Technical Note

Osteochondral Allograft Transplant for Combined Medial and Lateral Patellar Cartilage Lesions: The Osteochondral Wide Lesion (OWL) Technique

Rodrigo Araújo Goes, M.D., M.Sc., Thiago Alberto Vivacqua, M.D., M.Sc., Raphael Serra Cruz, M.D., M.Sc., Douglas Mello Pavão, M.D., M.Sc., Gabriel Garcez, M.D., João Alves Grangeiro, M.D., Rodrigo Salim, M.D., Ph.D., and José Leonardo Rocha de Faria, M.D., M.Sc.

Abstract: Symptomatic articular cartilage injuries are often seen in young active patients and athletes. Magnetic resonance imaging screening examinations have frequently identified such lesions in athletic patients. Patellofemoral chondral defects were previously identified as the most common knee cartilage lesion in high-level athletes. Chondral defects measuring 2 cm^2 or greater and complex cartilage defects involving bone loss are ideally replaced with fresh osteochondral allograft. We describe a technique indicated for patients with symptomatic and recurrent anterior knee pain associated with osteochondral patellar defects including the lateral and medial patellar facets. Patients who have undergone previous interventions, including membrane techniques, microfracture, or autologous chondral transplantation, without clinical benefit are also eligible to undergo osteochondral allograft transplantation for combined medial and lateral patellar cartilage lesions, that is, the osteochondral wide lesion (OWL) technique.

Symptomatic articular cartilage injuries are often seen in young active patients and athletes. Untreated focal injuries will likely progress to diffuse or deep chondral defects, leading to early osteoarthrosis (OA) changes with limited treatment options.[1] Elite athletes are perhaps unable to achieve desired positions or long-term careers because of focal and progressive knee chondral lesions.

Chondral lesions are frequently identified in basketball players during magnetic resonance imaging (MRI) screening examinations.[2,3] The incidence of the patellar lesions was reported as 36% in patients with cartilage lesions diagnosed by knee arthroscopy.[4] Patellofemoral chondral defects were previously identified as the most common knee cartilage lesion in high-level athletes.[5] However, a recent literature review has identified a prevalence of patellofemoral chondral injuries of 18% in professional soccer athletes.[6] The knee joint represents the most common joint affected by OA among retired professional soccer players.[7]

For symptomatic contained chondral lesions greater than 1 cm^2 and smaller than 2 cm^2, an autologous osteochondral transplant is often a reasonable approach that leads to a structural chondral restoration and is unlikely to have related donor side effects. Chondral defects measuring 2 cm^2 or greater and complex cartilage defects involving bone loss are ideally replaced with fresh osteochondral allograft (OCA). Therefore, OCA has been commonly used in patients with symptomatic large cartilage lesions at

From Knee Surgery Center, National Institute of Traumatology and Orthopedics of Brazil, Rio de Janeiro, Brazil (R.A.G., T.A.V., R.S.C., D.M.P., G.G., J.A.G., J.L.R.d.F.); School of Medicine, University of São Paulo—USP, Riberão Preto, Brazil (D.M.P., R.S., J.L.R.d.F.); and Research Fellow, Fowler Kennedy Sport Medicine Clinic, University of Western Ontario, London, Canada (T.A.V.).

The authors report no conflicts of interest in the authorship and publication of this article. Full ICMJE author disclosure forms are available for this article online, as supplementary material.

Received April 16, 2022; accepted July 20, 2022.

Address correspondence to José Leonardo Rocha de Faria, M.D., M.Sc., Instituto Nacional de Traumatologia e Ortopedia Jamil Haddad, Av Brasil, 500, São Cristovão, Brazil, CEP 20940-070. E-mail: drjoseleonardorocha@gmail.com

2212-6287/22525

https://doi.org/10.1016/j.eats.2022.07.012

the knee joint,[8] even in those with open physes.[9] OCA transplantation is mostly used to address post-traumatic defects, osteonecrosis, and idiopathic chondral defects or as a salvage-type procedure.[10,11] Complex articular fractures can also be treated using a structural allograft transplant.[12]

We describe a technique indicated for patients with symptomatic and recurrent anterior knee pain associated with osteochondral patellar defects including the lateral and medial patellar facets. Patients who have undergone previous interventions, including membrane techniques, microfracture, or autologous chondral transplantation, without clinical benefit are also eligible for the osteochondral wide lesion (OWL) allograft transplant technique.

Surgical Technique

Fresh Allograft Harvesting and Processing

Per our allograft protocol, entire knees were previously harvested from donors older than 18 years and younger than 45 years without previous articular abnormalities.[13] The donated tissue is routinely immersed in saline solution and preserved at 4°C to 10°C. The donated tissue is transported to the national tissue bank, and immediate processing is performed aiming to decrease chondrocyte death due to a lack of cellular nutrients. The chondral surface status is evaluated during tissue preparation, with confirmation of an intact chondral surface. Careful pulse lavage is performed during the preparation time, removing blood elements and antigenic components, decreasing any possible post-transplant immunologic humoral reaction. The preservation solution is composed of Iscove's serum-free cell culture medium supplemented with 10% human albumin and 100 μg/mL of vancomycin. Different serum-free media are often used worldwide for OCA preservation and research purposes, achieving acceptable survival of chondrocytes.

Our previous histologic study identified significant structural changes and discontinuity of the superficial layer after 30 days of preservation.[13] On the basis of those findings, we strongly recommend performing fresh allograft transplantation before 30 days of preservation, ideally within 15 days. Previous studies have recommended a maximum storage period of 42 days and transplantation by 24 to 28 days of preservation based on cellular viability evaluations.[14] Cook et al.[15] reported a chondrocyte survivorship rate over 80% in an animal model using the Missouri Osteochondral Preservation System when the OCA tissue was stored at 25°C. The use of higher temperatures (around the 25°c), presents potential benefits over the preservation of the OCA cellularity. However, the currently accepted standard temperature for fresh preservation is 10°C.

Positioning, Preparation, and Evaluation Under Anesthesia

The patient is placed in the supine position. An additional small gel bag is placed under the ipsilateral gluteus, leaving 15° of internal leg rotation to keep the patella centralized. Lateral support and a second foot roll are placed, helping to keep the knee in 30° of flexion during the surgical intervention. A preoperative clinical examination is performed with the patient under anesthesia, confirming a stable patellofemoral joint (PFJ) and excluding any additional joint abnormality. Full passive range of motion is also assessed before the surgical intervention is started (Fig 1A). Ideally, a second knee surgeon familiar with allograft tissue work should begin to prepare the OCA tissue on a separate table to decrease intervention time (Fig 1 B-D).

Arthroscopic Diagnosis and Assessment of Lesion Size

The tourniquet is insufflated to 150 mm Hg under systolic blood pressure. A standard superolateral portal is created, followed by a medial parapatellar portal, under direct arthroscopic visualization (Video 1). Arthroscopic diagnosis is made with the aim of confirming any additional chondral changes and the patellar chondral defect. Attention is turned to the trochlear groove to avoid any missed chondral defects, leading us to verify our previously suggested intervention: the osteochondral wide lesion (OWL) technique (Fig 2).

Surgical Intervention

With the knee placed at 60°, a longitudinal anteromedial incision is performed in line with the previous portal incision. Then, a medial parapatellar capsular incision is performed. Careful attention is required at this point to avoid any potential iatrogenic lesions at the medial meniscus. The Hoffa fat pad remains intact to preserve the patellar tendon blood supply. Carefully soft tissue dissection is performed, leading to movement of the patellar bone about 90° perpendicular to the ipsilateral trochlear surface.

The principal surgeon must be on the contralateral side, which provides a comprehensive view of the surface of the chondral patella. Before the osteochondral transplantation is started, intraoperative bone measurements are reviewed, including patellar mediolateral and anteroposterior length. We do not recommend any additional patellar denervation. With the knee in full extension, two 1.5-mm Kirschner wires (K-wires) are placed, passing through perpendicular to the medial border of the patella. Those should be positioned on the patella in order to move the patella, generating its bone eversion, acting as a joystick, obtaining greater precision and control of the positioning of this bone (Fig 3).

Fig 1. (A) Maximum knee flexion at time of surgery of the right knee, with the patient in the supine position. (ROM, range of motion.) (B-E) Femoral allograft prepared for use in osteochondral wide lesion technique.

Graft Measurement and Preoperative Preparation

Patellar bone measurement is confirmed with the operative leg in full extension, keeping the chondral patellar defect at 90° of inclination. Then, an arthroscopic probe is used to complete the intraoperative diagnosis. Finally, an Arthrex cannulated alignment rod (Naples, FL) is used (Fig 4A).

Chondral Defect Preparation

By use of the Arthrex cannulated alignment rod, a guide pin is first introduced into the injured side, then a specific cannulated drill is positioned measuring the size of the chondral defect. Next, the recipient side is drilled using a 20-mm sizer (in this case) and 8-mm depth (Fig 4B). Finally, the edges of the recipient area are manually smothed. The bone bridge between the 2 osteochondral plugs must remain intact. A similar technique is performed in the second osteochondral recipient area (Fig 4C).

Intraoperative Fresh Osteochondral Tissue Preparation

The fresh osteochondral tissue is placed on an Osteochondral Set (Arthrex) positioned on an auxiliary Mayo table. The lateral femoral condyle is first warmed with saline solution and evaluated, with confirmation of an intact cartilage layer. By use of four 1.0-mm K-wire pins, it is fixed on the Osteochondral Set to harvest appropriate osteochondral plugs. Then, 2 osteochondral plugs are prepared, measuring 20 mm in diameter and

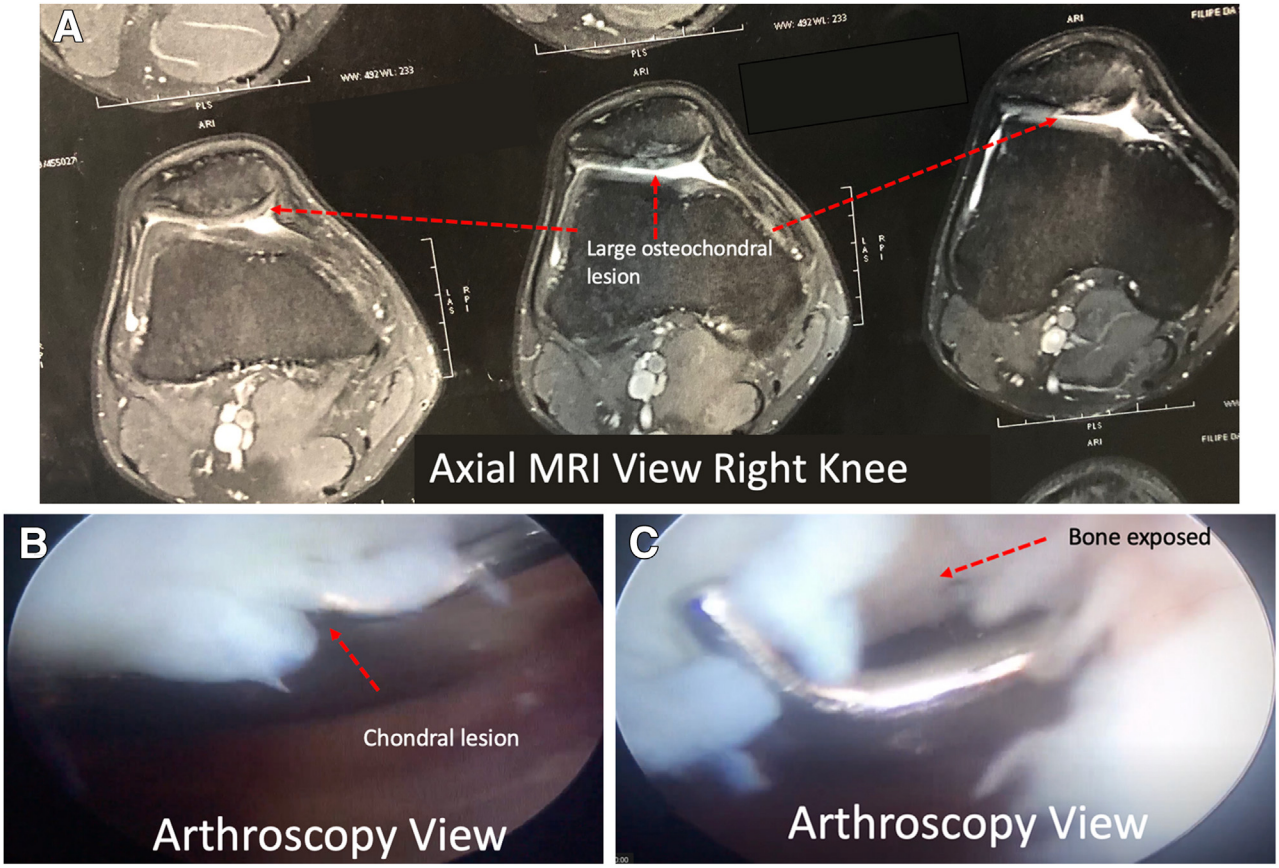

Fig 2. (A) Magnetic resonance imaging (MRI, axial view) showing osteochondral tear in patellar articular surface. (B, C) Arthroscopic views of chondral tear and bone exposed at osteochondral tear. LAS, left anterior superior; PLS, posterior left superior; RPI, right posterior inferior

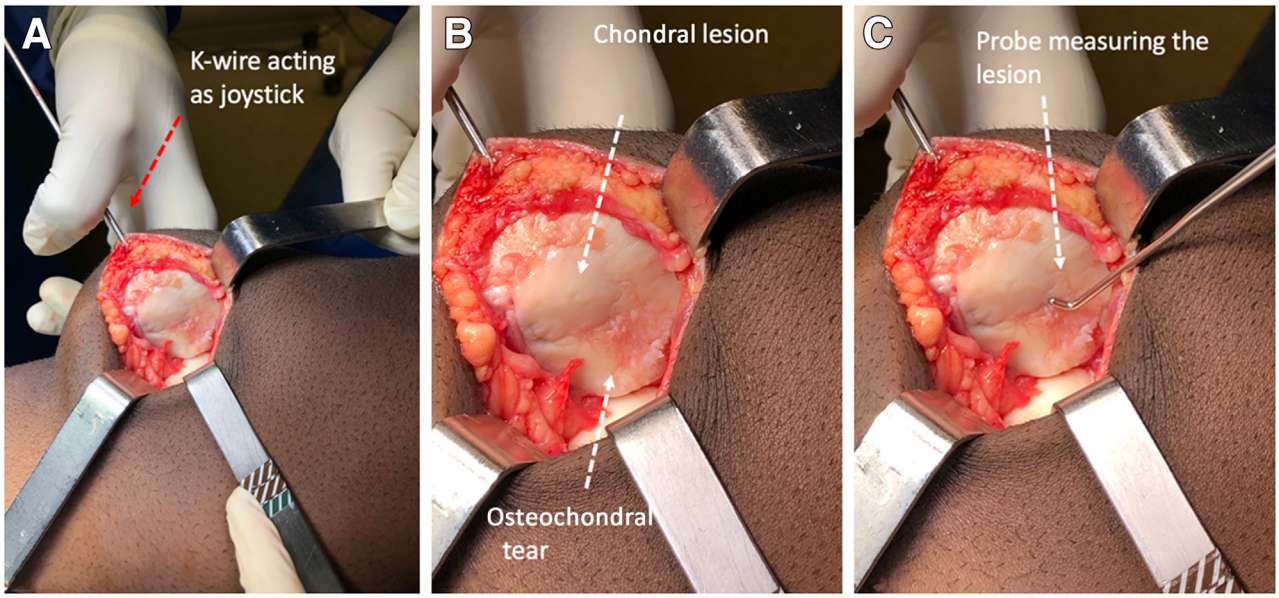

Fig 3. (A) After longitudinal arthrotomy has been performed, we use a K-wire as a joystick to facilitate eversion of the articular surface of the patella. (B) The lateral facet of the patella shows a large osteochondral tear, and the medial facet shows a chondral tear. (C) We use a probe to measure the size of the tear.

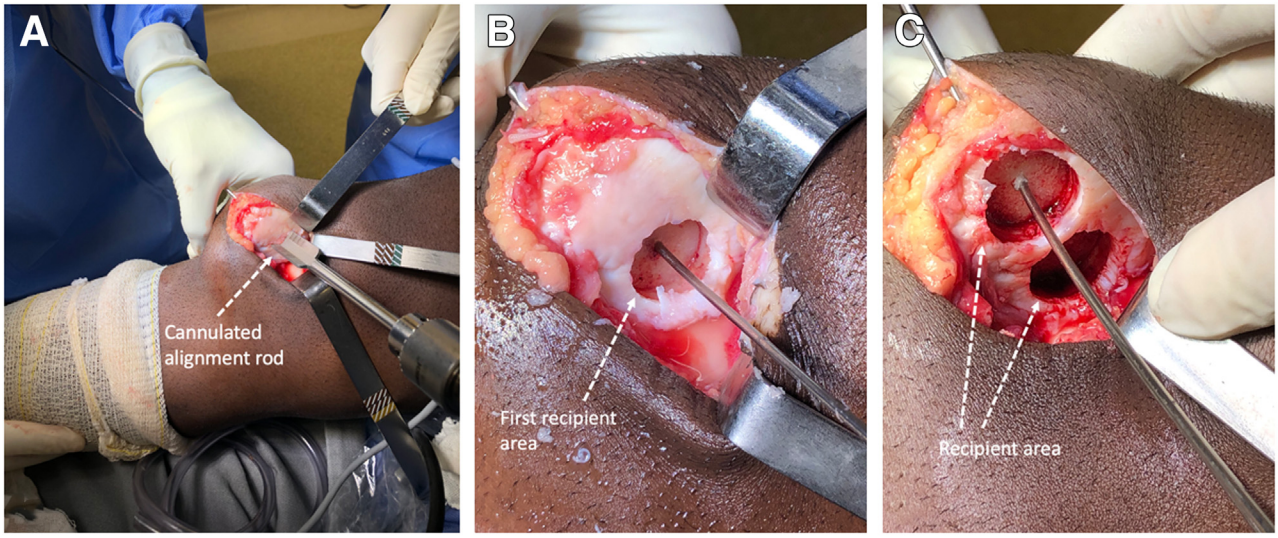

Fig 4. (A-C) With a guidewire inserted in the center of the tear, we use a 20-mm drill to create the recipient area in the medial and lateral facets.

8 mm in depth. Finally, both plugs are cleaned using a pulse lavage system to remove any additional blood marrow elements, decreasing the risk of an allogeneic inflammatory reaction (Fig 5).

Graft Impaction

The first osteochondral plug is placed in situ manually by a press-fit technique. The lateral edge of patellar surface, should aim to be at the same level as adjacent cartilage layer. A similar approach is used during placement of the second plug (Fig 6). Then, we visualize the final aspect of the cartilage surface with the 2 plugs attached, similar to the face of an owl (Fig 7). Finally, the K-wire is removed, and intraoperative patellar tracking is confirmed. An immediate improvement in preoperative patellar crepitation is confirmed.

Postoperative Dressing

The recipient cartilage and allograft transplant are washed intraoperatively using saline solution, and the knee capsule is closed by suturing the anatomic layers retrospectively. A No. 0 Vicryl suture (Ethicon, Somerville, NJ) is used approaching the knee capsule and deep subcutaneous layer. A No. 2-0 Monocryl suture (Ethicon) is then placed, closing the subcutaneous layer, and a No. 3-0 Monocryl suture is placed, finishing the surgical incision. Steri-Strips (3M, St Paul, MN) are placed over the surgical incision. A traditional Jones-fashion dressing is finally applied, leaving the surgical

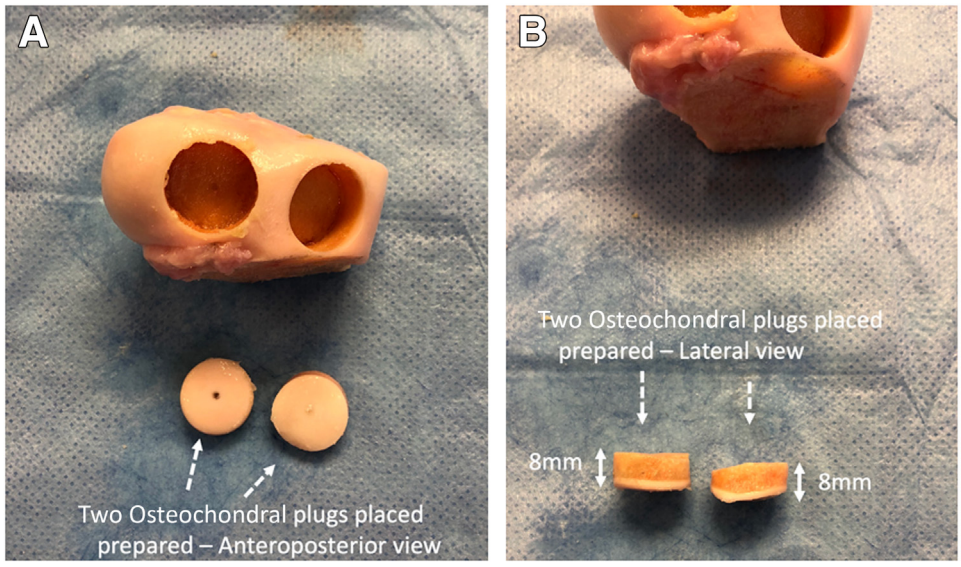

Fig 5. Anteroposterior view (A) and lateral view (B) of 2 osteochondral plugs of 20 mm in diameter.

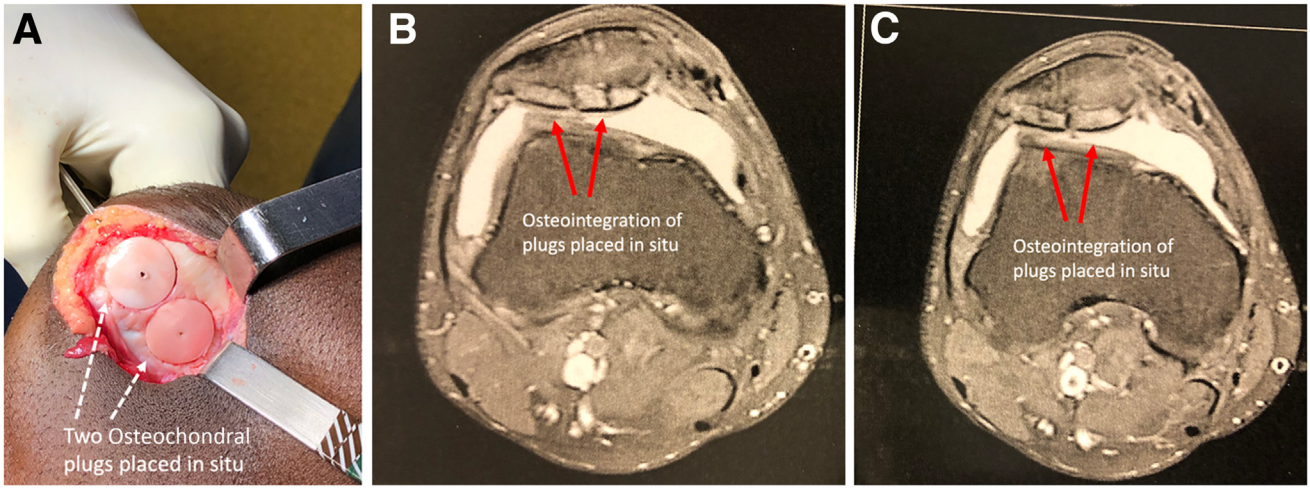

Fig 6. (A) Two osteochondral plugs placed in situ. (B, C) Postoperative magnetic resonance imaging (axial view) at 5 months of follow-up.

wound closed during the first 24 hours postoperatively. The patient receives a knee brace and is instructed to keep the knee straight when walking and sleeping.

The inclusion and exclusion criteria for focal osteochondral transplantation at the PFJ are shown in Table 1. The technique is shown in detail in Video 1, and the main surgical steps are summarized in Table 2. The main advantages and limitations are presented in Table 3, and pearls and pitfalls of this technique are described in Table 4.

Rehabilitation

The key point for the success of rehabilitation after the described surgical procedure is to understand the final goals of treatment: complete osseointegration of the osteochondral grafts in the patella and viable transplanted cartilage. To this end, we must keep in mind a series of restrictions throughout the process, especially not imposing a full load on the operative limb for a total of 6 weeks.

It is suggested that patients undergoing osteochondral transplantation be closely monitored postoperatively, during serial consultations, at 1 and 2 weeks. The main concerns are the status and healing of the operative wound (which should always be kept clean and dry with the application of occlusive dressing); pain control with analgesic and anti-inflammatory drugs; cryotherapy (6 times per day for 25 minutes) and limb elevation to control synovitis and joint effusion; restoration of joint mobility, as well as mobilization of the patella, patellar tendon, and quadriceps; muscle activation of the quadriceps and abductor and adductor muscles (with isometric exercises); and gains in range of motion, which is stimulated according to tolerance and for which the use of an arthrometer is recommended (in the first 3 weeks). Partial load restriction is recommended during gait, which is performed with the aid of Canadian crutches and prophylactic anticoagulation (enoxaparin at a dose of 40 mg once a day for 14 days).

From the third week onward, the partial load is increased with the aid of 2 crutches, with the knee kept in extension to go up and down steps or stairs and start activities in the pool. At 6 weeks postoperatively, the

Fig 7. The final aspect of the osteochondral wide lesion (OWL) technique is very similar to the face of an owl.

Table 1. Inclusion and Exclusion Criteria for Focal Osteochondral Transplant at PFJ

Inclusion criteria
Grade IV contained cartilage tear
Unipolar lesion
No trochlear dysplasia
Young and active patient
Recreational or professional athlete
Previous cartilage repair or restoration
Exclusion criteria
Uncontained cartilage tear
Articular inflammatory disease
Osteoarthrosis changes at PFJ
Osteoarthrosis changes at tibiofemoral joint
Patellar instability
Bipolar chondral changes at PFJ

PFJ, patellofemoral joint.

knee is expected to be with no swelling, with full extension and flexion close to 120°. Exercises to gain muscle strength in an open kinetic chain are added with elastic resistance and weight "shin guards." At the 8-week review, the patient is expected to have reacquired full range of motion. Radiographs of the knee are requested to assess bone incorporation and release the patient to begin weaning from crutch use contralateral to the operative knee. The exercise routine includes use of a stationary bike (initially with a raised seat and no resistance), with progressive time and resistance.

At 3 months (12 weeks), the patient starts full load bearing without crutches, as well as proprioception training with support and closed kinetic chain exercises without restrictions concerning knee angulation in execution (according to tolerance), always bilaterally simultaneously (leg presses and squats). At 16 weeks, a control MRI study is requested, and at this point, there are no more restrictions on weight bearing training exercise for the lower limbs, with a transition from bilateral to unilateral exercises. Freestyle swimming, elliptical machine use, and treadmill walking are allowed to increase aerobic fitness.

At 20 weeks (5 months), the patient is encouraged to progress in performing the previous activities and to start running in sand. Running training evolves to grass and use of a treadmill at 24 weeks (6 months). At this time, we suggest performing an assessment of the quadriceps index with a dynamometer (manual or isokinetic). The quadriceps strength of the operative limb should be above 65% of that of the unaffected limb at this stage.

After the 28th postoperative week, it is recommended to maintain muscle strengthening, to perform running training on alternating surfaces (sand, grass, treadmill, and track), and to start technical and specific training for the patient's sport. At 32 weeks (8 months), another evaluation of the quadriceps index should be performed with a dynamometer (manual or isokinetic), and the strength of the operative limb should be above 90% of that of the unaffected limb. The ability to achieve a total return to the sporting activity of the patient's choice should be evaluated at this time.

Discussion

The described technique offers a good treatment option for several double facet chondral defects on the patellar surface. With this technique, the patellar chondral surface is restored in affected patients, consequently improving pain and joint function.

Table 2. Step-by-Step Fresh Patellar OWL Transplant Technique

Step	Description
1	The patient is anesthetized and positioned supine with an inflated pneumatic cuff.
2	Knee arthroscopy is performed with particular attention to the patellar cartilage and femoral trochlea status.
3	A sterile support is placed under the knee to maintain 20°-30° of flexion during the open procedure.
4	Through a 6- to 8-cm longitudinal incision in the anteromedial region of the knee and a medial parapatellar arthrotomy, the medial meniscus and Hoffa fat pad are identified and preserved.
5	It is suggested that the main surgeon be positioned on the contralateral side of the operative limb to view the everted patella's articular surface directly.
6	Measurement of patellar thickness is performed with a caliper or with the aid of a millimeter ruler.
7	A 2.5-mm Kirschner wire is placed in the patella to achieve a joystick effect, and the patella is kept at 90° to the femoral trochlea.
8	The lesion is measured with a probe and an Arthrex transparent cannulated meter.
9	Evaluation of the plugs that will be placed in the patella is performed, with placement of the first guidewire.
10	Milling, preparation, and smoothing of the first receiving area are performed.
11	Placement of the second guidewire is performed, in addition to milling, preparation, and smoothing of the second receiving area.
12	Fixation, measurement, and preparation of the osteochondral grafts from the donor femoral condyle are performed.
13	Impaction of the first graft is performed with a press-fit technique in the most lateral bed of the recipient's patella, flush with the surrounding cartilage; impaction of the second graft is performed in the medial bed, flush with the first graft.
14	The Kirschner wires are removed, stability is test, and the planes are closed to the skin.

OWL, osteochondral wide lesion.

Table 3. Advantages and Disadvantages (Limitations)

Advantages
The technique is simple and easily reproducible.
Synthesis material is not used.
The technique allows evaluation through postoperative magnetic resonance imaging.
The regular movement of the patella impacts the plugs against the femur as a "tension band" system.
A patella-specific osteochondral graft is not needed.
A direct view of the lesion can be obtained (open procedure).
It is unnecessary to completely evert the patella (it is at 90° with the femoral trochlea).
The technique offers the ability to re-create a large area of the articular cartilage of the patella and to effectively treat large osteochondral lesions of the patella, especially in young patients and athletes.
It is not necessary to perform any type of denervation around the patella.
The technique is capable of providing security when performing strenuous activities and contact sports.
The technique offers a treatment option in cases of previous surgical treatment failure—either microfracture associated (or not) with collagen membrane or autologous osteochondral transplantation (mosaicplasty).
If a plug falls to the ground, the surgeon can resort to grafting and preparing another plug.
There are no limitations on passive range of motion in the immediate postoperative period, and partial weight bearing with crutches is started from the third postoperative week.
Disadvantages (limitations)
Accessing the fresh allograft can present difficulty, which requires essential logistics.
Logistical limitations allow storage for only up to 14 days before transplantation (the shorter the time, the greater the number of viable chondrocytes).
Team experience with homologous grafts and performance in transplant hospitals is needed.
Specific Arthrex material and instruments are used.
Mild or moderate patellofemoral pain is not an indication.
Only patients with severe chronic pain that limits their daily activities and sports performance without improvements with nonsurgical treatment or conventional arthroscopy are candidates for this treatment.
The technique cannot be performed arthroscopically.
Femoral condyle graft has a cartilage thickness inferior to that of the native patella.
The original patella shape is not re-created.
Patella of sufficient length and width is required for the impaction of 2 osteochondral plugs.

Previous studies have reported return-to-play rates ranging from 54% to 88% after OCA transplantation in non-professional athletes.[16-20] In a recent case series of professional basketball players, Balazs et al.[21] reported an overall rate of return to play at the same level of 80% after a mean of 14 months' follow-up. Fifty percent of these patients underwent patellofemoral OCA intervention. When data for National Basketball Association (NBA) athletes were extracted, a mean of 20 months was necessary to return to the previous activity level. Being away from sports practice for a long time, significantly decreased athletic performance, also changing a long-term carrier perspective.[21]

Transplantation of a large bipolar allograft has recently been reported as a salvage procedure in patients with diffuse chondral changes and was previously applied to correct patellar instability.[22] Biological allograft resurfacing has also been suggested as an alternative treatment in patients younger than 50 years with early to mild patellofemoral OA, without benefits after no surgical treatments.[23] Fresh patellar osteochondral resurfacing has been suggested for young and active patients with symptomatic diffuse chondral changes at the PFJ.[24] Anterior tibial tubercle osteotomy represents an alternative approach that allows access to bipolar lesions at the PFJ, and tibial tubercle arterialization can also be performed.[10,25]

The criteria for failure after OCA transplantation have generally been reported as conversion to partial or total knee arthroplasty, additional arthroscopic surgery, graft removal, and revision allograft procedures. Lower survivorship has been reported for bipolar and patellar OCA transplantation. Gracitelli et al.[26] reported a 78% rate of graft survivorship at 10 years' follow-up when approaching isolated chondral patellar defects; this rate dropped to 55.8% at 15 years' follow-up. Concerns related to adverse side effects and early graft failure should be discussed preoperatively, particularly in young and active patients.

The allogeneic reaction is unlike that seen after focal osteochondral transplantation. Lack of a direct vascular supply to the native chondral tissue reduces changes in the antigenic response in OCA tissue transplantation. Pulse lavage has largely been used to remove bone marrow elements and antigenic elements. Structural allograft transplantation has been suggested for young patients with multifocal lesions and early OA changes. After transplantation using the shell technique, the immunologic humoral reaction was associated with a chronic inflammatory response and incomplete allograft integration. Postoperative MRI scans can allow a comprehensive evaluation of the subchondral bone and degree of integration.[27]

Table 4. Pearls and Pitfalls

Pearls
Donors should be aged < 45 yr.
Kirschner wires should be inserted on the patella, working as a joystick, facilitating patellar bone eversion and control of its mobilization.
Detailed measurements of the thickness, width, and length of the patella should be performed.
Pitfalls
Care and control are necessary when preparing the receiving area, with 8-mm-deep milling.
To avoid postoperative stiffness of the knee joint, prolonged postoperative immobilization should be avoided.

We acknowledge that large OCA transplantation should be considered a biological approach in athletes and active patients with chronic anterior knee pain with no clinical benefit after previous rehabilitation programs or articular injections. In addition, we believe that full fresh allograft transplantation should be left to cases of diffuse patellar chondral wear or previous focal allograft failure. To define the standard surgical approach for this specific population, large case series or comparative studies should be performed in recreational and high-performance athletes facing recurrent symptoms due to deep and large chondral injuries at the PFJ.

We strongly recommend the reported technique in patients with complex unipolar patellar chondral changes, including the medial and lateral facets, without benefit after nonsurgical interventions. The reported approach should be considered in young and active patients to return to their previous sports activity level, avoiding early OA changes.

References

1. Carnes J, Stannus O, Cicuttini F, Ding C, Jones G. Knee cartilage defects in a sample of older adults: Natural history, clinical significance and factors influencing change over 2.9 years. *Osteoarthritis Cartilage* 2012;20:1541-1547.
2. Major NM, Helms CA. MR imaging of the knee: Findings in asymptomatic collegiate basketball players. *AJR Am J Roentgenol* 2002;179:641-644.
3. Kaplan LD, Schurhoff MR, Selesnick H, Thorpe M, Uribe JW. Magnetic resonance imaging of the knee in asymptomatic professional basketball players. *Arthroscopy* 2005;21:557-561.
4. Widuchowski W, Widuchowski J, Trzaska T. Articular cartilage defects: Study of 25,124 knee arthroscopies. *Knee* 2007;14:177-182.
5. Flanigan DC, Harris JD, Trinh TQ, Siston RA, Brophy RH. Prevalence of chondral defects in athletes' knees: A systematic review. *Med Sci Sports Exerc* 2010;42:1795-1801.
6. Andrade R, Vasta S, Papalia R, et al. Prevalence of articular cartilage lesions and surgical clinical outcomes in football (soccer) players' knees: A systematic review. *Arthroscopy* 2016;32:1466-1477.
7. Drawer S, Fuller CW. Propensity for osteoarthritis and lower limb joint pain in retired professional soccer players. *Br J Sports Med* 2001;35:402-408.
8. Sherman SL, Garrity J, Bauer K, Cook J, Stannard J, Bugbee W. Fresh osteochondral allograft transplantation for the knee: Current concepts. *J Am Acad Orthop Surg* 2014;22:121-133.
9. Gilat R, Haunschild ED, Huddleston H, et al. Osteochondral allograft transplantation of the knee in adolescent patients and the effect of physeal closure. *Arthroscopy* 2021;37:1588-1596.
10. Dekker TJ, Kennedy MI, Grantham WJ, DePhillipo NN, LaPrade RF. Patellar fresh osteochondral allograft transplantation. *Arthrosc Tech* 2019;8:e851-e854.
11. Vivacqua TA, Rocha T, Rocha de Faria JL, Prinz R, Mozella AP, Guimarães JAM. Fresh osteochondral allograft in a complex Hoffa fracture—Case report [published online March 7, 2022]. *Rev Bras Ortop (Sao Paulo). 2022.* doi:10.1055/s-0042-1742599
12. Bugbee W. *Editorial Commentary:* Osteochondral allografting is a "kid-friendly" cartilage repair procedure. *Arthroscopy* 2021;37:1597-1598.
13. Vivacqua TA, Prinz RD, Cavanellas N, Barretto JM, de Sousa EB, Aguiar DP. Protocol for harvest, transport and storage of human osteochondral tissue. *Rev Bras Ortop (Sao Paulo)* 2020;55:163-169.
14. Chahla J, Gross AE, Gross C, et al. Outcomes of osteochondral allograft transplantation in the knee. *Arthroscopy* 2013;29:575-588.
15. Cook JL, Stoker AM, Stannard JP, et al. A novel system improves preservation of osteochondral allografts. *Clin Orthop Relat Res* 2014;472:3404-3414.
16. Campbell AB, Pineda M, Harris JD, Flanigan DC. Return to sport after articular cartilage repair in athletes' knees: A systematic review. *Arthroscopy* 2016;32:651-668.e1.
17. Wagner KR, Kaiser JT, DeFroda SF, Meeker ZD, Cole BJ. Rehabilitation, restrictions, and return to sport after cartilage procedures. *Arthrosc Sports Med Rehabil* 2022;4:e115-e124.
18. Krych AJ, Robertson CM, Williams RJ III. Cartilage Study Group. Return to athletic activity after osteochondral allograft transplantation in the knee. *Am J Sports Med* 2012;40:1053-1059.
19. McCarthy MA, Meyer MA, Weber AE, et al. Can competitive athletes return to high-level play after osteochondral allograft transplantation of the knee? *Arthroscopy* 2017;33:1712-1717.
20. Nielsen ES, McCauley JC, Pulido PA, Bugbee WD. Return to sport and recreational activity after osteochondral allograft transplantation in the knee. *Am J Sports Med* 2017;45:1608-1614.
21. Balazs GC, Wang D, Burge AJ, Sinatro AL, Wong AC, Williams RJ III. Return to play among elite basketball players after osteochondral allograft transplantation of full-thickness cartilage lesions. *Orthop J Sports Med* 2018;6:2325967118786941.
22. Kerzner B, Gursoy S, Dasari SP, Fortier LM, Yanke AB, Chahla J. Trochlear osteochondral shell allograft technique to treat trochlear dysplasia in the setting of chondral damage and chronic patellar instability. *Arthrosc Tech* 2022;11:E241-E249.

23. Gelber PE, Ramírez-Bermejo E, Ibañez M, Grau-Blanes A, Fariñas O, Monllau JC. Fresh osteochondral resurfacing of the patellofemoral joint. *Arthrosc Tech* 2019;8:e1395-e1401.
24. Gelber PE, Perelli S, Ibañez M, et al. Fresh osteochondral patellar allograft resurfacing. *Arthrosc Tech* 2018;7:e617-e622.
25. Jalali O, Vredenburgh Z, Prodromo J, Benvegnu N, Hatch GFR III. Bipolar fresh osteochondral allograft transplantation and joint reconstruction for patellar and trochlear cartilage defects. *Arthrosc Tech* 2019;8:e1533-e1541.
26. Gracitelli GC, Meric G, Pulido PA, Görtz S, De Young AJ, Bugbee WD. Fresh osteochondral allograft transplantation for isolated patellar cartilage injury. *Am J Sports Med* 2015;43:879-884.
27. Nho SJ, Foo LF, Green DM, et al. Magnetic resonance imaging and clinical evaluation of patellar resurfacing with press-fit osteochondral autograft plugs. *Am J Sports Med* 2008;36:1101-1109.