



Arthroscopic Management of Isolated Tibial Plateau Defect With Microfracture and Micronized Allogeneic Cartilage–Platelet-Rich Plasma Adjunct

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Abstract: Articular cartilage lesions of the tibial plateau are an uncommonly encountered clinical entity, and they have been comparatively less well studied than femoral condyle or patellofemoral defects. The management of these lesions is complicated by the challenging geometry, difficult surgical approach, and proximity to important anatomic structures, and thus, treating these lesions by previously established methods, such as osteochondral allograft transplantation or osteochondral autograft transfer, can be a technically challenging endeavor. These lesions remain readily available to undergo microfracture, and this is the preferred method of management in the senior author's practice. Although less technically difficult and less invasive than other techniques, microfracture is currently limited by concerns over the long-term durability of the method. Current research seeks to improve the quality of cartilage fill stimulated by microfracture, and adjunct techniques have become increasingly popular. In this technical report, we present a technique for arthroscopic treatment of an isolated tibial plateau defect with microfracture using a micronized allogeneic cartilage (BioCartilage; Arthrex, Naples, FL) and platelet-rich plasma adjunct.

The techniques for and outcomes of management of articular cartilage defects of the knee have been well described for lesions of the femoral condyles and patellofemoral joint; however, the treatment of articular cartilage defects of the tibial plateau remains poorly described.¹ The challenging geometry, difficult surgical approach, and proximity to important anatomic structures (meniscus attachments, anterior cruciate ligament footprint) complicate the surgical management of focal articular cartilage defects of the tibial plateau. Although techniques such as fresh tibial osteochondral allograft transplantation have shown a 65% survival rate at 15 years, these techniques are likely better suited for larger defects or more

severe disease.² Retrograde osteochondral autograft transplantation has shown positive results at midterm follow-up.^{3,4} However, this technique can be technically challenging, is limited by the geometry of the tibial plateau, and carries an increased risk of donor-site morbidity or injury to surrounding structures and thus should be performed with caution. In contrast, marrow stimulation techniques such as microfracture are minimally invasive and have a limited risk of complications, with no risk of donor-site morbidity (no donor site) and no risk of disease transmission (no allograft).

In this Technical Note, we describe arthroscopic microfracture with a micronized allogeneic cartilage (MAC) (BioCartilage; Arthrex, Naples, FL) and platelet-rich plasma (PRP) adjunct for a focal chondral defect of the tibial plateau. A summary of the technique is provided in [Video 1](#).

Surgical Technique

Indications

Patients presenting with findings suggestive of a focal cartilage defect typically present with uni-compartmental, weight-bearing joint line pain, associated with effusion and/or mechanical symptoms ([Video 1](#)). They should be evaluated for the presence of articular cartilage pathology with a physical

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examination and magnetic resonance imaging. In the case of tibial plateau pathology, the physical examination findings can be vague and difficult to interpret. Although tibial tenderness may occasionally be elicited, this must be differentiated from tenderness due to pes anserine bursitis or a tibial bone bruise. Radiographs should be evaluated to assess for malalignment because malalignment may change the surgical planning to include a realignment osteotomy. Magnetic resonance imaging findings include subchondral edema and the presence of a focal articular cartilage defect that can be well visualized on T2-weighted images (Fig 1, Video 1).

In the following sections, we describe a technique for management of a symptomatic, isolated tibial plateau chondral defect after failure of nonoperative management. Microfracture is used in conjunction with an MAC-PRP adjunct with the goal of promoting hyaline articular cartilage fill.

Patient Positioning

The patient is positioned supine on a flat-top table with a thigh tourniquet under general anesthesia. The patient's lower extremity is prepared and draped in the usual sterile fashion. A timeout is then called to confirm the correct patient, procedure, operative site and side, and administration of antibiotics.

Diagnostic Arthroscopy

Diagnostic arthroscopy is performed at the start of the operation to evaluate for the presence of concomitant injuries, including meniscus tears, ligament tears, or additional articular cartilage pathology, and to survey the defect of interest. Arthroscopy shows a degenerative medial meniscal tear of approximately 10% that is debrided with an arthroscopic shaver (Video 1). In addition, a focal trochlear chondral defect is identified and debrided to a stable rim; however, it is left otherwise untreated because it is not consistent with the patient's symptoms and is considered an incidental finding. In the lateral compartment, a degenerative meniscal tear of between 10% and 20% is identified and debrided. A region of full-thickness cartilage delamination is identified on the lateral tibial plateau and measures approximately 15 mm by 6 mm. This is debrided down to a stable rim with a 4.5-mm shaver and a curette (Fig 2A).

Microfracture

In preparation for microfracture, the calcified layer is carefully removed with a curette (Fig 2B). The rim is debrided with a shaver to establish stable, vertical walls along the periphery of the defect (Video 1). Once the lesion has been appropriately prepared, a PowerPick (Arthrex) is used to create perforations in the subchondral plate to allow access to bone marrow elements (Fig 3A). In placement of the microfracture holes, the

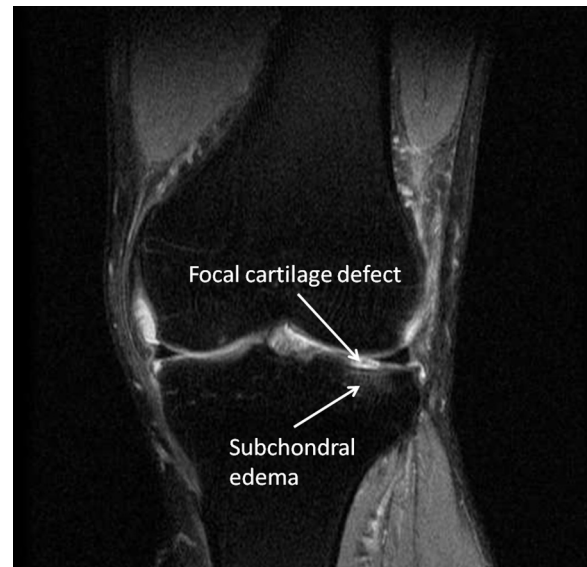


Fig 1. Left knee. T2-weighted coronal magnetic resonance imaging accentuates the presence of articular cartilage defects and allows easy assessment of subchondral edema. An isolated lateral tibial plateau cartilage defect with minimal subchondral edema is shown.

goal is to place the holes 2 to 3 mm apart while confluence is avoided (Fig 3B). This is done to minimize the risk of damage to the subchondral plate resulting in ectopic bone formation during healing.

Application of MAC and PRP

After creation of microfracture holes, all arthroscopic fluid is drained from the joint to allow a dry environment for the application of the MAC-PRP mixture. The base of the lesion is dried with neurosurgical patties to allow improved adherence by the MAC-PRP mixture (Fig 4A). Blood pressure control and a tourniquet are used to minimize bleeding into the area (Fig 4B). During this time, the MAC-PRP mixture is prepared on the back table. The PRP is prepared by use of the ACP (Autologous Conditioned Plasma) system (Arthrex). Fifteen milliliters of peripheral blood is drawn from the patient into the double-syringe ACP system and centrifuged at 1,500 rpm for 5 minutes to separate the blood into a leukocyte-poor PRP component, buffy coat, and red blood cell component (Fig 5A). By use of the double-syringe system, approximately 1.5 mL of PRP is drawn into the second syringe (Fig 5B). This is combined with 1 mL of the MAC extracellular matrix in a 1:1 ratio and mixed until homogeneous.

A cannula is introduced into the inferolateral portal to distract synovium away from the defect. The MAC-PRP mixture is applied to the defect with a Tuohy needle (Fig 6A, Video 1). A freer elevator is used to smooth the surface of the MAC-PRP mixture to lie slightly below the level of the surrounding articular cartilage (Fig 6B). After appropriate application of the MAC-PRP mixture,

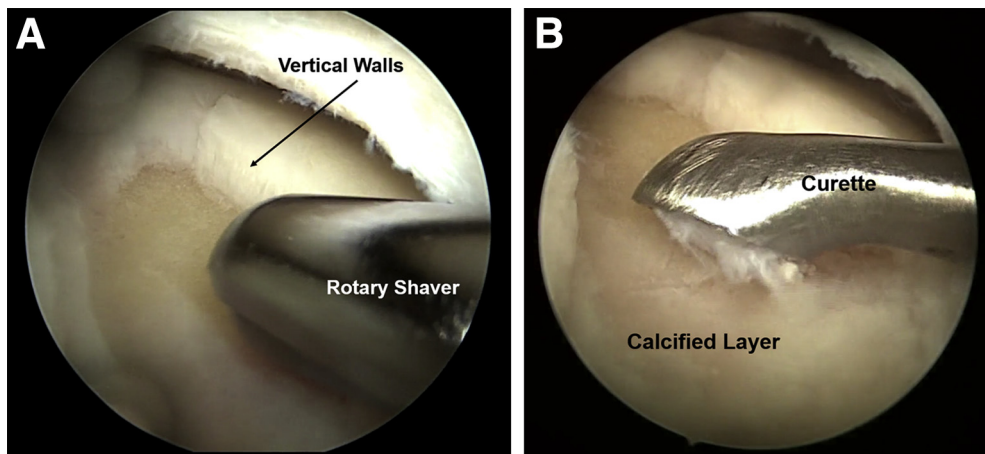


Fig 2. Arthroscopic debridement of articular cartilage defect. The left lateral tibial plateau is viewed through the anteromedial portal with the patient supine and the knee in figure-four position. (A) To prepare the defect for microfracture, the periphery should be debrided to a stable rim. Any delaminated cartilage is removed from the defect. Vertical walls are established to maximize the probability of complete cartilage fill. A rotary shaver can be useful in debriding the defect in preparation for microfracture. (B) The calcified layer of cartilage is removed before microfracture with a curette. Exposing bare subchondral bone promotes fibrocartilage fill after marrow simulation.

fibrin glue (Tisseel; Baxter, Deerfield, IL) is applied over the top of the mixture, with care taken not to over-apply the glue in an effort to reduce the risk of adherence to opposing surfaces. The fibrin glue is allowed to cure for 7 minutes before range-of-motion testing to minimize the risk of dislodgment. After curing, a compressive force is applied to the knee to allow defect contouring against the opposing femoral condyle. The arthroscopy portals are closed in the usual fashion. Clinical pearls and pitfalls of this technique are outlined in [Table 1](#). Advantages and disadvantages are outlined in [Table 2](#).

Rehabilitation Protocol

The patient undergoes bracing in extension and is restricted to non-weight-bearing precautions immediately postoperatively with a 1-week delay in the initiation of continuous passive motion because of the application of MAC-PRP ([Video 1](#)). At 1 week, continuous passive motion is initiated for 6 hours a day with passive and active range-of-motion exercises allowed as tolerated. Beginning at 6 weeks postoperatively, weight bearing is initiated with a steady increase of 25% weekly, as tolerated. At 8 weeks postoperatively, more advanced strengthening exercises are initiated, with a steady

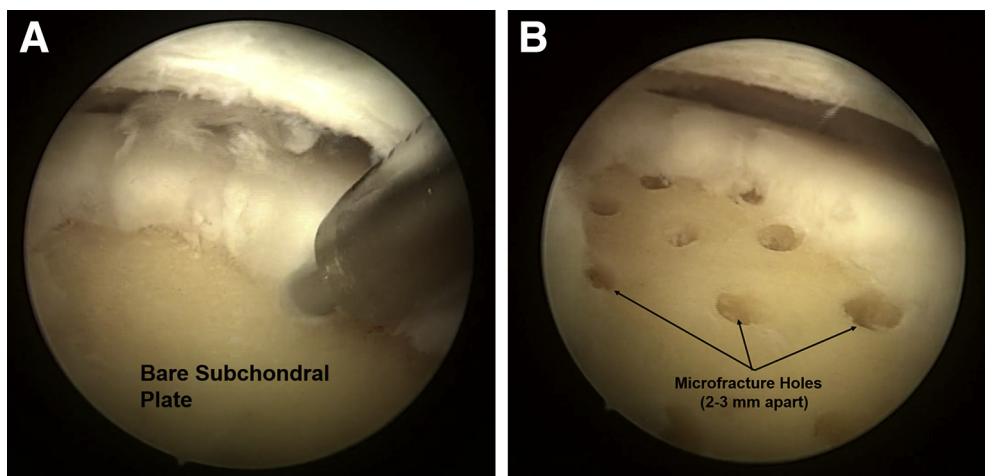


Fig 3. Microfracture technique. The left lateral tibial plateau is viewed through the anteromedial portal with the patient supine and the knee in figure-four position. (A) After debridement of any delaminated cartilage, microfracture holes are placed in the bare subchondral bone with a PowerPick to allow access to marrow elements, including mesenchymal stem cells. This device allows atraumatic perforation of the plate, minimizing the chance of ectopic bone formation. (B) Microfracture holes are placed 2 to 3 mm apart while confluence is avoided to minimize trauma to the subchondral plate. The goal is to obtain access to the bone marrow elements facilitating cartilage fill without causing excessive injury to the subchondral bone.

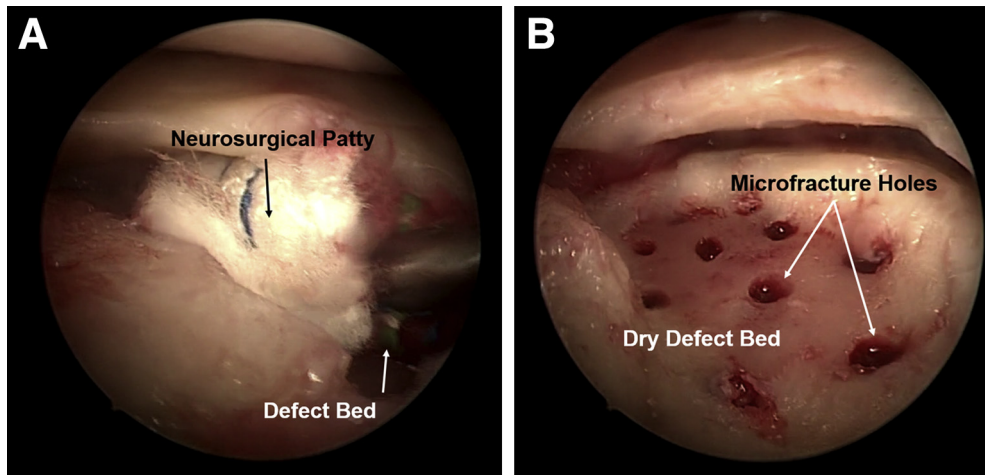


Fig 4. Preparation for micronized allogeneic cartilage (MAC)—platelet-rich plasma (PRP) application. The left lateral tibial plateau is viewed through the anteromedial portal with the patient supine and the knee in figure-four position. (A) To apply MAC-PRP to the defect bed, all arthroscopic fluid is removed from the joint. Neurosurgical patties are used to dry the defect bed thoroughly in preparation for MAC-PRP application. (B) Bleeding into the defect bed can be controlled with tourniquet pressure. A dry defect bed ensures optimal adherence of the MAC-PRP mixture.

increase in weight-bearing activities and strengthening exercises as tolerated. At 6 months, advancing functional activity is introduced. Return to full activity is allowed after 8 months with physician clearance.

Discussion

Tibial lesions are a difficult clinical entity because they often occur as bipolar defects associated with larger, femoral condyle lesions; possess a challenging overall geometry; and are difficult to access with arthroscopic

techniques.¹ Previous reports have shown success with osteochondral autograft transplantation procedures, but these techniques can be technically challenging and longer-term outcomes remain unclear.⁴ Although replacement of the osteochondral unit provides superior outcomes in cases with damage to the subchondral bone, for lesions without subchondral bone involvement, an alternative treatment for tibial plateau lesions is microfracture, a commonly performed procedure that is technically simple with low complication rates.^{1,5}

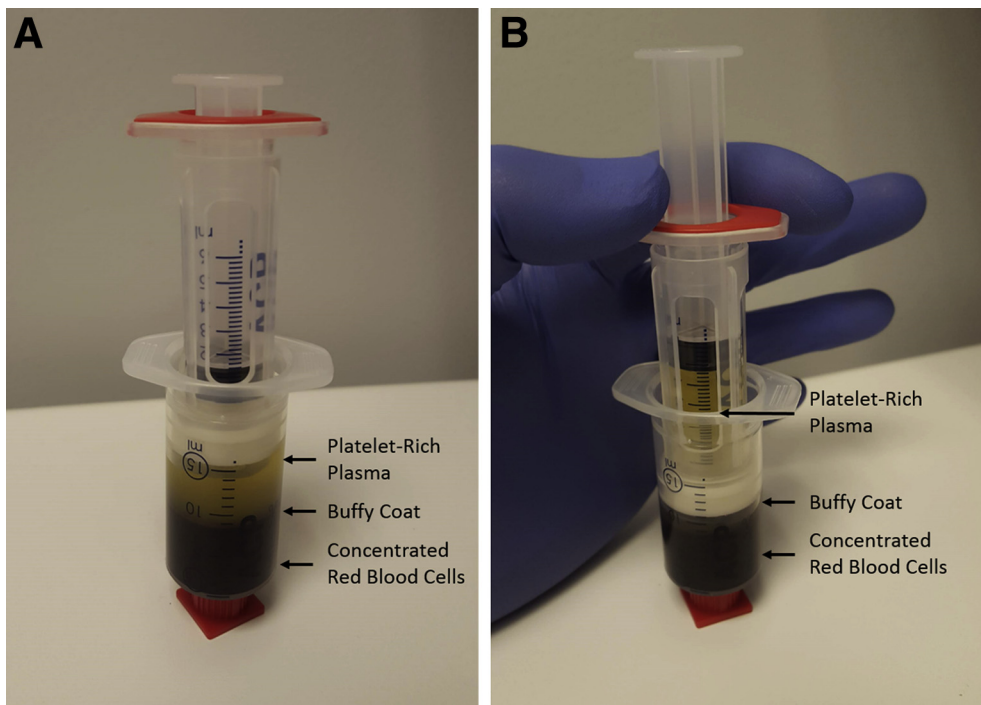


Fig 5. Platelet-rich plasma (PRP) preparation. (A) Arthrex double-syringe ACP (Autologous Conditioned Plasma) system for collecting PRP. Fifteen milliliters of peripheral blood is drawn from the patient into the larger syringe and placed into a centrifuge at 1,500 rpm for 5 minutes to separate it into PRP, buffy coat, and red blood cell constituents. (B) After centrifugation, the PRP component is drawn into the smaller syringe, with care taken not to aspirate the buffy coat or red blood cell layers. For micronized allogeneic cartilage applications, approximately 1.5 mL (enough for a 1:1 ratio with the micronized allogeneic cartilage powder) is sufficient.

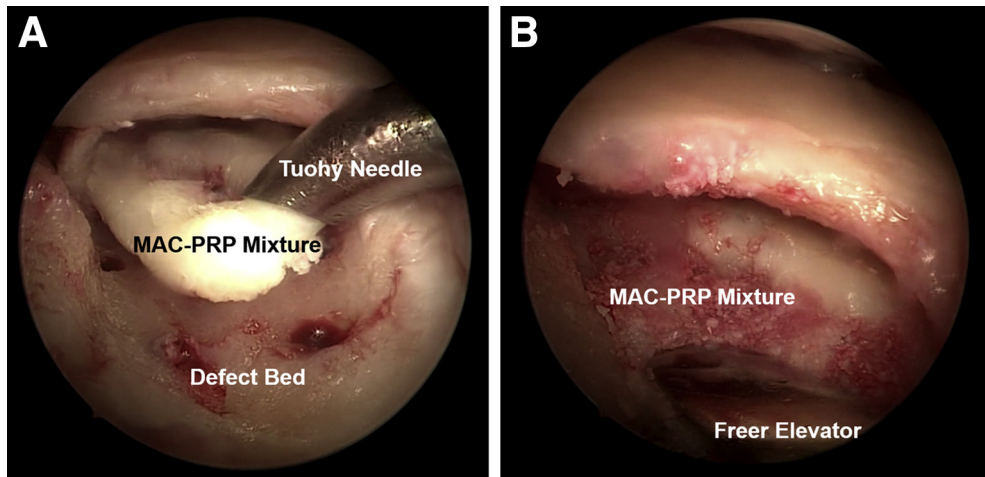


Fig 6. Application of micronized allogeneic cartilage (MAC)—platelet-rich plasma (PRP) mixture. The left lateral tibial plateau is viewed through the anteromedial portal with the patient supine and the knee in figure-four position. (A) The MAC-PRP mixture is applied into the joint with a Tuohy needle. Enough of the mixture is used to ensure complete coverage at a level that is slightly below that of the surrounding cartilage. (B) After application of the MAC-PRP mixture, a freer elevator can be used to smooth the surface of the mixture. The objective is to obtain a smooth surface that lies slightly below the surrounding cartilage rim before the mixture is fixed with fibrin glue.

Microfracture is often used for small tibial plateau lesions encountered during restorative treatment of the femoral condyle, and it can be applied to an isolated lesion as well.¹ The main concerns raised regarding the outcomes of microfracture surgery are due to the formation of less-durable fibrocartilage that has been linked to deteriorating long-term outcomes.⁶ Whereas the postoperative clinical outcomes of microfracture with and without an MAC-PRP adjunct are unclear, a recent investigation in an equine model has shown that the addition of MAC-PRP to microfracture improves the generation of hyaline cartilage compared with microfracture alone.⁷ Although further clinical research is necessary, MAC-PRP is a promising adjunct treatment to microfracture and possesses a low-risk profile.

Table 1. Pearls and Pitfalls of Surgical Technique

Pearls

- Debride the entire layer of calcified cartilage without injuring the subchondral bone.
- Establish a stable rim with vertical walls before microfracture to optimize the fibrocartilage fill.
- Use a PowerPick to create short, uniform-diameter holes and decrease the amount of force necessary to create the holes, minimizing trauma to the subchondral plate.
- Ensure the defect bed is as dry as possible before application of the micronized allogeneic cartilage and PRP mixture to promote adherence.

Pitfalls

- Avoid confluent microfracture holes.
- Avoid excessive application of the micronized allogeneic cartilage and PRP mixture.
- Avoid overapplication of the fibrin glue.

PRP, platelet-rich plasma.

In many cases, symptomatic tibial chondral defects occur in association with other knee pathologies including femoral condyle defects, meniscal pathology, ligamentous pathology, or malalignment. Bipolar (femur and tibia) defects present an exceptionally challenging clinical problem. A recent investigation reporting on the outcomes of fresh osteochondral allograft transplantation in large bipolar lesions of the tibiofemoral joint showed a 39% 10-year survival rate⁸—an outcome that is inferior to the results of unipolar tibial plateau lesions (65% 10-year survival rate) or unipolar femoral condyle lesions (75% 12.3-year survival rate).^{2,9} Although further research is needed on the optimal treatment methods of bipolar defects, in the senior author's (B.J.C.) practice, bipolar tibiofemoral defects are often treated with a femoral condyle osteochondral allograft and tibial plateau microfracture.

The primary limitation of the use of MAC-PRP to augment microfracture is the limited clinical outcome data available. Although translational studies have

Table 2. Advantages and Disadvantages of Surgical Technique

Advantages

- Minimally invasive
- Low risk of surgical complications
- Straightforward surgical approach
- Minimal risk of adverse events related to micronized allogeneic cartilage

Disadvantages

- Potential generation of fibrocartilage fill
- Added expense compared with traditional microfracture
- Limited human data on clinical outcomes of micronized allogeneic cartilage

shown improved generation of hyaline cartilage with MAC-PRP, addressing one of the largest criticisms of microfracture, clinical trials are ongoing. As such, MAC-PRP joins a long list of promising candidates as an augmentation to microfracture, and further clinical studies are needed. Overall, the presented technique provides a safe, technically feasible, minimally invasive approach to addressing challenging tibial plateau defects that can potentially improve on the long-term outcomes of microfracture.

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