

Osteochondral Autograft Transfer Procedure: Arthroscopic Technique and Technical Pearls

Ryan Rowland, M.D., Michael Colello, M.D., and Douglas J. Wyland, M.D.



Abstract: The Osteochondral Autograft Transfer System (OATS; Arthrex, Naples, FL) is an excellent option for the treatment of articular cartilage lesions within the knee. Current literature suggests that at early-term to midterm follow-up, patients experience improved function, alleviation of pain, and good satisfaction with acceptable complication rates. Although long-term data are lacking, studies in athletes have shown that the OATS can provide an adequate rate of return to sports. The OATS procedure has traditionally been considered an open procedure. However, with the advancement of arthroscopic techniques, the procedure can now be completed arthroscopically. We discuss this modern operation.

Articular cartilage is vital to the functionality of the knee and is a key area of study to enhance clinical outcomes. It primarily provides a smooth, low-friction surface for the transmission of forces through the joint.¹ Hyaline cartilage, however, has a very limited capacity for healing because of its avascularity.¹⁻³ Chondral defects are an extremely common musculoskeletal pathology, found in up to 60% of knees undergoing arthroscopy.⁴ Without treatment, these lesions can affect daily activities or sports participation and may lead to degenerative changes and premature osteoarthritis.⁵⁻⁸ The Osteochondral Autograft Transfer System (OATS; Arthrex, Naples, FL) has been shown to be very effective in treating chondral lesions and achieving positive patient outcomes.^{2,3,5,9-13} In addition, studies have suggested that the OATS procedure is superior to a microfracture technique in the treatment of such defects.^{5,7,14,15}

Several studies have reported clinical outcomes using the OATS with an open technique. In a study of 142

patients, Ollat et al.¹² reported that this is a reliable technique that yields significantly improved functional scores, good patient satisfaction, and a complication rate of 13% at minimum 5-year follow-up. In a systematic review, Camp et al.³ similarly determined that the procedure alleviated pain, enhanced activity scores, and showed a high rate of survivorship of the transferred tissue with acceptable failure rates. In a study of 152 patients, Emre et al.⁵ showed excellent results in restoring joint function with no complications at a short-term follow-up of 18 months. Although the goal of the procedure is to delay the progression of degenerative changes, many patients also wish to return to sports. In a study of 13 competitive or well-trained athletes, Muller et al.² found that 92% returned to sports at an intermediate to high level after 6 months, with excellent functional and clinical scores, no reported instability, no joint space narrowing, and an acceptable complication rate at a mean follow-up of 42 months.

Traditionally, the OATS procedure has been performed using an open technique. However, advances in arthroscopy have allowed this procedure to be performed through an arthroscopic approach, and this modern procedure is the focus of our discussion.

Indications

The indications for the procedure include the following: age younger than 50 years, body mass index lower than 35, previously unsuccessful conservative or surgical interventions, focal grade III to IV osteochondral defects of the femoral condyle diagnosed by magnetic resonance imaging (MRI) (Fig 1) or arthroscopy, normal or correctable alignment, normal or correctable ligamentous

From Steadman Hawkins Clinic of the Carolinas, Greenville Health System, Greenville, South Carolina, U.S.A.

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Address correspondence to Douglas J. Wyland, M.D., Steadman Hawkins Clinic of the Carolinas, Greenville Health System, 200 Patwood Dr, Ste C100, Greenville, SC 29615, U.S.A. E-mail: dwyland@ghs.org

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stability, normal or correctable meniscal integrity, willingness to comply with the rehabilitation protocol, and realistic postsurgical expectations.^{3,5-7,9,13,15,16} Although more controversial, the contraindications include obesity, generalized osteoarthritis, osteonecrosis, active infection or bone cancer, and lack of corresponding symptoms.^{7,9,10,13,16}

Surgical Technique

The patient is placed in the supine position on a standard operating bed with a lateral post positioned 1

handbreadth above the superior pole of the patella (Video 1). A tourniquet is then placed on the proximal thigh but left uninflated during the case; it is only used in the rare case of poor visualization related to bleeding. After the induction of general anesthesia, a standard vertical portal incision is made at the intersection of a line transecting the inferior pole of the patella with the lateral facet of the patella (Fig 2). A superolateral outflow portal is then made as part of our standard arthroscopic technique. A 4-mm arthroscope (Synergy; Arthrex) is introduced, standard diagnostic arthroscopy

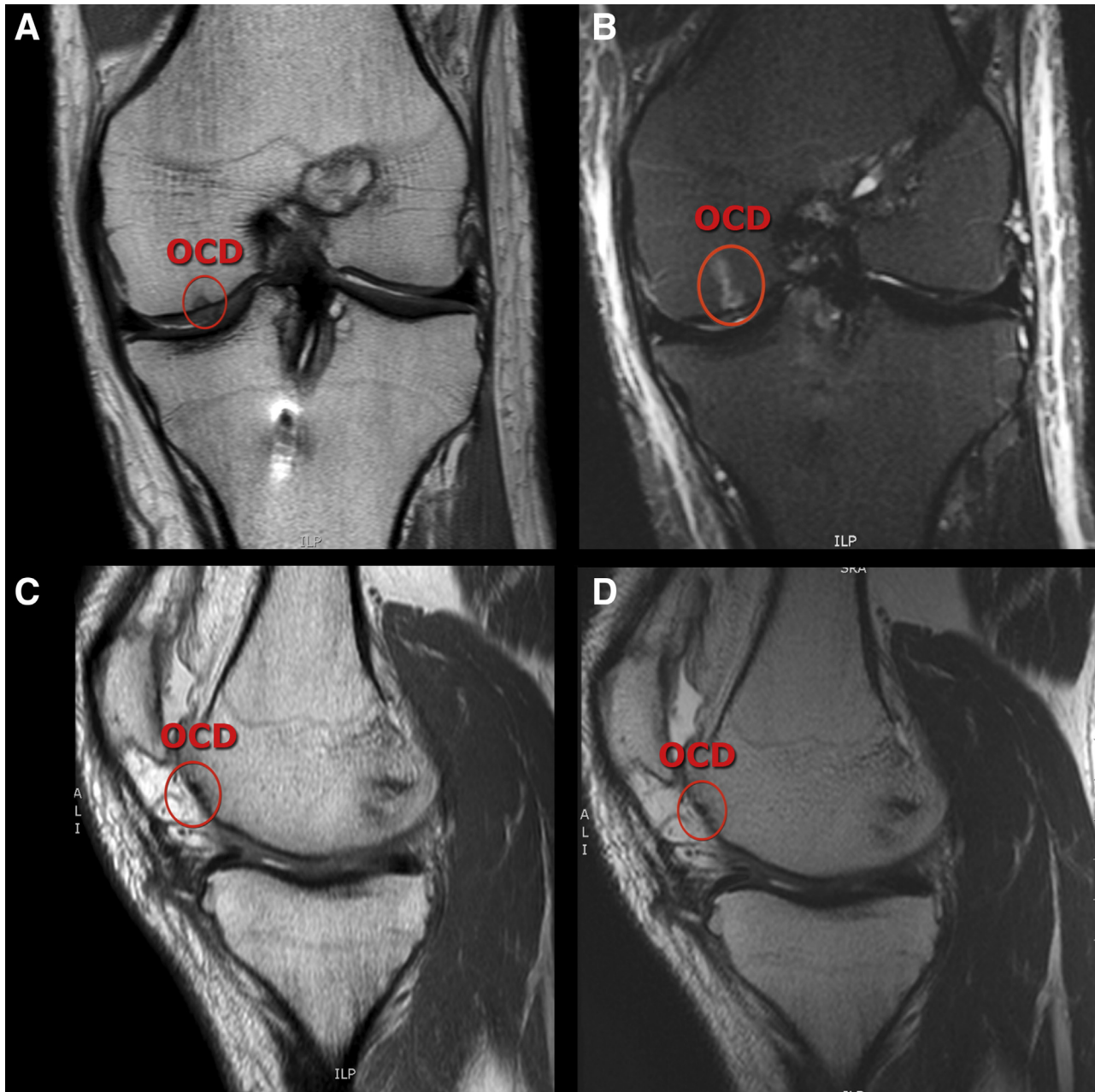


Fig 1. Magnetic resonance imaging of the left knee. (A) T1-weighted image in the coronal plane showing evidence of an osteochondral defect (OCD) along the left medial femoral condyle. T2-weighted image in the coronal plane (B), T1-weighted image in the sagittal plane (C), and T2-weighted image in the sagittal plane (D) showing the same OCD along the left medial femoral condyle.

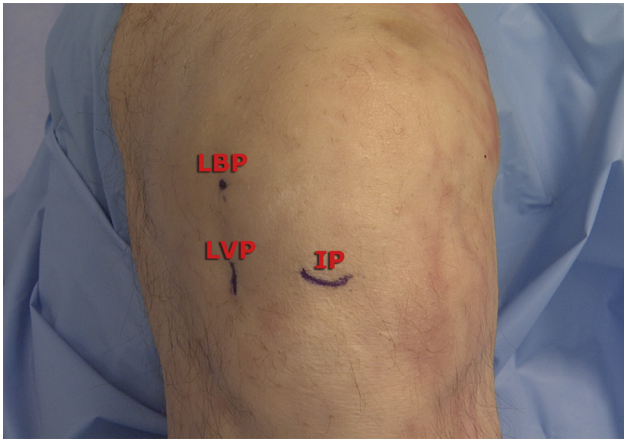


Fig 2. Photograph of the left knee flexed at 90° showing the lateral viewing portal (LVP), which is made at the intersection of the inferior pole (IP) of the patella with the lateral border of the patella (LBP).

is performed, and any concurrent pathology is treated appropriately. A non-aggressive shaver (Torpedo; Arthrex) and a thermal device (CoolCut; Arthrex) are used to resect a portion of the fat pad to aid in visualization of the cartilage lesion and the planned harvest site. In our demonstration, this is performed in the region of the lateral aspect of the medial femoral condyle at the planned repair site and in the region of the sulcus terminalis, where graft harvest will occur (Fig 3).

We prefer to use the Arthrex single-use OATS set for articular cartilage transfer. The cartilage defect is assessed via preoperative MRI, with the size and depth of the defect measured to assist in operative planning. After appropriate visualization of the lesion is obtained, a calibrated probe (3.4-mm hook probe with markings; Arthrex) is

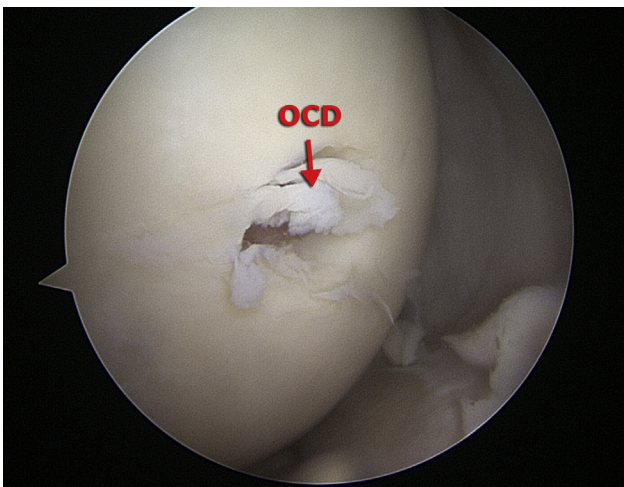


Fig 3. Arthroscopic image through the lateral viewing portal of the left medial femoral condyle showing the osteochondral defect (OCD).

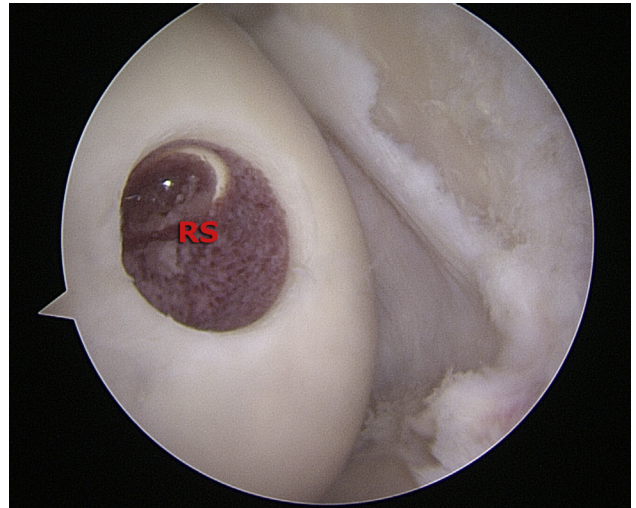


Fig 4. Arthroscopic image through the lateral viewing portal showing where a cannulated reamer is used to core out the site of the osteochondral defect on the left medial femoral condyle to prepare the recipient site (RS).

useful to confirm the defect size, as well as to assess the cartilage defect for stability of the area surrounding the visible lesion. After an assessment of the defect is performed, a longitudinal incision is made for the accessory anteromedial portal along the border of the patellar tendon to remain as perpendicular to the osteochondral lesion as possible. Options for graft harvest are 6, 8, and 10 mm, so multiple osteochondral plugs may be warranted for cartilage restoration in larger defects. A cannulated guide (Arthrex) is placed on the cartilage surface at the site of the cartilage lesion, and the amount of knee flexion is adjusted to ensure that the guide is placed

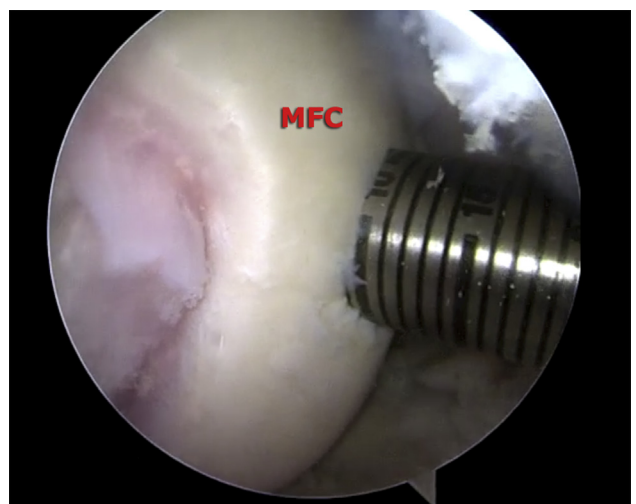


Fig 5. Arthroscopic image through the lateral viewing portal showing a measuring guide placed perpendicularly to the articular surface and the depth of the recipient site being measured at the 3-, 6-, 9-, and 12-o'clock positions of the left medial femoral condyle (MFC).

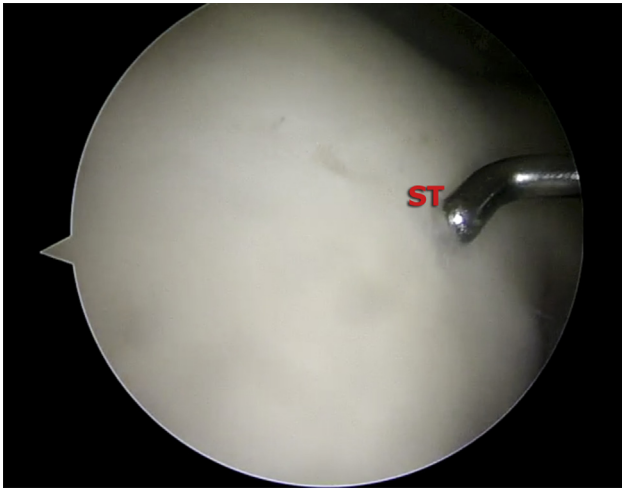


Fig 6. Arthroscopic image through the lateral viewing portal showing an arthroscopic probe identifying the sulcus terminalis (ST) for donor-site harvest from the left knee.

perpendicularly to the planned recipient site. The guide pin for the OATS is then advanced to a depth of approximately 10 to 12 mm, followed by removal of the cannulated guide. An appropriately sized cannulated reamer is placed over the pin and advanced to the depth of the cystic change on MRI, usually 8 to 10 mm (Fig 4). The central pin is then removed, and an arthroscopic shaver is reintroduced to remove any remaining bony debris and free edge cartilage. Next, a cannulated dilator from the OATS kit (Arthrex) is gently inserted into place with a mallet to obtain depth measurements at the 12-, 3-, 6-, and 9-o'clock positions (Fig 5). If we determine through this process that our positioning is slightly non-perpendicular to the cartilage surface (e.g. one side

measures 9 mm whereas another side measures 10 mm), then we will plan to have the donor-site harvest match this same angulation difference.

At this point, our attention is turned to obtaining the graft. Our usual graft harvest location is slightly anterior to the sulcus terminalis at the junction of the lateral trochlea and lateral femoral condyle (in the non-weight-bearing zone), although an area superior and lateral to the intercondylar notch may be used as an alternative harvest location (Fig 6). On identification of the sulcus terminalis, the anterolateral portal incision is extended longitudinally to a length of approximately 2 cm in preparation for graft harvest. An appropriately sized harvester (Donor Harvester; Arthrex) is then placed on the planned harvest site, positioned perpendicularly to the donor surface or matching the slight angulation of the recipient site as necessary (Fig 7). This is performed with the collared pin slightly prominent from the leading edge of the harvester in an effort to protect the chondral surface. On proper placement, the screw-in core extruder knob is removed, allowing the harvester to seat into the cartilage surface. It is then impacted to a depth of approximately 10 mm. On completion of impaction of the harvester, the T-handle is rotated firmly 90° clockwise and then counterclockwise to fracture the donor graft from the deep bone. An axial load is placed during these turns to assist in graft removal. Ultimately, a click will be heard when the graft bone is fractured; if necessary, another axial load may be performed on the graft if no click is heard during planned extraction. Depending on the size of each plug, one can usually harvest up to 3 grafts from the sulcus terminalis if needed.

After the graft is harvested, it is inspected as to the exact length at each of the 4 quadrants and a rongeur is

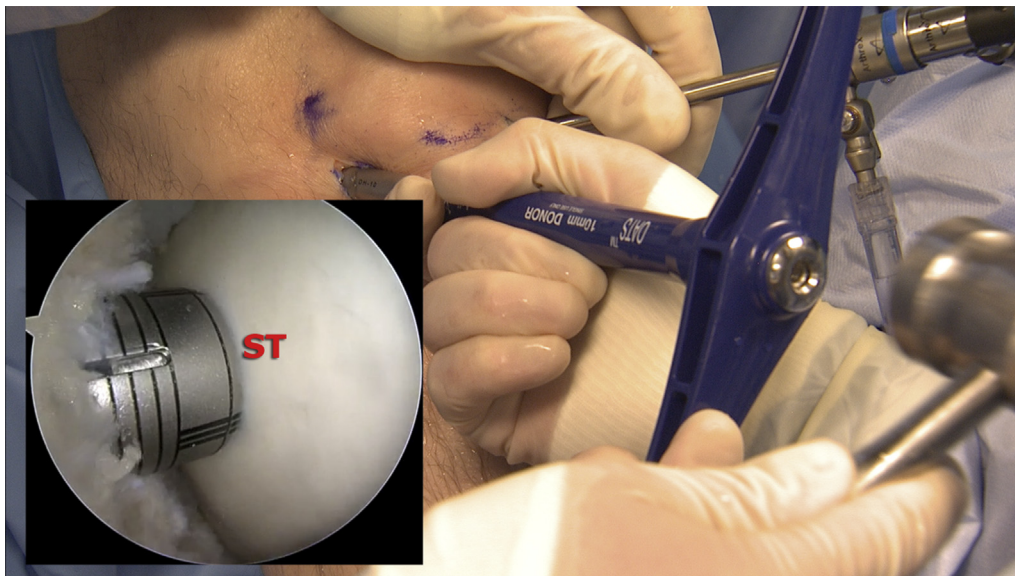


Fig 7. Arthroscopic image through the lateral viewing portal showing the Osteochondral Autograft Transfer System (Arthrex) graft harvester on the left knee at the anterior border of the sulcus terminalis (ST) and photograph showing the graft harvester being impacted using a mallet to a depth of approximately 10 mm. Care is taken to remain perpendicular to the articular surface when obtaining graft from the donor site.

Table 1. Pearls and Pitfalls**Pearls**

If the recipient site is not prepared perpendicularly to the cartilage surface, match the same angulation difference when harvesting the graft from the donor site.

Rongeur the graft to a depth 1 mm shorter than the prepared recipient site to ensure a flush surface.

When seating the graft, ensure proper orientation to match any angulation.

When obtaining donor graft, perform one-quarter turns to help ensure smooth removal of the graft from the donor site.

Pitfalls

Flex the knee appropriately to achieve perpendicularity and avoid angulation of the recipient or donor site.

When selecting the donor site, identify the sulcus terminalis to avoid graft harvest from a weight-bearing zone.

used to shape the bone graft end pertaining to graft length. The bone edges are slightly chamfered to allow for easier placement. The graft is ultimately rongeured to a depth 1 mm shorter than the prepared recipient site to ensure a flush surface, avoiding proud edges (Table 1). In addition, if slight angulation of the graft is observed, then during placement, the graft is oriented to match the angulation of the recipient site (Fig 8).

The cartilage side of the graft is placed inside the plastic delivery tube and reintroduced into the joint, perpendicular to the recipient site, and a bone tamp is used to gently tap the graft into place. This is performed while ensuring that the graft is seated in the appropriate orientation, until there is a flush surface with surrounding host cartilage (Figs 9 and 10). Finally, a backfill plug 1 mm larger than the harvested diameter is cut to the appropriate length and placed into the graft harvest site, tamping to a flush surface; alternatively, it can be left unfilled. Final arthroscopic images are obtained, and portal-site closure is performed. A local

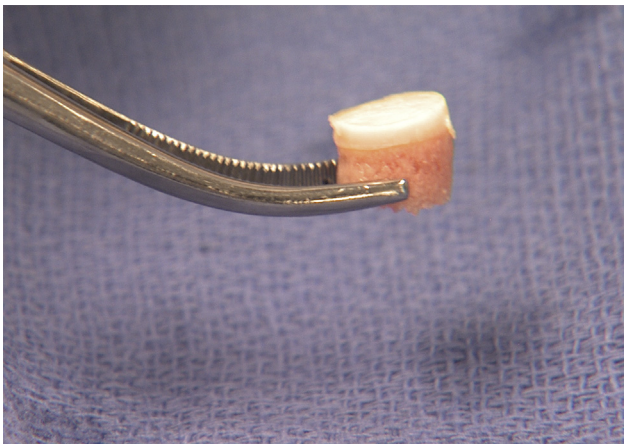


Fig 8. Osteochondral Autograft Transfer System donor plug from left sulcus terminalis. One should note the contoured appearance of the donor plug after it is rongeured to a depth 1 mm shorter than the prepared recipient site to ensure a flush finish.

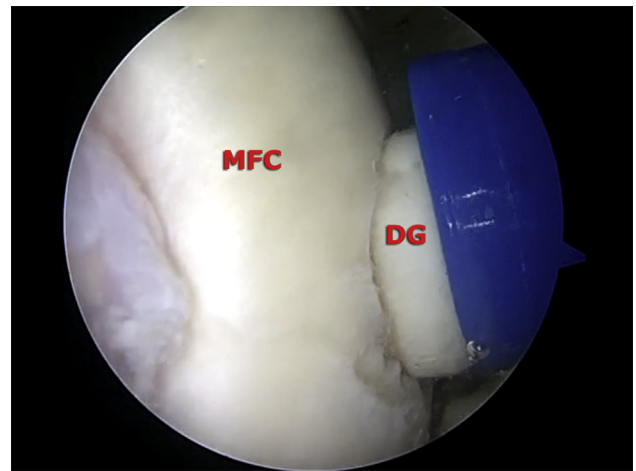


Fig 9. Arthroscopic image through the lateral viewing portal showing the arthroscopic impactor being used to advance the donor graft (DG) into the recipient site on the left medial femoral condyle (MFC). One should note that overlap occurs between the impactor and the recipient site to prevent countersinking of the donor graft.

anesthetic is injected around the incision sites, and the area is covered with a soft dressing, followed by ice application to the knee postoperatively, as is our standard regimen.

Rehabilitation

On completion of the procedure, immediate goals of healing include protection of the tissue from load and shear forces to allow for graft incorporation. Phase 1 (weeks 0-6 postoperatively) is aimed at reduction of pain and knee effusion with restoration of full passive



Fig 10. Arthroscopic image through the lateral viewing portal showing the final result after impaction of the donor graft (DG) into the ipsilateral recipient site on the left medial femoral condyle. The well-contoured, flush appearance of the articular surface should be noted.

Table 2. Advantages and Disadvantages

Advantages
Less invasive than open procedure
Less blood loss and shorter operative time than open procedure
Ability to treat larger osteochondral defects through harvest of multiple autografts
Disadvantages
Possible decreased visualization of donor and recipient sites owing to improper portal-site placement
Possible donor-site morbidity owing to improper graft harvest location

extension, regaining quadriceps control, and gradual improvement of knee flexion. The affected extremity remains non-weight bearing and patients sleep in a locked brace for 2 to 4 weeks. Partial weight bearing begins after 2 to 4 weeks with the brace locked in full extension. Continuous passive motion is used during this phase to assist with return of full range of motion.

Phase 2 (weeks 6-12) is geared toward functional activity improvement. Bracing is discontinued at post-operative week 6, and the patient is allowed 25% to 50% weight bearing using crutches. Full weight bearing with discontinuation of crutches is typically expected at weeks 10 to 12, with progression of standing and walking as tolerated.

Phase 3 (weeks 12-26) is the maturation phase and involves progression of muscular strength and endurance. Full range of motion should be regained prior to this phase, and exercises include squats, step ups, lunges, bicycling, and swimming, with a maintenance program typically initiated at weeks 16 to 20.

Phase 4 (weeks 26-52) is the final recovery phase, when patients typically return to full functional and sporting activities. Skating, rollerblading, and cycling are permitted between 6 and 8 months postoperatively. Jogging, running, and aerobics may be performed at 8 to 10 months, and high-impact sports such as tennis, basketball, and baseball are allowed at 12 to 18 months.

Discussion

In our experience, the described procedure offers a dependable technique for treating osteochondral defects of the knee. The steps can be applied to a lesion anywhere on the femoral condyle through careful preparation of the recipient site. This method uses an arthroscopic approach. In addition to being a quicker, less invasive procedure, arthroscopy has been shown in cadaveric models to be identical to, if not better than, the open approach in the precision and accuracy of graft harvesting, site preparation and perpendicularity, plug placement, and overall visualization^{17,18} (Table 2). Although more clinical research into this unique approach is needed, our experience with the arthroscopic OATS technique is promising for achieving excellent patient outcomes. This method also uses an autologous graft harvested from a non-weight-bearing

Table 3. Limitations

Treatment of larger osteochondral defects
Treatment of generalized osteoarthritis and osteonecrosis
Patients with abnormal alignment, ligamentous instability, or lack of meniscal integrity

compartment of the joint. Several studies have argued that using an allograft eliminates the possibility of donor-site morbidity while generating rates of graft survival and return to sports similar to those with autografts^{3,19-21} (Table 2). However, the limited time frame of allograft viability, large expense of the allograft, and possibility of immunologic reactions suggest that autografting is a more reliable method.³

A limitation of our technique relates to the size of the defect being treated (Table 3). Most studies using the OATS method have treated defects measuring 3 cm² or less in diameter and recommended that lesions of 4 to 6 cm² be the upper limit of eligibility.^{2,5,7,12,13} This is said to be because of the limited size of available donor sites. In fact, increasing lesion size, along with increasing patient age and concomitant intra-articular injuries, has been proposed as a negative prognostic indicator.⁵ However, a study by Baltzer et al.⁹ concluded that the overall defect surface area was not associated with poor outcomes and that these lesions can be treated with additional transplanted grafts. We argue that, through the use of multiple donor grafts, larger defects can be included for treatment. The risks of the procedure include postoperative hemarthrosis, deep venous thrombosis, donor-site morbidity, graft instability, graft fracture, arthrofibrosis, infection, and chronic pain.

The prevalence of chondral cartilage defects is becoming increasingly concerning because of their potential to alter daily activities, limit sports participation, and progress to degeneration. The described arthroscopic procedure offers a reliable and reproducible method of filling articular cartilage lesions within the knee.

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