Chapter 58
Osteochondral Allograft Transplant for Osteochondritis Dissecans Lesions of the Knee

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Background

- Osteochondritis dissecans (OCD) is a disorder primarily affecting subchondral bone, leading to osseous collapse and destabilization of overlying articular cartilage (Fig. 58-1).[1,2]
- OCD may be present in many joints but most commonly affects the medial femoral condyle of the knee (70% of cases).[3,4]
- While OCD may affect both pediatric and adult populations, the incidence of disease is higher in children and adolescents (9.5 per 100,000 persons age 6 to 19 per year).[5]
- Osteochondral allograft (OCA) transplantation has been shown to be an effective knee joint preservation procedure for OCD of the knee,[6] with high patient satisfaction and low rates of graft failure.[7]

Clinical Indications

- Isolated, unipolar symptomatic chondral or osteochondral lesions of the femoral condyle, trochlea, or patella
- Bipolar lesions of the patellofemoral compartment also can be treated with OCA, though outcomes are less predictable.
- Young (~~usually~~ chronologically <50 years of age), high physical demand patients
- Lesion area is typically >10 mm^2.
- Body mass index (BMI) < 35, neutral alignment, and meniscal status are modifiable risk factors that should be considered when deciding if OCA is appropriate.
  - OCA can be successfully performed concomitantly with osteotomy, meniscal procedure, or ligament repair/reconstruction.[6]
- Many patients with symptomatic lesions can be successfully treated with nonoperative measures including injections, physical therapy, and activity modification.
  - OCA is one option for patients who remain or become symptomatic and in whom conservative measures have failed and those with prior surgical intervention such as arthroscopic debridement, OCD fixation, or fragment excision; it also can be used as primary treatment for focal, symptomatic osteochondral defects in the knee.[8,9]

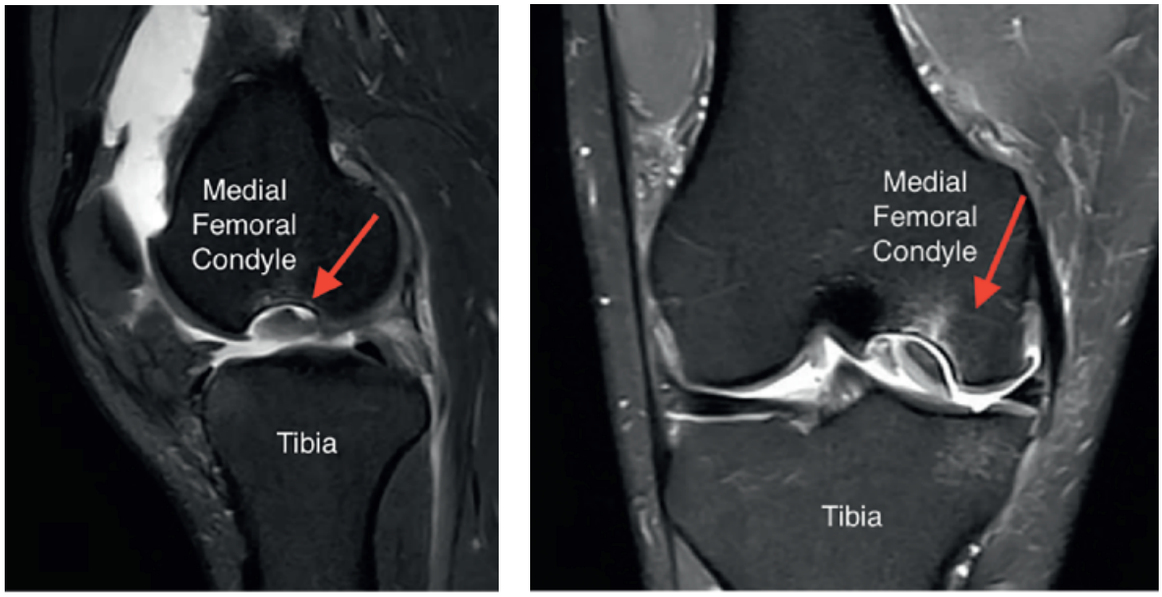

Figure 58-1 | Magnetic resonance image demonstrating an OCD lesion of the medial femoral condyle in a 31-year-old male. **A.** A sagittal plane, fat-suppressed T2-weighted image; **(B)** coronal plane, fat-suppressed T2-weighted MRI image.

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Sterile Instruments/Equipment

- Well-padded tourniquet
- A press-fit technique is commonly used for most contained defects of the femoral condyles by the senior author using commercially available systems (Allograft OATS, Arthrex, Naples, FL) (Fig. 58-2).

Figure 58-2 | Allograft OATS Harvest Set. (Arthrex Inc., Naples, FL.)

- Instrument and hardware considerations (many of the following may not be required and decision-making is based on surgeon experience and defect-specific variables)
  - Cannulated cylindrical sizing guides (15, 18, 20, 25, 30, and 35 mm)
  - Cannulated cutting bore
  - Allograft workstation
  - Donor harvester
- Arthroscopy tower and arthroscope
  - Arthroscopic shaver may be necessary.
- Z retractors (2), large rakes (2), and/or Hohmann retractors (2)
- No. 15 blade scalpel
- Small ruler
- Sterile marking pen
- Hemostat
- Room temperature saline
- Guidewire

- Pulsatile lavage of combination saline and CO_2 (CarboJet, Kinamed, Camarillo, CA)
- Oscillating saw
- Rongeur
- Hand tamp and mallet
- Metallic headless screws (Acutrak 2 mini screws, Acumed, Hillsboro, OR), Bio-Compression screws (Arthrex, Naples, FL), Orthosorb pins (Depuy, Inc., Warsaw, IN)

Positioning

- The patient can be positioned in the supine position, or the limb can be placed in a standard anterior cruciate ligament (ACL) leg holder (Fig. 58-3).

Figure 58-3 | Right knee is flexed to ~80 degrees in an arthroscopic knee holder.

  - For simple OCA transplantation, the patient is supine with the leg placed straight on the bed.
  - For complex OCA transplantation with concomitant procedures, we may use the ACL leg positioner such that the knee is draped free at 90 degrees of flexion allowing circumferential access.
- A well-padded thigh tourniquet is used for the duration of the case and deflated at the end of the case before closure to ensure hemostasis.
- The operative extremity is prepared and draped for a standard anterior approach to the knee.

Portals/Exposure

- This procedure typically is performed through a small parapatellar arthrotomy using a central incision.
  - In general, the arthrotomy is made on the ipsilateral side to the pathology, though this may vary based on the optimal angle to allow a perpendicular approach to the osteochondral lesion.
  - On the medial side, a vastus-sparing approach is preferred.
  - On the lateral side, we prefer to release the lateral retinaculum for exposure, which can largely be left open at the conclusion of the case.
  - The arthrotomy can be extended proximally or distally to improve exposure depending on lesion size and location.
  - The arthrotomy can be extended distally to accommodate a high tibial osteotomy (HTO) when indicated for a medial femoral condyle OCA.
- Z retractors or Hohmann retractors are used to (a) retract soft tissue and (b) retract the patella by placing a retractor in the notch (Fig. 58-4).
- The knee can then be flexed to optimally expose the lesion.
- A lateral approach is preferred for patellofemoral lesions with eversion of the patella to ~90 degrees or more when needed. Note that when concomitant tibial tubercle osteotomy is performed, we do this first to improve visualization but do not elevate the entire shingle of bone or disrupt the fat pad in an effort to minimize morbidity.
- For the remainder of the procedure, the flexion angle is kept the same by the leg positioner.

Figure 58-4 | Soft tissue retraction with two Z retractors to allow visualization of a medial femoral condylar defect.

Procedure

Step 1: Exposure

- Before induction of anesthesia, an appropriate-sized OCA is confirmed to be physically on site.
- Before the arthrotomy is made, we prefer to conduct a diagnostic arthroscopy to assess for concomitant pathology and to confirm that the chondral defect is suitable for allograft implantation.
  - If a prior staging arthroscopy was performed recently, the diagnostic arthroscopy can be eliminated at the time of OCA.
  - If concomitant pathologies are present, such as ligamentous injury requiring reconstruction, meniscal deficiency requiring meniscus debridement, repair or transplantation, and/or malalignment necessitating osteotomy, these procedures are performed before OCA transplantation.
- Following arthroscopy, a mini-arthrotomy as described previously is made in the standard fashion, exposing the defect along the medial or lateral femoral condyle (Fig. 58-5).

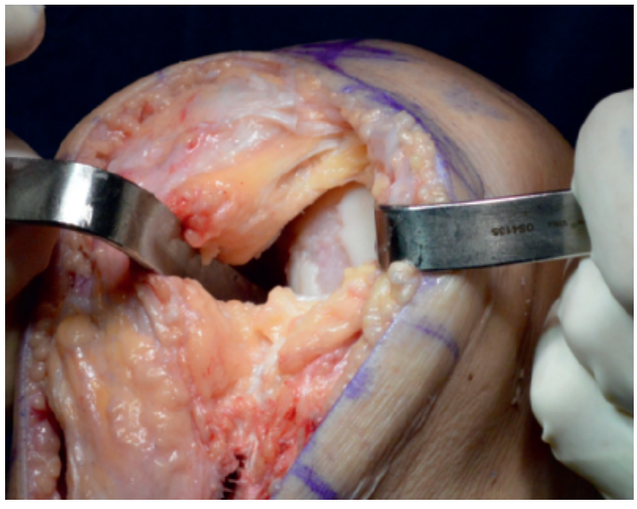

Figure 58-5 | Knee flexion to ~70 to 110 degrees, exposing the osteochondral lesion.

- The allograft is opened (Fig. 58-6) and soaked in room temperature sterile saline on the back table. Sudden changes in temperature may be chondrotoxic and should be avoided.

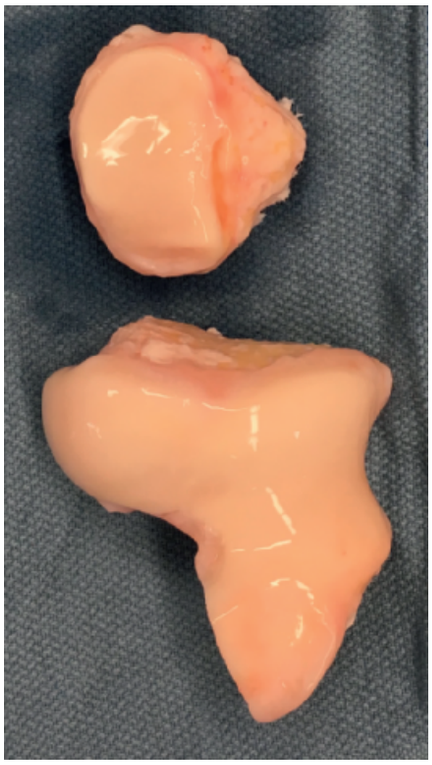

Figure 58-6 | A donor osteochondral allograft hemicondyle and patella.

Step 2: Preparation of the Cartilage Lesion

- The lesion is inspected to define the margins, with any adjacent damaged cartilage debrided to allow accurate sizing of the lesion.
  - The shape of the lesion will determine if a single cylindrical plug or multiple plugs are necessary for larger, oblique lesions. Alternatively, newer instrumentation (Bio-Uni, Arthrex, Naples, FL) can be used for long oblique lesions of the medial femoral condyle.
  - We prefer a press-fit technique rather than a customized hand-cut shell graft.
- Any number of allograft preparation and implantation trays can be used. The following steps describe preparation of the OCD bed and allograft with one of these available systems.
  - The allograft OATS set (Arthrex, Naples, FL) allows allograft implants of the 15, 18, 20, 25, 30, and 35 mm.
- Different cannulated, cylindrical sizing guides are placed over the lesion to estimate the appropriate size of the allograft.
  - It is essential to place the sizing guide perpendicular to and flush with the surrounding articular cartilage to ensure congruity.
  - It is better to slightly oversize the lesion than leave marginal quality tissue on its perimeter.
- Once the appropriate size is determined, a cannulated sizer is placed in the center of the lesion so that the sizer completely covers the lesion.
- The same cylindrical sizer is placed perpendicular on the donor condyle to ensure that a plug with similar topographical anatomy can be harvested.
  - A marking pen is used to mark its location along with the 12 o'clock position.
- Once the donor knee is found to be of acceptable size, the cannulated sizer is placed back over the recipient lesion, and a 2.4-mm guide pin is inserted perpendicular through it to a depth of at least 3 cm (Fig. 58-7).
- The sizer is removed leaving the guide pin, and a cannulated cutting bore of the same size is placed on the guide pin. The cutting bore is used to score the peripheral cartilage and a portion of the subchondral bone.

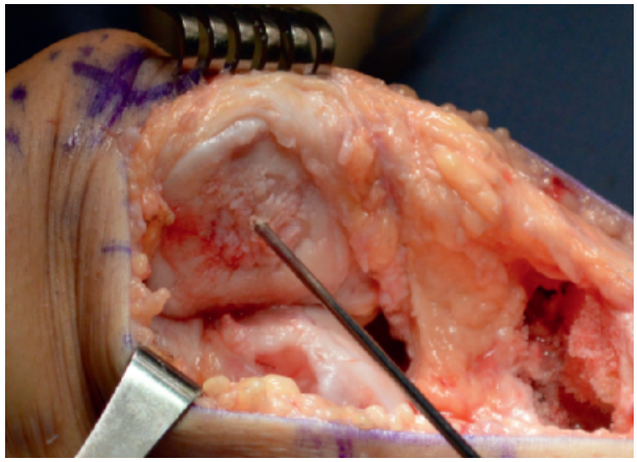

Figure 58-7 | A 2.4-mm guide pin placed into the center of the patellar osteochondral defect.

- A cannulated reamer of the same size is placed on the guide pin and used to create a cylindrical defect in the recipient bone of a depth of 6 to 8 mm (Figs. 58-8 to 58-10).

Figure 58-8 | A cylindrical sizing guide placed over the 2.4-mm guide pin to appropriate size of a lateral femoral condyle defect.

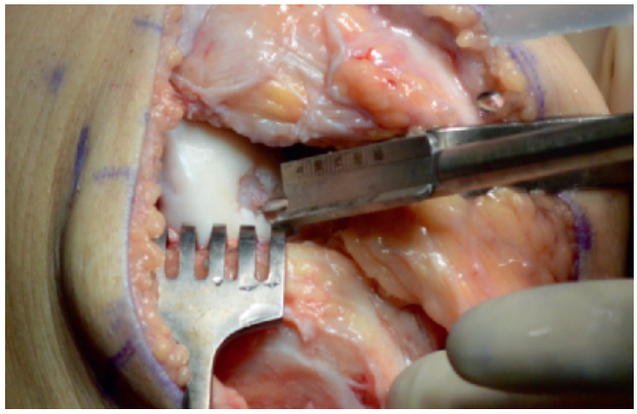

Figure 58-9 | A cannulated reamer used to ream a lateral femoral condylar lesion.

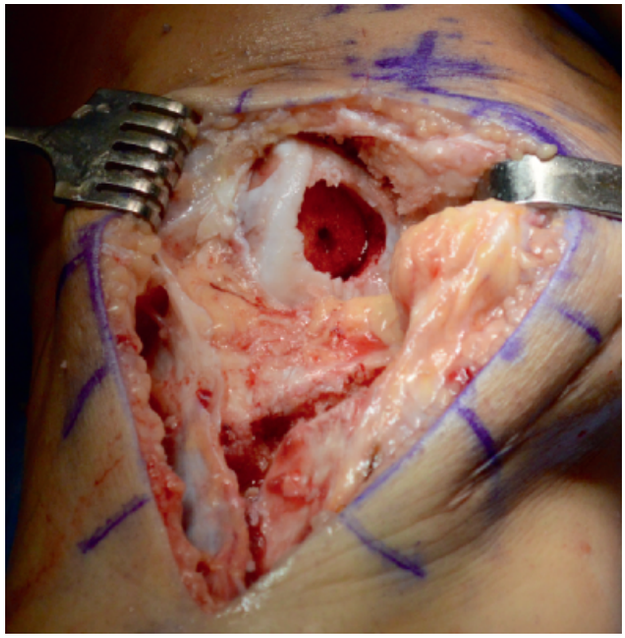

Figure 58-10 | A lateral trochlear defect reamed to a depth of ~6 to 8 mm.

- Cold saline irrigation is used during reaming to decrease the risk of thermal necrosis to the surrounding cartilage.
- The reamer and guidewires are both removed.
- Precise depth measurements are taken of the four quadrants on the recipient lesion (12, 3, 6, and 9 o'clock) using a small paper ruler held with a hemostat (Fig. 58-11).

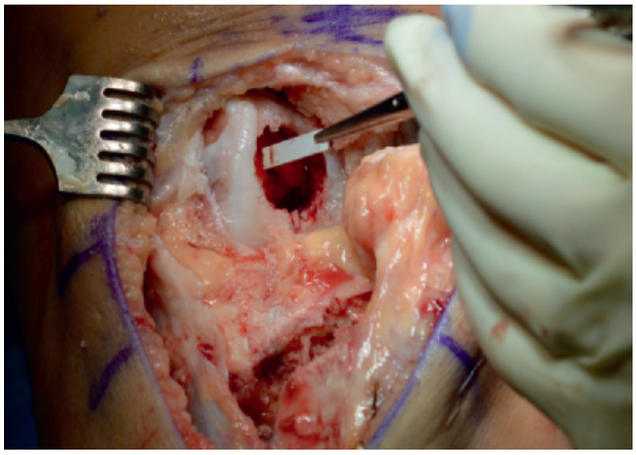

Figure 58-11 | A small ruler attached to a hemostat used to measure depth at 3, 6, 9, and 12 o'clock.

- A fresh no. 15 blade is used to remove any loose or frayed cartilage on the perimeter of the lesion.
- A small Kirschner wire (K-wire) can be used to drill multiple nonconfluent holes in the bed of the socket to induce further bleeding for osseous healing.
- Autologous bone graft can be used from the remaining to graft any cystic change exposed during the reaming.

Step 2 Pearls

- In some OCD lesions, the graft may not be completely contained within the defect and may need additional fixation such as a biocompression screw.
- Maintaining a perfectly perpendicular approach provides the optimal restored surface. If the cannulated guide is not able to reach this position, the flexion angle and varus/valgus position of the knee can be adjusted to improve access.
- Accurate measurements will also lead to a graft that fits well within the created defect. Care should be taken to ensure that the ruler does not bend against the bone, which will alter the measurement.

Step 3: Allograft Preparation

- If a full hemicondyle is received, it may need to be trimmed with a saw to fit on the back table workstation (Fig. 58-12).
- The donor condyle is secured in the workstation using the four screws.
  - Alternatively, if an extra assistant is available, the donor condyle can be held on the table by the assistant while the graft is fashioned.
- The bushing of appropriate size is placed over the graft at the exact position that matches the previously marked 12 o'clock position.

Figure 58-12 | An oscillating saw being used to trim down the donor distal femur.

- The bushing is adjusted three dimensionally so that a sizer placed through the bushing fits directly over the marked spot on the graft. The bushing is secured (Fig. 58-13).

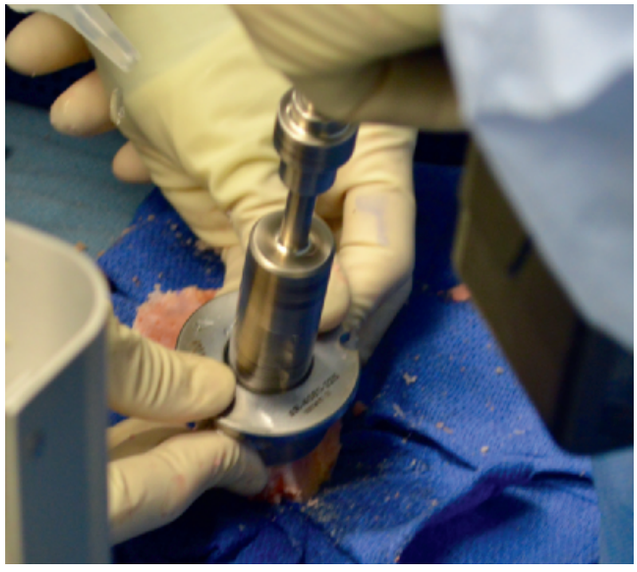

Figure 58-13 | A graft harvester of the appropriate size placed over the bushing and cored through the extent of the donor tissue.

- A donor harvester is used to drill through the entire donor condyle. The graft is then gently extracted (Fig. 58-14).
  - An assistant secures the plug with forceps, taking care to avoid damaging the articular surface.

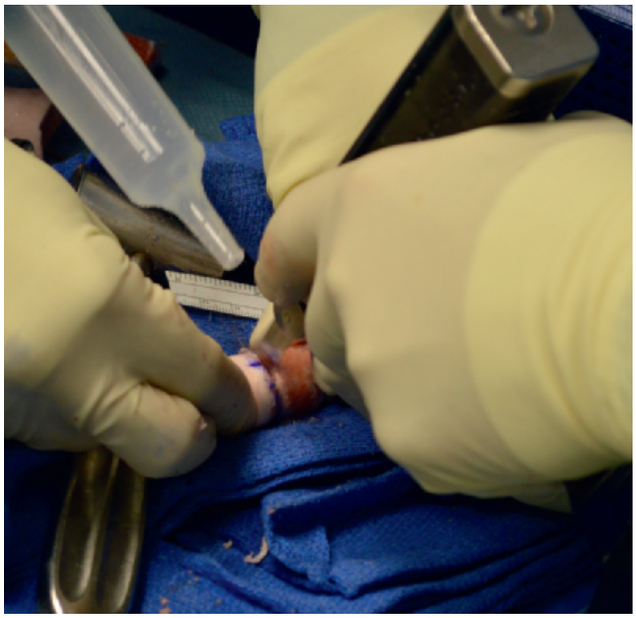

Figure 58-14 The donor plug being trimmed to ~6 to 8 mm depending on the deepest measurement in the recipient defect.

- The depth measurements previously made in the recipient socket are marked at the four corners of the donor plug taking careful note of 12 o'clock (Fig. 58-15).

Figure 58-15 The donor plug being marked at the 12 o'clock position to line up at the 12 o'clock position on the recipient defect.

- The allograft is secured to the holding clamp at the marked positions and trimmed with an oscillating saw.
  - If the four quadrants are of different depths, the saw is used to gently trim subchondral bone to the appropriate depth.

Step 3 Pearls

- Ensuring that the bushing and all instrumentation are perfectly perpendicular is the key point to producing a graft that matches the recipient condyle.
- When marking the depth for trimming the graft, the depths at each quadrant is marked first. Next, a line connecting this can be drawn to plan for the appropriate angle of the cut to reach the appropriate depth at each part of the graft.
- For patellar grafts, the contour of the defect can be especially challenging to match if it involves the vertical ridge. Replicating the appropriate contour will depend on the anatomy of the donor graft and lesion location. The donor patella should be carefully inspected with this in mind to find the optimal location for a graft (or multiple grafts) that will match the topography of the recipient patella.
- Inappropriate trimming of the depth of the donor plug at 3, 6, 9, and 12 o'clock leads to incongruity, with the graft being recessed or sitting too proud relative to the surrounding host.
- Excessive force or a high number of impactions may diminish chondrocyte viability.[10,11]

Step 4: Graft Implantation

- A combination of saline and CO_2 pulsatile lavage is used to remove remaining marrow elements from the donor allograft plug and is applied to the recipient site to remove residual bony debris (Fig. 58-16).[12]
- The graft is gently press fit into the socket, lining up the two 12 o'clock positions on the donor and recipient sides (Fig. 58-17).
- If the graft cannot be fit flush to the surrounding cartilage by hand, a tamp can be used to gently tap the graft in place.

Figure 58-16 | Pulsatile saline lavage of an osteochondral allograft plug.

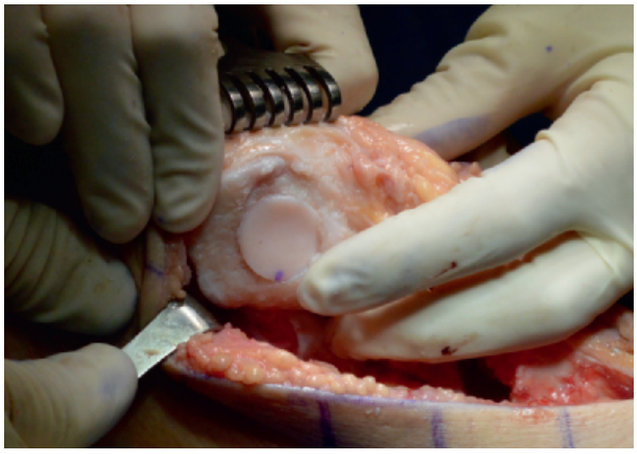

Figure 58-17 | A patellar osteochondral allograft plug being gently press fitted into the donor socket.

Step 4 Pearls

- If the graft is too tight, a same-sized dilator can be used to dilate the socket.
- If the graft is too loose, bone grafting can be done on the periphery of the plug. Adjunct fixation also may be necessary through the center of the graft.
- Positioning the graft in the deepest location first and then levering the remainder into the recipient site often is a successful way to place the graft.

Step 5: Graft Fixation

- If a tight press fit cannot be achieved, additional fixation may be necessary. Options for graft fixation:
  - Metallic headless screws (Acutrak 2 mini screws, Acumed, Hillsboro, OR)
    - Useful for large and uncontained plugs

- Bioabsorbable screws (Bio-Compression screws, Arthrex, Naples, FL)
  - Preferred by the authors for large and uncontained plugs
- Orthosorb pins (Depuy, Inc., Warsaw, IN)
  - Made of PDS (absorbable)
  - Available in 1.3- and 2.0-mm diameters
  - Useful for small plugs (under 20 mm in diameter)
  - Technique
    - The appropriate K-wire from the kit is placed through the center of the plug into the bone.
    - The K-wire is removed and the Orthosorb pin is advanced over a cannulated inserter into the bone.
    - The pin is trimmed to be flush with the bone.
    - If more than one pin is used, they should be placed in a divergent fashion.

Step 5 Pearls

- If the graft does not fit flush against the recipient condyle, the graft size and recipient site should both be checked and rereamed/recut as necessary.
- If the graft needs to be removed, a Freer elevator can be used to work the graft out of its position or a reverse threaded extractor can be used by screwing it into the graft and gently tamping the graft out of position by grasping the extractor post.

Step 6: Closure

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- The thigh tourniquet is deflated, and hemostasis is obtained.
- The knee is irrigated with saline, and the arthrotomy is closed in layers.
- Our preference is to place small absorbable sutures (2-0 Vicryl [Ethicon, LLC, San Lorenzo, Puerto Rico]) in the fat pad to limit bleeding from the fat pad.
- The medial retinaculum is closed with interrupted, strong absorbable sutures (no. 1 Vicryl [Ethicon, LLC]).
- If a lateral release was performed, it can be left open.
- A hinged knee brace locked in full extension is applied and is taken off only for physical therapy and continuous passive motion (CPM).

Postoperative Rehabilitation

- Phase I (0 to 6 weeks)
  - Heel-touch weight bearing
  - The hinged knee brace locked in full extension is used for the first 2 weeks, with removal allowed for CPM machine use. The brace is discontinued at 2 weeks.
  - CPM is used ~6 hours per day beginning at 0 to 40 degrees and advancing 5 to 10 degrees daily as tolerated from weeks 0 to 6.
  - Exercises for weeks 0 to 2 include quadriceps sets, calf pumps, passive leg hangs to 90 degrees, and seated leg raises.
  - Passive and assisted active range-of-motion is advanced at 2 weeks. Side-lying hip and core, hamstring, and gluteus medius exercises are initiated.
- Phase II (6 to 8 weeks)
  - Weight bearing is advanced 25% weekly until full.
  - Full range of motion should be achieved.
  - Phase I exercises are advanced.
- Phase III (8 to 12 weeks)
  - Full weight bearing is achieved.
  - Gait training, closed chain activities, wall sits, shuttle movements, mini-squats, and toe raise exercises are initiated.
  - Unilateral stance activities and balance training are advanced.
- Phase IV (12 weeks to 6 months)
  - Phase III exercises are intensified including core, gluteal, pelvic stability, and eccentric hamstring movements.

- Patients may advance to use of elliptical, stationary bicycle, and pool as tolerated.

- Phase V (6 to 12 months)
  - Functional activity is advanced.
  - Return to sport-specific activity and impact can begin at ~8 months.
- Rehabilitation pearls
  - Rehabilitation protocols may be altered depending on treatment of concomitant pathology such as osteotomy, meniscal allograft transplantation, or ligament reconstruction.

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Queries

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