



## Controversies

- Patients with inflammatory arthritis
- Morbid obesity
- Medical problems that may interfere with the incorporation of the allograft into the host tissue

## PITFALLS

- *Freezing of allograft tissue leads to chondrocyte death.*
- *Contemporary tissue banking procedures generally do not allow graft implantation beyond 28 days of cold preservation.*

## Indications

- Localized, unipolar symptomatic chondral lesions of the femoral condyle, tibia, trochlea, or patella.
- The patient is typically less than 50 years old and places relatively high physical demand on the knee.
- Common lesions include osteochondritis dissecans (OCD), avascular necrosis (AVN), and posttraumatic osteochondral defects.
- Lesion diameter typically ranges from 15 to 35 mm.

## Examination/Imaging

- Radiographs/magnetic resonance imaging studies
  - These are used to diagnose and size the lesion (Fig. 1).
  - Precise radiographic matching between the donor and recipient is essential to ensure success of the implantation. Radiographs are corrected for magnification and matched for the medial or lateral condyle. In addition, tibial width measured 1 cm below the articular surface is used to correlate the donor tissue with the host dimensions.
  - Long cassette view standing radiographs are taken if malalignment is suspected.
- Previous operative records and arthroscopic images should be reviewed.
- Other concomitant issues such as ligament instability and meniscal deficiencies are evaluated and addressed at or prior to allograft implantation.

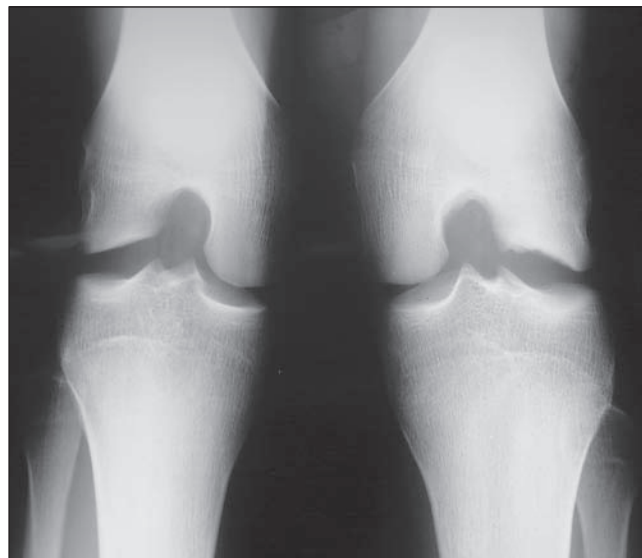


FIGURE 1

## Treatment Options

### NONOPERATIVE TREATMENT OPTIONS

- Nonsteroidal anti-inflammatory drugs
- Cortisone injections
- Viscosupplementation
- Unloader braces
- Assistive devices (canes, walkers)

### OPERATIVE TREATMENT OPTIONS

- Consider osteotomy in all patients with malalignment.
- Lesions less than 2–3 cm<sup>2</sup>
  - For low-physical-demand patients and low-level symptoms: débridement, microfracture
  - For high-physical-demand patients and high-level symptoms: débridement, microfracture, osteochondral autograft
  - If the above fail: osteochondral allograft, autologous chondrocyte implantation
- Lesions greater than 2–3 cm<sup>2</sup>
  - For low-physical-demand patients and low-level symptoms: débridement, microfracture, osteochondral allograft, autologous chondrocyte implantation
  - For high-physical-demand patients and high-level symptoms: osteochondral allograft, autologous chondrocyte implantation
  - If the above fail: osteochondral allograft, autologous chondrocyte implantation, arthroplasty

- Osteochondral allografts are harvested by a local organ procurement organization within 24 hours of asystole and then aseptically processed by regional tissue banks. The tissue is then refrigerated at 4° C for up to 28 days. No tissue matching is required between the donor and recipient.

## Positioning

- The patient can be positioned in the supine position or the limb may be placed in a standard leg holder. Our preference is to place the patient supine with the foot in a standard leg positioner, which provides a stable, assistant-free knee flexion angle.
- A tourniquet is applied and used throughout the case and deflated at the end of the case prior to closure to achieve hemostasis.

## Portals/Exposure

- This procedure is generally done through a small ipsilateral arthrotomy. On the medial side, a vastus-sparing approach is used. On the lateral side, a lateral retinacular release is used.
- The arthrotomy can be extended proximally or distally to improve exposure.
- A Z-retractor or Hohmann retractor is placed in the notch to retract the patella and extensor mechanism, and another Z-retractor or large rake is used on the other side of the lesion to retract the soft tissue. The knee is flexed to a point that exposes the lesion fully (Fig. 2).
- For the remainder of the procedure, the flexion angle is kept the same using the leg positioner.

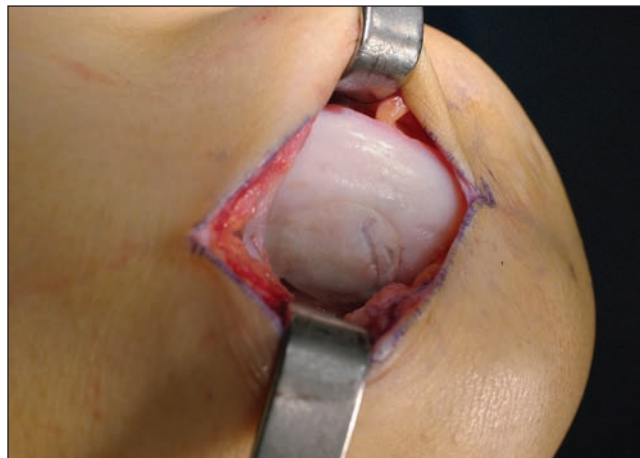


FIGURE 2

## Procedure

### STEP 1: EXPOSURE

- Prior to administering anesthesia, physical confirmation of the appropriate graft is performed.
- Arthroscopy is only necessary if insufficient information regarding the defect is available or comorbidities are suspected. In this instance, a brief diagnostic arthroscopy confirms that the lesion is amenable to the allograft implantation.
- The tourniquet is inflated and the small arthrotomy is performed in the standard fashion. The lesion is exposed (Fig. 3).
- The allograft is opened (Fig. 4) and soaked in cold saline. Sudden changes in temperature may be harmful to the chondrocytes and should be avoided.

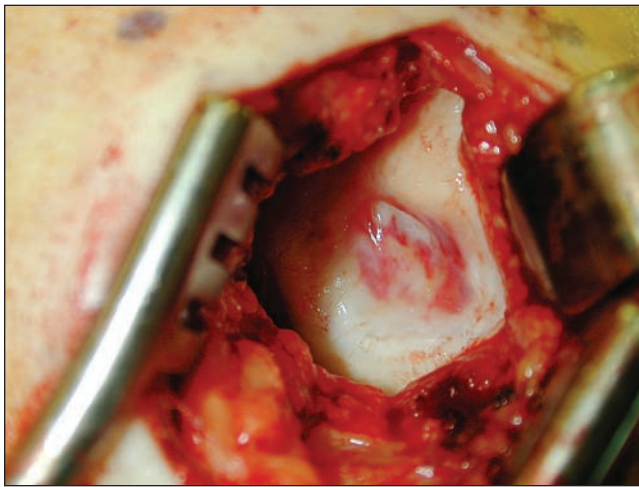


FIGURE 3



FIGURE 4

### PEARLS

- *Keeping the sizer perpendicular to the lesion will achieve the most symmetric measurements.*
- *Changing the knee flexion angle can help expose the lesion and allow easier access to it.*

### STEP 2: PREPARATION OF THE CARTILAGE LESION

- Although a number of companies manufacture allograft implantation sets, we prefer the Mega-OATS osteochondral allograft system (Arthrex, Inc., Naples, FL). The allograft set allows allograft implants of the following sizes: 15, 18, 20, 25, 30, and 35 mm.
- Different cannulated sizers are placed over the lesion to estimate the appropriate allograft diameter (Fig. 5). It is better to oversize the lesion than leave marginal-quality tissue on its perimeter.
- Once the appropriate size is chosen, the cannulated sizer is placed in the center of the lesion so that the sizer completely covers the lesion.
- Cold irrigation is used during all mechanical steps to prevent thermal necrosis to the surrounding cartilage.
- The chosen sizer is now placed over the allograft condyle to make sure a similar-sized plug can be harvested (Fig. 6). A marking pen is used to mark its location along with the 12 o'clock position.

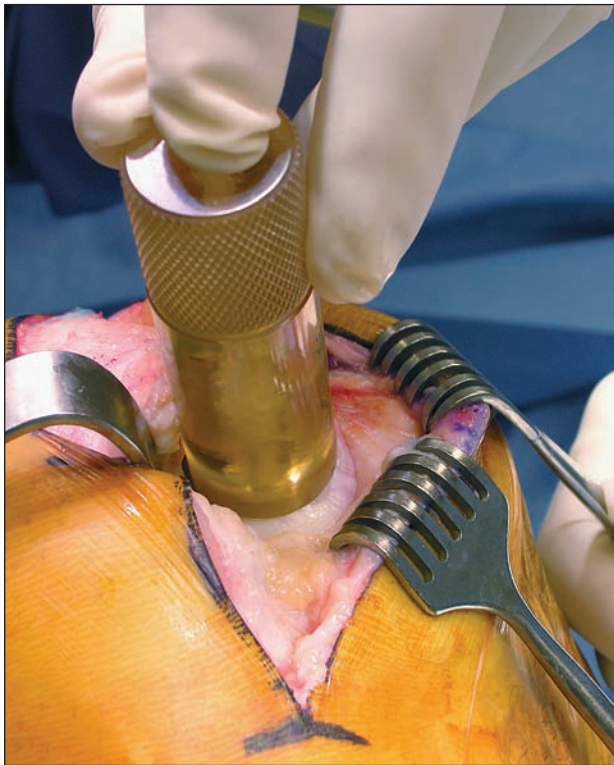


FIGURE 5



FIGURE 6

- The cannulated sizer is then placed over the recipient lesion and a 2.4-mm guide pin is advanced to a depth of at least 3 cm (Fig. 7).
- The sizer is removed, leaving the guide pin, and a cannulated recipient harvester of the same size is placed over the guide pin. The harvester is used to score the peripheral cartilage and a portion of the subchondral bone (Fig. 8).
- A cannulated counterbore of the same size is placed over the guide pin and used to create a cylindrical defect in the recipient bone of a depth of 6–8 mm (Fig. 9). The counterbore and guidewires are both removed.

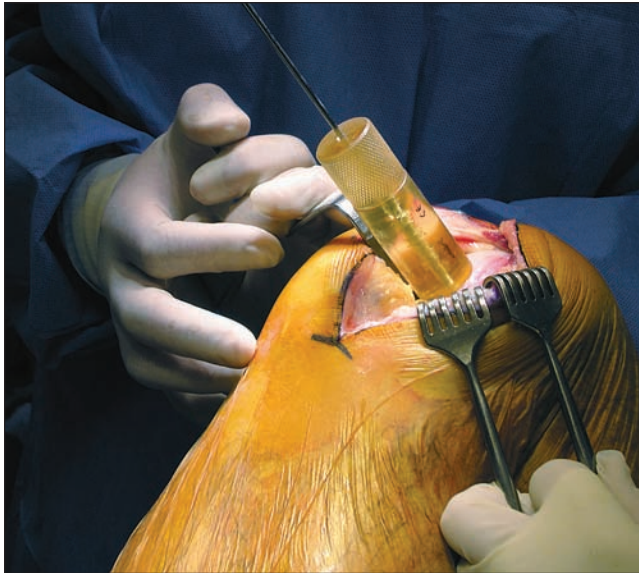


FIGURE 7

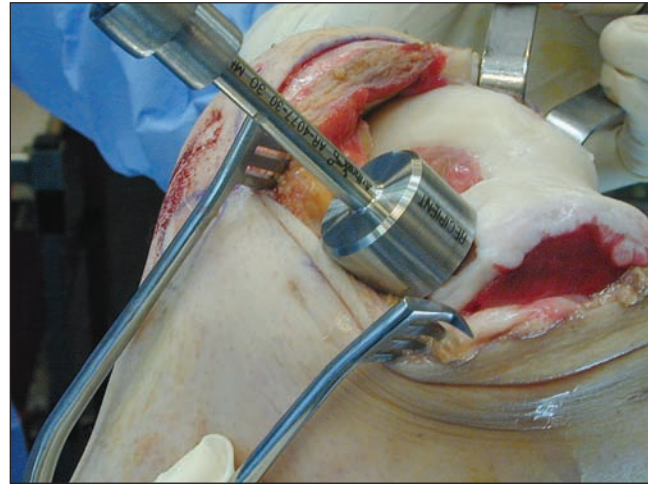


FIGURE 8

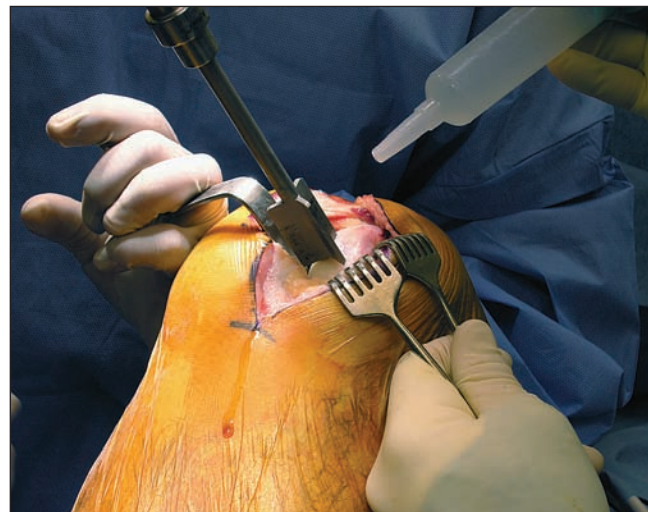


FIGURE 9

- The 12 o'clock position is marked with a pen.
- Precise measurements are taken of the four quadrants on the recipient lesion (12, 3, 6, and 9 o'clock) (Fig. 10). Ideally, the quadrant measurements should be fairly similar.
- A fresh #15 blade is used to remove any loose or frayed cartilage on the perimeter of the lesion.
- A calibrated allograft dilator is inserted into the recipient socket and gently tapped to achieve an additional 0.5-mm dilation (Fig. 11).
- A Kirschner wire (K-wire) is used to make multiple small drill holes in the bed of the socket to induce further bleeding (Fig. 12).

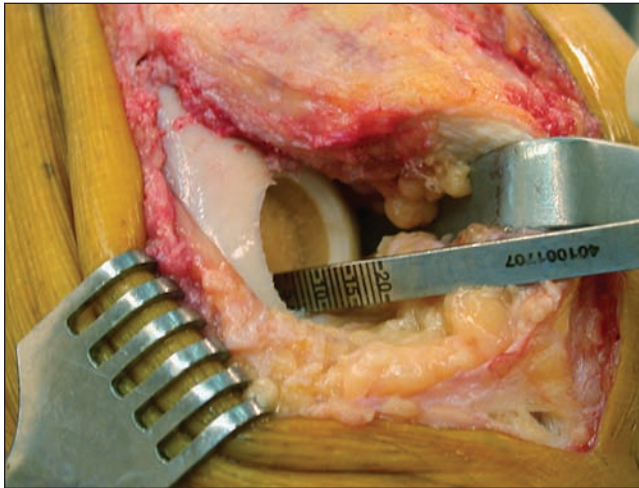


FIGURE 10

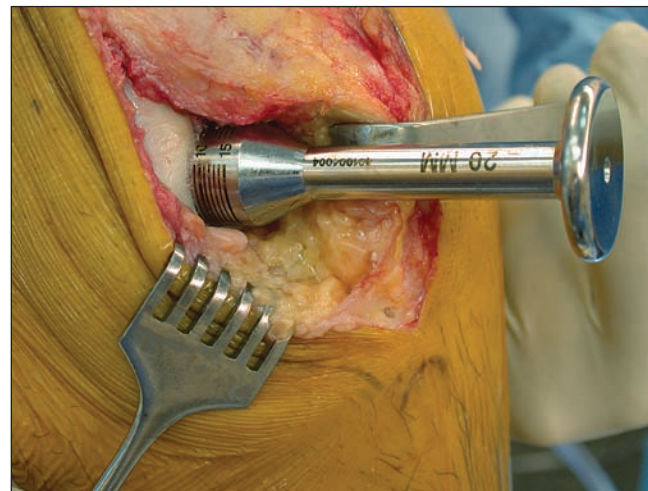


FIGURE 11



FIGURE 12

## PEARLS

- *The bushing should be adjusted so that the graft is harvested in a perpendicular fashion similar to how the defect was prepared.*

## STEP 3: ALLOGRAFT PREPARATION

- If a full hemicondyle is received, it may need to be trimmed slightly with an oscillating saw to allow it to fit on the allograft workstation (Fig. 13).
- The donor condyle is secured in the workstation using the four screws (Fig. 14).
- The bushing of the same size is placed over the graft.
- The bushing is adjusted three-dimensionally so that a sizer placed into the bushing fits directly over the marked spot on the graft. The bushing is secured (Fig. 15).



FIGURE 13

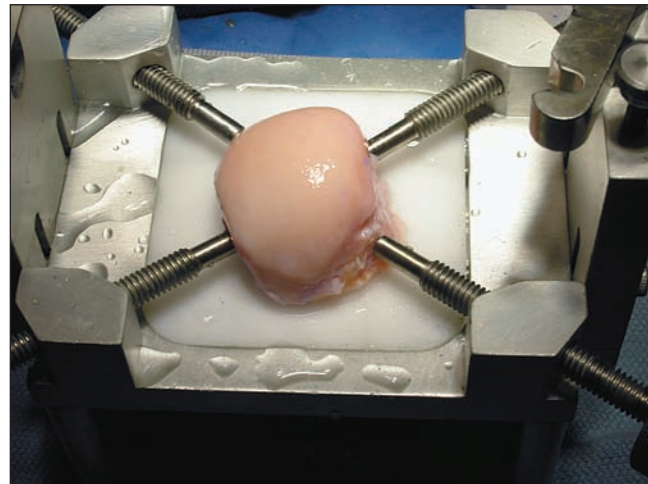


FIGURE 14

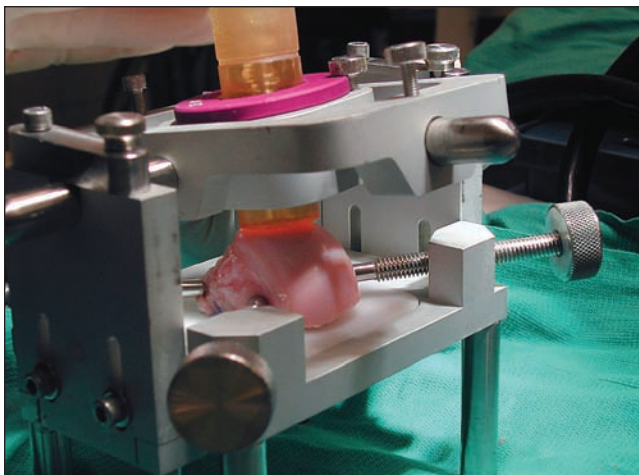


FIGURE 15



- A donor harvester is used to drill through the entire donor condyle. The graft is then gently extracted (Fig. 16).
- The depth measurements previously made in the recipient socket are now marked on the donor plug (Fig. 17).
- The allograft is secured to the holding clamp at the marked positions and trimmed with an oscillating saw (Fig. 18).
- A rongeur or a saw can be used to slightly round off the corners of the bone to facilitate the insertion of the donor plug into the recipient socket (Fig. 19).

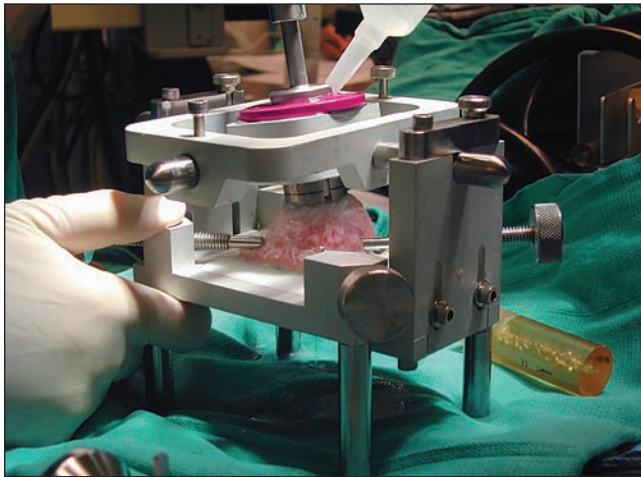


FIGURE 16

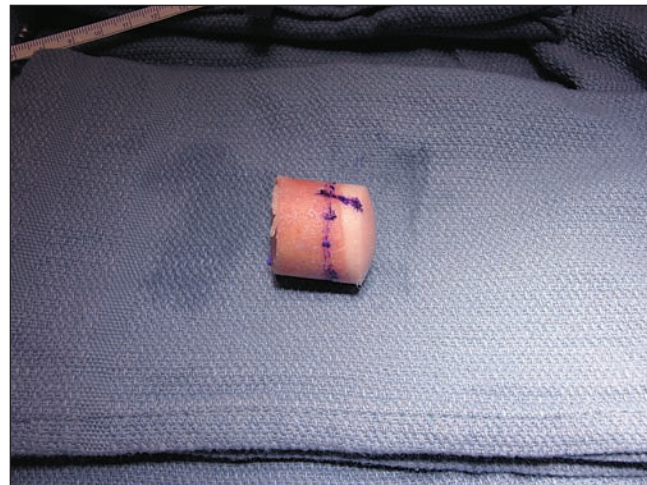


FIGURE 17

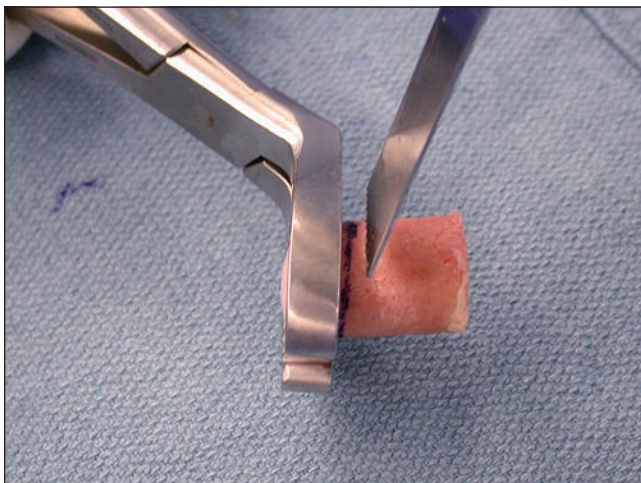


FIGURE 18



FIGURE 19

## PEARLS

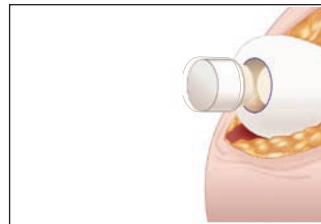
- *If the graft is too proud, it should be removed. A small Freer elevator can be used to lever the plug out of the socket. Alternatively, a graft retriever is available with the allograft set and can be used to extract the plug. Some of the potential causes of a mismatch are:*
  - *Inaccurate measurement: trim the donor bone.*
  - *Bone debris in the base of the socket: thoroughly clean the base using a curette.*
- *If the graft is too recessed, it should also be removed. Allograft bone can be crushed and placed in the base of the socket to build it up.*
- *If the graft is too tight, the dilator can be used again to dilate the socket.*
- *If the graft is too loose, bone grafting may be performed on the periphery of the plug. Augmented fixation may also be necessary.*

## STEP 4: GRAFT IMPLANTATION

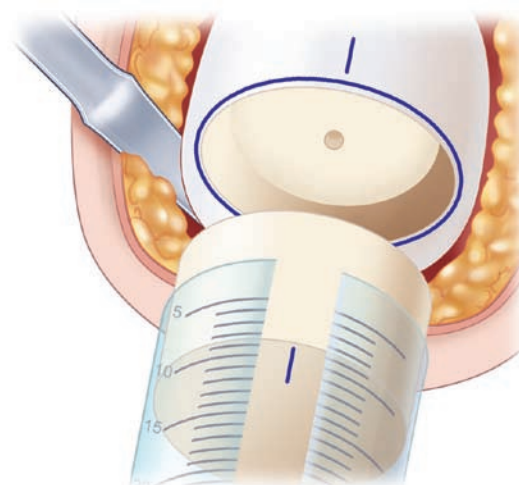
- The graft is pulse lavaged thoroughly with saline to remove all marrow elements.
- The graft is gently press-fit into the socket, lining up the two 12 o'clock positions on the donor and recipient sides (Fig. 20A and 20B).
- If the graft cannot be flush-fit by hand, a tamp can be used to gently tap the graft in place.

## STEP 5: GRAFT FIXATION

- In cases in which a tight press-fit cannot be achieved, additional fixation may be necessary. Options for graft fixation include metallic headless screws, bioabsorbable screws, and Orthosorb Pins.
- Metallic headless screws (Acutrak 2 miniscrews; Acumed, Hillsboro, OR) (see Procedure 14)
  - Useful for large and uncontained plugs (Fig. 21).
- Bioabsorbable screws (Bio-Compression screws; Arthrex, Inc., Naples, FL) (see Procedure 14)
  - Useful for large and uncontained plugs (Fig. 22).
- 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



A



B

FIGURE 20

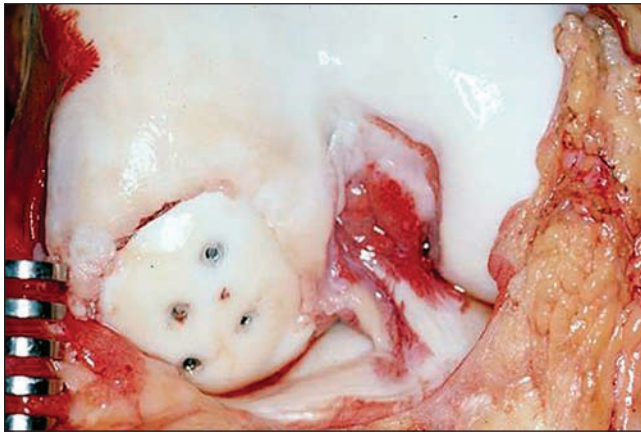


FIGURE 21

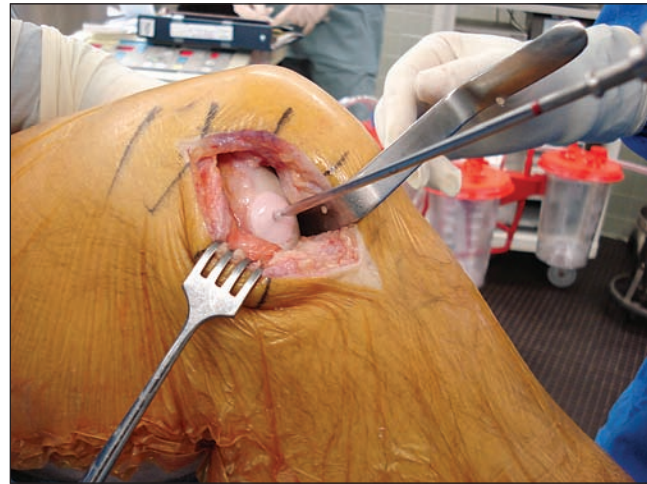


FIGURE 22

- ◆ 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 (Fig. 23).

#### STEP 6: CLOSURE

- The tourniquet is deflated and hemostasis is achieved.
- The knee is irrigated with saline, and the arthrotomy is closed in layers.
- A knee brace locked in full extension is applied and is taken off for therapy and continuous passive motion (CPM).

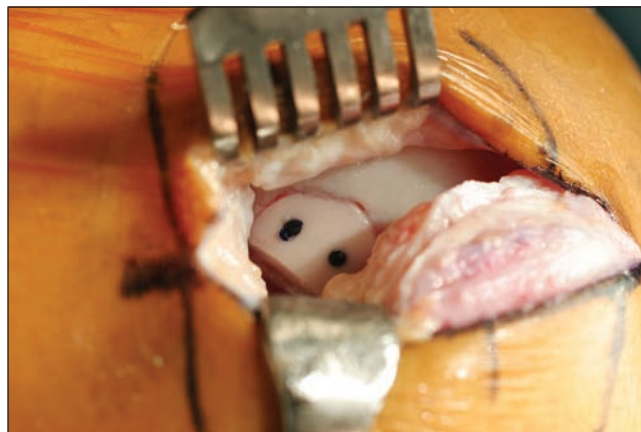


FIGURE 23

## Potential Complications

- Infections
- Arthrofibrosis
- Graft failure can occur early or late. Early failures include the failure to incorporate or graft collapse. Late failures include graft collapse or progressive joint space narrowing.

## Postoperative Care and Expected Outcomes

- Phase I (0–6 weeks)
  - Patients are started on a CPM machine immediately. The CPM is used for about 6 hr/day for 6 weeks.
  - The brace is unlocked after 2 weeks and is discontinued when the patient is able to perform a straight leg raise without an extension lag.
  - Depending on the quality of fixation, weight bearing may range initially from complete non-weight bearing to touch-down weight bearing.
  - Physical therapy mainly works on passive range of motion (ROM) and active-assisted ROM
- Phase II (6–8 weeks)
  - Partial weight bearing is allowed.
  - 130° of flexion and full extension should be achieved.
  - Physical therapy includes quad and hamstring strengthening exercises and a stationary bike for ROM.
- Phase III (8–12 weeks)
  - Full weight bearing is allowed.
  - Full ROM should be achieved.
  - Physical therapy begins closed-chain exercises and works on gait training.
- Phase IV (12 weeks to 6 months)
  - Advanced strengthening with minimal restrictions
  - Return to vigorous activities is discouraged for at least 12 months.

## Evidence

Aubin PP, Cheah HK, Davis AM, Gross AE. Long-term follow-up of fresh osteochondral allografts for posttraumatic knee defects. *Clin Orthop*. 2001;391:S318-27.

*Osteochondral allografts were used to treat 60 patients with articular defects in the distal femur. The average patient age was 27 years. Mean follow-up was 10 years. Twenty percent of the patients had failures and 84% of the patients were rated as good or excellent.*

Chu CR, Convery FR, Akeson WH, Meyers M, Amiel D. Articular cartilage transplantation—clinical results in the knee. *Clin Orthop*. 1999;360:159-68.

*Fifty-five patients with a mean age of 35 years underwent osteochondral allografts. The average follow-up was 75 months. Overall, 76% of the knees were rated as good or excellent. In the unipolar transplant category, 84% of the patients regained full use of their affected knee. Conversely, only 50% of bipolar lesions were rated as good or excellent.*

Garrett JC. Fresh osteochondral allografts for treatment of articular defects in osteochondritis dissecans of the lateral femoral condyle in adults. *Clin Orthop*. 1994;303:33-7.

*Seventeen patients with OCD lesion were treated with allografts and followed for an average of 3.5 years. The mean age was 20. Herbert screws were used to augment the fixation of the allografts. At follow-up, 94% of the patients had successful outcomes.*

Ghazavi MT, Pritker KP, Davis AM, Gross AE. Fresh osteochondral allografts for post-traumatic osteochondral defects of the knee. *J Bone Joint Surg Br*. 1997;79:1008-13.

*This is a review of 126 knees with posttraumatic osteochondral defects that were treated with osteochondral allografts. The mean age was 35 years and the mean follow-up was 7.5 years. The authors demonstrated 95% survival at 5 years, 71% at 10 years, and 66% at 20 years.*

Jamali AA, Emmerson BC, Chung C, Convery RF, Bugbee WD. Fresh osteochondral allografts. *Clin Orthop*. 2005;437:176-85.

*Twenty knees were treated with osteochondral allografts in the patellofemoral joint. There were 5 failures (25%). The knee scores improved from 11.7 to 16.3. Of the 10 knees evaluated radiographically, four knees had no patellofemoral arthrosis and six had mild arthrosis.*

McCulloch PC, Kang RW, Sobhy MH, Hayden JK, Cole BJ. Prospective evaluation of prolonged fresh osteochondral allograft transplantation of the femoral condyle. *Am J Sports Med*. 2007;35:411-20.

*Twenty-five patients received osteochondral allografts for isolated defects. Two patients had a history of AVN and 24 had previous surgery. The average age was 35 years and the average follow-up was 35 months. Nineteen patients received one plug and six patients received two plugs. At follow-up, 88% of the grafts were fully incorporated. General satisfaction averaged 84%.*

Meyers MH, Akeson W, Convery R. Resurfacing of the knee with fresh osteochondral allograft. *J Bone Joint Surg Am*. 1989;71:704-13.

*The authors reported their results on 39 patients who received osteochondral allografts who were followed for an average of 3.6 years. The patients had an average age of 38 years; 77.5% successful results were documented. In patients with traumatic unicompartamental arthritis, the success rate was only 30%.*

Shasha N, Krywulak S, Backstein D, Pressman A, Gross AE. Long-term follow-up of fresh tibial osteochondral allografts for failed tibial plateau fractures. *J Bone Joint Surg Am*. 2003;85(Suppl 2):33-9.

*Sixty-five patients with failed tibial plateau fractures were treated with fresh osteochondral allografts. The patients were followed for an average of 12 years. Overall, 67.7% had intact grafts and the remainder were converted to total knee replacements. Kaplan-Meier survivorship analysis showed the rate to be 95% at 5 years, 80% at 10 years, 65% at 15 years, and 46% at 20 years.*

