead to osteoarthritis over time, symptoms of these defects may be just as debilitating as end-stage osteoarthritis. Early treatment can provide relief from these debilitating symptoms and possibly delay the progression of osteoarthritis.

In patients with knee lesions classified as Outerbridge grade III and IV, the second most common location for defects, after the medial femoral condyle, is the patella. Patellar lesions can be difficult to treat because of high shear and compression stresses across the joint, and treatment may be complicated further because of abnormal stress caused by tilt, malalignment, and/or tracking problems. Although the cause of anterior knee pain is often uncertain with multiple confounding variables, a careful history assessment, a physical examination, and diagnostic
studies will typically elucidate the cause from mechanically identifiable factors and associated chondral defects.

Autologous chondrocyte implantation (ACI) has been shown to be an effective treatment for articular cartilage lesions. In some cases, ACI was shown to have better outcomes and longer efficacy compared with alternative treatments, such as microfracture and mosaicplasty. One of the theoretical advantages of ACI is that it may produce more hyaline-like repair tissue as opposed to other techniques, such as microfracture, which often produces predominantly fibrocartilage; however, this is controversial. For example, Knutsen et al and Saris et al published similar histological results, and Van Assche et al showed similar clinical outcomes between different ACI techniques and microfracture. However, the studies by these authors were of lesions on the femoral condyle and may not apply to lesions of the patella. To date, there is no evidence linking histological findings to clinical outcomes. Over the past 20 years, ACI has been shown to produce functional repair tissue, and clinical long-term results show that 73.5% of patients still have satisfactory results up to 20 years after surgery (mean, 12.8 years). Therefore, favorable outcomes of ACI in the patellofemoral (PF) joint have resulted in a greater acceptance of ACI as an effective treatment with a good safety profile, even though outcomes are usually less favorable for PF lesions than for condylar lesions.

Whereas the ACI technique is used to fill the defect, anteromedialization (AMZ) is one of several procedures used to correct malalignment. By transferring the tibial tubercle anteriorly and medially, the AMZ procedure has also been shown to decrease contact stresses across the PF joint. Generally, clinical outcomes of full-thickness patellar lesions treated with AMZ alone have been poor when the lesion is diffuse, proximal, or located in the medial facet. Additionally, the ACI procedure alone for patellar full-thickness chondral lesions results in relatively poor outcomes if malalignment is not corrected. However, the treatment of patellar lesions with AMZ has resulted in good clinical outcomes, as described in several short-term studies (2-5 years), noting significantly greater improvements in multiple clinical outcomes in patients undergoing ACI combined with realignment when required.

In this study, the primary indication for AMZ was patellar malalignment, and decreasing the contact forces across the PF joint was seen as an enhancement for chondral repair addressed with ACI. This combination of procedures is supported by a recent systematic review by Trinh et al, noting significantly greater improvements in multiple clinical outcomes in patients undergoing ACI combined with distal osteotomy versus ACI alone for PF lesions.

As there are no longer term studies of ACI in patients with lesions of the patella, our specific aim was to evaluate longer term results of ACI to repair the chondral lesion combined with AMZ to correct malalignment in patients with isolated symptomatic patellar defects using established clinical outcome measurements. We hypothesized that ACI with concomitant AMZ would improve clinical outcomes in patients with a chondral lesion of the patella and malalignment.

MATERIALS AND METHODS

Study Patients and Design

The clinical database of patients of the senior surgeon was evaluated for consecutive patients who underwent AMZ for an isolated patellar full-thickness (modified Outerbridge grade IV) chondral defect and AMZ of the tibial tubercle between November 1999 and December 2005 (who were at least 5 years postoperatively). Data from patient charts, including their demographic and lesion characteristics and preoperative outcome scores, were prospectively entered into the study database. Patients were excluded from the study if they had patellar and trochlear lesions or a patellar defect with a femoral condyle lesion or if they did not undergo AMZ of the tibial tubercle. One patient with a history of osteomyelitis of the tibial tubercle was excluded. Ethical approval for the study was obtained from the hospital institutional review board.

In these eligible patients, ACI was indicated for persistent symptomatic full-thickness chondral defects of the patella that had failed previous nonoperative or operative treatments (ie, chondroplasty, edge stabilization, or microfracture). Failure of prior treatments was characterized as an inadequate improvement in symptoms and functional status as defined by the patient and surgeon.

Prospective data were collected throughout the time period of the study using patient-completed history scan forms, which included the following objective outcome measures (Sparrow Systems, Charlotte, North Carolina, USA): International Knee Documentation Committee (IKDC), Lysholm, modified Cincinnati Knee Rating System, and 12-item Short Form Health Survey (SF-12) questionnaires. To obtain final follow-up outcome scores, patients were located through clinic records or by using public domain electronic methods. After providing study-specific consent, the patients completed follow-up scan forms that included the above measures as well as a nonvalidated patient satisfaction survey. The patient satisfaction survey included an overall rating of their treatment as excellent, good, fair, or poor. Patients were also asked if they felt improved, if they would undergo the procedure again, if they were satisfied with sports, and whether their sports performance was improved using a scale of “definitely,” “probably,” “neutral,” or “no.”

Adverse events and subsequent surgical procedures were recorded in the database from the patients’ records or history. Surgical failure was defined as objective findings of graft delamination requiring secondary surgery, revision biological resurfacing, or conversion to knee arthroplasty. Graft delamination was assessed arthroscopically using the grading system that was described by Peterson et al. With use of an arthroscopic probe, total delamination of the repair tissue was defined as 50% to 100% dissociation of the repair tissue from the bony bed, leaving a recurrent full-thickness chondral defect.
Surgical Procedures and Technique

Before ACI treatment, patients underwent knee arthroscopic surgery for the assessment of defect location and size and patellar tracking and to obtain a cartilage biopsy specimen, if not already obtained. Patellar tracking was evaluated by a physical examination, the quadriceps (Q) angle, a sunrise view on plain radiographs, computed tomography (CT) scans with and without quadriceps contraction, and an arthroscopic intraoperative assessment. In our clinical practice, we believe that it is important to consider clinical parameters obtained during the physical examination as well as patient symptoms to support the imaging parameters from plain radiographs and CT/magnetic resonance imaging (MRI). Additionally, all patients underwent an index arthroscopic procedure to evaluate the chondral defect(s) and assess patellar tracking and morphological characteristics of trochlear cartilage. All patients showed persistent lateral tracking and failure to centralize in the trochlea by ≥45°. Of all the parameters and evaluation methods, an increased Q angle and visualization of persistent lateral tracking at arthroscopic surgery, combined with a large isolated patellar full-thickness chondral defect, were the essential indications for concomitant AMZ of the tibial tubercle. Although measuring the distance between the tibial tubercle and trochlear groove (TT-TG) has now become the accepted standard for determining lateral patellar instability, it was not routinely collected during the study period and therefore was not a variable measured during the preoperative evaluation. Patellar height was calculated using the Insall-Salvati method to determine if patella alta or baja was present.

Essentially, AMZ was performed in conjunction with ACI to decrease contact stresses across the site of cartilage repair and to correct or alter patellar maltracking. When indicated, modifications were made to the AMZ technique to prevent overmedialization. Patients with recurrent dislocations and a flat or convex entrance to the trochlear groove suspected on any imaging studies and then observed intraoperatively during the index arthroscopic procedure underwent concomitant trochleoplasty at the time of the ACI procedure. The trochleoplasty procedure used was designed to provide a biomechanical entrance to the trochlear sulcus with bony and cartilage reshaping in the manner described by Peterson and Vasiliadis. The benefit of lateral lengthening was unclear at the time of the ACI procedure. Medialization of the trochar sulcus and intercondylar notch (Whiteside line). Saranathan and colleagues indicated that medializing the tuberosity by 10 mm reduces the pressure applied to the lateral patellar cartilage for intact cartilage and cartilage with lateral lesions but does not overload the medial cartilage. The goal was not to overmedialize the tubercle. With our customized approach, osteotomy of the tibial tubercle was typically performed using an angle of 45°, allowing both unloading and improved tracking for typical distal and lateral lesions. For more diffuse or medial lesions, the slope of the osteotomy was increased up to 60° to provide greater unloading (anteriorization) and less medialization.

The full-thickness chondral defect was debrided down to the level of the subchondral bone and extended peripherally to a rim of stable, healthy chondral tissue with vertical walls. Care was taken to avoid violation of the subchondral bone, and any intralesional osteophytes were lightly debrided with a bur or gently impacted to the level of the surrounding subchondral bone. A perioseal graft was harvested from the proximal medial tibia in a size slightly larger than the prepared defect. With the cambium layer facing into the defect, the perioseal graft was sewn to the chondral rim using undyed 6-0 Vicryl sutures (Ethicon, Westwood, Massachusetts, USA) spaced 2 to 3 mm apart. The graft was trimmed as needed to provide even tension of the graft without redundancy. The perioseal graft was then circumferentially sealed along the suture line with fibrin glue (Baxter, Westlake Village, California, USA), leaving a small opening for cell injection. For uncontained lesions, drill holes were made with Keith needles (Aspen Surgical Products, Grand Rapids, Michigan, USA) to secure the perioseal patch to bone or marginal...
osteoarthropathies, or micro-suture anchors (DePuy Mitek, Raynham, Massachusetts, USA) loaded with 5-0 absorbable Vicryl sutures were used. After a test injection of saline under the peristomal graft to ensure a watertight seal, the suspended autologous chondrocytes were injected under the peristomal graft with an angiocatheter and a 1-mL syringe. The injection site was then closed with an additional suture and fibrin glue.

The tibial tubercle was then positioned for appropriate anterior and medial correction and held with a K-wire, while final fixation was achieved with two 4.5-mm cortical screws in men or 4.5- and 3.5-mm screws in women in the lag mode, placed in the anterolateral to posteromedial direction. The correct position for anteromedial correction was determined before implanting the cells to avoid further manipulation of the implanted cells.

**Postoperative Rehabilitation**

After routine postoperative recovery, patients were placed in the prone position to allow gravity to assist in maximizing cell adherence to the underlying subchondral bone. Patients maintained the prone position for the first postoperative night as much as possible but were allowed to move for meals, to turn over for incentive spirometry, and to use the bathroom. Patients were allowed to partially bear weight in a hinged knee brace locked in extension immediately postoperatively. Continuous passive motion was initiated on the first day after surgery in 1- to 2-hour increments for 4 to 6 hours per day to tolerance for the first 2 to 3 weeks. Passive range of motion was increased with a goal of 90° of flexion by the end of week 1. Open chain quadriceps exercises were avoided for the first 16 postoperative weeks. A gradual return to full function was expected to occur by 8 months after surgery.

**Statistical Analysis**

Patient data were analyzed for both preoperative and postoperative scores. Some preoperative values for the IKDC score (n = 5) were not collected because the tool was not yet developed in the early time frame of treatment. For each outcome variable, the change from pretreatment to posttreatment values was assessed using a paired t test (SAS v9.3, SAS Institute, Cary, North Carolina, USA). P values were considered significant if they were less than .05. A 9-point improvement in the IKDC score and a 2-point improvement in the modified Cincinnati Knee Rating System score from baseline have been reported as the minimal clinically important difference for these scores.

The assumption of normality was evaluated with quantile-quantile (Q-Q) plots. Subgroup analyses were also performed in which the change from pretreatment to posttreatment values for the modified Cincinnati Knee Rating System score from baseline have been reported as the minimal clinically important difference for these scores.

The mean patellar defect size was 6.4 cm² after debridement, and more than half of the defects (n = 13; 52%) were uncontained.

**RESULTS**

**Patient Disposition and Demographics**

Between November 1999 and December 2005, 27 patients (29 knees) underwent ACI for an isolated patellar full-thickness chondral defect and AMZ of the tibial tubercle. Of these 27 patients, we were able to contact 23 patients for postoperative evaluation (4 lost to follow-up), for a total of 25 knees (86%) for the analysis. The follow-up period ranged from 5.1 to 11.4 years, with a mean of 7.6 years (Table 1).

Patient demographics and lesion characteristics are shown in Table 1. The mean age of the patients was 31.0 years at the time of surgery, and the number of male and female patients was similar. Overall, the cohort had undergone 39 previous operations for a mean of 1.6 (range, 0-4) surgeries per knee evaluated. The primary previous procedures included lateral release (n = 6), microfracture (n = 4), and ligament reconstruction (n = 1). The remaining procedures included debridement, chondroplasty, and "clean-outs" as described by the patients. Five patients were treated as part of a workers’ compensation claim.

The mean patellar defect size was 6.4 cm² after debridement, and more than half of the defects (n = 13; 52%) were type IVb (panpatellar involvement >80% of the surface) according to the patellar defect classification described by Pidoriano et al. (Figure 1). Twenty percent (n = 5) of the defects were uncontained.

<table>
<thead>
<tr>
<th>TABLE 1</th>
<th>Patient and Lesion Characteristics (n = 25 Knees)</th>
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<tr>
<td>Characteristics</td>
<td>Value</td>
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<td>Patient characteristics</td>
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<tr>
<td>Age at surgery, mean ± SD, y</td>
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<td>Male</td>
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<td>Female</td>
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<td>Affected knee, n (%)</td>
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<td>Left</td>
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<td>Follow-up, mean ± SD, mo</td>
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<tr>
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*aAccording to Pidoriano et al. Also see Figure 1.
Clinical Outcomes

Statistically and clinically significant improvements ($P < .001$) from preoperative baseline scores to postoperative scores were observed for all outcome measures (Figure 2). After a mean postoperative follow-up time of 7.6 years, the modified Cincinnati Knee Rating System score improved by 4.0 points (Figure 2A), the IKDC score by 33.2 points (Figure 2B), the Lysholm score by 39.1 points (Figure 2B), the mental component score of the SF-12 by 12.6 points, and the physical component score of the SF-12 by 6.4 points (Figure 2C). After surgery, patellar tracking, postoperative Q angles, and radiograph findings were all improved to within normal parameters.

The majority of patients (83%; 19/23) reported good to excellent outcomes in their knees at follow-up, while 3 patients (13%) reported fair outcomes, and 1 patient (4%) reported a poor outcome. Ninety-one percent (21/23) of patients felt that their knee was improved from their preoperative status, and the same number (21/23) would definitely or probably undergo the procedure again (Figure 3). About half of the patients (48%; 11/23) reported that they were satisfied with their level of sports involvement, although 52% (12/23) reported an improvement in sports.

Subgroup analysis revealed that the postoperative modified Cincinnati Knee Rating System and IKDC scores significantly improved from preoperative values whether or not the lesions were contained or uncontained or if they were classified as type IVb or type I, II, or III (see the Appendix, available in the online version of this article at http://ajsm.sagepub.com/supplemental). Furthermore, the few patients who underwent concomitant trochleoplasty with the ACI/AMZ procedures also showed improvement in their scores, although not statistically significant, whereas those not requiring trochleoplasty also showed significant improvement (see the Appendix). Similar subgroup results were also observed for the Lysholm score and physical and mental component scores of the SF-12 (see the Appendix).

Ten knees (40%) underwent a total of 15 subsequent surgical procedures. Five patients underwent arthroscopic debridement for graft hypertrophy and hardware removal, 3 underwent debridement for graft hypertrophy, and 1 each underwent loose body removal and chondroplasty.

![Figure 1. Patellar defect classification described by and adapted from Pidoriano et al: type I: lesions involving the distal mid-patellar area; type II: lesions involving the lateral facet; type III: lesions involving the medial facet; type IVa: lesions involving the proximal patella only; and type IVb: lesions involving the proximal patella and \( \geq 80\% \) of the overall patella.](image1)

![Figure 2. Change in clinical scores from baseline to final follow-up. Clinical outcome scores for the (A) modified Cincinnati Knee Rating System (n = 25), (B) Lysholm (n = 25) and International Knee Documentation Committee (IKDC) (n = 20), and (C) 12-item Short Form Health Survey (SF-12) physical and mental component scores (n = 25). Postoperative scores were compared with preoperative scores: \*P < .0001, \( ^1P = .002 \), and \( ^1P = .0001 \).](image2)
for a new lesion in another compartment. Three of these 10 patients also underwent additional surgeries, including 2 patients for subsequent meniscal tears from new trauma and 1 patient who underwent 3 procedures including debridement, lateral release, and excision of a cutaneous neuroma of the infrapatellar branch of the saphenous nerve. An example of the appearance of repair tissue firmly filling a diffuse lesion observed at repeat arthroscopic surgery is shown in Figure 4. One clinical failure was observed, with this patient undergoing PF arthroplasty 5.9 years postoperatively. One patient was diagnosed with deep vein thrombosis and was treated with anticoagulation medication for 3 months without sequelae.

**DISCUSSION**

In this longer term study (up to 11 years) of patients with isolated symptomatic patellar chondral defects and malalignment, the combination of ACI and AMZ resulted in significant improvements of symptoms and function at a mean follow-up time of 7.6 years. Overall, clinically significant improvements from baseline to final follow-up were demonstrated for the IKDC, modified Cincinnati Knee Rating System, Lysholm, and SF-12 scores. The combination of ACI and AMZ procedures in treating patellar full-thickness chondral lesions was successful in 96% of patients with a good safety-related profile. Good clinical outcomes with ACI and AMZ were observed in patients with either uncontained or contained lesions or if lesions were of types IVb or I, II, and III. To our knowledge, no other study has examined the results of isolated patellar lesions treated with both ACI and AMZ with a comparable length of follow-up.

Similar to our longer term results, other shorter term studies have shown significant improvements in their clinical scores in patellar lesions treated with ACI and AMZ.9,32 Only 1 other report of longer term follow-up (>7 years) showed good clinical outcomes with ACI for treating patellar lesions when malalignment was corrected, but with procedures other than AMZ.39 However, this study provides evidence for the clinical value of correcting malalignment concomitantly with AMZ during ACI.

The clinical value of correcting malalignment and decreasing contact forces across the PF joint with AMZ to improve outcomes with ACI for patellar lesions has been demonstrated in studies that showed better outcomes with ACI and AMZ relative to ACI alone.22,38 Pascual-Garrido and colleagues38 found significant improvements in most clinical outcome scores at a mean follow-up of 4 years for patellar defects treated with ACI and AMZ. Within this same study, patellar defects treated with ACI only showed significant improvements in some of the clinical scores but not in all, suggesting that patients who underwent both procedures had better outcomes.38 Similarly, Henderson and Lavigne22 also showed improved outcomes for patellar lesions treated with both ACI and AMZ or with ACI alone at a mean follow-up of 2 years, but those who underwent both procedures had significantly better modified Cincinnati Knee Rating System scores postoperatively than patients treated with ACI alone. Pidoriano et al44 correlated the type of patellar cartilage lesions with outcomes of AMZ. They reported that lesions located on the inferior pole and lateral facet produced good to excellent results in 87% of patients, while lesions on the medial facet and/or proximal pole or diffuse lesions were less successful (good to excellent results in 20%-55% of patients).44 In this current study, 64% of the patients had either type III or IV defects, of which the majority was type IVb involving greater than 80% of the patellar chondral surface. Unlike the diminished results normally observed for these diffuse lesions when treated with AMZ alone, the combination of ACI and AMZ in this study demonstrated statistically significant improvement on all outcome measures for these difficult lesions. Furthermore, significant improvement was observed in both contained and uncontained lesions.

Patient satisfaction questionnaires completed in our study suggest that while the majority of patients are
improved and would undergo the surgery again, there are challenges in returning to a satisfactory level of sports activity despite improved subjective outcomes. Our results are similar to those of a study by Mithofer and colleagues, who reported that 72% of the soccer players treated with ACI for a chondral defect graded their knee function as good or excellent but that only 33% of them returned to play soccer. Another study by the same authors, of adolescent athletes treated with ACI for articular cartilage defects, reported that 95% of their patients graded their knee as good or excellent but that only 60% of them returned to their preinjury athletic levels. Chondral repair in combination with AMZ can yield good clinical outcomes, especially for difficult type III and IV lesions. However, with these more severe lesions, the procedures are often salvage, and patients are not likely to return to completely normal knee function, especially when returning to sports.

No unanticipated safety concerns were reported. Consistent with other reported studies of ACI using a periosteal graft, more than half of the subsequent surgical procedures performed in our study were debridement because of periosteal graft hypertrophy, usually caused by a proliferative hypertrophic periosteal healing response possibly due to continual shear stresses across the PF joint. The high incidence of periosteal hypertrophy after ACI with a periosteal membrane has been noted in other studies and has ranged from 15% to 26%. However, these same authors have also demonstrated a decreased reoperation rate ranging from 2% to 5% with the use of an absorbable collagen membrane as a substitute for the periosteum. We have subsequently modified our surgical technique by replacing the periosteal graft with an absorbable collagen membrane (collagen-covered ACI). This strategy has dramatically decreased our reoperation rate because of graft hypertrophy, as supported by recent studies.

Limitations of this study include the fact that we had no control or comparator group. It is our opinion that a randomized study with a sham surgery would not be feasible or in the best interest of the patient because a sham surgery would not be beneficial to the patient. Furthermore, because we believe that the mechanical unloading and realignment that occur with AMZ benefit chondral repair tissue, we do not perform ACI without AMZ for patellar lesions and thus were unable to compare with a group that was treated with ACI alone. However, historical data show that patellar lesions perform poorly when treated with ACI alone. In fact, a study by Henderson and Lavigne found that patients who had their patellar lesions treated with ACI and had their abnormal patellar tracking corrected did significantly better than patients who had their patellar lesions treated with ACI but who did not require realignment. Conversely, we were also unable to compare our group of patients with patients who only underwent AMZ, as this procedure is historically used to correct only patellar malalignment and not to treat chondral defects.

Another study limitation was the fact that TT-TG measurements were not performed on patients before 2006, when Schoettle et al, reported a correlation between CT and MRI measurements. The TT-TG measurements provide an objective value for assessing patellar maltracking and also aid in determining the amount of anteriorization and medialization. Additionally, the small number of patients limits our ability to perform analyses between subgroups within various strata and test for the effect of previous microfracture, defect classification, trochleoplasty, or workers’ compensation status. However, subanalyses from preoperative to postoperative score changes did indicate significant improvements in the modified Cincinnati Knee Rating System score, Lysholm score, as well as IKDC score for patients independent of lesion containment and defect classification (type IVb or others). Furthermore, because of the retrospective nature of this study, we were unable to contact some additional patients (n = 4) despite exhaustive search measures and therefore were unable to account for their status and include them in these analyses.

Our systematic and customized approach to treating most full-thickness chondral defects of the patella with both AMZ and ACI has demonstrated excellent results in patients with different types of lesions, including lesions that are historically known to be challenging to treat (ie, type IVb or uncontained lesions). Overall, the results of our longer term study provide evidence that ACI with AMZ is an effective and durable treatment option for symptomatic full-thickness chondral defects of the patella. Further studies are required to understand the relationship between the range of TT-TG values and the indications for or the amount of correction for AMZ in conjunction with ACI.

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REFERENCES


