

Osteochondral Allografts

Applications in Treating Articular Cartilage Defects in the Knee

Craig M. Capeci, M.D., Michael Turchiano, B.A., Eric J. Strauss, M.D., and Thomas Youm, M.D.

Abstract

Chondral injury in the knee is a unique challenge to the orthopaedic surgeon. Given the high probability of progression to knee arthrosis, the treatment of symptomatic cartilage defects of the knee has become an important surgical intervention in young, active patients. The demand for an alternative to prosthetic resurfacing has driven the trend towards biologic resurfacing and joint preservation. Osteochondral allografts are composed of hyaline cartilage attached to subchondral bone and are suited for large osteochondral lesions. This allograft tissue must be harvested, processed, and stored appropriately to reduce the risks of graft failure and potential complications. With appropriate indications and surgical techniques, osteochondral allografts have been shown to have good long-term graft survival and patient outcomes.

Over the last decade, cartilage restoration has come to the forefront of orthopaedic surgery. Procedures to restore function and decrease pain in young patients with osteochondral defects are increasing. This demand for an alternative to prosthetic resurfacing has driven the trend towards biologic resurfacing and joint preservation.

While there are several reparative and restorative options for cartilage replacement, osteochondral transplantation is the only technique that mimics normal biology in restoring architecturally sound, mature hyaline cartilage.¹ Over the last decade, osteochondral transplantation in knee reconstruction has been increasingly utilized due to improved availability,

Craig M. Capeci, M.D., Eric J. Strauss, M.D., and Thomas Youm, M.D., are in the Department of Orthopaedic Surgery, NYU Hospital for Joint Diseases, New York, New York. Michael Turchiano, B.A., is in the New York University School of Medicine, New York, New York.

Correspondence: Eric J. Strauss, M.D., NYU Hospital for Joint Diseases, 301 East 17th Street, Suite 1402, New York, New York 10003; eric.strauss@nyumc.org.

extensive screening and procurement protocols, and advancing surgical techniques.

Osteochondral allograft (OCA) transplantation has an extensive history dating back to the early twentieth century, when Erich Lexer treated two patients with free osteochondroplasty for post-septic knee ankylosis.² Currently, OCA transplantation is utilized to treat a broad spectrum of osteoarticular lesions of the knee. Although osteochondral allograft transplantation has also been used for the treatment of articular disease in the hip, ankle, and shoulder, the majority of research and clinical data to date has been in the treatment of large cartilage defects of the knee.³⁻⁸

Incidence of Chondral Injury

Hunter first described the limited restoration and healing potential of cartilage tissue in 1742.⁹ He noted that “an ulcerated cartilage is universally allowed to be a very troublesome disease; that it admits of a cure with more difficulty than carious bone; and that, when destroyed, it is not recovered.” When symptomatic, cartilage lesions persist indefinitely and have the potential to cause pain and disability. Currently, the incidence rate of these symptomatic chondral injuries is not fully known.

It has been estimated that between 5% and 10% of young patients who present with a hemarthrosis of the knee after trauma will have a focal chondral injury.¹⁰ Curl and colleagues reviewed over 30,000 knee arthroscopies of patients in all age groups and reported chondral lesions in 63% of patients. In this cohort, Grade III and IV lesions were found in 41% and 19% of cases, respectively.¹¹ Hjelle and coworkers in 2002 reviewed 1,000 consecutive knee arthroscopies and reported a 5.3% incidence of Grade III/IV lesions of at least one cm² in patients less than 40 years of age.¹² Aroen and associates in a group of young patients (mean age 35 years of age) found an 11% incidence of full-thickness cartilage lesions. From these data, it can be inferred that many

asymptomatic lesions exist in the general population.¹³

Unipolar, unicompartmental full-thickness lesions have been shown to progress to joint space narrowing on plain radiographs following simple arthroscopic debridement.¹⁴ Furthermore, cartilage-specific magnetic resonance imaging studies demonstrate a close correlation between chondral defects, clinical symptoms, and the likelihood of symptom progression.¹⁵ Given the high probability of progression to knee arthrosis, the treatment of symptomatic cartilage defects of the knee has become an important surgical intervention in young, active patients.

Osteochondral Allograft Composition

Articular cartilage is a viscoelastic material, which minimizes the surface friction on the articular surface. Chondrocytes make up only 2% of the total volume of adult articular cartilage; however, the health of the chondrocytes is integral to articular cartilage survival as they synthesize the extracellular matrix and contribute to the highly organized zones of hyaline cartilage. The articular cartilage of the knee is composed of mature hyaline cartilage, with a thickness of approximately 4 mm.¹⁶ The subchondral bone supports the structural integrity of the cartilage layer.

Osteochondral allografts are composed of two key components: a layer of articular cartilage and the non-living subchondral bone to which it is attached. The fundamental concept of osteochondral allograft use is the transplantation of hyaline cartilage of the same thickness as the surrounding native tissue with viable chondrocytes capable of maintaining their metabolic activity after transplantation. The allograft chondrocytes must survive hypothermic storage and retain high amounts of viability to sustain the extracellular matrix.

Allograft cartilage is ideal for transplantation for a multitude of reasons. It is an avascular and aneural tissue. Additionally, cartilage is a relatively immunoprivileged tissue with chondrocytes embedded in the extracellular matrix.¹⁷

The subchondral bone serves as a structural support for the articular cartilage layer. The osseous portion of the allograft differs from the cartilage in that its cells do not survive transplantation. It has been demonstrated that osseous allografts function as a scaffold for healing by creeping substitution and are susceptible to a host immune response of a questionable clinical significance.^{18,19} The two components of an osteochondral allograft—living mature hyaline cartilage anchored to non-living subchondral bone—create a functional unit which can replace the same diseased components in a living knee joint.

Graft Harvest and Processing

Significant advances have been made in the harvesting and processing of osteochondral allografts in the last decade. It is important for any surgeon or patient involved with their use to understand the complex process of tissue recovery, testing, and processing. In the past, only fresh-allograft centers and large institutions had the resources necessary to utilize this treatment modality; now, improved graft harvest

and processing procedures have made graft availability less of a barrier to their use.

The age criterion for tissue donors is between 15 and 40 years of age. The knee joint surface must pass a visual inspection for joint congruity and cartilage quality. Osteochondral allograft procurement protocols are based on guidelines created by the American Association of Tissue Banks (AATB) under the authority of the Food and Drug Administration (FDA).²⁰ The grafts must be harvested within 12 hours of the donor's death.²¹ The knee joint is removed en bloc and the bone marrow, which is the main source of potential disease transmission and immune response, is copiously pulse lavaged. The grafts are then placed in antibiotic solution at 37° C for 24 hours and then stored. The importance of strict adherence to the tissue banking protocol has recently been identified as a critical point in assuring that harvested allografts are acceptable for transplantation.

In the last decade concerns have been voiced over the accreditation of tissue banks in the United States. The Department of Health and Human Services, in their report in 2001, noted that approximately 750,000 allografts were transplanted in 1999 and called into question the oversight ability of the FDA.²² Of the 154 tissue banks identified, only 118 had been inspected, and only 58 were accredited by the AATB. Over the last decade since the report, it is hoped that oversight and inspections have become more standardized as allograft use has seemingly continued to increase to meet demand.

Graft Storage

The primary goal of osteochondral allograft use in orthopaedic surgery is the transplantation of an architecturally sound composite of subchondral bone and articular cartilage with viable chondrocytes capable of maintaining metabolic activity following implantation. The largest advances in achieving this goal have come from research into the optimal storage conditions for the osteochondral allografts. There are three variables that factor into the storage of osteochondral allografts: radiation, time, and temperature.

Each variable has important implications on the structural integrity of the graft and preserving optimum chondrocyte viability. Irradiation of allograft tissue is utilized to decrease the risk of disease transmission in the host after transplantation. The radiation dose to eliminate viral DNA is 3 to 4 mRad, which kills chondrocytes and significantly decreases the graft's stiffness and strength.²³ For this reason, radiation is not used for fresh osteochondral allografts.

With respect to temperature, three types of storage techniques exist for osteochondral allografts: fresh-frozen, cryopreserved, and fresh. Fresh-frozen osteochondral allografts can be stored indefinitely at -80° C and subsequently have a very low immunogenicity. The deep freezing, however, leads to very poor levels of chondrocyte viability (< 5%) in the articular cartilage portion of the grafts.²⁴ Cryopreservation entails adding glycerol or dimethyl sulfoxide to the storage medium, followed by controlled freezing to -70° C. Although early research demonstrated improved angiogen-

esis and decreased immunogenicity in a mouse model with cryopreserved allografts, subsequent studies have shown poor chondrocyte viability that is limited to the superficial zone.²⁵⁻²⁷ The low chondrocyte viability in both fresh-frozen and cryopreserved grafts led to the transplantation of only fresh osteochondral allografts.²⁸

After harvest and 24 hours of treatment in an antibiotic solution, fresh osteochondral allografts, sometimes referred to as fresh-refrigerated to differentiate from fresh-frozen grafts, are stored in either a lactated ringers solution or a physiologic culture medium at 4° C. Williams and associates assessed chondrocyte survival and material properties in a sheep condyle model and found a large drop-off in chondrocyte viability after 28 days of storage.²⁹ Ball and coworkers examined the effects of the lactated ringers or culture medium storage on chondrocyte viability. At 14 days, culture medium outperformed the lactated ringer's solution (91% vs. 81% chondrocyte viability) and at 28 days showed an even larger difference (83% vs. 29%).³⁰ Two recent studies have demonstrated that grafts stored at 37° C had significantly better chondrocyte viability in the superficial and middle zones and decreased bone viability, which may decrease immunogenicity.^{31,32} Based on the findings of these studies, tissue banks have converted to the use of nutritive culture medium for graft storage and current recommendations include implantation of fresh osteochondral allografts within 28 days of procurement. The extension of the time period for implantation has led to the terminology of fresh (< 14 days) and prolonged-fresh (14 to 28 days) osteochondral allografts.

Immunogenicity and Risks of Disease Transmission

In current practice, small allografts are not human leukocyte antigen (HLA) or blood-type matched between donor and recipient. Although the cartilage component of an osteochondral allograft is immunoprivileged, fresh unmatched allografts elicit a variable immune response.³³ The bone marrow and osseous component of an osteochondral allograft is the most immunogenic. The irrigation and lavage during procurement significantly decreases its antigenic potential but does not eliminate it entirely. Human allograft retrieval studies have shown that patients tolerate the transplant immunologically, with little to no histological response or evidence of immune rejection.^{34,35} In a 2001 MRI study, however, 50% of shell graft recipients demonstrated anti-HLA antibodies, and those antibody positive patients had statistically significant MRI findings including edema at the graft interface, abnormal graft marrow, and surface collapse. The clinical significance of these reactions remains unknown. The issue of the immune response to allografts may prove to be clinically significant in the future, and it is clearly an area where more research is necessary.

The potential for transmission of a communicable disease is often cited as a disadvantage of the use of fresh osteochondral allografts. Following the guidelines of the AATB, all grafts harvested include a detailed donor history as well as

serologic and bacteriologic testing. As with transplantation of any blood product or tissue product, there remains a risk of disease transmission despite donor screening and testing.³⁶ Although Zhou and coworkers in an observational study found high levels of donor viremia, Buck and colleagues estimated the risk of HIV transmission at 1/1.6 million.^{37,38} A case report in 1992 is the only reported transmission of HIV from an allograft bone, which was transplanted prior to screening standards that were instituted in 1985.³⁹ It is readily agreed upon that osteochondral allograft transplantation is safe; however, both the surgeon and the patient need to discuss the small risk of bacterial or viral transmission as part of the informed consent process.

Indications and Contraindications

Osteochondral allografting has a role as both a primary procedure and a salvage procedure in the spectrum of cartilage restoration of the knee. Primary fresh osteochondral allografts are uniquely suited for the treatment of large osteochondral lesions (> 2 cm²) for which other procedures may be inadequate or the bone involvement is greater than 6 mm to 10 mm deep.⁴⁰⁻⁴² Over a 10 year period, a large series of 365 cases noted that the majority of allografts are performed for lesions of the medial (36%) and lateral (18%) femoral condyles, whereas the patellofemoral compartment (patellar, trochlear and bipolar) accounted for 18%.⁴³ Specific diagnoses for which osteochondral allografting should be considered include osteochondritis dissecans, post-traumatic focal defects, patellofemoral arthrosis, and unicompartmental degenerative tibiofemoral arthrosis.⁴⁴⁻⁴⁹ Osteochondral allografts have also proven to be a valuable tool for the salvage of knees in which other cartilage restoration procedures, such as microfracture, osteochondral autograft transplantation (OATs), and autologous chondrocyte implantation (ACI), have failed.⁵⁰ Paramount during the indications and informed consent process with a patient is to outline the goals for the surgery: a primary allograft in a young patient with a focal lesion may be able return to near preoperative athletic activities whereas the goals of a salvage-type procedure may be a reduction in knee pain and return to functional activities of daily living.

The mechanical and biologic status of the knee joint needs to be thoroughly assessed preoperatively; a careful ligamentous exam must be performed and the alignment of the limb determined with long-leg alignment films. Any instability or malalignment should be addressed before allografting is considered or as a concomitant procedure to achieve a stable joint surface. Although bipolar and multicompartmental osteochondral allografting procedures can be successful in younger patients, advanced multicompartmental arthrosis is a relative contraindication to allografting. Older patients with symptoms and a lower activity level who meet criteria for prosthetic replacement should not be considered for osteochondral allografting of the knee. Inflammatory arthropathies are a relative contraindication to allografting, as is the presence of altered bone metabolism, which can be

seen with chronic steroid use, alcohol abuse, and smoking.

Preoperative Planning and Surgical Technique

All fresh allografting procedures require donor-recipient size matching. This is performed by obtaining anteroposterior and lateral radiographs of the knee with a magnification marker. After correction for magnification, the femoral condyle or tibial plateau size is recorded.^{42,51} This measurement is forwarded to the tissue bank where a size-matched (within 2 mm) donor allograft is identified. There can be substantial variability in anatomy, however, which is not reflected on plain radiograph size measurements. In patients with osteochondritis desiccans, the pathologically affected condyle may be larger, wider, and flatter and necessitate a larger donor condyle.⁴² The final allograft should be thoroughly inspected by the operating surgeon before beginning the procedure.

Diagnostic arthroscopy is occasionally performed at the onset of the case; although in most cases, it has been performed shortly before the allografting procedure and is not necessary. If there is any interval concern for new meniscal pathology or other intraarticular concerns a diagnostic arthroscopy should be performed. Osteochondral allograft implantation in the knee necessitates an open procedure, including an arthrotomy of appropriate size to access the lesion. The patient is positioned supine, and a thigh tourniquet is utilized. A leg or foot-holder can be valuable during the procedure for positioning of the knee in various degrees of flexion to facilitate access to the lesion.

A standard midline incision is made from the center of the patella to the tibial tubercle. Depending on lesion location, a medial or lateral arthrotomy is made while taking care not to injure the anterior horn of the meniscus or damage the articular surface. If the lesion is posterior or very large, the anterior horn of either meniscus can be detached with a cuff of tissue, reflected, and then later repaired.⁴² Medial and lateral retractors are placed, with attention paid to protecting the cruciate ligaments in the intercondylar notch. The lesion is then identified and inspected, noting that excessive flexion will limit patellar mobilization. Lesions of the condyles are readily accessible; trochlear and patellar lesions are approached similarly although further patellar mobilization or eversion may be necessary.⁴⁸ Pathologic tissue is removed from the defect and the subchondral bone is scored with hand and power instrumentation in preparation for allografting.

Dowel Technique

Many instrumentation systems exist for dowel allografting of femoral condyle lesions, with dowel sizes available up to 35 mm in diameter. The lesion is sized, and a guidewire is inserted into the center of the lesion, perpendicular to the articular surface (Fig. 1). A core reamer is used to remove remaining articular cartilage in the periphery of the lesion. At least 7 to 8 mm of subchondral bone is removed; when a deeper lesion is encountered, all fibrous and sclerotic bone should be removed to a healthy, bleeding base. If a depth

of greater than 10 mm is necessary, packed morselized autologous bone graft should be used to fill the deeper osseous defect. On the back table, the corresponding anatomic location is identified on the allograft, and it is placed in a graft holder. A tube saw of the matching size is used to core out the graft, and an identifying twelve o'clock mark is made to ensure appropriate orientation. Depth measurements are made, and the graft is trimmed to the precise depth in all four quadrants. The graft is pulse lavaged to remove any final marrow elements. The graft is then implanted with the use of finger pressure; if necessary, the recipient site can be dilated with a slightly oversized tamp. Any use of tamps to impact the graft should be avoided.

The use of metal or plastic punches to impact grafts, even with less than five taps, has been shown in a sheep model to decrease chondrocyte viability by 30% to 50%.⁵² Similarly, a human allograft study found 60% chondrocyte death in upper zone, 20% to 30% death in deeper zones, and diminished cell viability across all time points (2 and 7 days) with the use of plastic punches with an average of 18 taps.⁵³ Usually no additional fixation is necessary; if it is deemed necessary, bioabsorbable pins or compression screws can be utilized. Once flush, the knee is put through a range of motion to identify catching or soft tissue impingement.

Shell Technique

For larger, or more irregular femoral condylar lesions, a shell grafting technique can be employed. The circumference of the lesion is identified with a marking pen. Normal cartilage should be preserved, and an attempt is made to make a shell graft shape which can be easily hand-crafted. A scalpel is used to score the cartilage, and curettes are used to remove tissue inside the marked area. The defect is debrided to a depth of 4 to 5 mm with the use of a motorized burr and sharp curettes. The graft is created in a free-hand manner and should be slightly oversized and carefully downsized to fit accordingly in the prepared bed. The shell graft is applied, and the need for fixation is assessed; usually fixation is necessary with bioabsorbable pins or compression screws.

Postoperative Management

The patient is kept non-weightbearing or toe-touch weightbearing for 8 to 12 weeks depending on the size of the graft, type of fixation, and radiographic signs of incorporation. Patients are allowed full range of motion unless they underwent a concomitant reconstructive procedure requiring knee motion restrictions. An early range of motion and quadriceps-strengthening program should be instituted. Braces are not used unless the grafting involves the patellofemoral joint where flexion is limited to 45° for 4 to 6 weeks. In rare instances of bipolar tibial and femoral allografting, an unloader brace should be considered to prevent excessive stress on the grafted surfaces. The immediate and extensive use of continuous passive motion (CPM) machines has been routine after osteochondral allografting and nearly all cartilage restoration procedures in the knee. However, a

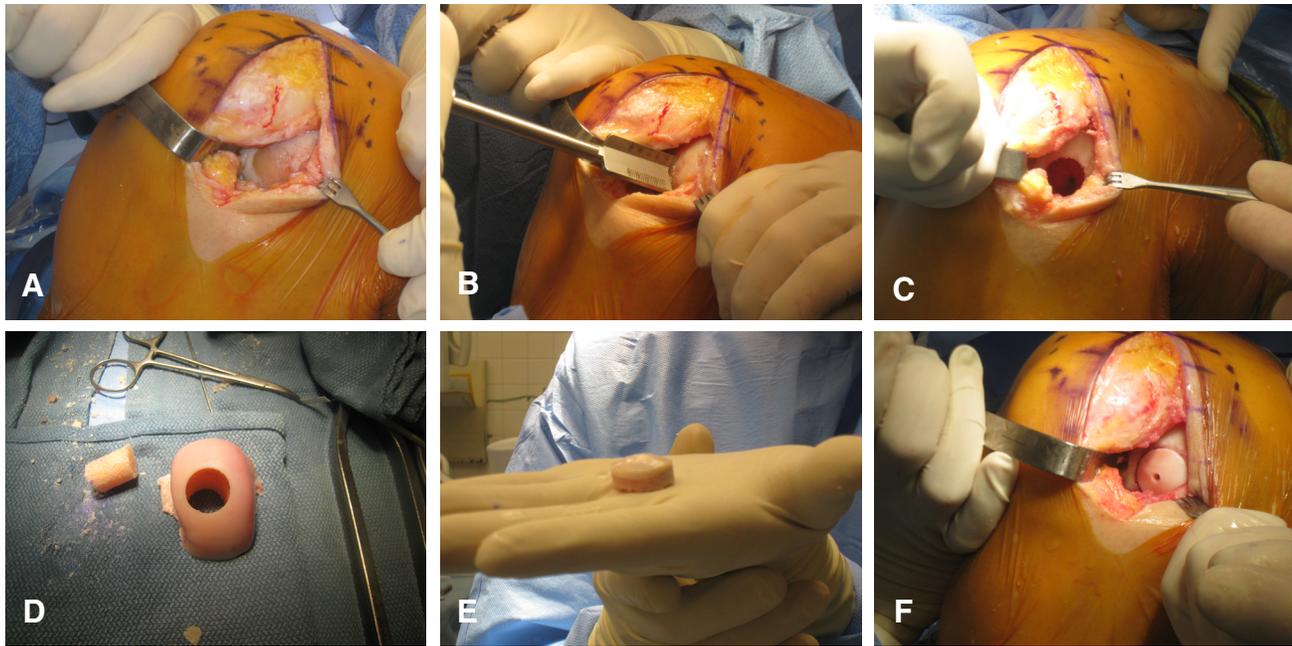


Figure 1 The dowel technique for osteochondral allograft transplantation. **A**, An arthrotomy is made exposing the lesion on the femoral condyle. **B**, The lesion is sized, and **C**, a core reamer is used to remove the remaining cartilage and subchondral bone to a bleeding base. **D**, The corresponding location of the lesion is identified on the allograft, and **E**, a tube saw is used to produce an allograft of matching size. **F**, The allograft is implanted into the defect in the native knee, using finger pressure.

recent meta-analysis identified only four Level III clinical studies that compared CPM to no CPM, which offered no good evidence for its widespread use.⁵⁴

At 4 weeks patients are allowed to perform closed chain exercises and progressive weightbearing is permitted at 3 months. When functional rehabilitation is complete, usually at 6 months, patients can return to recreational sports activities but should be cautioned about excessive impact loading of the allograft. The preoperative goals that had been discussed with the patient should be re-visited as they will vary greatly between the young patient with a focal lesion and patients undergoing osteochondral allografting in a salvage situation.

Complications

As discussed earlier, the risk of viral or bacterial infection after osteochondral allografting is very low in grafts harvested by the appropriate protocol. Transmission of a bacterial infection is rare but can be devastating to the allograft and the patient and has been reported.⁵⁵ Deep infection needs to be distinguished from superficial infection on the basis of physical examination and joint aspiration if necessary. Treatment of deep infection requires irrigation and debridement and graft removal, as the fresh tissue may be the source or a nidus for infection recurrence.

Progression of arthrosis can lead to a poor clinical outcome. Patients will present with new onset pain or mechanical symptoms. Fragmentation and late graft collapse can also cause a clinical failure of the procedure. The degree of creeping substitution and revascularization is variable,

especially with larger grafts. Magnetic resonance imaging can assess for other causes of pain and assess the host-graft incorporation. Caution in interpreting these MRI images is necessary, however, as well-functioning grafts can demonstrate signaling abnormalities that may resolve over a period of years as creeping substitution occurs.⁵⁶

Results

For over 20 years, successful outcomes have been reported following the use of osteochondral allografts in the knee.⁴³ The orthopaedic literature is full of Level III/IV studies evaluating the effectiveness of osteochondral allografting in the knee. These studies are summarized in Table 1. The studies utilize many different techniques, treat differing pathology, and have different methodology making comparisons between them difficult; however, the depth of data from osteochondral allografting in the knee allows some conclusions to be drawn about its effectiveness. As previously discussed, the majority of new research and data fueling the use of allografts involves graft processing and storage to maximize chondrocyte viability.

There is limited data on osteochondral allografting in the patellofemoral joint. Jamali and coworkers retrospectively reviewed the outcomes of 20 knees in 18 patients with a mean age of 42 years who had undergone a mean of 2.6 prior surgical procedures for patellofemoral lesions.⁴⁸ At a mean of 7.5 years of follow-up the investigators reported good to excellent results in 60% of the study patients with survivorship analysis demonstrating 67% graft survival at 10 years. Despite the relatively lower rate of clinical success,

Table 1 Studies Evaluating the Outcome of Osteochondral Allografts of the Knee

Study	Site of Lesion	N	Average Age	Mean Follow-up (yrs)	Outcomes	Notes
Bugbee 2011	MFC, LFC	576	34	7	Graft survival 82/72/70% at 5/10/25 yrs	Risks for failure: age > 40, female, defect > 10 cm ²
Laprade 2009	MFC, LFC	23	30	3	IKDC 52 → 68 Cinci 49 → 69	Average graft storage 20 days
Emmerson 2007	MFC, LFC	66	28	7.7	72% good to excellent	10% reoperation
Davidson 2007	MFC, LFC, trochlea	10	32	3.3	IKDC 27 → 79	Second look arthroscopies
McCulloch 2007	MFC, LFC	25	35	3	84% satisfaction	Consecutive prospective cohort
Gross 2005	MFC, LFC	60	< 60	10	85% survival at 10 years	Histological analysis
Jamali 2005	PF	20	42	7.8	75% improved clinical scores	Patellofemoral only

14 of 16 patients interviewed (87.5%) reported pain relief following the procedure, and 87.5% said they would have the operation again if necessary.

Ghazavi and colleagues reviewed the usage of osteochondral allografts in the treatment of post-traumatic defects of the knee in 126 patients and reported clinical success in 85% at a mean follow up of 7.5 years.⁴⁰ Failure was associated with age over 50 years, bipolar defects, malaligned knees, and workers' compensation cases. Similarly, Gross and associates found an 85% graft survival rate at 10-year follow-up in 60 patients.⁵⁷ Emmerson and colleagues reported the results of their case series of 65 knees in 63 patients with a mean age of 28.6 years treated for osteochondritis dissecans lesions of the femoral condyle.⁴⁴ At a mean follow-up of 7.7 years, 47 knees (72%) were rated as good to excellent on the modified D'Aubigne and Postel scale. Subjective knee function improved from 3.4 preoperatively to 8.4 on a 10 point scale at the time of final evaluation.

McCullough and coworkers, in a prospective consecutive study of 25 patients, examined the effectiveness of prolonged-fresh grafts (mean storage 24 days) in the treatment of osteochondral defects in the femoral condyles.⁵⁸ They reported significant improvements in mean Lysholm scores, 39 preoperatively to 67 postoperatively; International Knee Documentation Committee (IKDC) scores, 29 to 58; and SF-12 physical component scores, 36 to 40, at a mean of 35 months of follow-up. The study patients reported 84% satisfaction with their clinical outcome believing that their operative knee functioned at 79% of their unaffected contralateral side. Radiographically, 88% had complete graft incorporation.

Davidson and colleagues reported on 10 patients (out of a cohort of 67) who underwent second-look arthroscopy with biopsy of both graft and host cartilage, histological analysis, and MRI at a mean of 40 months following the index osteochondral allografting procedure on the femoral condyles or trochlea.⁵⁹ Average prolonged-fresh graft storage

time was 36 days in cell culture medium at 4° C. At second-look arthroscopy, the mean International Cartilage Repair Society score was 10, and the mean Outerbridge score of the repaired defect improved from 4.3 preoperatively to 0.6. MR imaging demonstrated complete graft incorporation, and biopsy specimens demonstrated no significant difference in chondrocyte viability and density between the grafted tissue and the surrounding normal articular cartilage.

In a histologic analysis of osteochondral allografts, Gross and associates noted that early failures were due to a lack of chondrocyte viability while late failures demonstrated viable chondrocytes, functional preservation of matrix, and complete replacement of the graft bone with the host bone.⁶⁰ They concluded that long-term allograft survival depends on graft stability by fixation of host bone to graft bone, and that with the stable osseous graft base, the hyaline cartilage portion of the allograft can survive and function for 25 years or more.

In another study of prolonged-fresh osteochondral allografts, LaPrade and coworkers reported their experience in 23 consecutive cases (average age of 30) of femoral osteochondral defects managed with osteochondral allografts implanted after a mean of 20.3 days of storage in culture medium at 4° C.⁶¹ At a mean of 3 years of follow-up, significant improvement in both Cincinnati knee scores was reported, 49.2 preoperatively to 69.0 postoperatively and IKDC scores, 52 to 68.5. Postoperative radiographs demonstrated evidence of stable host incorporation of the implanted allograft in 22 of the 23 cases. They concluded that prolonged-fresh grafts stored in culture medium at 4° C can provide significant functional and clinical improvement after an average follow-up of 3 years in patients treated for a full-thickness osteochondral defect of the femoral condyle.

The longest follow-up to date was presented by Bugbee and colleagues, who reported on their experience of 25 years (576 knees) of osteochondral allografting.⁶² The average age of the patient was 34 years of age, with a mean follow-up of 7 years. They reported graft survival rates of 82%, 72%, and

70% at 5, 10, and 25 years, respectively. Overall patient satisfaction scores were 90%, and patients with a diagnosis of osteochondritis dissecans significantly outperformed those with a diagnosis of osteoarthritis. In a regression analysis for risk of failure, they identified age greater than 40, female gender, and a mean defect size of greater than 10 cm².

Conclusion

Osteochondral allografting in the knee has been performed for decades and continues to have a role in treating articular pathology of the knee that include both osseous and cartilage components. Osteochondral allografting is a one-stage procedure that can compensate for bone loss, restore normal architecture, and allow osseous integration. With regard to fresh grafts, basic science research has determined that culture medium storage at 4° C for less than 28 days is the optimum setting prior to implantation. The ability to use these prolonged-fresh grafts with high chondrocyte viability allows sufficient time for rigorous serologic and bacteriologic testing by tissue banks, which improves patient safety. Similarly, with additional time available before implantation, more centers will be able to obtain fresh grafts and meet the increasing demand. Despite these advances, high cost, and limited availability will continue to remain a challenge to both surgeons and patients.

A thorough discussion with the patient regarding goals and expectations prior to osteochondral allografting surgery is imperative. The surgical procedure for femoral condylar lesions requires precision to limit chondrocyte death during graft impaction and early graft failure due to poor fixation. The rigorous postoperative course requires attention to detail and an adherent patient. Future research into modulating the healing response to improve graft integration may further advance short- and long-term outcomes. With enhanced graft safety and availability, fresh osteochondral allografting for the treatment of osteoarticular lesions in the knee continues to develop as an effective cartilage restoration procedure.

Disclosure Statement

None of the authors have a financial or proprietary interest in the subject matter or materials discussed, including, but not limited to, employment, consultancies, stock ownership, honoraria, and paid expert testimony.

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