Transplantation of a Tibial Osteochondral Allograft to Restore a Large Glenoid Osteochondral Defect

CHRISTOPHER L. CAMP, MD; JONATHAN D. BARLOW, MD; AARON J. KRYCH, MD

Abstract

Osteochondral disease of the glenoid is a well-known cause of shoulder pain and disability in young and active patients. The etiology can be multifactorial, and disease severity can exist across a wide spectrum. Symptoms can often interfere with athletic performance, job responsibilities, and activities of daily living. Although a number of cartilage restoration techniques exist for other joints, such as the hip, knee, ankle, and elbow, restorative options for glenoid osteochondral defects are currently limited. Given the success of osteochondral allograft transplantation in other joints, the authors hypothesized that osteochondral allograft transplantation may be a reasonable option in treating osteochondral disease of the glenoid if a suitable donor source could be identified. After performing the procedure in a cadaveric model, the authors found the articular geometry of the medial tibial plateau to closely resemble that of the glenoid articular surface. This graft option is advantageous because it is readily accessible from allograft tissue banks, whereas glenoid allografts are not currently available. After failure of extensive nonoperative treatment, a former multisport athlete underwent osteochondral allograft transplantation of a large glenoid defect with a medial tibial plateau osteochondral allograft. After 1 year of follow-up, the patient showed significant improvement in the subjective shoulder value (from 40% to 99%), QuickDASH score (from 36 to 2), and American Shoulder and Elbow Score (from 46 to 92). Ultimately, medial tibial plateau allograft was a viable option for treatment of an osteochondral glenoid defect in this patient, and additional study of this treatment strategy is warranted. [Orthopedics. 2015; 38(2):e147-e152.]

The authors are from the Department of Orthopedic Surgery, Mayo Clinic, Rochester, Minnesota. The authors have no relevant financial relationships to disclose. Correspondence should be addressed to: Aaron J. Krych, MD, Department of Orthopedic Surgery, Mayo Clinic, 200 First Street SW, Rochester, MN 55905 (krych.aaron@mayo.edu). Received: March 19, 2014; Accepted: June 24, 2014. doi: 10.3928/01477447-20150204-92
Symptomatic osteochondral disease may occur in as many as 13% to 17% of overhead athletes and patients with rotator cuff tears. Chondral injuries of the glenohumeral joint have a number of causes, including trauma, osteochondritis dissecans, infection, avascular necrosis, inflammatory arthritis, instability, rotator cuff arthropathy, osteoarthritis, chondrolysis, and iatrogenic injury, such as aberrant anchor placement. Although glenohumeral arthroplasty has a long and successful track record in treating end-stage disease in older and lower-demand patients, the increasing demands and activity levels of younger patients with osteochondral disease warrant consideration of alternative, joint-sparing treatments to maximize functional outcome.

Current surgical treatment options for osteochondral disease (eg, osteochondritis dissecans) of the shoulder include arthroscopic debridement, microfracture, osteochondral autograft transplant, osteochondral allograft transplantation, autologous chondrocyte implantation, resurfacing arthroplasty, soft tissue interposition arthroplasty, and unconstrained total shoulder arthroplasty. Generally, small focal lesions that are not treated successfully with nonoperative management may be treated with less demanding techniques, such as debridement and microfracture, whereas larger defects may require more advanced procedures. Although many of these technologies have been studied in other joints, such as the elbow, hip, knee, ankle, and even the humeral head and subchondral bone, and any treatment method should target repair of the entire osteochondral unit. Because osteochondral allograft transplantation is used to treat large lesions affecting both the cartilage and subchondral bone in the humeral head and other joints, such as the elbow, hip, knee, and ankle, the authors believed that it may offer a viable option for treating osteochondral disease of the glenoid as long as a geometrically matched donor surface can be obtained. After successfully completing the procedure on cadaveric specimens, the authors concluded that the articular architecture of the medial tibial plateau would be an acceptable match for the glenoid surface. This technique resulted in near-perfect visual geometric matching and congruency of the medial tibial plateau surface with the surrounding glenoid. After cadaveric confirmation of the geometry, the technique was used to treat a symptomatic osteochondritis dissecans lesion of the glenoid in a 25-year-old former multisport athlete. The goal of this report is to explain the technique and discuss clinical and radiographic outcomes in a patient undergoing transplantation of a medial tibial plateau osteochondral allograft to treat an articular cartilage defect of the glenoid.

**CASE REPORT**

A 25-year-old right-hand-dominant male radiography technician presented to the clinic with a 6-year history of increasing right shoulder pain. Formerly, he played football, baseball, and rugby. The pain began insidiously, with no acute traumatic event. He had no history of dislocation or instability. The pain was deep and achy and was exacerbated by activity. The patient rated the pain as high as 7 of 10 on the visual analog scale. At presentation, progressive shoulder pain significantly limited activities of daily living and work-related tasks. He had undergone a comprehensive course of physical therapy, used nonsteroidal anti-inflammatory drugs, and modified his activities, but the symptoms progressed. On examination, the patient was a fit and athletic man without tenderness to palpation about the right shoulder. Active motion examination showed full motion equivalent to the noninjured side, with 170° elevation in the scapular plane without scapular dyskinesis, external rotation to 45°, and internal rotation to T10. Strength examination showed full strength with internal rotation, external rotation, and elevation. Results of special tests, including apprehension testing, sulcus sign, and posterior jerk tests, were unremarkable. Axial loading reproduced activity-related pain. Preoperative functional performance scores were as follows: subjective shoulder value score, 40%; QuickDASH, 36; and American Shoulder and Elbow Surgeons score, 46 for the right upper extremity and 98 for the left upper extremity.

Radiographs and magnetic resonance imaging (MRI) scans were obtained preoperatively. Anteroposterior radiograph showed a central osseous defect in the glenoid measuring approximately 16×7 mm (Figure 1). The MRI scan showed a large cavitary cystic lesion in the glenoid, with surrounding bone marrow edema (Figure 1). High-grade chondromalacia of the overlying cartilage was noted, with fissuring of cartilage to the bone. The anterior and posterior labrum showed moderate degenerative changes without clear tearing and no evidence of humeral-sided cartilage lesions or rotator cuff abnormality. After nonoperative and operative treatment options were discussed with the patient, he elected osteochondral allograft transplantation to the glenoid lesion.

**SURGICAL TECHNIQUE**

The patient had an interscalene block and a general anesthetic. He was positioned in the beach chair position with the right scapula free. A deltopectoral approach was completed, with preservation of the cephalic vein, which was retracted medially. Deltidoid adhesions were released from the rotator cuff, and the proximal third of the pectoralis tendon was tenotomized. The rotator interval was...
incised, and subscapularis tenotomy was completed through its tendinous portion, approximately 1 cm medial to the insertion site. The tendon was tagged for later repair, and care was taken to protect the underlying articular cartilage. The patient had significant inflammation and partial tearing of the biceps tendon. Before glenoid exposure, the biceps tendon was tenodesed into the bicipital groove with a single interference screw (Arthrex, Naples, Florida). The glenoid was carefully exposed, with anterior and posterior capsular release completed in an alternating fashion as needed until the humeral head could be retracted sufficiently posteriorly to access the glenoid.

The glenoid had a 15-mm-diameter circular defect (Figure 2A). Full-thickness cartilage loss was noted in the area of the lesion, and soft, cystic bone was encountered on removal of the overlying cartilage layer. The posterior labrum showed degenerative changes but was intact. A template of the recipient site footprint was made, and a 20-mm dowel sizer was used to cover the lesion in its entirety. A guide pin was placed perpendicular to the articular surface in the center of the lesion. Reaming was completed with a cannulated reamer with a diameter of 20 mm over the guide pin to a depth of 8 mm, which was determined on preoperative studies to be the maximum depth that could be reamed without violating the posterior glenoid vault. A few small cysts remained at the base of the reaming, but healthy, bleeding bone was seen throughout most of the defect (Figure 2B).

A fresh osteochondral medial tibial plateau dowel allograft was prepared on the back table. The donor tibia had previously been cryopreserved at -80°C for 14 days to allow for microbiologic and serologic analysis before implantation. The donor plug was procured with a 20.5-mm reamer. The plug was trimmed to a depth of 8 mm to fit the recipient site (Figure 2C). The donor graft was pulse lavaged to remove marrow elements and then gently impacted into the glenoid with finger pressure. A supplementary solid Bio-Compression screw (Arthrex) was placed over a guide pin in the center of the transplanted allograft for backup fixation (Figure 2D). The articular geometry of the graft matched the native glenoid contour well, without articular incongruity. The shoulder was taken through a range of motion and had full motion with no instability or crepitus. The incision was copiously irrigated, and the subscapularis tenotomy was repaired with interrupted sutures with the arm in 30° external rotation. The rotator and deltopectoral intervals were reaproximated, and the incision was closed in layers. The patient was placed in a shoulder immobilizer before transfer from the operative table.

RESULTS
Postoperatively, passive range of motion was initiated with external rotation limited to 20° and elevation limited to 90°. Six weeks postoperatively, the patient began active and active assisted range of motion without restriction. Lifting with the operative extremity was limited to 9 pounds. At 3 months postoperatively, the patient began to work on strengthening
and maintained a 25-pound lifting restriction. Clinical examination was repeated, and the patient had full symmetric range of motion compared with the contralateral extremity, including forward elevation to 170° without scapular dyskinesis, external rotation to 45°, and internal rotation to T10.

Notably, the patient had transient brachial plexopathy postoperatively, possibly as a result of retraction for glenoid exposure. At 2 weeks postoperatively, sensation was present but diminished in the axillary nerve distribution and in the thumb and index finger. Strength testing showed 2/5 deltoid and biceps strength, 3/5 thenar strength, and 5/5 interossei, wrist flexor, and wrist extensor strength. Deltoid strength improved to 4/5 at 3 months and returned to full strength by 6 months. At 3 months postoperatively, strength in all other muscle groups was 5/5. Sensation was normal throughout the right upper extremity. One year after surgery, functional scores improved from preoperative baseline scores. Subjective shoulder value score improved 59% (from 40% to 99%), QuickDASH score improved 34 points (from 36 to 2), and American Shoulder and Elbow Surgeons score improved 46 points (from 46 to 92) for the right upper extremity. Articular surface restoration appeared well maintained on radiograph obtained 3 months postoperatively (Figure 3) and on MRI scan obtained 6 months postoperatively (Figure 4). The graft appeared to be incorporating into the surrounding subchondral bone, with appropriate congruity of the articular surfaces of the graft and glenoid (Figure 4).

**DISCUSSION**

Transplantation of a medial tibial plateau osteochondral allograft led to a successful outcome in the treatment of this patient’s glenoid defect. Although relatively uncommon, symptomatic glenohumeral osteochondral disease can be significantly disabling in high-demand patients. Given the activity level and longevity of these patients, joint-sparing surgery is preferred when nonoperative treatment modalities are unsuccessful. Because osteochondral disease affects both the articular cartilage and subchondral bone, treatment strategies that address both tissue defects are likely to optimize patient outcome and satisfaction. The various options for restoration of articular cartilage (eg, microfracture, osteochondral autograft transfer, osteochondral allograft transplantation, autologous chondrocyte implantation)
have shown efficacy in other large joints, such as the elbow, knee, hip, ankle, and humeral head, but few studies have reported treatment of chondral disease of the glenoid surface outside of shoulder arthroplasty.3,7

To the authors’ knowledge, this case is the first published report of osteochondral allograft transplantation of an osteochondral dowel from the medial tibial plateau to fill an osteochondritis dissecans defect of the glenoid. However, further proof of this concept was established by Rios et al17 in computed tomography comparison of the medial tibial plateau with the glenoid for osteochondral allograft transplantation. Currently, fresh-stored glenoid grafts with viable hyaline articular cartilage are not available from tissue banks, so a fresh-stored medial tibial plateau was used. Benefits of this technique include its ability to address large lesions of the glenoid, fill subchondral bone defects, immediately restore the articular geometry of the glenoid, and eliminate donor site morbidity caused by autograft harvests. The main limitations of this technique are the lack of published long-term functional outcomes and the potentially difficult surgical exposure. The large exposure is necessary because the recipient site should be prepared and the allograft should be transplanted perpendicular to the glenoid surface. This requires appreciable retraction of the humeral head, which likely contributed to this patient’s transient brachial plexopathy. Although they did not occur in the current patient, other potential complications of the use of allograft tissue in the shoulder include loss of graft fixation, failure of incorporation, and inadequate surface restoration or congruency, resulting in inadequate pain relief. When performing this procedure, care must be taken to ensure that perpendicular access to the glenoid is obtained while minimizing distraction and trauma to surrounding tissues. In addition, bacterial or viral infection is possible and graft availability can affect scheduling of the surgery.

**CONCLUSION**

Medial tibial plateau osteochondral allograft transplantation appears to be a viable treatment option for high-demand patients with osteochondral injury of the glenoid surface of the shoulder. This joint-preserving strategy provides greater functional capacity for athletes compared with arthroplasty. Although this technique provided a satisfactory functional outcome in the current patient, caution should be exercised whenever a new sur-
gical technique is used. Great care and attention should be paid to preoperative preparation, precise surgical steps must be executed, and postoperative rehabilitation should be followed diligently. In the future, this technique may be a satisfactory surgical option for higher-demand patients with osteochondral defects of the glenoid surface; however, additional long-term outcome data are needed before more definitive conclusions can be drawn.

REFERENCES


