

# Fresh Osteochondral Allograft to the Humeral Head for Treatment of an Engaging Reverse Hill-Sachs Lesion

## Technical Case Report and Literature Review

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Posterior dislocation of the shoulder is rare, occurring in approximately 2% to 4% of all shoulder dislocations.<sup>18,32</sup> Through a mechanism similar to that first characterized by Hill and Sachs,<sup>17</sup> these dislocations have the potential to result in impaction fractures of the anterior aspect of the humeral head.<sup>32,33</sup> These so-called reverse Hill-Sachs or McLaughlin<sup>26</sup> lesions are estimated to occur in 86% of acute traumatic posterior shoulder dislocations<sup>35</sup> and are often clinically significant, giving rise to persistent shoulder instability in approximately 35% of cases.<sup>32</sup> An array of treatment options are described in the literature, dependent on factors including but not limited to the location, size, and scale of the defect; mechanism of recurrence; chronicity of the dislocation; and, importantly, the patient's age, prior activity, and postoperative goals.

Osteochondral autograft has been reported rarely, save for a few patients with bilateral fracture-dislocations of the humeral head wherein the contralateral shoulder provides the graft source during treatment with concurrent hemiarthroplasty.<sup>8,19</sup> Discussion of osteochondral allograft has focused largely on the treatment of chronic, locked posterior fracture-dislocations.<sup>12,16</sup> These authors express concern

regarding the potential for degenerative changes associated with chronic instability, suggesting a biomechanical environment distinctly different from lesions treated in the period shortly after initial presentation.

In a systematic review of osteochondral allograft for humeral head reconstruction, Saltzman et al<sup>34</sup> identified 2 instances of fresh humeral head osteochondral allograft in humeral head reconstruction. In both instances, the allograft was fixed to adjacent tissue using nonabsorbable compression screws. Several case series involving osteochondral allograft for the treatment of similar Hill-Sachs lesions have been reported using a variety of fixation methods.<sup>24,25,28</sup> We report the use of fresh osteochondral allograft to the humeral head using a press-fit dowel technique in the context of the spectrum of historical options.

## METHODS

A 24-year-old, right hand-dominant male laborer presented to our level 1 trauma center after being struck by a car while riding his bicycle. His injuries were limited to the musculoskeletal system. Physical examination of the left upper extremity elicited shoulder pain with limited passive range of motion. Neurovascular examination of the left upper extremity was otherwise normal. Radiographs indicated a reverse Hill-Sachs lesion and a small cortical irregularity of the posterior glenoid (Figure 1).

A fracture of the ipsilateral tibial plateau was remarkable, as it required open reduction and internal fixation. This delayed treatment of the symptomatic and unstable index shoulder injury.

Magnetic resonance imaging (MRI) (Figure 2) further characterized the shoulder injury. The humeral impaction

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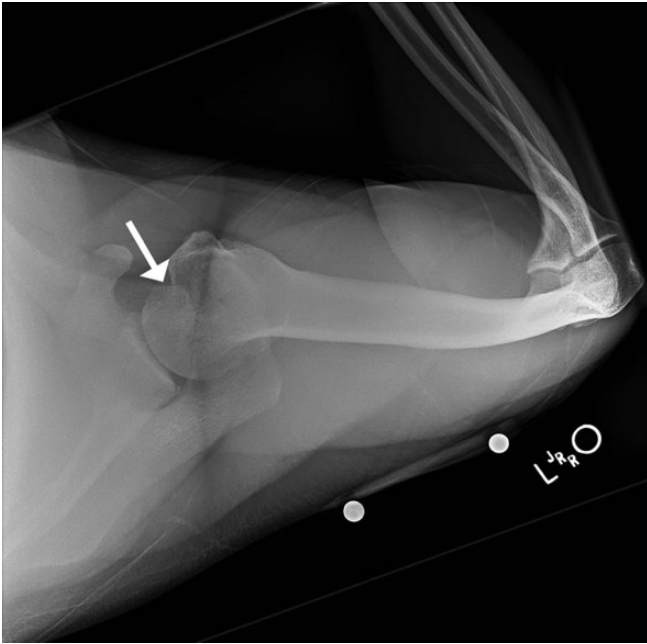
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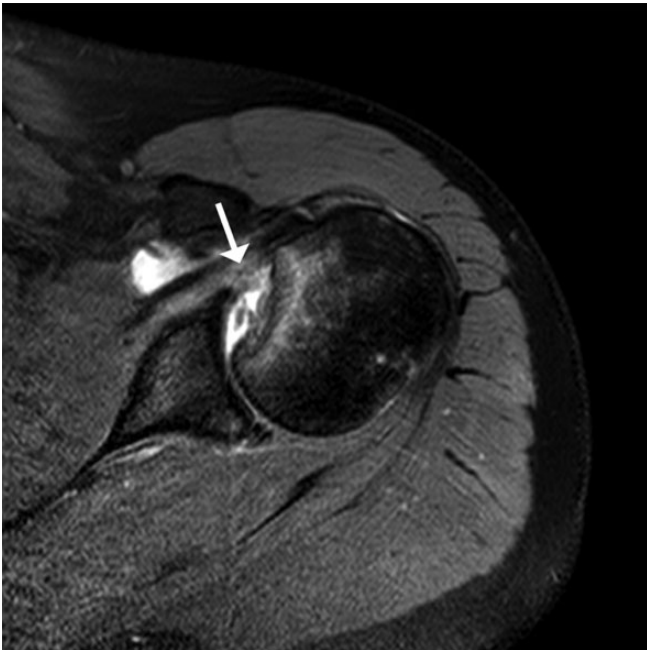
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**Figure 1.** Preoperative radiograph of the left shoulder illustrating a reverse Hill-Sachs lesion (arrow) and a small, minimally displaced fragment associated with a Bankart lesion of the posterior cortical glenoid.



**Figure 2.** Preoperative magnetic resonance image of the left shoulder illustrating a reverse Hill-Sachs lesion (arrow) 2 cm in width and 5 mm in depth involving 33% of humeral articular surface.

was estimated to measure approximately 2 cm in width with a depth of approximately 5 mm. Using the methodology described by Nathan and Parikh,<sup>27</sup> the lesion was

estimated to involve approximately 33% of the articular surface of the humeral head. A small soft tissue Bankart lesion was minimally displaced adjacent to a posterior cortical glenoid subchondral edema. Shoulder function was both subjectively painful and limiting. This was further assessed via standard outcomes measures. This included a total score of 73 on the American Shoulder and Elbow Surgeons (ASES) scoring system,<sup>22,31</sup> an Oxford Shoulder Score<sup>10</sup> of 28, and concomitant health-related quality of life deficits as reflected by Veterans RAND 12-Item Health Survey (VR-12) physical and mental component scores<sup>20</sup> of 37.2 and 48.4, respectively.

Operative treatment using fresh osteochondral allograft was recommended to address persistent shoulder instability and the limitations reflected by the patient-reported outcome (PRO) scores. Treatment was deferred until the lower extremity fracture was healed and crutch-assisted limited weightbearing was no longer required. Ultimately, this required a delay of 18 weeks from the index shoulder injury to the repair described herein.

General anesthesia and a single injection of 20 mL of ropivacaine 0.5% to the interscalene region of the ipsilateral neck provided adequate sedation and pain control for examination and surgery. The patient was positioned in the beach-chair position to obviate the need for traction and provide for an open anterior approach after arthroscopy. The shoulder was found to subluxate and dislocate with passive internal rotation as the reverse Hill-Sachs lesion engaged beyond 20° of internal rotation, with as little as 10° of shoulder abduction suggesting the impaction fracture contribution to the recurrent instability.

After standard sterile surgical preparation and preoperative pause, arthroscopy proceeded using gravity flow sterile lactated Ringer solution with dilute epinephrine. A standard posterolateral portal was used to introduce the diagnostic arthroscope. Evaluation identified stable labral tissue, with no superior labral anterior-posterior (SLAP) tear and no loose bodies. The impaction fracture of the anterior humeral head indicated in preoperative imaging was confirmed.

A standard anterosuperior portal was created using an inside-out technique lateral to the coracoid. A 5.0-mm cannula was placed via this rotator interval cannula and used to transmit instruments. Further diagnostic evaluation found the posterior labrum to be healed in a stable position and not requiring further stabilization. With the diagnostic arthroscopy complete, attention was turned to the anterior shoulder for the arthrotomy.

A mini-deltpectoral incision (4 cm) allowed access to the joint. The subscapularis tendon was identified, and its upper border was dissected from the lesser tuberosity. The posterior capsule did not require capsulorrhaphy. The extent of the impaction fracture of the anterior humeral head was measured as 18 mm in maximum diameter using components of the Arthrex Giant Osteochondral Allograft Transplant system. Specifically, this was accomplished by placing recipient sizing guides over the defect at a 90° approach to the humeral articular surface until near complete coverage. We selected the smallest diameter to

minimize damage to the adjacent native tissue, assuring best congruity at the posterior margins of the uninjured adjacent cartilage in deference to the anterior elements adjacent to the subscapularis insertion.

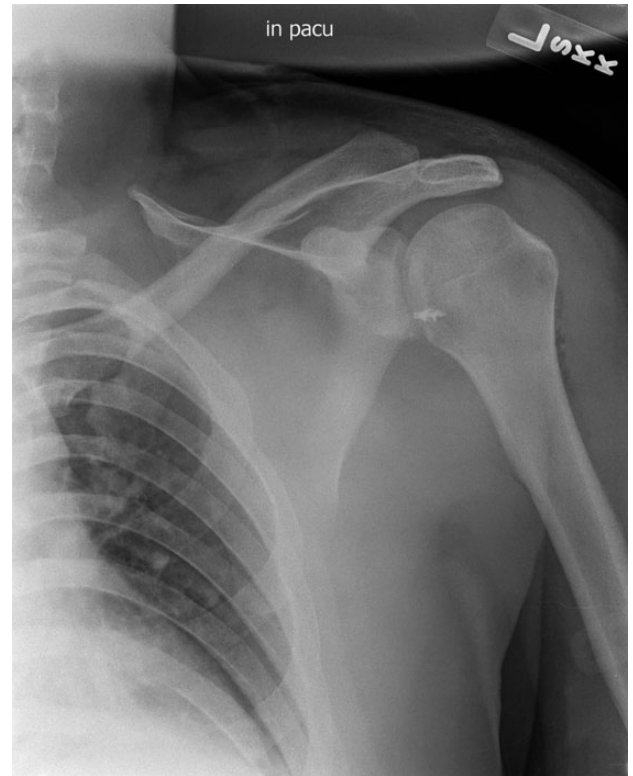
A guide pin was placed securely in the center of the lesion via the sizing guide, and a “cookie cutter” resection tool was used to sharply demarcate and score the peripheral area of damaged tissue from adjacent healthy cartilage. A line-to-line, 18-mm cannulated drill was placed over the guide pin allowing for removal of the damaged tissue to a depth of 4 to 5 mm. This provided for a contained defect bed, with right angle walls to accept and secure the osteochondral allograft tissue. The nonviable tissue was removed and the prepared bed irrigated with lactated Ringer solution.

A fresh, ipsilateral humeral head allograft of appropriate size was procured from the Joint Restoration Foundation in compliance with US Food and Drug Administration regulations. The graft tissue had been harvested 18 days prior to implantation and tested negative to serologic evaluation for hepatitis B, hepatitis C, human immunodeficiency virus, syphilis, and human T-cell lymphotropic virus types I and II. An 18-mm transplant dowel was prepared from the analogous region of the donor tissue using an 18-mm coring reamer to mimic the geometry of the surface area. The graft was transversely cut through the subchondral bone to a thickness of 4 to 5 mm to sit within the defect bed with a goal of creating a flush articular surface. Prior to insertion, it was thoroughly washed using a pulse lavage vacuum system with lactated Ringer solution to remove any remnant donor cells in the bony element of the osteochondral graft. It was further tailored for a press-fit application by beveling the first millimeter of subchondral bone at the graft periphery with a rongeur to allow less resistance to press-fitting. Note that this was done around the entire graft, leaving the majority of the graft margin at a right angle to the cartilage surface.

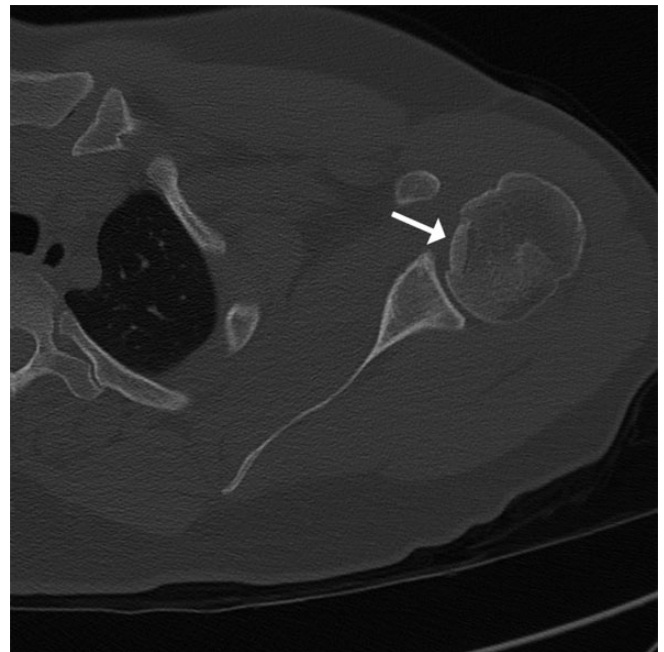
The transplant tissue was then placed into the prepared bed, gently pushed by hand rather than impacted, such that the entire graft was flush or potentially slightly countersunk in relation to adjacent native cartilage. The graft was then further assessed for stability by gentle internal and external rotation, which both assured congruency (ie, no catching or step-off click) and final position. Thus, the biologic implant required no additional internal fixation.

With the humeral head surface restored, the subscapularis tendon was repaired using a single rotator cuff anchor. The anterior capsule was closed anatomically after repair of the subscapularis, and the wounds were closed routinely. There were no complications during the procedure.

Postoperative radiographs performed immediately after the procedure illustrated the osteochondral allograft in situ and the anchor used to repair the subscapularis tendon (Figure 3). A sling for protection of the subscapularis repair was prescribed for 6 weeks, excluding physical therapy and daily home exercises. Active internal rotation and passive external rotation of the glenohumeral joint were prohibited during this period. Similarly, weightbearing was restricted to less than 2 pounds, but active forward flexion and external rotation were encouraged without resistance.



**Figure 3.** Postoperative radiograph immediately after surgical treatment with osteochondral allograft. The single rotator cuff anchor was used in the repair of the subscapularis tendon.



**Figure 4.** Postoperative computed tomography image (+12 weeks) illustrating the 18 × 18-mm osteochondral allograft of the anterior aspect of the proximal humerus in near-anatomic alignment with signs of early incorporation.

TABLE 1  
Patient-Reported Outcome Measures of Shoulder Function and Health-Related Quality of Life<sup>a</sup>

Time	ASES			VR-12		Oxford Shoulder Score
	Total	Pain	Instability	Physical	Mental	
Preoperative	73	2	9	37.2	48.4	28
6 mo	88	2	2	48.5	60.4	46
10 mo	83	3	1	50.3	55.0	45
32 mo	92	1	1	55.3	50.5	47

<sup>a</sup>ASES, American Shoulder and Elbow Surgeons; VR-12, Veterans RAND 12-Item Health Survey.

## RESULTS

At 6 weeks' follow-up, the wound had healed and motion was limited. Passive range of motion was 80° of forward flexion, 15° of external rotation with arm at side, internal rotation to a neutral position (approximately 70° of internal rotation), and abduction to 80°. The motor examination on the operative shoulder was limited by pain and was notable for 3- strength with shoulder flexion, extension, abduction, and internal rotation and 2+ strength to external rotation. Unrestricted motion and limited weightbearing were encouraged, including formal physical therapy.

At 12 weeks, the patient had a near normal passive arch of shoulder motion and minimal muscle atrophy. Computed tomography indicated the subchondral portion of the graft in near-anatomic alignment with signs of bone bridging and healing (Figure 4). This was taken as evidence of proper incorporation of the graft to the surrounding bone, and full unrestricted activity was permitted and encouraged.

At 20 weeks, active range of motion was within normal limits and was equal to the unaffected shoulder. The patient reported complete resolution of shoulder pain, mild occasional stiffness, and full return to work activity without difficulty. Formal physical therapy was discontinued.

Patient-reported measures of shoulder function and health-related quality of life improved by 6 months, and remained durably improved through 32 months (Table 1).

Thirty-two months after treatment, the patient remained able to perform all preinjury work and recreational activity, specifically bicycling, snowboarding, and skateboarding, without increased or limiting shoulder symptoms and was satisfied with the outcome.

## DISCUSSION

Much of the literature addressing management of the reverse Hill-Sachs lesion has focused on the extent of the defect, reported as the fraction of the articular surface of the humeral head covered by the lesion. While the scale of the defect is an important consideration, the potential for subsequent instability is of equal importance in developing an appropriate treatment plan.<sup>32</sup>

Engaging lesions, first described in the context of anterior dislocations,<sup>5</sup> present an elevated risk of future

instability. As such, the value of thorough examination of primary posterior dislocations cannot be overstated, beginning with careful clinical examination, involving radiographic and MRI as needed, and culminating with sound perioperative assessment.

The management of engaging reverse Hill-Sachs lesions remains controversial. Options include disimpaction<sup>1,2,14,38</sup>; soft tissue procedures such as posterior Bankart repair,<sup>37</sup> remplissage,<sup>30</sup> the McLaughlin procedure,<sup>15,23,26</sup> and a derivative involving the middle glenohumeral ligament<sup>13</sup>; osteochondral allograft<sup>16,24,25</sup>; rotational osteotomy<sup>21,36</sup>; partial arthroplasty<sup>6</sup>; and total arthroplasty.<sup>7</sup>

Partial arthroplasty was considered for the current case, but it was not felt to be the best option for such a young, active patient. Soft tissue procedures are described for reverse Hill-Sachs lesions; however, given the size and location of this patient's lesion, these would be expected to result in significant loss of motion.<sup>11</sup> In this case, given the patient's age and the size, location, and engaging nature of the lesion in combination with the relatively intact anatomy of the glenoid, fresh osteochondral allograft was recommended.

Prior discussion of allograft in the literature has focused largely on frozen allograft tissue with metallic screw fixation.<sup>16,24,25</sup> While this is a reasonable approach, it poses a number of considerations. First, fresh allograft has demonstrated superior chondrocyte viability when compared with frozen allograft, approaching that of native tissue.<sup>3,4,9,29</sup> Second, metallic fixation requires disruption of the articular surface, with the potential for hardware complications and limiting future MRI studies. The use of the press-fit technique avoids these concerns.

To yield the necessary interference fit, this technique requires the creation of a cylindrical site on the humeral head into which a similarly shaped, slightly larger graft is press-fit. It is noted that the allograft may not be shaped to precisely fill the entirety of the bony defect. However, the reverse Hill-Sachs lesion can be repaired without complete congruency of the allograft as long as a smooth arc of motion is restored and any remaining incongruency is sufficiently small that it does not engage the glenoid rim. This is conceptually analogous to the function of a partial articular resurfacing implant.

Surgeons should consider fresh osteochondral allograft for treatment of engaging reverse Hill-Sachs lesions, where appropriate, particularly in the younger, active patient with a lesion not ideally amenable to traditional hemiarthroplasty. Fresh allograft applied using a press-fit

technique both eliminates risk of hardware complication and provides a biologically anatomic reconstruction, and in this case, a sustained improvement in pain and function.

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