Technical Note

All-Arthroscopic Treatment of Off-Track Hill—Sachs Lesions Using Fresh Osteochondral Allograft Plugs: "Rocks in a Stream"

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Abstract: Osteochondral allograft transplantation is a well-described technique for the treatment of large, engaging Hill—Sachs lesions. Traditionally, osteochondral allografts are size-matched to the defect, which can be expensive and time-consuming, and the majority of described techniques require an open approach. This Technical Note describes an all-arthroscopic approach to Hill—Sachs osteochondral allograft transplantation using premade osteochondral allograft plugs, eliminating the need for size-matching and graft harvest. This approach works not by anatomically filling the defect, but rather by bridging the defect to prevent it from engaging the glenoid.

The Hill—Sachs (HS) lesion is an osseous defect of the posterosuperolateral humeral head that can occur with anterior dislocation of the glenohumeral joint.[1] A better understanding of the association between humeral head osseous defects and recurrent shoulder instability has led to increased efforts to better classify and manage these injuries.

Management of HS lesions must consider the bipolar nature of these injuries—that is the contribution of humeral-sided and glenoid-sided injury and their interplay.[2-4] Small HS lesions that do not engage the glenoid rim ("on-track") are typically treated nonoperatively, with arthroscopic labral repair alone if warranted.[5,6] A variety of procedures is available for the treatment of clinically significant lesions that engage the glenoid rim ("off-track").[7] Historically, rotational humeral osteotomy was used to increase humeral head retroversion, thereby preventing the lesion from engaging the glenoid rim.[8] More recently, techniques have been developed to directly fill the defect, including tissue filling with the infraspinatus tendon (remplissage), disimpaction, resurfacing, and use of osteochondral allograft (OCA).[1,9-11]

Humeral head OCA is classically indicated for clinically significant HS lesions with or without concurrent glenoid bone loss.[1] The goal of the procedure is to restore the native humeral arc as it rotates on the glenoid, in turn converting the off-track lesion into an on-track lesion. Traditionally, humeral head allografts are size-matched to the defect. This entails using 3-dimensional computed tomography reconstruction imaging as a guide for securing donor graft from a certified tissue bank, which can be expensive and time-consuming (both pre- and intraoperatively), and typically requires an open incision and arthrotomy to fill the HS defect.[12] The following technical report describes an all-arthroscopic approach for the treatment of off-track HS lesions using premade and readily available fresh OCA plugs. Together, the OCA plugs function like "rocks in a stream," effectively allowing the glenoid to traverse the HS lesion during shoulder motion without falling into the defect.

Surgical Technique (With Video Illustration)

Preoperative imaging demonstrates a large HS lesion, and the Hill—Sachs interval is measured on an axial

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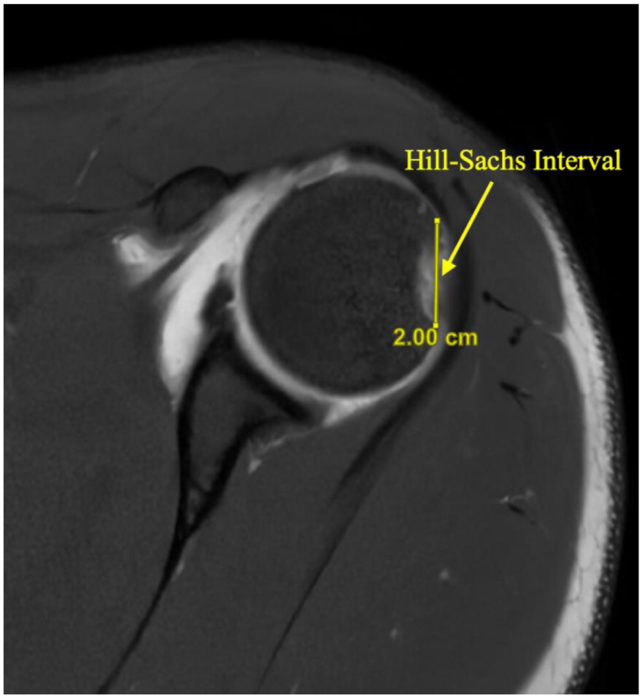

Fig 1. Axial magnetic resonance imaging of a left shoulder with calculation of Hill–Sachs interval (HSI). HSI = width of Hill–Sachs lesion plus width of any intact bone bridge between the lateral margin and rotator cuff insertion.

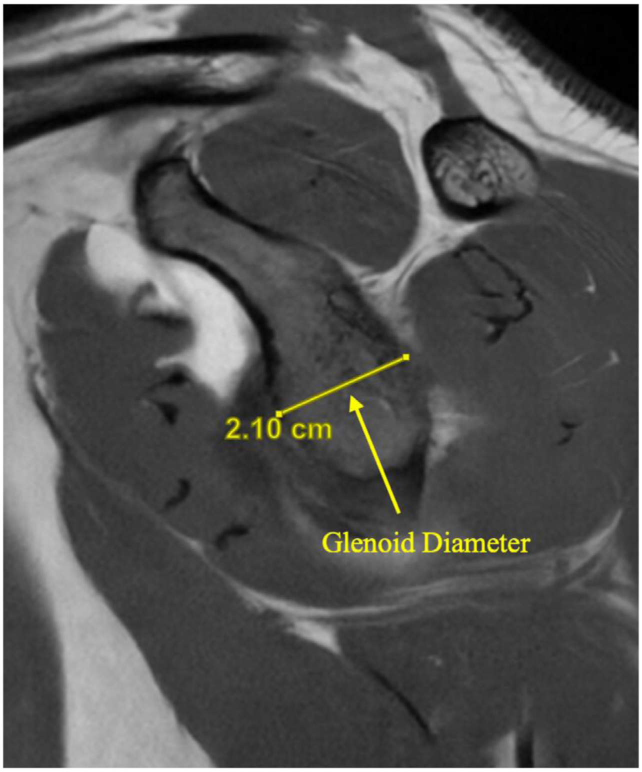

Fig 2. Sagittal magnetic resonance imaging of a left shoulder with measurement of glenoid diameter. Glenoid track = 0.83 (glenoid diameter − width of glenoid bone loss). In this case, there was no glenoid bone loss. Therefore, the glenoid track is 0.83 × 2.10 cm = 1.74 cm, less than the HSI measured in Figure 1.

view (Fig 1). The glenoid diameter is measured on a sagittal view (Fig 2), and the glenoid track is calculated using the formula 0.83D − d (D = diameter of glenoid, d = width of anterior bone loss). As the Hill–Sachs interval > glenoid track, the lesion is determined to be "off-track."

After induction of general anesthesia, the patient is placed in the beach-chair position (Table 1). Diagnostic arthroscopy is performed through the posterior portal, and the Bankart lesion is identified (Video 1). The arthroscope is then placed in the anterior portal to determine whether the Bankart lesion extends posteriorly. The unstable edges of the labral tissue are debrided, and the glenoid rim is freshened to punctate bleeding. The pattern of suture anchor placement is determined. A curved suture passer (ConMed Spectrum Kit; ConMed, Largo, FL) is used to shuttle #1 polydioxanone suture through the capsule and labrum. A second, low anterior portal is typically created to facilitate suture passing. Knotless suture anchors (Arthrex Knotless FiberTak; Arthrex, Naples, FL) are placed along the glenoid margin, and the sutures are tensioned on the capsular side of the labrum to restore labral height and tension the ligaments (Fig 3). If present, a posterior labral tear is repaired using a separate posterolateral portal with the scope anteriorly. The posteroinferior labrum is reattached to the glenoid rim using a similar technique as previously mentioned, tensioning the posterior portion of the axillary pouch.

The HS lesion is then visualized from the high anterior portal. The lesion is debrided of any soft-tissue remnants with a curette and shaver. Osteochondral allograft transplantation is performed with the Small Joint OATS Kit (Arthrex), using a 2.4-mm pin and 10-mm reamer. Precut fresh OCA plugs (JRF Ortho, Centennial, CO) are available in 10-, 12-, and 16-mm

Table 1. Step-by-Step Technique

1. Preoperative workup includes obtaining advanced imaging (computed tomography and magnetic resonance imaging) to determine whether the Hill–Sachs lesion is "on-track" or "off-track."
2. The patient is placed in the beach-chair position and diagnostic arthroscopy is performed.
3. Arthroscopic labral repair is performed, using a low anterior portal to facilitate suture passing.
4. The Hill–Sachs lesion is visualized through the high anterior portal and is freshened using a curette and shaver.
5. Two fresh osteochondral allograft plugs are irrigated with pulsatile lavage to remove all marrow elements.
6. Two corresponding sockets are drilled, and their depth confirmed.
7. The grafts are seated to best restore the native chondral curvature.

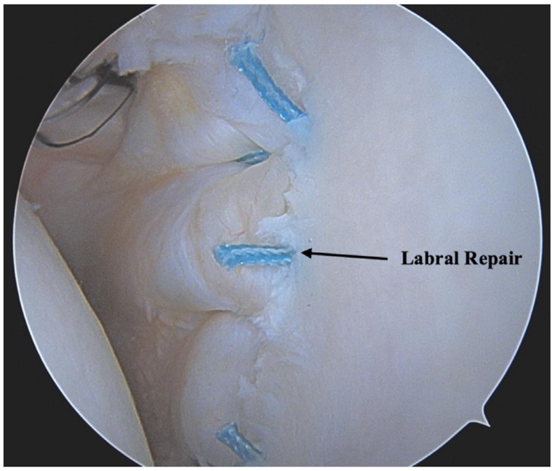

Fig 3. Arthroscopic labral repair is performed using knotless suture anchors (left shoulder, viewed from posterior portal).

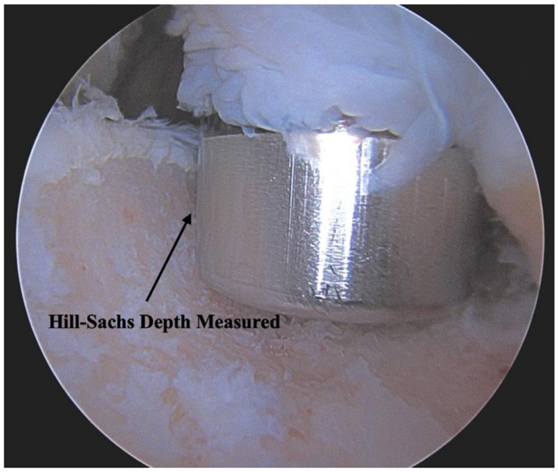

Fig 4. Measurement of Hill−Sachs depth (left shoulder, viewed from high anterior portal). Depth is confirmed after reaming to avoid a graft position that is proud.

diameters. The plugs have mature hyaline cartilage and contain living chondrocytes. Two plugs are irrigated using pulsatile lavage to remove all marrow elements, and their height is measured. The posterior portal incision is lengthened to allow for entry of the plugs. A clamp is inserted in the portal and opened to clear any soft tissue that may interfere with plug placement (Table 2). A cannula of appropriate size can be placed if necessary. The planned position of the plugs is determined. The inferior plug is placed first, as placing the superior plug first may obscure visualization of inferior plug placement. The socket is reamed and its depth confirmed (Fig 4). The graft is seated in a manner that recreates the native chondral curvature as closely as possible (Fig 5). This is determined by the trajectory of the recipient socket that is reamed. The most common error is to place the plug in a "flat" orientation; this is to be avoided as restoration of the arc is critical. Modifying the arm position is often needed to facilitate plug entry into the joint, as well as to optimize the entry angle of the plug. The same steps are then repeated for placement of the superior plug (Fig 6). The shoulder is taken through a range of motion to demonstrate smooth articulation. The portal sites are irrigated and closed in standard fashion. A sterile dressing is applied followed by a shoulder immobilizer.

Table 2. Pearls/Pitfalls

- Confirm socket depth after reaming to avoid a graft position that is proud.
- It is critical to clear any intervening posterior soft tissue to allow for ease of plug entry.
- Modifying the arm position may help facilitate plug entry into the glenohumeral joint and the angle of plug positioning.
- The inferior plug should be placed first, as placing the superior plug first will potentially obscure visualization for placement of the inferior plug.
- Ensure that planned placement of the second plug is a sufficient distance away from the first plug to avoid reaming out the first plug during socket preparation.

Postoperatively, the patient is rehabbed according to standard anterior instability protocols. The immobilizer is worn for 4 to 6 weeks. External rotation is initially limited with a goal of gradually restoring full motion followed by strengthening, and a full release to all activities between 4 and 6 months postoperatively. Magnetic resonance imaging of the shoulder obtained 2 months postoperatively demonstrates healing of the OCA plugs with incorporation into the humeral head (Fig 7).

Discussion

HS lesions can occur with anterior dislocation of the glenohumeral joint, and the incidence of these lesions is relatively high in the setting of recurrent shoulder instability.[1] Lower-grade lesions may be reasonably treated with remplissage. For larger defects in which

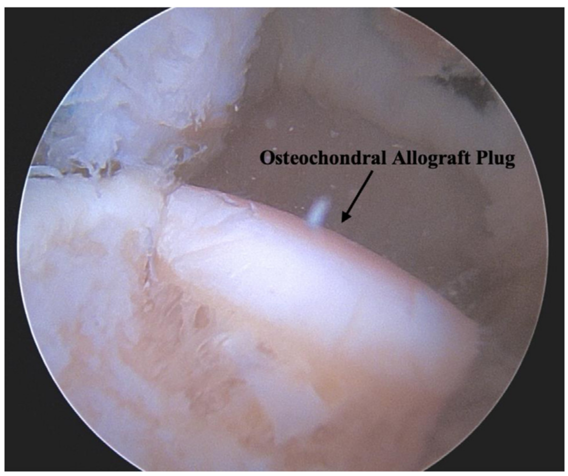

Fig 5. Osteochondral allograft plug inserted. The native chondral curvature is recreated as closely as possible (left shoulder, viewed from high anterior portal).

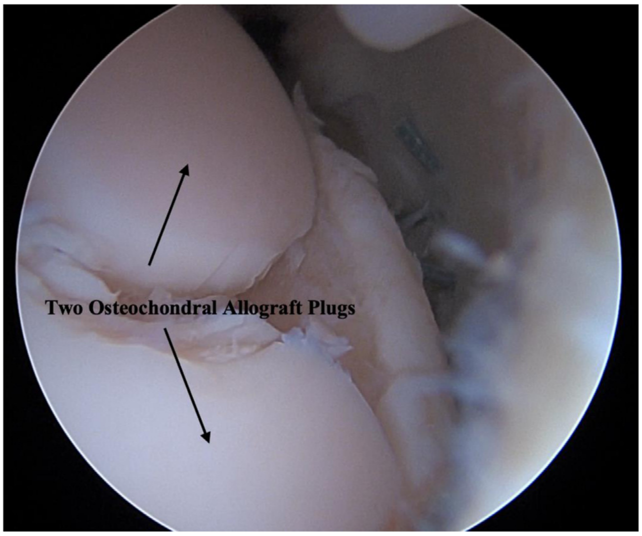

Fig 6. Arthroscopic view of final reconstruction. Two plugs are in place bridging the defect (left shoulder, viewed from high anterior portal).

external rotation may be limited with remplissage, OCA transplantation is a reasonable option to restore stability while avoiding the morbidity of a Latarjet procedure. Several open techniques have been described for OCA transplantation for the treatment of HS lesions.[13-17] Saltzman et al.[12] conducted a systematic review of OCA transplantation for large osteochondral defects of the humeral head, including 12 studies and 33 patients with large HS lesions due to shoulder instability. The authors found significant improvement in range of motion and American Shoulder and Elbow Surgeons scores at 12 months. Average length of follow-up was 57 months. At final follow-up, 1 patient had evidence of recurrent instability and 90% of patients reported satisfaction with the procedure. Complication rates were between 20% and 30%, and reoperation rate was 27%. Complications included complex regional pain syndrome, prominent hardware, and development of glenohumeral osteoarthritis. Notably, an open deltopectoral approach was used in 11 of 12 studies—one study described arthroscopic anatomic humeral head reconstruction using size-matched fresh frozen humeral head allograft.[18]

This technique has several advantages. First, it avoids the deltopectoral approach and capsulotomy required for open techniques through an anterior approach, as well as obviating the more extensive trauma to the posterior rotator cuff required for an en-bloc OCA through a posterior approach. In addition to being minimally invasive, it avoids the risks of hardware complication associated with internal fixation, i.e., with cancellous screws.[12] Most importantly, fresh osteochondral plugs are readily accessible without the need for a matched donor, avoiding delaying surgery and minimizing time spent size-matching the defect pre- and intraoperatively. In contrast to size-matched "lemon wedge" grafts conventionally used for anatomic humeral head OCA, this technique works not by anatomically filling the entirety of the defect but rather by bridging the defect to prevent it from engaging the glenoid, analogous to traversing rocks in a stream. Accordingly, the principal challenge of this technique is restoring the native chondral curvature as much as possible. In certain scenarios with very deep HS lesions, orienting the graft to best restore the articular curvature (i.e., positioning the plug parallel to the joint surface) may result in uncovering of the backside of the plug. In these cases, a large OCA via a posterior approach is preferred. There is also a potential risk for cyst formation, graft reabsorption, graft failure, and graft disease transmission, but these are not unique to this technique.[19] Further studies are needed to evaluate the outcomes of this technique in comparison with traditional open, size-matched approaches.

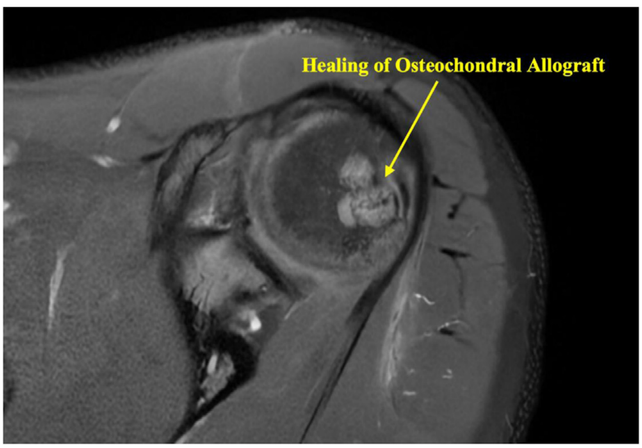

Fig 7. Axial magnetic resonance imaging of the left shoulder 2 months postoperatively demonstrates healing of osteochondral allografts in the humeral head.

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