Technical Notes

Osteochondral Allograft Transplantation for Treatment of Focal Patellar Osteochondral Lesion

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Abstract: Patellar osteochondral lesions are common and particularly disabling injuries that can affect young and highly active patients. If enough functional impairment, ranging from difficulty climbing stairs to pain with squatting, is present, surgical treatment may be warranted. For the treatment of these lesions, various techniques have been described, including autologous osteochondral transplantation, as well as microfracture surgery. However, these are not without disadvantages. Although morbidity is noted in cases of autologous osteochondral transplantation, uncertain and possibly unsustainable results are associated with the microfracture procedure. Therefore, we present an alternative surgical treatment option for this pathology. The objective of this Technical Note is to describe our preferred approach for an osteochondral allograft transplant procedure to treat a focal patellar osteochondral lesion.

Osteochondral lesions (OCLs) are regularly found in various locations throughout the knee, most frequently at the femoral condyles. Of all OCL cases of the knee, 58% are found at the medial femoral condyle. In contrast, patellar osteochondritis dissecans (OCD) is more rare and is found in only approximately 11% of all OCD cases.[1] OCLs of the patella are typically seen after recurrent patellar instability and result in functional impairment.[2] Along with this functional impairment, painful patellar crepitus is expected during physical examination.[2] Furthermore, in some cases, patients will present with localized swelling of the patella as well as prolonged nonspecific pain aggravated by regular activity.[3] Typically, OCLs are discovered in the context of the regular practice of sports.[4-6]

Although conservative treatment is possible for articular cartilage lesions of the knee, including pain control through nonsteroidal medication, bracing, rest, and ice, long-term results are not well defined and require further investigation. However, a better understanding of articular cartilage lesions of the knee, along with the associated treatment options for the femoropatellar compartment for these lesions, has developed in recent years.[1] These operative techniques include mosaicplasty with osteochondral cylindrical bone plugs, autologous osteochondral transplantation,[7,8] autologous chondrocyte implantation,[9] and microfracture surgery.[2,10] Although positive outcomes have been reported after these treatment options, several disadvantages have been reported in association with each of these procedures.[11,12] Therefore, we present our technique to address a focal OCL. The objective of this Technical Note is to describe our preferred approach to treat a focal OCL through osteochondral allograft transplantation (OAT).

Surgical Technique

Preoperative Setup and Platelet-Rich Plasma Extraction

The patient is placed supine on the operating table (Video 1). After the induction of general anesthesia, a

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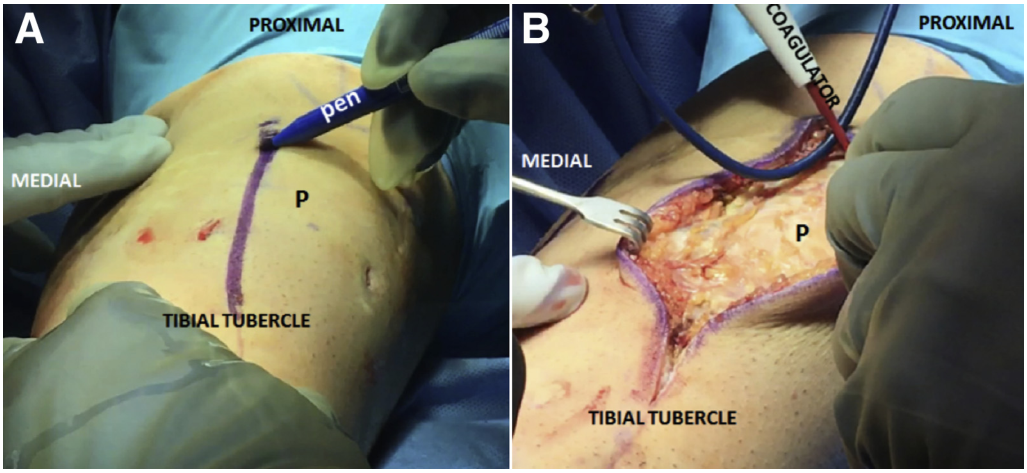

Fig 1. (A) A surgical pen is used to mark the site of our surgical approach on a left knee. The proximal aspect of the patella (P) and the tibial tubercle are palpated and used as references. (B) A longitudinal medial parapatellar incision is performed beginning 1 cm proximal to the proximal patellar pole and extending to the tibial tubercle.

bilateral knee examination is completed to verify the presence of any concomitant pathology. As part of this examination with the patient under anesthesia, knee range of motion, patellar mobility and instability, and crepitus during knee range of motion are evaluated. Once the knee has been fully assessed, a well-padded thigh tourniquet is placed on the upper thigh of the operative leg, which is prepared and draped in a sterile fashion. After this, the iliac crest is prepared and sterilized before exposure of the patella to collect 60 mL of peripheral blood to prepare the combination of autologous conditioned plasma (ACP)[13] and platelet-rich plasma (PRP) that will later be used prior to graft fixation. Once 60 mL of blood has been collected, the leg is exsanguinated with the tourniquet inflated to 200 mm Hg.

Exposure of Patella

The medial and proximal parts of the patella, as well as the tibial tubercle (TT), are palpated to ensure the initial incision is correctly performed for optimal exposure of the patella. A longitudinal medial parapatellar incision is made starting 1 cm proximal to the proximal patellar pole and extending to the TT (Fig 1). After the initial incision, blunt dissection of the subcutaneous tissue is performed with both a coagulator and Metzenbaum scissors. During exposure of the patella, we recommend avoiding a large dissection of the medial aspect of the incision and, instead, focus on dissection directly above the patella and patellar tendon. This method of dissection will result in easier eversion of the patella while also minimizing the risk of postoperative seroma. After this, a medial arthrotomy is performed through the initial skin incision to expose the trochlear cartilage surface (Fig 2). The patella is then carefully everted (Fig 3) with care to avoid avulsion of the patellar tendon from the TT attachment. For this reason, it is imperative that the knee be in full extension during eversion of the patella.

Evaluation and Measurement of Lesion

Once the patella has been successfully everted, the infrapatellar and trochlear cartilage surfaces are directly visualized. The position and dimensions of the osteochondral defect on the patella are assessed at this point to ensure applicability of the allograft. The patellar cartilage surface defect is measured with a ruler. In this

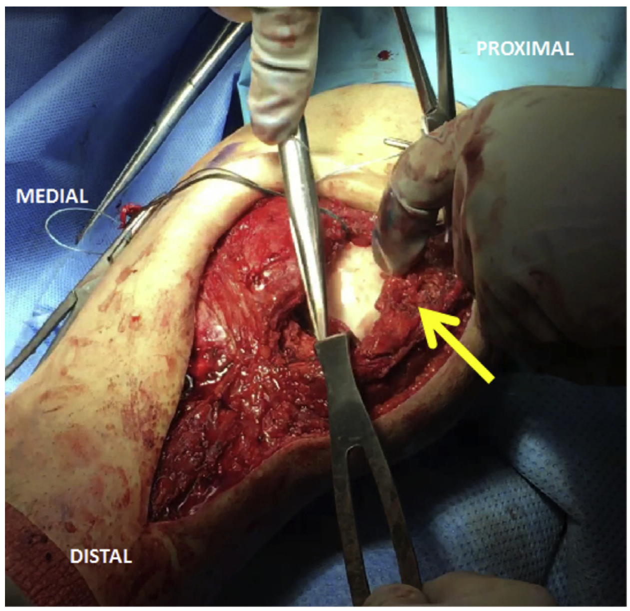

Fig 2. After the initial incision, a medial arthrotomy of the left knee is performed to expose the cartilage surfaces. A US Army-Navy retractor can be placed under the patellar tendon to position the patella more laterally and allow for better visualization of the trochlea. The patella (arrow) is carefully everted, thereby exposing the osteochondral defect.

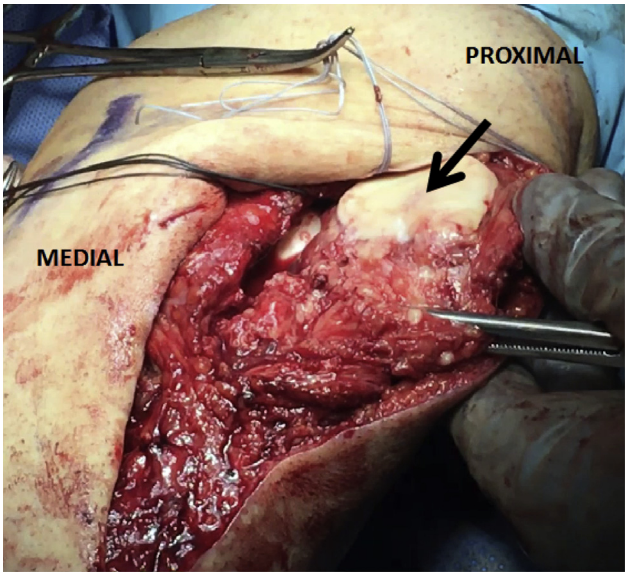

Fig 3. To safely expose the patellar osteochondral defect (arrow), the left knee is positioned in full extension and the patella is then everted. A Kocher or Crile clamp can be used to secure the patellar tendon if necessary. Of note, care must be taken to avoid avulsion of the patellar tendon during eversion.

case the defect measured 18 mm in diameter. A sizer of 18 mm in diameter (Arthrex, Naples, FL), which matches the size of the reamer to be used, is then placed on the defect to verify that the entirety of the lesion will be reamed.

Preparation and Measurement of Defect

Once the sizer has been used to verify the proper size of the reamer, a guide pin is inserted through the middle of the sizer. Once the guide pin is fixed, a Tube Harvester Driver (Arthrex) is placed perpendicularly atop the defect. After this, a mallet is used against the ends of the Tube Harvester Driver to impact to the necessary depth. The OCL is reamed to a total depth of 7 to 8 mm with a total resection of about 4 mm of subchondral bone and 4 to 5 mm of cartilage (Fig 4). After this, the height of the created defect is measured at the 12-, 3-, 6-, and 9-o'clock positions. These measured values will be used as reference points during preparation of the allograft to ensure a press fit of the allograft into the defect.

Fresh Patellar Osteochondral Allograft Preparation

On the basis of the measured heights of the defect at each of the clock-face positions, the patellar allograft is prepared. The allograft is transferred to the back table and carefully positioned and secured with either a Backhaus or Kocher clamp with the help of an assistant. The outline of the allograft to be prepared is then marked with a surgical pen by use of the 18-mm sizer, which was previously used during preparation of the defect (Fig 5). While the outline of the allograft to be formed is being drawn, the 12-, 3-, 6-, and 9-o'clock positions of the graft should also be marked. After this, an 18-mm-diameter bushing with its corresponding drill (Arthrex) is used to initially drill through and form the allograft to be used. After this initial step, a 10-mm fine-toothed oscillating saw is used to make the rest of the necessary cuts. Once the allograft is cylindrical in shape with the necessary diameter, the height of the allograft at each clock-face position is re-verified to ensure adequate filling of the defect and leveling of the surfaces between the allograft and native bone. The allograft is held in place with Lobster Claw Forceps (Arthrex); then, the height at each clock-face position is further refined with a 10-mm fine-toothed oscillating saw and/or rongeur. Once the graft is appropriately sized, both in diameter and in height for each clock-face position, pulse lavage is performed for a total of 10 minutes. After pulse lavage, the allograft is soaked in a combination of ACP and PRP for application through use of a Double Syringe System (Greyledge Technologies, Vail, CO). Prior to this, 60 mL of peripheral blood had been collected from the patient and submitted to centrifugation for approximately 10 minutes to heterogeneously divide the blood.

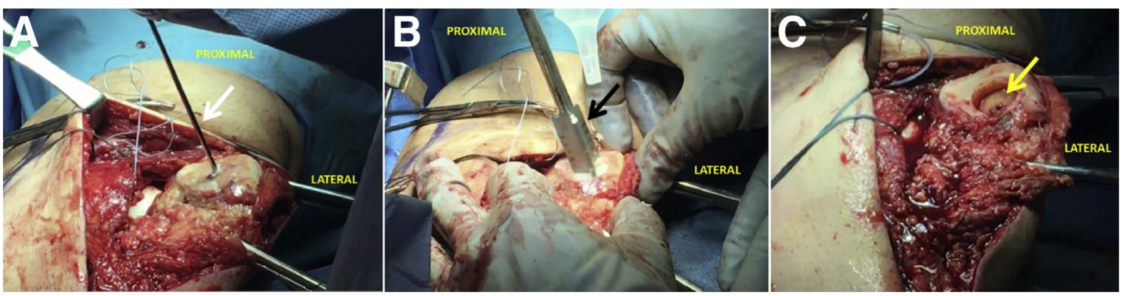

Fig 4. Once the osteochondral defect in the left knee is identified and measured, a sizer is used to ensure that the reamer will sufficiently overlay the entirety of the lesion. (A) The sizer is placed over the defect, and a guide pin (arrow) is inserted through the center of the lesion. (B) A reamer (arrow) is then used to resect the lesion, approximately 8 mm in depth. (C) As a result, a defect (arrow) is created that will be measured and later filled with the allograft.

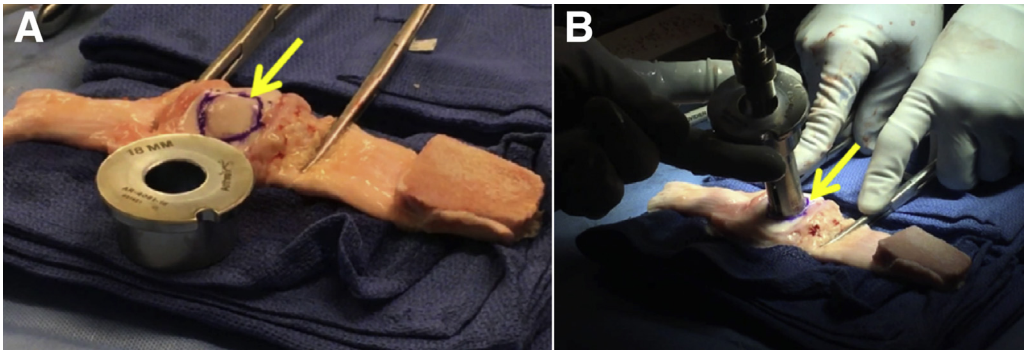

Fig 5. (A) By use of the exact dimensions of the osteochondral lesion of the left knee (in our case, 18 mm in diameter) on the patella (arrow), the allograft is prepared. (B) A bushing with its corresponding drill, as well as a 10-mm fine-toothed oscillating saw, is used to make all necessary cuts (arrow).

Fixation of Allograft

Once the allograft has been sufficiently soaked in ACP-PRP, it is placed into the defect with use of the 12-o'clock position as a reference point to ensure that the height of the clock-face positions for the allograft matches the corresponding heights of the defect. The allograft is then tamped down gently into position by use of a sterile laparotomy sponge to avoid direct contact between the tamper and allograft (Fig 6). It is of utmost importance to verify that the allograft sufficiently fills the entirety of the lesion, both in diameter and in depth. Once the allograft has been press fixed into place, the medial retinaculum is closed with a No. 2 Ethibond suture (Ethicon, Somerville, NJ) and a No. 0 Vicryl suture (Ethicon). After the medial retinaculum is closed, the knee is taken through its full range of motion and patellar tracking is evaluated. Closure of the subcutaneous tissue layer and the skin layer is then performed in standard fashion. Relevant advantages and disadvantages regarding the described technique are listed in Table 1, and pearls and pitfalls are shown in Table 2.

Rehabilitation Protocol

Immediately after the procedure, the patient is placed in an articulated knee brace, which must be used for the initial 6 postoperative weeks. Our recommended rehabilitation protocol focuses on early passive range of motion as well as early mobilization of the patella, patellar tendon, and quadriceps muscle. However, we suggest that the patient remain limited to 90° of knee flexion during the first 2 weeks after surgery to protect the allograft. After these initial 2 weeks, knee flexion may be gradually progressed to full passive range of motion with the pace of progression individualized according to each patient's ability. The patient is allowed to assume a progressive weight-bearing protocol over the initial 6-week period. Early in the rehabilitation period, cardiovascular exercise is incentivized and encouraged through the introduction of stationary bike exercise for the unaffected leg at week 1, with progression to both limbs (with no resistance) by week 8. After week 10, the patient is allowed to incorporate several other strengthening exercises.

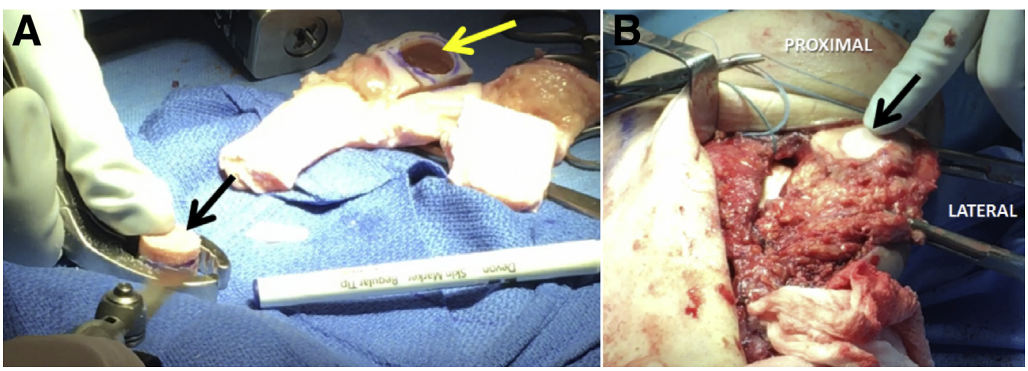

Fig 6. (A) Once the cuts are completed, the graft is removed (yellow arrow) and secured with Lobster Claw Forceps for final preparation prior to fixation in the left knee. A 10-mm fine-toothed sagittal saw, as well as a small rongeur, can be used to perform the cuts at the 4 clock-face positions. The allograft (black arrow) undergoes pulse lavage for approximately 10 minutes and is then bathed in a combination of autologous conditioned plasma and platelet-rich plasma. (B) After this, the allograft (arrow) is placed at the patella by use of the 12-o'clock position as a reference point to ensure adequate filling of the defect.

Table 1. Advantages and Disadvantages

Advantages	
	Lack of donor-site morbidity
	Healing potential increased by use of combination of autologous conditioned plasma and platelet-rich plasma
	Restoration of native patellar anatomy and biomechanics
Disadvantages	
	Possible unavailability in some regions of world
	High cost and technically demanding
	Greater risk of infection than arthroscopic procedure given more exposure

These include bike exercises with increasing resistance, aqua jogging, walking on a treadmill with inclination, swimming with fins, cord exercises, balance squats, and leg presses. Then, at week 16, the patient can begin to use elliptical and stair-stepper machines while also commencing single-plane agility exercise until week 24. Multidirectional exercises are initiated at week 20. Although the timeline for a complete return to sport is patient dependent, in general, a complete return to sport is not suggested before 6 months postoperatively.

Discussion

OCLs remain a challenging pathology and may require surgical intervention in severe cases. However, these OCLs are difficult to treat as a result of the avascularity and minimal healing potential associated with the cartilaginous layer. Operative techniques such as patellar microfracture,[10] abrasion chondroplasty, and osteochondral drilling aim to address symptoms but are unable to properly restore the articular surface of the patella.[1,14-17] Moreover, in particular, a microfracture procedure may be difficult to perform as a result of the need to reach a perpendicular angle to the patellar surface arthroscopically.[1] Therefore, the use of a Kirschner wire drilled through the patella, which is then used to manually maneuver the patellar articular surface during arthroscopic exposure, as described by Gomes et al.,[10] may be necessary in many cases.

Aside from microfracture surgery, the use of biologics for articular cartilage restoration treatment include osteochondral autograft transfer, OAT, and autologous chondrocyte transplantation.[18] Although autologous osteochondral transplantation may lead to a successful outcome for the treatment of a patellar OCL,[19,20] donor-site morbidity is a noted disadvantage of the technique, which may result in future functional impairment.[21]

OAT is another surgical treatment option capable of addressing and resolving OCD of the patella, which avoids the need for graft harvest. In a comparison study of outcomes after OAT and microfracture surgery, OAT showed better postoperative outcomes than microfracture surgery.[22] Moreover, histologic studies have reported a high rate of viability for transferred hyaline cartilage.[23] After treatment of patellar and/or trochlear OCLs with autologous osteochondral mosaicplasty, histologic findings showed a considerable improvement in clinical scores in 79% of patients.[24] Autologous osteochondral mosaicplasty is performed to fill the defect with hyaline cartilage, which is more durable than the fibrocartilage growth that occurs after ablation or microfracture.[25] The donor plugs allow immediate restoration of the joint articular surface with viable hyaline cartilage[26] and are particularly effective for defects greater than 2 cm^2 in total surface area.[18] This procedure is appealing not only in the treatment of younger and more active patients but also as a salvage procedure after failed microfracture or a prior allograft transplant, given its durability and overall effectiveness.[27]

We describe in detail our preferred approach for an OAT procedure to treat a focal OCL. The advantages associated with this technique include no associated patient morbidity because of the use of an allograft, considerably high healing potential, and an anatomic restoration of the joint surface. Although we recommend the described technique to treat focal OCLs, future long-term studies with large sample sizes are needed to provide further evidence of the efficacy of this technique.

Table 2. Pearls and Pitfalls

Pearls	
	A preoperative evaluation to thoroughly assess for any concomitant pathology is necessary to achieve a positive postoperative outcome.
	The location of the osteochondral defect must match the location of the cadaveric patella from which the osteochondral allograft is harvested.
	Measuring the height of the allograft at the 12-, 3-, 6-, and 9-o'clock positions will allow for optimal preparation and provide a press-fix fixation.
Pitfalls	
	Avulsion of the patellar tendon may occur during eversion of the patella.
	The technique requires removal of cartilage and subchondral bone that surpasses the size of the original lesion.
	Thermal necrosis of the graft may occur during preparation; therefore, we suggest drilling at a low speed and maintaining constant saline solution irrigation to minimize the risk of thermal necrosis.

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