Autologous Osteochondral Transplantation to Treat Patellar Chondral Injuries

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Introduction

Autologous osteochondral transplantation for the treatment of patellar chondral injuries is a single-stage procedure through a single surgical approach that allows replacement of the chondral injury with an osteochondral plug that has the same cartilaginous hyaline characteristics as the site had before the injury.

A few techniques for the treatment of isolated patellar cartilage injuries have been reported in the literature¹⁻⁴. Although each one has different indications, they all aim to improve the patient's knee function and relieve pain. The most popular surgical technique for this type of injury is based on performing a microfracture at the site of the lesion⁵; however, it does not result in hyaline cartilage regeneration. Autologous chondrocyte transplantation is a costly technique and usually requires a two-stage surgical procedure.

Autologous osteochondral transplantation restores articular surface height and shape in a durable manner through an autologous graft, thereby decreasing fibrocartilage filling of the defect¹. Well-known surgical techniques to treat cartilaginous femoral, trochlear, and condylar defects are available, but their application in patellar chondral injury is still underreported^{2-4,6,7}.

The diagnosis is based on the clinical evaluation and imaging studies. Magnetic resonance imaging provides details on the injury site, including its size, depth, and characteristics. To perform an autologous osteochondral transplantation, a parapatellar approach is made at the same side as the injured patellar facet, which provides access to both the donor and recipient sites. The lesion is then outlined and resected with adequate tools, usually creating a 10-mm-deep tunnel. At this point, the osteochondral plug is harvested from the donor site at the respective femoral condyle, at its most proximal and lesser weight-bearing portion. Having the same depth as its receptor site, the graft plug is carefully inserted in the previous lesion site. As a result, a newly shaped and aligned cartilaginous surface is created.

It is very important to select the ideal patient for this procedure. The inclusion criteria are a patient age of less than sixty years, anterior knee pain, a Grade-III or IV chondral lesion (according to the International Cartilage Repair Society [ICRS] classification⁸), and cartilaginous injury of 1 to 2.5 cm in size. Patients should be excluded if they have an injury of <1 or >2.5 cm, a patellar tilt abnormality, patella alta or baja, a tibial tubercle-trochlear groove measurement of >15 mm, an associated anterior cruciate ligament (ACL) injury in need of surgical reconstruction, a meniscal tear, infection, and/or systemic inflammatory disease.

Step 1: Preoperative Planning

Make radiographs (anteroposterior, lateral, and Merchant patellofemoral views), computed tomography (CT) scans, and magnetic resonance imaging (MRI) of the knee for an anatomic study and to determine cartilage lesion details.

- Obtain a complete patient history.
- Perform a complete clinical evaluation.
- Make radiographs of the knee. Radiographs are important for anatomic characterization of trochlear dysplasia, patellar morphology, bipartite patella, patellar height, and patellar tilt.
- Make a CT scan to analyze the morphology and patellar alignment through the tibial tubercle-trochlear groove measurement, which is the distance between the tibial tubercle and the trochlear groove with a normal value in full knee extension between 10 and 15 mm.
- Perform an MRI scan. On the basis of the MRI findings, classify the cartilage lesion as a full or partial-thickness injury and determine its extent and location.

Step 2: Perform Knee Arthroscopy and Lesion Identification

Classify and locate the cartilage lesion on the basis of the intraoperative arthroscopic knee evaluation (Video 1).

- Position, drape, and prepare the leg in a standard fashion for arthroscopic procedures.
- Use a tourniquet for this procedure.
- Perform an arthroscopic study of the knee through standard infrapatellar lateral and medial portals.
- Classify the cartilage lesion according to the ICRS classification system⁸. In knees with an ICRS Grade-III or IV lesion, choose autologous osteochondral transplantation and proceed with the surgical procedure (Fig. 1).
- Study the location and extent of the cartilage lesion. We suggest a medial parapatellar skin incision for a lesion of the medial facet and a lateral parapatellar skin incision for a lesion of the lateral facet.

Step 3: Use a Parapatellar Approach

Perform a parapatellar incision and patellar eversion as they are necessary to access cartilage lesions.

- Perform a parapatellar longitudinal incision (with a medial approach if lesion is in the medial facet or a lateral approach if lesion is in the lateral facet) from 2 to 2.5 cm (Fig. 2).
- Dissect subcutaneously and expose the joint capsule. Perform an arthrotomy the same length as the skin incision.
- Use a Kirschner wire (2 mm) in the patella as a joystick for better visualization and access to the cartilage defect. Orient the Kirschner wire in a different direction from the cartilage lesion as it may interfere with the preparation of the recipient site. In most cases, we place it in the mid-thickness of the patella, and we alter its placement in the body of the patella depending on the site of the lesion (Fig. 3).
- Measure the cartilage defect with the appropriate sizer to match the defect (Fig. 4).

Step 4: Harvest the Osteochondral Plug at the Donation Site

Harvest an appropriate osteochondral graft, which is essential for a successful procedure. Perpendicular graft harvesting is crucial for a perfect cartilage surface match.

- The donor site should be from the non-weight-bearing zone of the femoral condyle. The peripheral

areas of both condyles at the level of the patellofemoral joint can be used. The cartilage in the proximal part of the trochlea is not recommended because of its concave surface. We suggest the peripheral area of the condyle because of its thicker cartilage and accessibility via the same parapatellar incision (Fig. 5-A). Depending on where the lesion is located in the patella, choose the surface most similar to the lesion.

- Position the knee in full extension. Place the harvesting device perpendicular to the chosen chondral surface. Any misalignment will harm a perfect chondral implantation (Fig. 5-B).
- Strike the plug harvesting device with a mallet until a depth of approximately 10 to 12 mm is reached (Fig. 5-C).
- Rotate the device 90° clockwise twice to release the graft from subchondral bone and remove the plug graft (Fig. 5-D).
- Use the same harvesting device to adjust the osseous portion of the plug graft to match the same depth of the recipient burr hole. When necessary, use a blade for height adjustments.

Step 5: Characterize and Prepare the Lesion

At this point, prepare the receptor area with a power drill.

- Determine the size of the osteochondral cylinder to prepare the recipient site. In our experience, the average length of the graft cylinder is approximately 10 mm.
- Utilize a guidewire in the center of the lesion for symmetrical drilling and to avoid drill slippage (Fig. 6-A).
- Prepare the recipient site with a cannulated drill, perpendicular to the remaining cartilage surface (Fig. 6-B).
- Avoid the use of manual devices because a patellar fracture may occur as a result of the impaction force of an instrument. After irrigating the burr hole, widen it with an adequate device and measure its depth (Fig. 6-C). Hole depth is usually between 8 and 12 mm.

Step 6: Insert the Osteochondral Plug into the Receptor Site

Insert the graft with press-fit fixation.

- Position the universal device with the plug perpendicular to the patellar cartilage surface (Fig. 7-A). Manually rotate the device for progressive advancement of the graft (Fig. 7-B).

- Remove the device when there is only 2 mm remaining for insertion. Use a tamp and carefully impact the plug until it achieves the appropriate depth.
- An arthroscopic evaluation of the autologous osteochondral transplantation can be done after closing the wound (Fig. 8). We do not usually perform this step because of a high rate of subcutaneous infiltration.

Step 7: Postoperative Care

Instruct all patients to follow a rehabilitation protocol.

- Knee range-of-motion exercises performed both on the ground and under water are encouraged during the first postoperative week.
- Gait training in water at chest depth is allowed immediately. We encourage exercise on a stationary bicycle, respecting the patient's limits and tolerance, for three to four weeks, leading to progressive muscular strengthening and sensorimotor training and stretching.
- Allow the patient to partially bear weight on the operatively treated leg after two to three weeks. Running is allowed after four to six months.
- High-functional-demand sports are allowed after six months.

Results

Our clinical experience with this procedure has corresponded to the scores and MRI-based findings in our original study⁹, in which we prospectively evaluated thirty-three knees in patients who underwent autologous osteochondral transplantation for a symptomatic full-thickness cartilaginous injury on the patellar articular surface. The average Lysholm score¹⁰ (and standard deviation) was 57.27 ± 19.97 points preoperatively and 80.76 ± 12.26 points postoperatively ($p < 0.05$). For the Fulkerson questionnaire¹¹, the average score was 54.24 ± 18.89 points preoperatively and 80.42 ± 10.20 points postoperatively ($p < 0.05$). The average preoperative score for the Kujala questionnaire¹² was 54.76 ± 17.61 points, while the average postoperative score was 75.18 ± 12.47 points ($p < 0.05$). A significant difference ($p < 0.05$) was detected between preoperative and postoperative results for all items on the Short Form-36.

Six months postoperatively, 83% of the plugs had complete osseous integration, which increased to 100% at one year, according to conventional MRI supplemented with a T2 relaxation time-mapping technique. No articular surface incongruence was noted. Quantitative analysis of morphologic MRI allied to the evaluation of a four-color-scale imaging map allowed the identification of pattern maintenance between the patellar joint surface

and the osteochondral plug⁹. Morphologic MRI allowed assessment of the chondral thickness maintenance and the reintegration tissue in between both surfaces. Evidence of Grade-III and IV cartilage at and around the plug site indicates successful integration and signs of emergence of a collagen network with the shape and overall organization similar to those seen in normal cartilage.

The only complication was arthrofibrosis, which occurred in three patients (9%). All patients had a successful result (i.e., a normal range of motion) after arthroscopic lysis of adhesions in the knee. There were no intraoperative complications.

What to Watch For

Indications

- Young and active patients
- Patellofemoral pain
- A single lesion
- A Grade-III or IV (ICRS) cartilaginous lesion
- A chondral lesion of 1 to 2.5 cm

Contraindications

- Patellofemoral malalignment
- Grade-I or II (ICRS) cartilaginous lesions
- A chondral lesion of <1 or >2.5 cm
- Patellar osteoarthritis

Pitfalls & Challenges

- Always perform a knee arthroscopy to dynamically evaluate the chondral lesion
- Choose the approach on the basis of the point at which there is greater patellofemoral contact, especially for extensive lesions.
- Use a power drill to prepare the receptor hole at the injury site because the patella has thick cortical bone.
- Always harvest the plug graft so that it is 1 to 2 mm deeper than the recipient site for adequate press-fit and impaction.
- A Kirschner wire in the patella can work as a joystick; place it as shallowly as possible and in a divergent direction to the lesion.
- The donor plug should not exceed a 15-mm depth to avoid a patellar fracture.

Clinical Comments

- What is the best case and point in time to perform surgery?
- We believe that the postoperative results are markedly superior to the preoperative findings.
- Preoperative physical therapy is suggested

before surgery. The aim is to balance and strengthen muscle groups surrounding the patellofemoral joint.

- Postoperative rehabilitation should be supervised by a physical therapist to avoid complications such as arthrofibrosis and new injuries.

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Figures

Fig. 1
Visualization of the cartilage lesion in the lateral facet in the right knee.

Fig. 2
Lateral parapatellar incision in the right knee.

Fig. 3
Patellar eversion with the Kirschner wire in the patella used as a joystick to allow access to (left) and marking (right) of the lesion in the right knee.

Fig. 4
Metric guide measuring the size of the cartilage lesion in the right knee.

Fig. 5

Fig. 5-A Suggested area for plug graft harvesting (donor site). **Fig. 5-B** The harvesting device is placed perpendicular to the cartilage surface. **Fig. 5-C** The harvesting device is impacted to a depth of 10 to 12 mm. **Fig. 5-D** Donor site after graft removal.

Fig. 6

Fig. 6-A A guidewire is placed in the center of the patellar cartilage lesion. **Fig. 6-B** Cannulated drilling is done perpendicular to the cartilage surface. **Fig. 6-C** A graduated alignment rod is used to measure the recipient socket depth and insertion angle of the graft.

Fig. 7

Fig. 7-A The universal device is inserted perpendicular to the cartilage surface in the right knee. **Fig. 7-B** Surgical appearance of the graft after transplantation.

Fig. 8

Arthroscopic visualization of the graft position in the right knee.