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# Treatment of osteochondral injuries of the humeral head using fresh osteochondral allograft transplantation

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**Background:** Large osteochondral lesions of the humeral head can result from locked posterior dislocations, avascular necrosis, and osteochondritis dissecans. Fresh osteochondral allograft (OCA) transplantation is a treatment option for young patients with focal osteochondral defects of the humeral head. The purpose of this case series was to assess graft survivorship, subjective patient-reported outcomes, and satisfaction among 7 patients who underwent OCA transplantation of the humeral head.

**Methods:** We identified 7 patients who underwent humeral head OCA transplantation between 2008 and 2017. A custom questionnaire including the American Shoulder and Elbow Surgeons score, Quick Disabilities of the Arm, Shoulder, and Hand score (QuickDash), Likert satisfaction, and reoperations was mailed to each patient. Clinical failure was defined as further surgery that involved removal of the allograft.

**Results:** Median follow-up duration was 10 years (range, 4.6 to 13.5 years) with a median age of 21.6 years (range, 18.5 to 43.5 years). Most patients (86%) reported improved function and reduced pain. At the final follow-up, 71% of patients reported ongoing problems with their shoulder including pain, stiffness, clicking/grinding, limited range of motion, and instability. Return to recreational activities was high at 86% but 43% expressed limitations with activity due to their shoulder. Overall satisfaction was high at 71% with mean American Shoulder and Elbow Surgeons and QuickDASH scores at 62.4 and 29.2, respectively. Reoperation after OCA occurred in 1 patient (14%).

**Conclusion:** Among this case series of 7 patients who underwent OCA transplantation of the humeral head, patient satisfaction was high at 10-year follow-up and most returned to recreational activity although most also had persistent shoulder symptoms.



Osteochondral lesions of the humeral head are difficult to manage in young, active patients and can result from locked posterior dislocations, avascular necrosis (AVN), and osteochondritis dissecans.[17,18,24] Posterior shoulder dislocations comprise less than 5% of all shoulder dislocations but result in a reverse Hill-Sachs lesion in 40%-90% of cases.[1]

Surgical treatment options are divided into 3 categories: (1) arthroplasty, (2) nonanatomic procedures, and (3) anatomic cartilage procedures. Shoulder arthroplasty with hemiarthroplasty (HA) and total shoulder arthroplasty (TSA) provide reliable pain relief and improvement in shoulder function. Classically, HA was preferred to TSA in younger patients given the lack of glenoid component for loosening; however, studies have shown lower implant survivorship and patient satisfaction of HA compared to TSA.[11] Patient age is also a factor for arthroplasty given implant longevity and risk of implant loosening. In younger patients under 55 or 60, revision rates have been shown to be higher at 15%-20% with mixed outcomes in patient satisfaction.[4,12,26,28,33] A specific age cut off for "young" is also variable with studies in the literature citing from 50-65 years old. [4,12,26,28,33] Subtotal resurfacing of humeral head defects with HemiCAP implants is another treatment option; however, there is a lack of data for its use in reverse Hill-Sachs lesions and implant survival remains an important consideration for younger patients.[2,16] Given the higher risk for complications requiring revision arthroplasty, alternative treatment options should be considered for young, active patients with humeral head lesions.

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Nonanatomic procedures for reverse Hill-Sachs lesions include subscapularis advancement (modified McLaughlin) and humeral rotational osteotomy. The modified McLaughlin procedure has been shown to have good results for locked posterior shoulder dislocations; however, it is not recommended when there is a delay from injury to diagnosis of more than 6 months.[8] Weber rotational osteotomy is a challenging operation to perform accurately and has been associated with high complication rates with 25 complications in 17 patients as reported by Brooks-Hill et al.[5]

Anatomic procedures for humeral head cartilage defects include microfracture, osteochondral autograft transfer, osteochondral allograft (OCA), and autologous chondrocyte implantation. Microfracture is less effective in treating larger osteochondral defects and should not be used in the setting of unaddressed shoulder instability.[23,29] Osteochondral autograft transfer is more effective for smaller lesions with donor site pain being an important complication to consider.[31] Research is limited on autologous chondrocyte implantation for humeral head osteochondral defects with important considerations including the 2-stage surgical design and relative increased cost.[3]

OCA transplantation is an anatomic procedure that restores the native spherical contour of the humeral head in osteochondral defects by press fitting a size-matched fresh humeral head allograft into the host defect site. Current studies regarding treatment of osteochondral injuries of the humeral head using OCA transplantation is limited to case studies and case series, predominantly for large Hill-Sachs lesions.[6,7,9,10,13-15,21,22,27,30,32,34] These studies mainly report on postoperative range of motion, radiographic outcomes, complications, and outcome scores with few studies reporting on graft survivorship and satisfaction. The purpose of this study is to assess graft survivorship, subjective patient-reported outcome measures (PROMs), and satisfaction among 7 patients who underwent OCA transplantation of the humeral head.

## Methods

Through a retrospective chart review, 7 patients that received a humeral head OCA transplantation performed between 2008 and 2017 at our institution were identified. Surgical indications included posterior dislocations with reverse Hill-Sachs lesions, AVN, osteochondritis dissecans, and focal osteochondral defects. A custom questionnaire was mailed to each patient and assessed current shoulder problems, pain, function, return to recreational activities, satisfaction, and further surgery. American Shoulder and Elbow Surgeons (ASES) and Quick Disabilities of the Arm, Shoulder, and Hand score (QuickDash) surveys were also included. Clinical failure was defined as any further surgery that involved removal of the allograft.

### *Surgical technique*

Patients were positioned in a beach chair and a standard deltopectoral approach was utilized. The subscapularis was identified and elevated with a peel to access the glenohumeral joint. In cases where the humerus remained posteriorly dislocated, an extensive capsular release was performed to reduce the shoulder. The humeral head articular surface was then examined and the osteochondral defect identified.

The size of the osteochondral defect(s) was then measured to determine the appropriately sized round dowel to cover the entire defect. A guide pin was placed into the osteochondral defect perpendicular to the articular surface. A cartilage cutter was used to score cartilage in the area to be replaced. A coring reamer was used to ream through the articular cartilage down to healthy subchondral bone to a depth of about 5 to 8 mm. A depth gauge was then used to measure the depth of the north, south, east, and west.

A fresh humeral head donor allograft was then prepared. A guide pin was placed in the homologous spot on the donor allograft as matched to the host defect site. A coring reamer was placed to a depth of about 10 to 12 mm and the donor plug was removed. The excess bone of the graft was then trimmed to match the depth of the recipient sites as previously measured.

The donor graft was then gently tamped into the host defect for a press fit technique. In cases where graft press fit fixation was not felt to be stable, supplemental graft fixation was performed with chondral darts. Two overlapping grafts were used in some larger lesions (Fig. 1).

## Results

Seven patients received humeral head OCA transplantation at a median follow-up of 10.0 years (range, 4.6 to 13.5 years). All patients were male, and the median age was 21.6 years (range, 18.5 to 43.5 years). The procedure was performed on the right side in 3 of 7 patients. Three patients received humeral head OCA transplantation for reverse Hill-Sachs lesions, 3 for osteochondral defects, and 1 for avascular necrosis. Five patients required 1 graft with the median graft diameter in these patients being 27.5 mm (range, 22.5 to 30 mm). The 2 other patients required 2 grafts each. One had graft sizes of 22 mm and 22.5 mm. The other had graft sizes of 27.5 mm and 25 mm. Demographics are summarized in Table I.

Five of 7 patients (71.4%) reported shoulder problems at the latest follow-up (Table II), which included pain, stiffness, clicking/grinding, instability, limited range of motion, and/or worry of reinjury. Six of 7 patients (85.7%) reported less pain and better function. The 1 patient not reporting less pain or better function was the only patient that required further surgery. Eleven years following OCA transplantation, this patient underwent arthroscopic débridement with capsulorrhaphy, loose body removal, and labral repair. Because the graft remained in situ, this was not considered failure of the allograft. Overall, allograft survivorship after OCA transplantation was 100% at a median follow-up duration of 10 years.

Five of 7 patients (71.4%) currently participate in sports or recreational activities including dirt bike riding, basketball, baseball, golf, swimming, weightlifting, and woodworking. Four of 7 (57.1%) patients reported limitations in returning to sports or recreational activities which included pain and instability, a limited golf swing, no longer participating competitively, and no longer participating at all.

Overall, 5 patients were very satisfied with surgery, 1 was somewhat dissatisfied, and 1 was very dissatisfied. Five patients were very satisfied with improvement in their pain, 1 was somewhat satisfied, and 1 was somewhat dissatisfied. Five patients were very satisfied with the improvement in their ability to do home or yard work and 2 were somewhat dissatisfied. Five patients were very satisfied with the improvement in their ability to perform recreational activities, 1 was somewhat dissatisfied, and 1 was very dissatisfied.

Mean ASES score was 62.4 postoperatively (range, 26.7 to 100) and mean QuickDASH score was 29.2 (range, 0.0 to 75.0). Results of all PROM measures are summarized in Table II.

## Discussion

Factors that affect treatment decision making for humeral head cartilage lesions include the patient's age and humeral head defect size. In young patients with defects less than 50% of the articular surface, joint preservation surgery is preferred over shoulder arthroplasty given the patient's need for longevity of the shoulder. Our small case series continues to support the use of OCA for

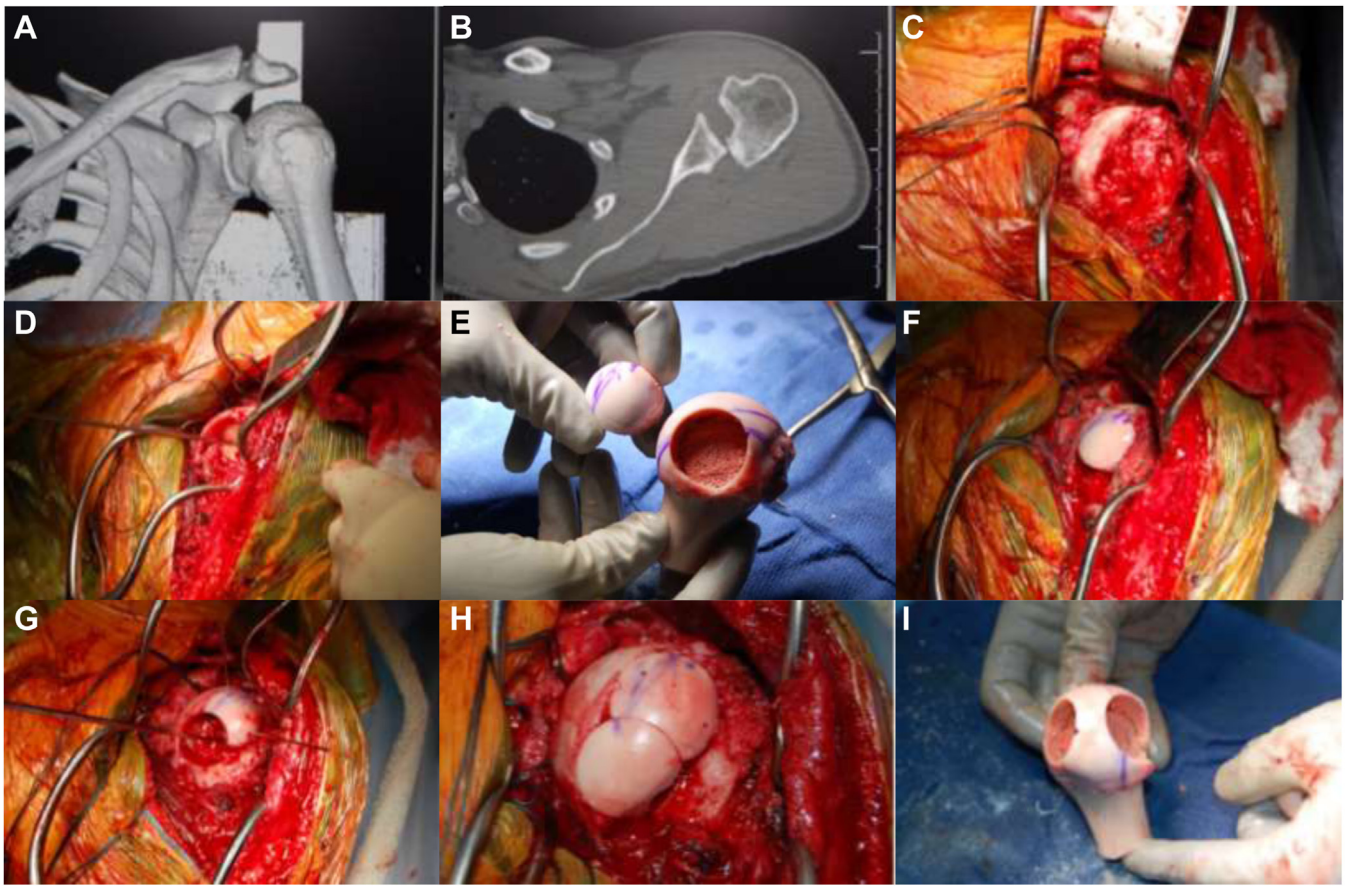


**Figure 1** (**A**) Computed tomography 3-dimensional reconstruction and (**B**) magnetic resonance imaging of the left shoulder demonstrating a chronic posterior dislocation with reverse Hill-Sachs lesion in a 30-year-old male. (**C**) The large osteochondral defect is identified and exposed. (**D**) A guide pin is placed into the osteochondral defect perpendicular to the articular surface. A cartilage cutter is used to score cartilage in the area to be replaced and a coring reamer is used to ream through the articular cartilage down to healthy subchondral bone. (**E**) A fresh humeral head donor allograft is then prepared and (**F**) gently tamped into the host defect for a press fit. (**G, H**) For this larger osteochondral defect, the process is repeated and grafts were overlapped to cover the defect. (**I**) Both grafts were obtained from the same fresh humeral head donor allograft.

**Table I**
Patient demographics and follow-up data.

| Patient | Sex | Age | Indication for OCA | Number of grafts | Follow-up time (y) |
|---|---|---|---|---|---|
| 1 | M | 18.5 | Osteochondral defect | 1 | 11.1 |
| 2 | M | 38.3 | Reverse Hill-Sachs | 2 | 13.5 |
| 3 | M | 20.3 | Osteochondral defect | 1 | 11.0 |
| 4 | M | 21.6 | Avascular necrosis | 1 | 7.8 |
| 5 | M | 43.5 | Reverse Hill-Sachs | 1 | 6.6 |
| 6 | M | 17.0 | Osteochondral defect | 1 | 4.6 |
| 7 | M | 30.9 | Reverse Hill-Sachs | 2 | 10.0 |

*OCA*, osteochondral allograft.

articular cartilage defects in young patients with good results in patient satisfaction, pain improvement, and shoulder function.

Literature for humeral head OCA is limited to case studies and case series given the rarity of these injuries in young patients. Recently Kasier et al 2023 published their series of 21 patients showing 60% survival at 10-year follow-up.[19] Saltzman et al 2015 published a systematic review on the outcomes of humeral OCA that included 12 studies with 35 shoulders.[30] Overall they found good aggregate results at mean follow-up of 4.75 years with 90% patient satisfaction, 3% recurrent instability, and 32% residual pain. The largest single-case series included were by Gerber et al in 2014 with 19 shoulders, followed by Diklic et al 2010 with 13 shoulders, and Muccioli et al 2021 with 12 shoulders.[9,13,21] Gerber found patient satisfaction over 90% at 10-year mean follow-up but a 30% rate of radiographic signs of osteoarthritis.[13] Diklic used the femoral head as the donor graft and found 92% satisfaction at 4.5-year follow-up with 1 failure (8%) with spontaneous osteonecrosis.[9] Muccioli found a mean Constant Score of 82 points, mild grade I or II Samlison-Prieto osteoarthritis in all patients, and no failures or reoperations at mean 5.5-year follow-up.[21] Similar to these previously published case series, our study shows good patient satisfaction of 70% at 10 years with no patient failure as defined by graft removal or conversion to arthroplasty. One patient underwent subsequent arthroscopic débridement with capsulorrhaphy, loose body removal, and labral repair. Overall, patients demonstrated satisfactory ASES and QuickDASH scores at the latest follow-up, but the majority (4 of 7) continued to have persistent symptoms of pain or instability with activity.

**Table II**
PROM measure results.

| Patient | Shoulder problems | Further surgery | Less pain | Better function | Participation in sports/rec | Limitation in sports/rec | Other limitations to sports/rec | Overall satisfaction | Satisfaction with pain improvement | Satisfaction with improvement in ability to do yard work | Satisfaction with improvement in sports/rec | ASES score | Quick DASH score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Yes | Yes | No | No | No | Yes (Pain and instability) | No | Somewhat dissatisfied | Somewhat dissatisfied | Somewhat dissatisfied | Somewhat dissatisfied | 32.0 | 75.0 |
| 2 | Yes | No | Yes | Yes | Yes | Yes (Limited golf swing) | No | Very satisfied | Very satisfied | Very satisfied | Very satisfied | 26.7 | 31.8 |
| 3 | No | No | Yes | Yes | Yes | No | Yes (Finished athletic career) | Very satisfied | Very satisfied | Very satisfied | Very satisfied | 98.3 | 0.0 |
| 4 | Yes | No | Yes | Yes | Yes | No | No | Very satisfied | Very satisfied | Very satisfied | Very satisfied | 81.6 | 18.2 |
| 5 | Yes | No | Yes | Yes | No | Yes (No longer participate) | No | Very dissatisfied | Somewhat satisfied | Somewhat dissatisfied | Very dissatisfied | 36.6 | 45.5 |
| 6 | No | No | Yes | Yes | Yes | No | Yes (Less interest) | Very satisfied | Very satisfied | Very satisfied | Very satisfied | 100.0 | 2.3 |
| 7 | Yes | No | Yes | Yes | Yes | Yes (No longer play competitive) | No | Very satisfied | Very satisfied | Very satisfied | Very satisfied | 61.6 | 31.8 |

*ASES*, American Shoulder and Elbow Surgeons; *PROM*, patient-reported outcome measure; *DASH*, Disabilities of the Arm, Shoulder, and Hand.

There are limited studies in comparing the outcomes of humeral head OCA to other shoulder procedures. Longo et al 2014 published a systematic review with 26 studies and 769 shoulders on the outcomes of several surgeries including remplissage, OCA, rotational osteotomies, and arthroplasty.[20] When comparing PROMs with Constant Score across 10 of the 26 studies, OCA patients scored on the lower end with a mean of 76.2 compared to the mean averages of 94.6, 79, and 58.2 for remplissage, rotational osteotomies, and arthroplasty patients, respectively. OCA also had the highest rate of postoperative complications at 74% although they included persistent pain, stiffness, mechanical symptoms, and AVN in this number. Arthroplasty had a complication rate of 19% with the most common issue being persistent instability (14%) and others including subscapularis rupture, component loosening, periprosthetic fracture, scapular notching, and nerve injury. In contrast, humeral allograft reconstruction had no recurrent instability. Although there are no direct comparative studies examining OCA and arthroplasty, current evidence suggests that OCA is a viable option for function and stability despite the majority of patients having persistent symptoms.

Limitations of our study include a small sample size and diversity of etiology, causing osteochondral defects. Our patients included 3 posterior dislocations with reverse Hill-Sachs, 3 osteochondral defects, and 1 case of AVN. Although we did not find a difference in patient outcomes based on etiology, others have found poorer outcomes with AVN cases. Miyazaki et al 2017 published a small case series of 5 humeral head OCA cases for AVN with 3 satisfactory outcomes and 1 failure with conversion to hemiarthroplasty.[25] Another limitation of the study is the lack of PROM scores that measure pain and an overall assessment of well-being or quality of life. Due to the rarity of the procedure, we did not routinely collect these outcomes on patients undergoing shoulder OCA at our institution. Additionally, we also did not collect outcome scores preoperatively, which limits our ability to assess changes in scores from preoperatively to the latest follow-up. Lastly, due to the varying duration of follow-up among the 7 patients included in this case series, we are limited in our ability to assess the longevity of the graft or change in function over time. Despite these limitations, the authors believe this study provides a significant contribution to the literature given the rarity of the procedure.

## Conclusion

OCA for humeral head defects in the young and active patient has an overall high survivorship at 10 years although the majority of patients reported persistent symptoms. Although the PROMs may not be as high as in shoulder arthroplasty, OCA does avoid the complications that can be seen in shoulder arthroplasty such as implant loosening that would require revision. When counseling young patients with large humeral head defects for OCA, one should set expectations of improved function and return to recreational activities but persistent symptoms.

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