Systematic Review

Humeral Head Reconstruction With Osteochondral Allograft Transplantation

Bryan M. Saltzman, M.D., Jonathan C. Riboh, M.D., Brian J. Cole, M.D., M.B.A., and Adam B. Yanke, M.D.

Purpose: To synthesize, in a systematic review, the available clinical evidence of osteochondral allograft transplants for large osteochondral defects of the humeral head. **Methods:** The Medline, Embase, and Cochrane databases were searched for studies reporting clinical or radiographic outcomes of osteochondral allograft transplantation for humeral head defects. Descriptive statistics were provided for all outcomes. After checking for data normality, we compared postoperative and preoperative values using the Student *t* test. **Results:** We included 12 studies (8 case reports and 4 case series) in this review. The study group consisted of 35 patients. The mean age was 35.4 $\pm$ 18.1 years; 77% of patients were male patients. Thirty-three patients had large Hill-Sachs lesions due to instability, 1 had an osteochondritis dissecans lesion, and 1 had an iatrogenic lesion after resection of synovial chondromatosis. The mean lesion size was 3 $\pm$ 1.4 cm (anteroposterior) by 2.25 $\pm$ 0.3 cm (medial-lateral), representing on average 40.5% $\pm$ 4.73% of the native articular surface. Of the 35 patients, 3 received a fresh graft, with all others receiving frozen grafts. Twenty-three femoral heads, 10 humeral heads, and 2 sets of osteochondral plugs were used. The mean length of follow-up was 57 months. Significant improvements were seen in forward flexion at 6 months (68° $\pm$ 18.1°, $P < .001$), forward flexion at 12 months (83.42° $\pm$ 18.3°, $P < .001$), and external rotation at 12 months (38.72° $\pm$ 18.8°, $P < .001$). American Shoulder and Elbow Surgeons scores improved by 14 points ($P = .02$). Radiographic studies at final follow-up showed allograft necrosis in 8.7% of cases, resorption in 36.2%, and glenohumeral arthritic changes in 35.7%. Complication rates were between 20% and 30%, and the reoperation rate was 26.67%. Although only 3 patients received fresh allografts, there were no reports of graft resorption, necrosis, or arthritic changes in these patients. **Conclusions:** Humeral head allograft—most commonly used in the setting of large Hill-Sachs lesions due to instability—has shown significant improvements in shoulder motion and American Shoulder and Elbow Surgeons scores as far as 1 year postoperatively. Return-to-work rates and satisfaction levels are high after the intervention. Complication and reoperation rates are substantial, although it is possible that use of fresh allograft tissue may result in less resorption and necrosis. **Level of Evidence:** Level V, systematic review of Level IV and V studies.

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Traumatic glenohumeral instability is a common problem facing orthopaedic surgeons, with an annual rate of 11.2 per 100,000 patients.[1] Hill-Sachs lesions and reverse Hill-Sachs lesions are impaction injuries to the softer cancellous portions of the humeral head that may occur after traumatic anterior and posterior glenohumeral joint dislocations, respectively. These bony injuries are associated with a higher rate of recurrent shoulder instability, by creating an articular arc mismatch.[2] Large defects pose a significant challenge to the orthopaedic surgeon when attempting to restore normal glenohumeral biomechanics and prevent continued subluxation or dislocation events.[2,3] In the setting of humeral bone loss, nonoperative treatment for shoulder instability is generally reserved for patients with low functional demands, poor compliance with post-operative rehabilitation protocols, significant medical comorbidities that would preclude surgical intervention without unacceptably high risks, or anatomic factors including a small osseous defect size or non-engaging lesions.[4,5] Kaar et al.[6] quantified through cadaveric analysis that glenohumeral stability decreased in abduction and external rotation with defects of greater than five-eighths of the humeral head radius. Many surgical strategies have been used in recent years to address these

From the Department of Orthopedic Surgery, Rush University Medical Center, Chicago, Illinois, U.S.A.

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Address correspondence to Bryan M. Saltzman, M.D., Department of Orthopedic Surgery, Rush University Medical Center, 1611 W Harrison St, Ste 300, Chicago, IL 60612, U.S.A. E-mail: bryan.m.saltzman@gmail.com

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large lesions, including humeral head augmentation, humeroplasty, disimpaction with elevation and bone grafting, and arthroplasty.[7] Remplissage has been proposed as well for smaller defects, with success in terms of redislocation and recurrent instability rates.[8]

Another recently implemented method to restore a spherical humeral head is osteochondral allograft transplantation. The use of osteochondral allografts has been proposed to address moderate to large humeral-sided defects (>40% of the articular surface). Size-matched fresh-frozen humeral or femoral head allograft plugs are press fit into the humeral defect and seated flush with the surrounding articular surface.[5] This allows reconstruction of the native articular contour, as well as filling of the subchondral bony defect with structural graft.[4,5] However, fresh-frozen grafts are essentially acellular because of the freeze-thaw process. Fixation devices may be used to secure the graft; however, it is unclear to what extent this is necessary.[9] In theory, the addition of a cartilaginous interface with restoration of normal anatomy for articulation with the glenoid may prevent future lesion engagement and subsequent instability. Because humeral head osteochondral allograft transplantation has only recently been introduced, the outcomes of the procedure are poorly understood.

The objective of this systematic review was to assess the clinical and radiographic outcomes after humeral head reconstruction with osteochondral allograft transplantation. Our hypothesis was that osteochondral allograft transplantation for traumatic defects of the humeral head in the setting of glenohumeral instability would improve range of motion (ROM) and functional outcome scores and would prevent recurrent instability episodes.

Methods

Study Design and Data Collection

The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (www.prisma-statement.org) were used to design our systematic review of the literature. The Medline, Embase, and Cochrane databases were reviewed for all English-language studies published between inception of the databases and August 2014. Two key phrases were used to search each database: (1) “humerus allograft” and (2) “humeral allograft.” The inclusion criteria included (1) Level I through V studies, (2) studies reporting on the use of osteochondral allograft transfer for humeral head defects, and (3) studies reporting clinical or radiographic outcomes. The exclusion criteria included (1) studies that were not available in English, (2) unpublished studies, and (3) studies that used allograft tissue for purposes other than cartilage resurfacing of the humeral head. All abstracts were reviewed in duplicate by 2 of the authors (B.M.S., J.C.R.) and assessed based on the aforementioned criteria. The full text of eligible studies was then reviewed by the same authors before final inclusion. Data were extracted in duplicate from all studies using a standardized form created by the authors at the onset of the review. Inconsistencies between reviewers were resolved by joint review of the involved studies.

Data Synthesis and Statistical Analysis

Because of the availability of Level IV and V studies only, formal meta-analysis was not indicated. Therefore frequency-weighted means were calculated with standard deviations to summarize continuous variables from multiple studies. Weights were assigned based on the number of patients in each study. For continuous variables that were reported preoperatively and postoperatively, 2-tailed t test calculations were performed using the summary data in Tables 1 and 2. Statistical significance was set at $P < .05$. All analyses were performed with JMP software (SAS Institute, Cary, NC).

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No internal or external funding sources were used in this investigation.

Results

Study and Patient Demographic Characteristics

Twelve studies, published between 1996 and 2013, met the inclusion criteria for this systematic review (Table 3).[7,10-20] Our search strategy is summarized in a PRISMA flowchart (Fig 1). Four of the studies were cases series, whereas 8 were single-case reports. A total of 35 patients were available for analysis. They were followed up for a mean of 57.02 ± 34.14 months (range, 8 to 122 months). The patients were predominantly male patients (77.14% ± 26.37%), and the dominant arm was typically affected (74.15% ± 27.99%). At baseline, the patients had poor ROM in all planes and low American Shoulder and Elbow Surgeons (ASES) scores (Table 1). In 33 of the 35 patients, osteochondral defects of the humeral head developed from traumatic instability; 1 patient had synovial chondromatosis with extensive humeral head erosion; and 1 patient had a diagnosis of osteochondritis dissecans. Of the patients with glenohumeral instability, 9 had anterior instability and 24 had posterior instability. The humeral head defects requiring allograft tissue were on average 3 ± 1.41 cm in anteroposterior diameter, 2.25 ± 0.35 cm in medial-lateral diameter, and 1.62 ± 0.54 cm deep. This represented 40.52% ± 4.73% of the native humeral head (Table 1).

Surgical Technique and Graft Fixation

In all but 1 study (with a single patient), a deltopectoral approach to the shoulder was used; a single patient underwent arthroscopic placement of humeral head allograft plugs.[10] A variety of graft types and fixation techniques were used. Of 12 studies, 5 used fresh-frozen femoral head