Bipolar Articular Chondral Lesions of the Knee

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Abstract

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Also known as “kissing lesions,
Bipolar articular chondral lesions
” bipolar chondral defects are less common than isolated chondral lesions in the non-arthritic knee. In published literature, bipolar lesions are often inappropriately classified as having either widespread osteoarthritis (OA) or multiple isolated lesions, so it is difficult to ascertain the exact prevalence, with rates reported at 9–18%. In a multicenter study of 1020 patients undergoing knee arthroscopy specifically for the treatment of a symptomatic cartilage lesion (61% male; mean age, 37.6 years), 95 cases (9.3%) of bipolar chondral lesions were identified. Of these 95 cases, 27 (28%) were patellofemoral, 57 (60%) involved the medial tibiofemoral articulation, and 11 (12%) affected lateral compartment. In a different study of 1000 patients undergoing knee arthroscopy (59% male; mean age, 47 years), 57% of arthroscopies revealed chondral or osteochondral lesions, with bipolar lesions found in 103 patients (10%). Patients with bipolar lesions are more likely to have a degenerative or indolent onset rather than traumatic etiology. Additionally, patients are likely to present with a greater degree of dysfunction. Solheim et al. reported that while mean Lysholm score was not significantly affected by lesion location, number of lesions, or total area of lesions, mean Lysholm score was significantly lower for patients with bipolar lesions than for patients with isolated lesions.
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Keywords

Bipolar lesions
Chondral defect
Treatment
Cartilage lesion

Introduction

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” bipolar chondral defects are less common than isolated chondral lesions in the non-arthritic knee. In published literature, bipolar lesions are often inappropriately classified as having either widespread osteoarthritis (OA) [1] or multiple isolated lesions [2], so it is difficult to ascertain the exact prevalence, with rates reported at 9–18%. In a multicenter study of 1020 patients undergoing knee arthroscopy specifically for the treatment of a symptomatic cartilage lesion (61% male; mean age, 37.6 years), 95 cases (9.3%) of bipolar chondral lesions were identified [3]. Of these 95 cases, 27 (28%) were patellofemoral, 57 (60%) involved the medial tibiofemoral articulation, and 11 (12%) affected lateral compartment [3]. In a different study of 1000 patients undergoing knee arthroscopy (59% male; mean age, 47 years), 57% of arthroscopies revealed chondral or osteochondral lesions, with bipolar lesions found in 103 patients (10%) [4]. Patients with bipolar lesions are more likely to have a degenerative or indolent onset rather than traumatic etiology [3]. Additionally, patients are likely to present with a greater degree of dysfunction [3]. Solheim et al. reported that while mean Lysholm score was not significantly affected by lesion location, number of lesions, or total area of lesions, mean Lysholm score was significantly lower for patients with bipolar lesions than for patients with isolated lesions [4].

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Despite a significant prevalence in younger and physically active patients, bipolar lesions are often a relative contraindication for multiple surgical cartilage restoration or resurfacing procedures [5]. However, under treatment may contribute to heightened risk of revision reoperation or secondary arthroplasty with further degenerative progression [6]. Due to this disconnect, chondral restoration procedures are being increasingly explored. These treatments are often accompanied by adjunctive procedures to address associated pathology, correct underlying coronal or rotational malalignment, and off-load treated chondral defects. Spahn et al. reported that malalignment was significantly associated with the occurrence of bipolar lesions of the medial tibiofemoral joint (87.8%), lateral tibiofemoral joint (57.2%), and patellofemoral articulation (15.8%) [3]. Additionally, malalignment may contribute to faster rate of arthritic progression [7, 8]. Furthermore, meniscal procedures are commonly performed concomitantly in patients with tibiofemoral lesions. Spahn et al. reported a significantly higher incidence of concomitant meniscal tear in the medial tibiofemoral lesion group (57.1%) than in the patellofemoral lesion group (16.9%) [3]. Notably, combined meniscus allograft transplantation (MAT) and chondral restoration [osteochondral allograft transplantation (OCA), autologous chondrocyte implantation (ACI)] for biologic knee reconstruction has shown promise at midterm follow-up [9, 10]. However, in a study with long-term follow-up, failure occurred in four out of seven knees with bipolar lesions treated with combined MAT and ACI [11]. Additionally, ligament repair is a common concomitant procedure in the treatment of bipolar chondral lesions. This is due to the relatively high incidence of ligament injury and bipolar lesions. Previous rupture or chronic insufficiency of the ACL has been reported to increase the likelihood of developing bipolar lesions and secondary arthritis [12, 13]. Additionally, both PCL and MPFL injury are associated with chondral lesions [14, 15].

Despite the prevalence of bipolar lesions in patients with knee dysfunction, there is a lack of published literature and high-level evidence focusing specifically on treatments for bipolar lesions. The following cases present three patients with bipolar chondral lesions treated with different cartilage restoration or resurfacing procedures.

Clinical Case Presentation

Case 1

A 36-year-old female with a BMI of 21.3 kg/m^2 presented initially with anterior left knee pain. She had experienced a patellar dislocation 20 years prior while playing soccer, which was initially treated conservatively with closed reduction at the time of injury and physical therapy. After approximately 15 years, the patient developed persistent anterior knee pain, episodic subluxations, and intermittent effusion exacerbated by stair-climbing, kneeling, and running. She was subsequently treated with further physical therapy, McConnell taping, and a patellofemoral stabilizer brace, which improved stability but did not reduce activity-related pain. Upon further presentation, she exhibited a pathologic J sign with audible crepitations during an active range of motion arc of 0–140°, and no evidence of generalized ligamentous instability. She also demonstrated positive patellar apprehension, lateral tilt, and patellofemoral grind test. Plain and advanced radiographic imaging revealed no

frank evidence of arthritis, slight patella alta, and a focal chondral defect in the apex of the patella (Figs. 12.1 and 12.2). At the time of diagnostic staging arthroscopy, bipolar lesions of the lateral patella (28 mm × 20 mm) and lateral trochlea (10 mm × 12 mm) were observed, and chondroplasty was performed. Rotational malalignment was not an issue.

Figure 12.1

Sunrise view of plain axial radiographs displaying patellar malalignment

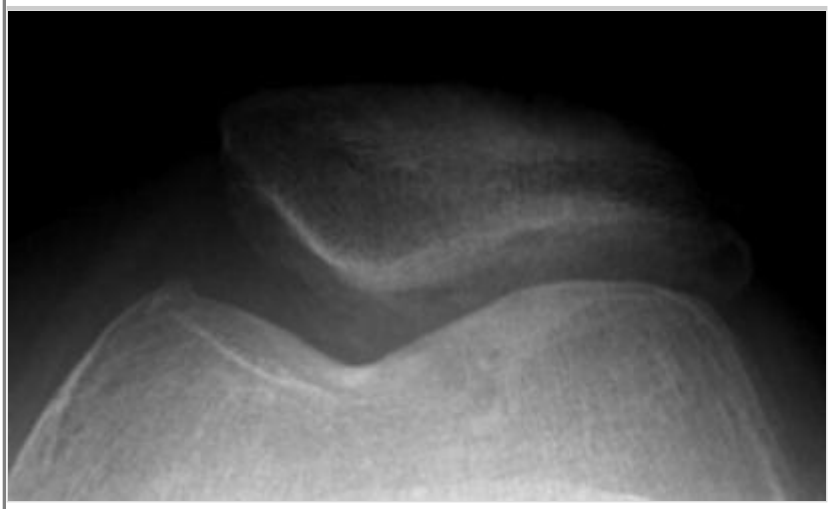
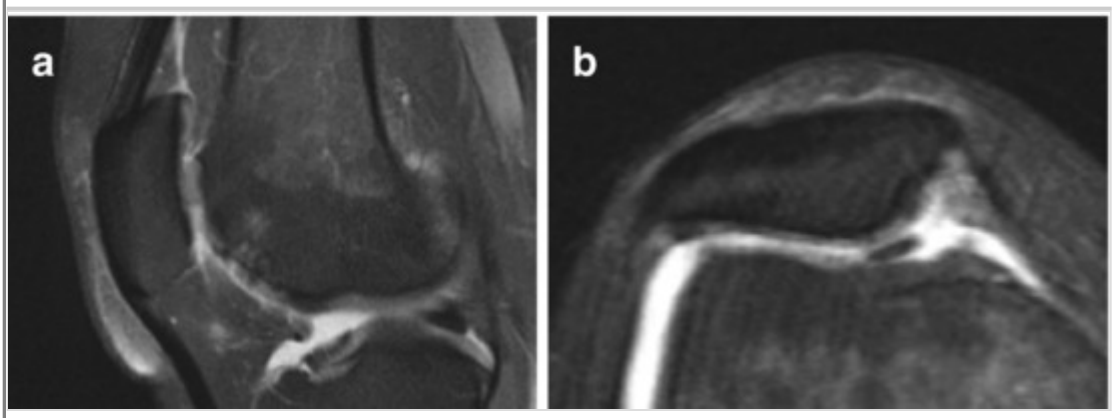


Figure 12.2

Axial and sagittal T2-weighted MRI displaying bipolar patellofemoral chondral defects



Due to limited improvement, the patient underwent particulated juvenile allograft cartilage transplantation (DeNovo NT, Zimmer Biomet, Warsaw, IN) to the patella, microfracture of the trochlea, and tibial tubercle osteotomy with anteromedialization at 5 months following the initial arthroscopy. The anteromedialization was performed with 10–12 mm of correction. For the patella, a subvastus arthrotomy was performed and extended distally to allow eversion of the patella for defect exposure (Fig. 12.3). Vertical walls were created, and a pineapple bur was used to create subchondral vents to improve the adherence of the de novo allograft material. Minced particulate allograft cartilage was placed in the defect to approximate a 50% lesion fill and then secured with fibrin glue. On the trochlear side, the lesion had progressed in size to an uncontained lesion, and the subchondral plate demonstrated a sclerotic base with intralesional osteophyte formation. Accordingly, gentle curettage was performed to restore the normal contour of the subchondral bone (Fig. 12.4), and nanofracture was

performed using a 1.5-mm-powered drill. Finally, a titrated lateral lengthening procedure was performed to address tilt and achieve congruity. Postoperatively, the patient was given a cryotherapy unit and continuous passive motion device to facilitate edema control and prevent excessive scar formation. Partial weight-bearing was permitted with the brace locked in full extension for ambulation with crutches.

Figure 12.3

An intraoperative photo displaying the patella everted through a subvastus arthrotomy exposing a bipolar patellofemoral defect

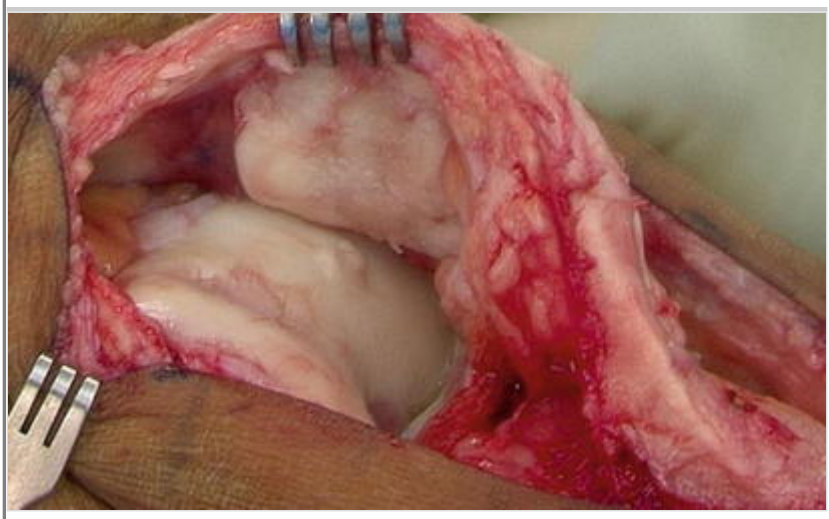


Figure 12.4

An intraoperative photo displaying left knee bipolar defects after preparation via curettage

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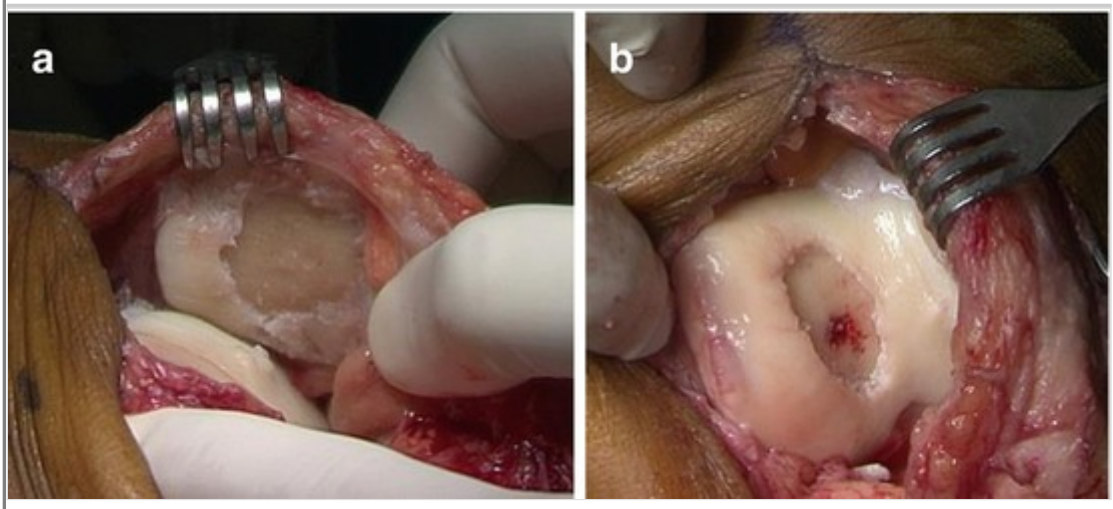


At 6-week follow-up, physical examination revealed notable quadriceps atrophy, with passive range of potion from 0° to 90°. Continued brace wear with crutches was encouraged, and physical therapy was initiated. At 3-month follow-up, the patient was instructed to progress to further strengthening and core-based exercises outside of the brace.

At 6 months, the patient reported generally doing well. The patient did not have significant difficulty with ambulation or stairs. The patient affirms that she has not done any running yet. The patient has full passive range of motion and rates her pain level at 1–2/10, compared to 5/10 at best prior to surgery. She did not require any additional formal physical therapy.

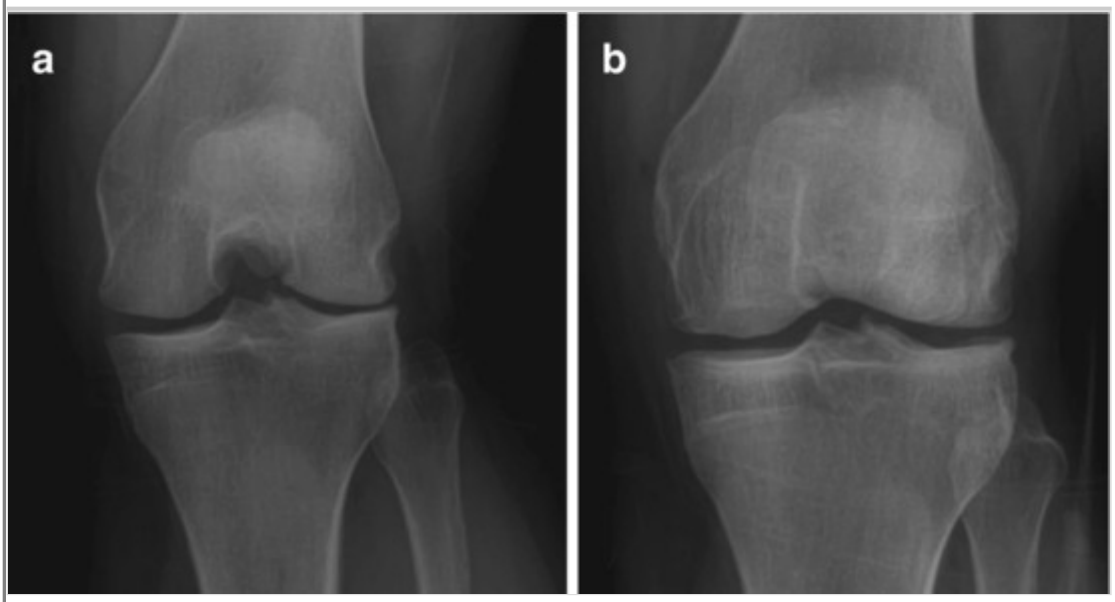
Particulated juvenile allograft cartilage (PJAC) transplantation remains a fairly new technique, and the available case series and indications are still evolving. Unipolar lesion treated with PJAC has demonstrated modest success in series by Tompkins et al., Bucketwalter et al., and Farr et al., although these series are limited to only 25 patients with short-term follow-up. Recent Level V evidence again suggests that bipolar lesions are a contraindication to juvenile transplantation due to shear of lesions against each other destabilizing the transplanted material [16]. Notably, the patient in this case underwent tibial tubercle osteotomy to off-load the bipolar lesions and diminish shear stress, which can also be facilitated through additional use of an overlying type I/III collagen patch.

Case 2

A 28-year-old male former college basketball player with a BMI of 27.6 presented with sharp lateral left knee pain aggravated by walking, standing, bending, and twisting, swelling, and painful mechanical symptoms. The patient had a history of left knee lateral meniscal tear 12 years prior and underwent two lateral meniscectomies on separate occasions. He previously received prior hyaluronic acid injections in the left knee and had failed a prolonged course of physical therapy and activity modification. Plain radiography revealed KL grades II to III with lateral joint space narrowing (Fig. 12.5). No other osseous abnormality including fracture or dislocation was observed.

Figure 12.5

Preoperative imaging of (**a**) standing posterior-anterior Rosenberg radiograph and (**b**) standard anterior-posterior radiograph displaying lateral joint space narrowing of the left knee



Based on recent arthroscopic images, the patient was indicated for combined osteochondral allograft transplantation to the lateral femoral condyle, microfracture to the lateral tibial plateau, and lateral meniscal allograft transplantation. Standard diagnostic arthroscopy was performed to reveal normal medial compartment, no ligamentous damage and normal patellofemoral articulation. Inspection of the lateral compartment revealed meniscal insufficiency with bipolar lesions of the lateral femoral condyle and the lateral tibial plateau measuring

25 mm × 25 mm and 12 mm × 12 mm, respectively (Fig. 12.6). In order to prepare for the lateral meniscal allograft transplant, a complete meniscectomy was performed, with care to preserve the peripheral meniscal rim for fixation. A posterolateral accessory approach was performed, with an incision 1/3 above and 2/3 below the joint line, and the lateral head of the gastrocnemius was elevated to expose the posterior capsule. A 10 mm × 8 cm slot was made through a cannulated guide and transpatellar portal, and a pituitary rongeur and box rasp were used to contour the recipient site. The meniscus was thawed and prepared to match the recipient slot, while maintaining the native anterior and posterior horn attachments on the bone block. The graft was subsequently manually inserted through an extended anterior incision while carefully pulling on traction sutures placed at the junction of the anterior two-thirds of the meniscus and exiting lateral to the popliteal fossa. Inside-out suture repair was then performed in a vertical mattress pattern on the superior and inferior surface of the meniscus and additional all-inside device posteriorly. Finally, a 7 × 23 mm biocomposite screw was placed for interference fixation lateral to the bone block. After fixation, the arthrotomy incision was then extended further proximally to expose and debride the tibial plateau defect to stable margins. Marrow stimulation was performed with both curettage and microfracture awl fenestration (Fig. 12.7). On the corresponding femoral condylar lesion, central guide pin placement and reaming were performed to achieve a depth of 7 mm and diameter of 25 mm. The fresh osteochondral allograft was sized and prepared for a line-to-line fit and gently impacted into place. Flush margins with the surrounding intact articular cartilage were obtained, and final arthroscopic images confirmed secure fixation of both the meniscal and osteochondral allograft (Figs. 12.8 and 12.9).

Figure 12.6

Arthroscopic images through the lateral portal of (**a**) a grade IV lateral femoral condyle defect and (**b**) a grade IV lateral tibial plateau cartilage defect of the left knee

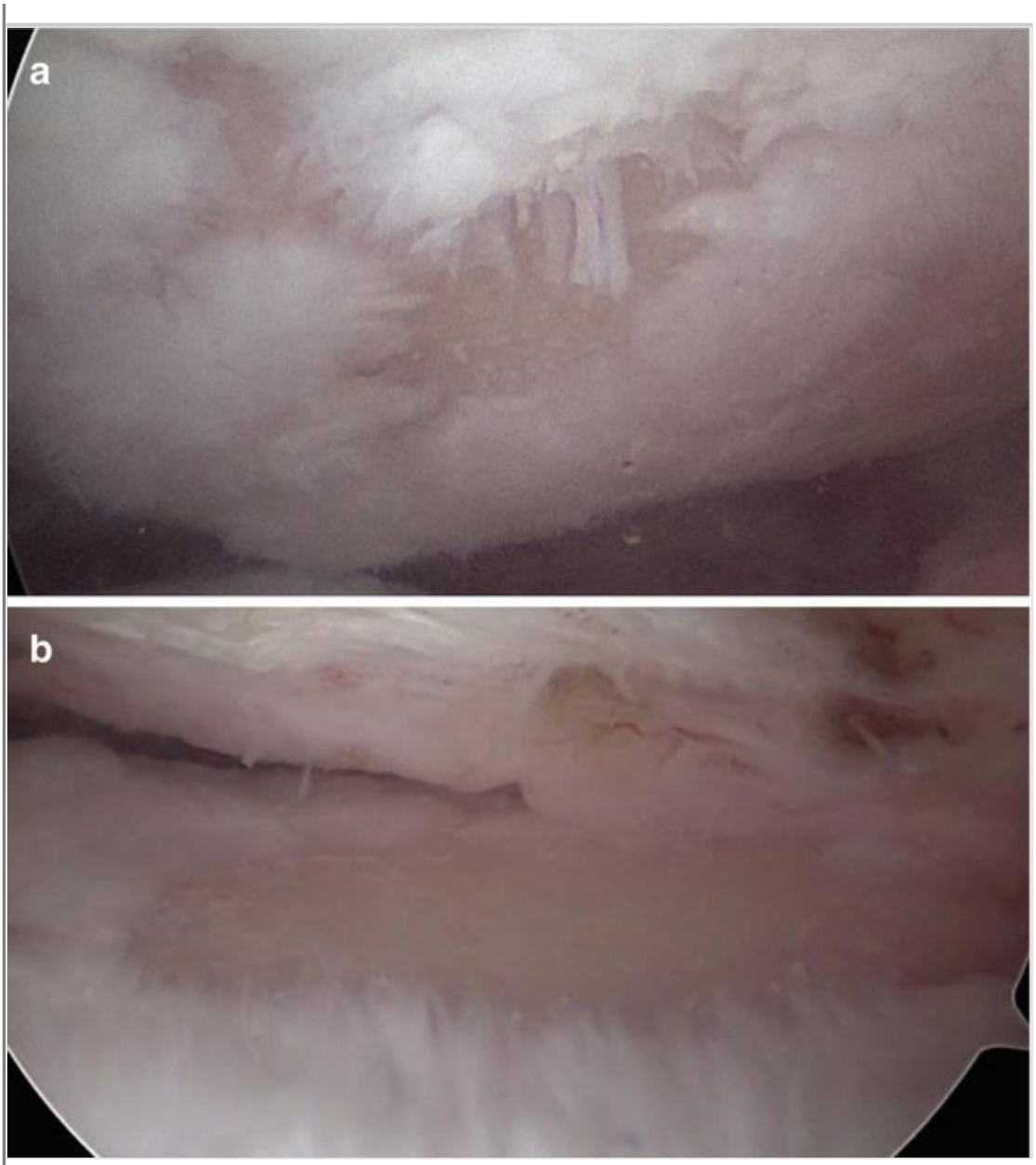


Figure 12.7

An arthroscopic image displaying marrow stimulation of a grade IV lateral tibial plateau defect

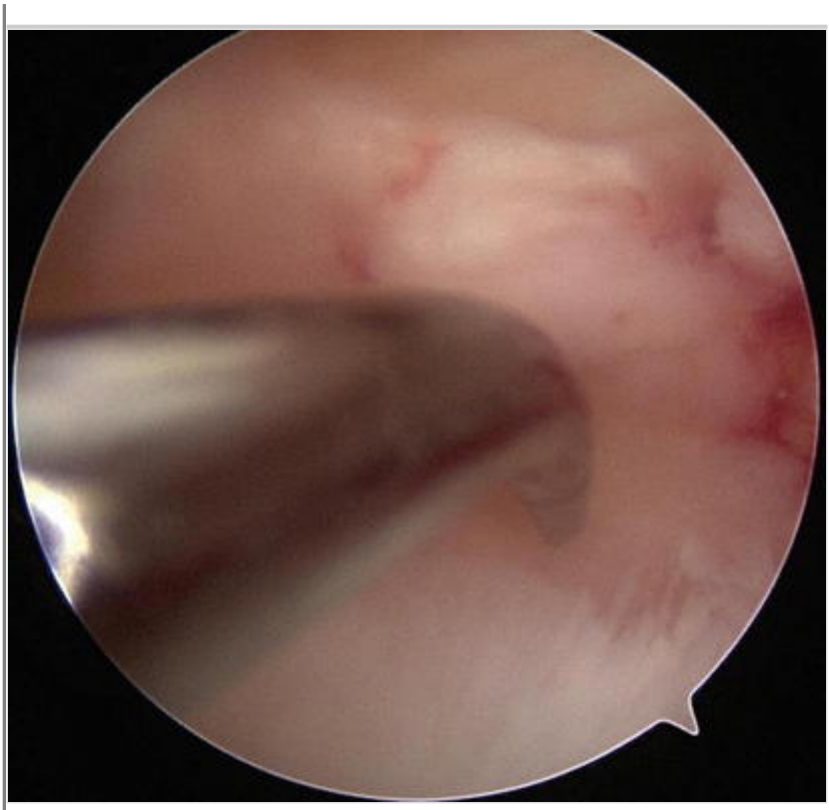


Figure 12.8

An arthroscopic image displaying confirm secure fixation of a lateral meniscus allograft transplantation of the left knee

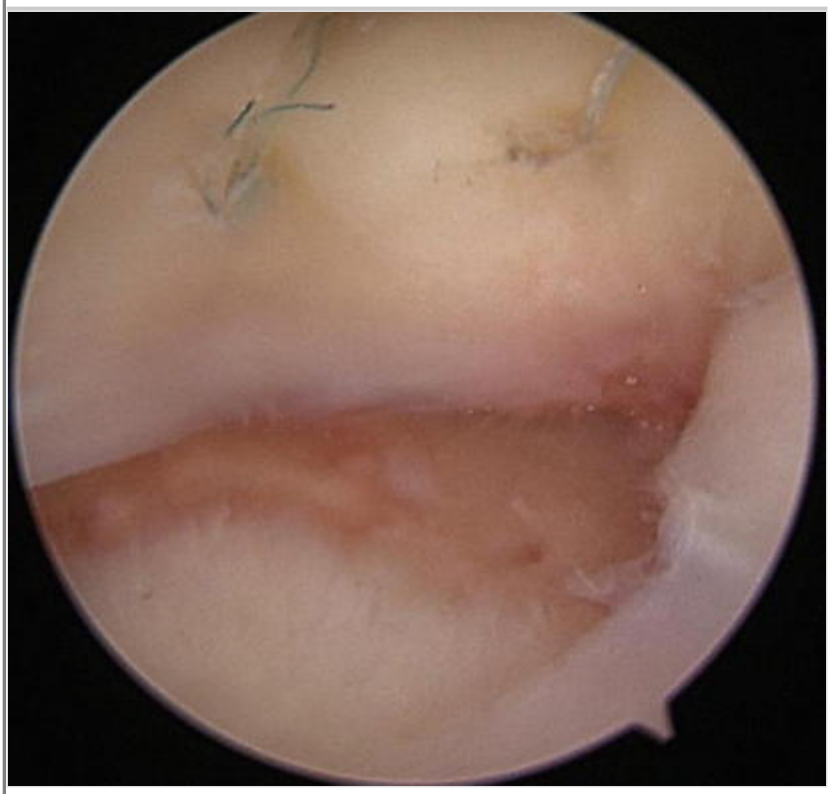
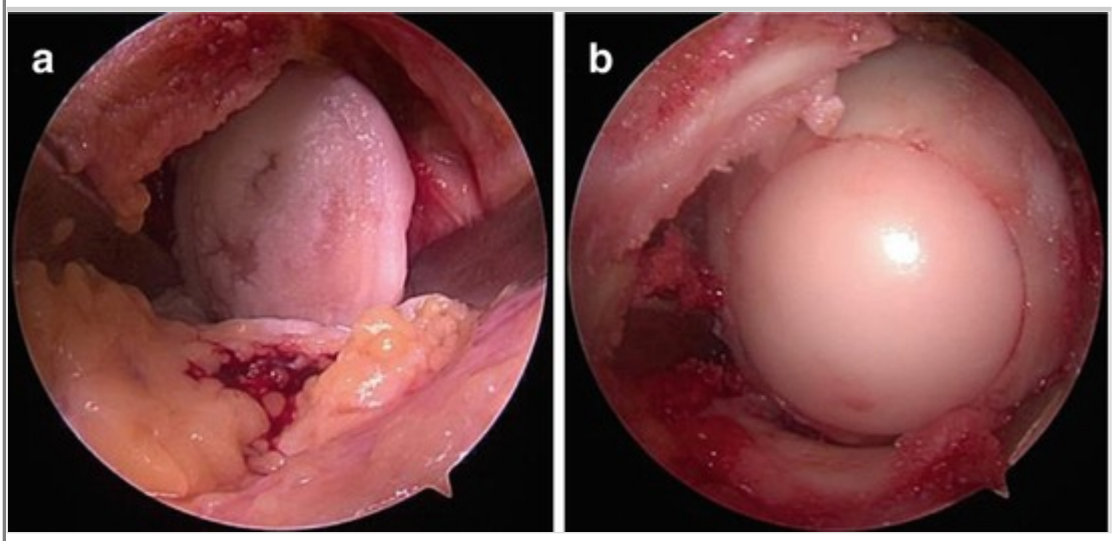


Figure 12.9

(**a**) An arthroscopic image displaying a lateral femoral condyle defect prior to preparation. (**b**) An arthroscopic image displaying secure fixation of an osteochondral allograft transplantation on the lateral femoral condyle



At 6-week follow-up, the patient was able to achieve full extension and flexion to 90°. He demonstrated minimal tenderness and was instructed to gradually progress weight-bearing to full at 8 weeks while increasing his range of motion as tolerated. At 6-month follow-up, physical examination revealed trace effusion, no lateral joint line tenderness, and range of motion from 0° to 115° flexion. Surveillance MRI revealed a stable meniscus, incorporation of the osteochondral allograft, and resolution of underlying marrow edema in the tibia. At this point, the patient was cleared for running and jumping, and he returned at 1-year follow-up with continuing improvement and full resumption of all pre-injury activities despite mild degenerative changes in the lateral compartment on routine radiographs.

There is a paucity of literature on treatment of bipolar lesions with osteochondral allograft transplantation. Most existing series suggest that treatment of bipolar lesions has worse outcomes than the treatment of isolated lesions. Ghazavi et al., Chu et al., and Fischer et al. reported bipolar lesions as a contraindication for osteochondral allograft transplantation in 1997 and 1999 and 2006, respectively [17, 18, 19]. Additionally, a high reoperation rate (50%) was observed for patients undergoing bipolar osteochondral allograft transplantation in more contemporary series [20]. However, this study did note that patients who did not undergo reoperation had significant clinical improvement.

Comprehensive treatment of patellofemoral lesions requires optimization of axial or coronal plane malalignment and dynamic patellar instability in order to ensure reproducible outcomes. Importantly, this patient had previously undergone tibial tubercle osteotomy with MPFL reconstruction to both off-load symptomatic defects and decrease shear stress or eccentric loading patterns. The combination of these procedures may serve to both prevent recurrence of patellar instability and enhance likelihood of symptomatic relief with revision osteochondral allograft transplantation.

Meniscal allograft transplantation is fairly common in conjunction with treatment of tibiofemoral lesions, especially bipolar lesions, because it has been shown to effectively provide symptomatic relief and improve joint contact forces and dynamic loading patterns [21]. However, it also has a significantly higher failure rate in patients with bipolar lesions [21]. There is limited data to suggest the success of microfracture alongside other hybrid treatments of bipolar lesions. However, multiple lesions have been reported to do worse with microfracture than isolated defects at both midterm and long-term follow-up [22, 23]. Additionally,

microfracture is contraindicated by larger lesion size (>2-cm^2), degenerative etiology, and untreated malalignment – all factors commonly associated with bipolar lesions. This suggests that bipolar lesions are a relative contraindication to microfracture, although further research is necessary to delineate its role, particularly on the tibial surface where limited options exist.

Other Treatments

There are many emerging options for treatment of chondral lesions, but more research is needed to determine if they will be effective for bipolar lesions. Bone marrow aspirate concentrate (BMAC) has shown promise in the treatment of focal chondral defects and in early stage OA [24], and platelet-rich plasma (PRP) has shown promise for treatment of overall degenerative changes in the knee [25]. However, more research is necessary to determine if BMAC and PRP are appropriate and effective treatments for bipolar lesions. Additionally, procedures using scaffolds for new cartilage to grow, in conjunction with either BMAC or PRP, have shown promising results for treatment of focal chondral lesions [26, 27]. Gobbi and Whyte reported superior outcomes of an HA scaffold supplemented with BMAC as compared to microfracture at 5-year follow-up for the treatment of large lesions and multiple lesions, although the study does not specify if this included any bipolar lesions [26]. Siclari et al. included 10 patients with bipolar lesions in their larger study cohort of patients undergoing treatment of one lesion with a PGA-HA scaffold and PRP injection [27]. There was significant improvement in KOOS score at 5-year follow-up of the total cohort, but subgroup analysis did not include the presence of bipolar lesions and did not address the outcomes of the original 10 bipolar lesion patients [27]. More research is necessary to determine the effectiveness of these procedures for treatment of bipolar lesions. Additionally, while novel hybrid techniques show promise for the treatment of chondral lesions, to the best of the authors' knowledge, there does not exist any literature examining these techniques in patients with bipolar lesions.

Bipolar lesions cause a high degree of dysfunction in patients and are often difficult to treat. This is complicated by the relative dearth of literature detailing evidence-based treatment strategies of bipolar lesions. Further research is warranted to determine the most appropriate and effective treatment for this complicated pathology.

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