Technical Note

Arthroscopic Hill-Sachs Filling Technique Using an Absorbable Interference Screw

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Abstract: We present an arthroscopic technique used to treat traumatic shoulder instability in the patient with a Hill-Sachs lesion, especially an off-track lesion. The incidence of this bony defect is approximately 40% to 90% of all anterior shoulder instability cases—and up to 100% in patients with recurrent anterior instability. Incorrect management of this humeral bone defect can lead to treatment failure, and it is essential to define characteristics such as the lesion's location, depth, width, and orientation. Many arthroscopic and open procedures have been described for the surgical management of the Hill-Sachs lesion. Using arthroscopy for the surgical treatment of shoulder instability offers numerous advantages. We describe an arthroscopic technique that consists of filling the Hill-Sachs lesion with absorbable interference screws made out of an advanced biocomposite material. After repair of the Hill-Sachs lesion, the Bankart lesion is repaired. As these screws are resorbed by bone tissue over several months, the bony anatomy is restored.

A Hill-Sachs (HS) lesion is an impression fracture along the posterior superolateral aspect of the humeral head that occurs after an anteroinferior glenohumeral dislocation. The incidence of this bony defect is approximately 40% to 90% of all anterior shoulder instability cases—and up to 100% in patients with recurrent anterior instability.[1] A reverse HS lesion is an anterior humeral head impression fracture that occurs in up to 86% of posterior shoulder dislocations, which is relatively uncommon.

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HS lesions vary in depth, width, location, and orientation.[2] There are many classification systems: The Calandra classification measures the depth of the lesion through arthroscopy[3]; the radiographic classification described by Rowe et al.[4] takes into account both the width and depth of the defect based on axillary-view radiographs; and an axillary magnetic resonance imaging method has been described by Richards et al.[5]

Lesions involving less than 20% of the humeral head articular surface are rarely clinically significant. HS lesions greater than 20% associated with glenoid bone loss are clinically significant, especially if the humeral defect is medially located and horizontally oriented.[6] High-function-demand patients are more sensitive to apprehensive symptoms.[7]

The treatment of shoulder instability is usually focused on capsulolabral lesions or on glenoid bone defects but rarely on HS lesions. Simple repair of a Bankart lesion in the presence of humeral bone defects results in an unacceptably high rate of recurrent dislocation.[8] Several studies have in fact shown an increased risk of recurrence when treatment of the HS lesion is not performed at the same time as capsular stabilization.[9-12]

A variety of arthroscopic and open procedures are available for the surgical management of HS lesions, depending on the clinical significance of the defects and on symptoms of instability. The most-applied open procedures are humeral osteotomy,[13,14] humeral head reconstruction,[15,16] and partial humeral head arthroplasty,

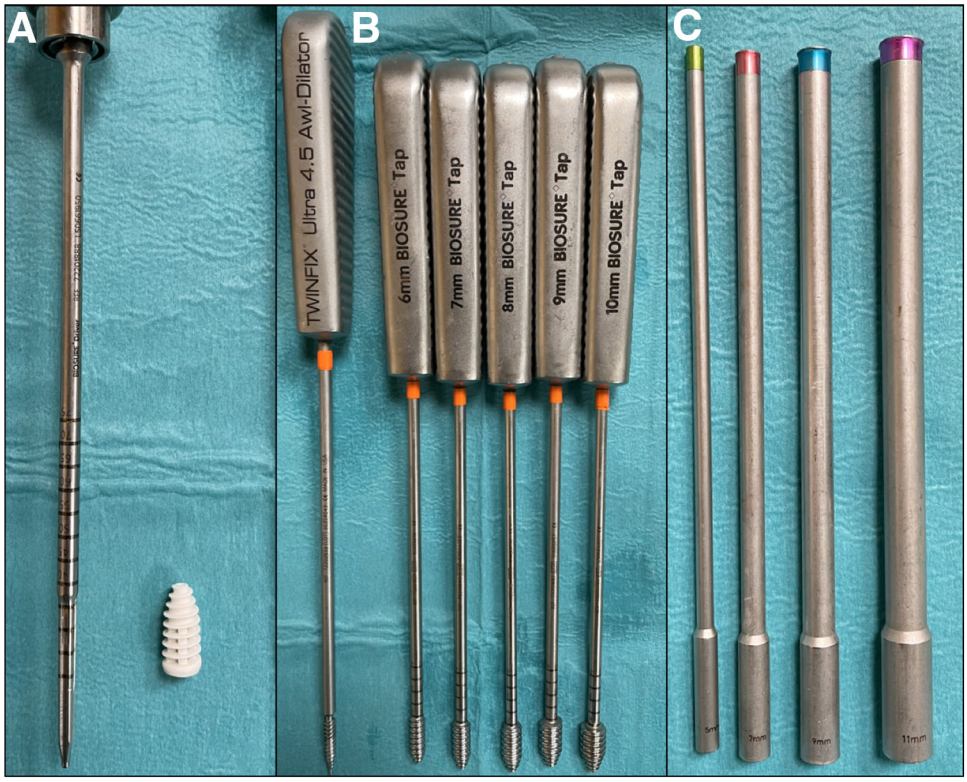

Fig 1. Instruments to perform Hill-Sachs lesion filling technique: Biosure Regenesorb Interference Screw and Biosure Driver (A), tap system (B), and sizers-tamps (C).

whereas the most-applied arthroscopic technique is remplissage.[17]

The remplissage technique is the most popular method of management for HS lesions. This technique consists of an arthroscopic posterior capsulotomy and tenodesis of the infraspinatus, with fixation of the soft tissues at the HS lesion achieved by filling the lesion. A disadvantage associated with remplissage is that it usually alters the rotator cuff anatomy and kinematics.[18,19] It can also lead to reduced external rotation or posterior-superior shoulder pain, but this topic is still controversial.[20] On the basis of the same principle (i.e., "to fill"), we describe an alternative arthroscopic technique that uses absorbable interference screws to fill HS lesions resulting from recurrent anterior shoulder instability.

Technique

Equipment

To successfully perform our arthroscopic technique for the Hill-Sachs filling (HSF) procedure, the following items are required (Fig 1):

- Standard shoulder arthroscopy equipment including a 30°, 4.0-mm arthroscope (Smith & Nephew, Andover, MA)
- Shaver handpiece (Dyonics Powermax; Smith & Nephew)
- Biosure Driver (product No. 72201887; Smith & Nephew) (Fig 1A)
- Biosure Regenesorb Interference Screw (Smith & Nephew), which is made out of an advanced biocomposite material with an open-architecture design to allow bone ingrowth (Fig 1A)

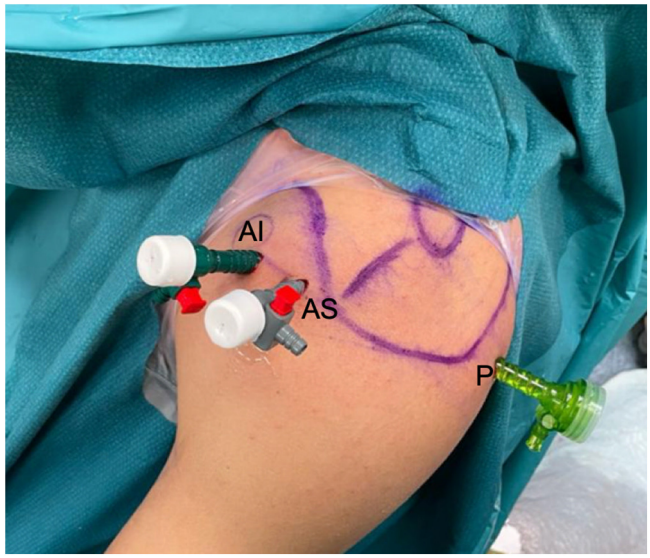

Fig 2. Standard arthroscopic portals in left shoulder with patient in beach-chair position: posterior (P), anteroinferior (AI), and anterosuperior (AS).

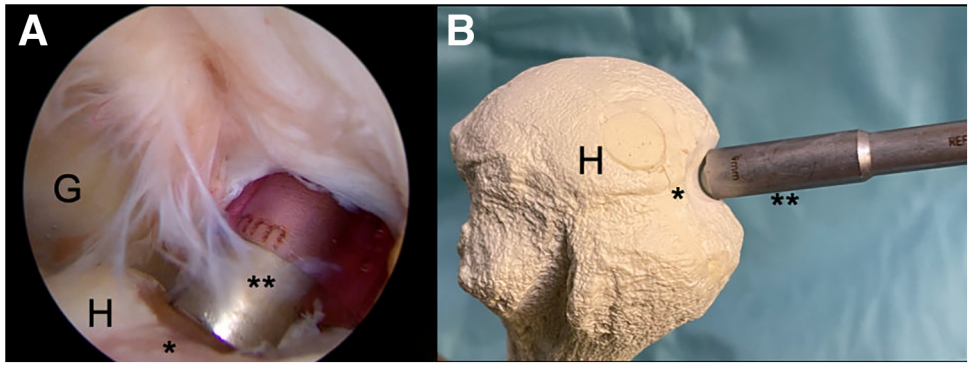

Fig 3. Arthroscopic visualization of left shoulder from anterior portal with patient in beach-chair position (A) and representative model (B): Hill-Sachs lesion (1 asterisk) measurement with appropriate tamp (2 asterisks). (G, glenoid; H, humeral head.)

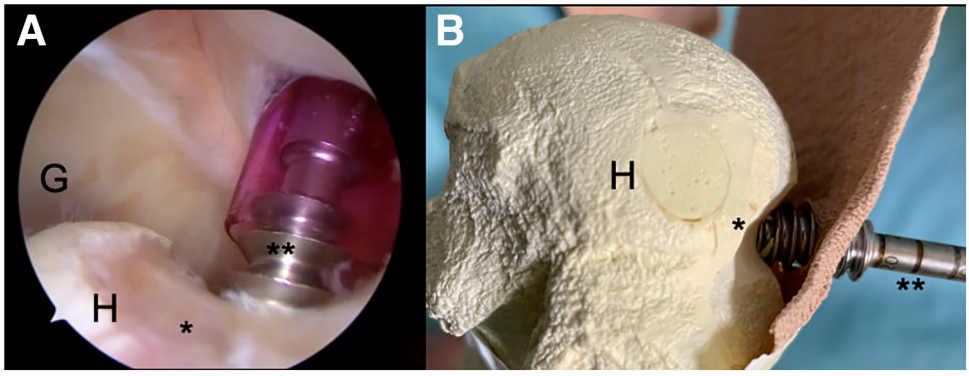

Fig 4. Arthroscopic visualization of left shoulder from anterior portal with patient in beach-chair position (A) and representative model (B): Hill-Sachs lesion (1 asterisk) tapping for screw housing using 4.5-mm starter tap (2 asterisks). (G, glenoid; H, humeral head.)

- Tap system (Biosure Tap System [product No. 72201941]; Smith & Nephew) (Fig 1B)
- Sizer-tamp (5-10 mm; Smith & Nephew) (Fig 1C)

It must be noted that the use of the Biosure Regenesorb Interference Screw to treat HS lesions described in this article is an off-label procedure.

Preoperative Planning

Preoperative planning consists of a radiographic study of both shoulders integrated with 3-dimensional computed tomography (CT) to evaluate the size (width and depth measured on axial and coronal images), orientation (HS lesion angle), and location (bicipital and vertical angles) of the HS lesion. Three-dimensional CT with the PICO method is always used for the assessment of the amount of glenoid bone loss. Patients with glenoid defects of less than 20% are candidates for arthroscopic treatment. Arthro–magnetic resonance imaging is required to identify capsulolabral lesions. The final confirmation of engagement is obtained by arthroscopy.

Surgical Technique

The procedure is performed with the patient in the beach-chair position under an interscalene block or general anesthesia. The operative arm is positioned

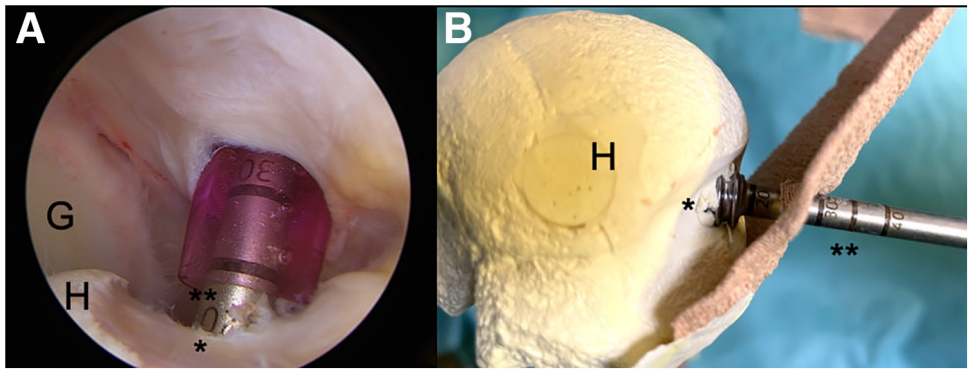

Fig 5. Arthroscopic visualization of left shoulder from anterior portal with patient in beach-chair position (A) and representative model (B): Hill-Sachs lesion (1 asterisk) tapping for screw housing using tap (2 asterisks) of same diameter as chosen screw to implant. (G, glenoid; H, humeral head.)

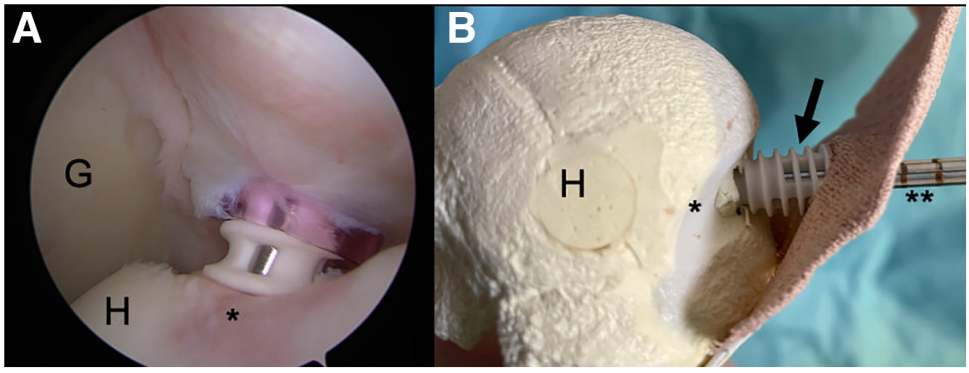

Fig 6. Arthroscopic visualization of left shoulder from anterior portal with patient in beach-chair position (A) and representative model (B): screwing of Regenesorb Interference screw (arrow). One asterisk indicates the Hill-Sachs lesion; 2 asterisks, the Biosure Driver. (G, glenoid; H, humeral head.)

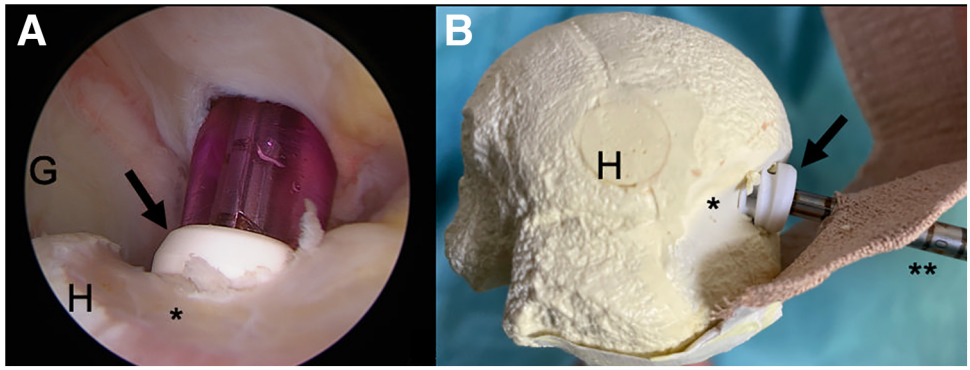

Fig 7. Arthroscopic visualization of left shoulder from anterior portal with patient in beach-chair position (A) and representative model (B): screwing of Regenesorb Interference screw until proximal part of screw (arrows) is at same level of cartilage surface of remaining humeral head (H). One asterisk indicates the Hill-Sachs lesion; 2 asterisks, the Biosure Driver. (G, glenoid.)

using an arm positioner (Trimano support arm; Arthrex, Naples, FL).

Standard anterosuperior and posterior portals are used. An accessory anteroinferior (5-o'clock) portal is required: It is first localized with a spinal needle and then established in the glenohumeral joint just over the superior border of the subscapularis tendon and just lateral to the coracoid. Large 7.5- and 5.5-mm threaded cannulas are used for the anteroinferior and anterosuperior portals. A large 8.5-mm cannula is placed in the posterior portal, typically 2 cm inferior and 1 cm medial to the posterolateral corner of the acromion (Fig 2).

The 30° arthroscope is inserted into the glenohumeral joint through the posterior portal to begin diagnostic arthroscopy of the shoulder (Video 1). On the basis of recommendations from the Southern California Orthopedic Institute, 15 points in the glenohumeral space are visualized to perform a complete a diagnostic examination of the shoulder[21] and to evaluate anteroinferior labral detachment, SLAP lesions, and capsular deficiency. In the presence of humeral bone

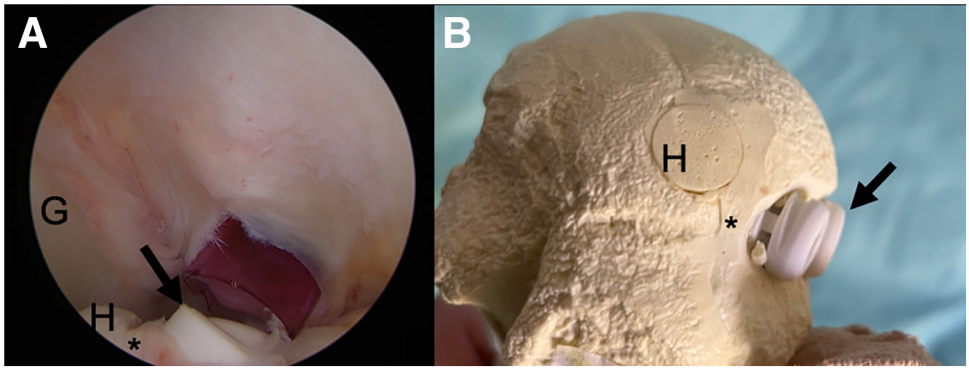

Fig 8. Arthroscopic visualization of left shoulder from anterior portal with patient in beach-chair position (A) and representative model (B): final result with complete Hill-Sachs lesion filling (arrows). The asterisks indicate the Hill-Sachs lesion. (G, glenoid; H, humeral head.)

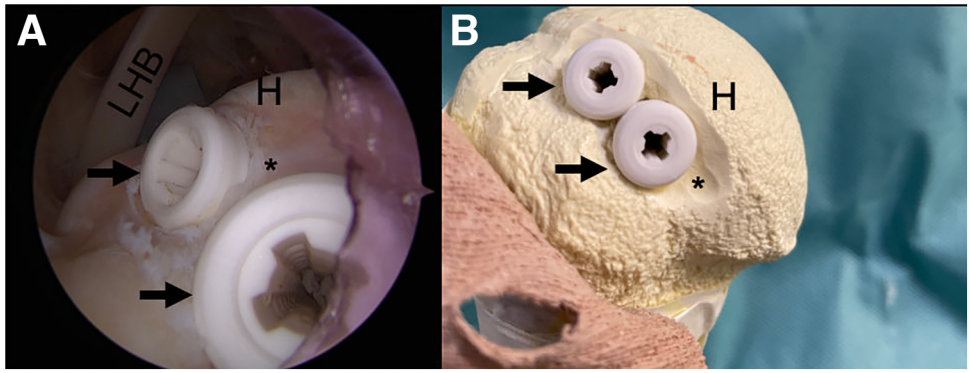

Fig 9. Arthroscopic visualization of left shoulder from anterior portal with patient in beach-chair position (A) and representative model (B): final result. The asterisks indicate the Hill-Sachs lesion; the arrows indicate the interference screws. (G, glenoid; H, humeral head; LHB, long head of biceps.)

defects, HSF is indicated according to the Calandra classification.

Before treating the anterior labrum, we start the preparation of the HS lesion with a shaver. The camera is switched to the anterosuperior portal for an excellent view of the entire HS lesion. The appropriate screw size is selected based on the size of the HS lesion, measured with various kinds of sizers-tamps (Fig 3). At this point, once the size of the lesion is established, the type and number of screws to be used are chosen so that the defect can be "filled." Using a tapping tool, we create the screw housing (Fig 4). We start with a 4.5-mm tap; then, we continue with a tap of the same diameter as the chosen screw to implant. Moreover, the tap provides a measure of the depth so that it is also possible to select the appropriate length of screw (Fig 5). The ideal direction to be applied to each screw is achieved by managing the position of the arm in flexion-extension and internal rotation—external rotation through the Trimano support arm. By use of a Biosure screwdriver, each screw is tightened to fill the bone defect until the proximal part of the screw is at the same level of the cartilage surface of the remaining humeral head, as shown in Figures 6 and 7. Depending on the extent of the HS lesion, the procedure is repeated by placing additional resorbable screws (Figs 8 and 9). Once the HSF procedure has been completed, the camera is switched to the posterior portal and the anterior capsulolabral lesions are repaired according to a standard technique.

Postoperative Care

After the procedure, while the patient is still under anesthesia, we place the operative arm in a sling in internal rotation; this position is maintained for 4 weeks. Movements of flexion and extension of the elbow are allowed keeping the shoulder still. Continual movement of the hand and scapular positioning are advised. After 4 weeks, the patient starts physiotherapy. External rotation is allowed after 8 weeks from surgery. After 12 weeks, the operative arm is comparable to the contralateral side in terms of normal ROM and dynamic strengthening can start. Conditioning to enable a return to manual work and/or sport is introduced after 24 to 30 months.

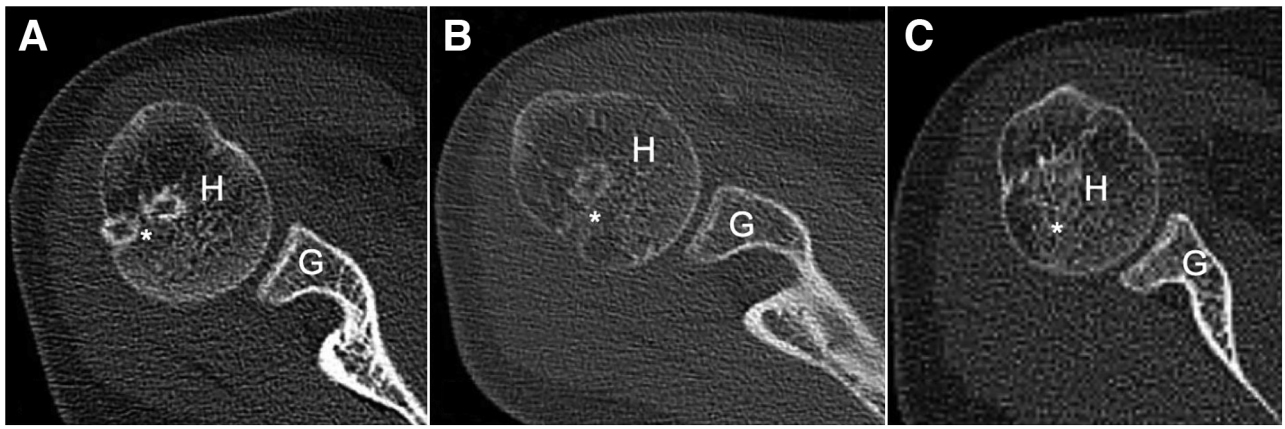

Fig 10. Two-dimensional computed tomography scans (axial views) showing changes in Hill-Sachs lesion (asterisks) in a right shoulder after surgery (A), at 1 year of follow-up (B), and at 2 years of follow-up (C). (G, glenoid; H, humeral head.)

Table 1. Advantages and Disadvantages of HSF Procedure

Advantages
A long learning curve is not required.
The anatomy is respected.
Bone defect filling is achieved.
The recurrence rate is decreased.
The rate of the Latarjet procedure is decreased.
The technique is an arthroscopic technique.
The technique uses an absorbable device that is then replaced by bone.
Different sizes of screws can be used for different HS lesions.
No ROM reduction occurs.
Disadvantages
Arthroscopic skills are required.
There exists a possibility of incorrect positioning and consequent glenoid impingement with iatrogenic damage.
Need to confirm that the HS lesion in engaging and off-track.
Less performing in HS lesion with large and complex humeral head defect.
The technique is not always performable, especially in the case of medial HS lesions.
There is a risk of non-replacement with bone after bio-absorption of the screw.

HS, Hill-Sachs; HSF, Hill-Sachs filling; ROM, range of motion.

Discussion

It is important to start considering a bipolar surgical approach to instability syndrome because of the high association between glenohumeral bony defects and high rates of recurrent instability, especially with isolated Bankart repair. Bone lesions of the humeral head have several clinical implications. Imaging and arthroscopic findings are essential in the decision-making process. Large HS defects (grade II-III per the Calandra classification) require combined procedures that directly address the humeral defect in order to decrease the rate of recurrence. Various surgical techniques have been described to approach humeral bone defects, among which remplissage is the most practiced and reproducible. Originally described by Purchase et al.,[17] the remplissage technique consists of arthroscopic tenodesis of the posterior portion of the capsule and infraspinatus tendon, aiming to fill the HS lesion. The technique reduces the rate of recurrence by making humeral lesions "off-track" extra-articularly—hence incapable of engagement. Although most studies have reported good to excellent outcomes, remplissage remains a nonanatomic technique that can lead to a decrease in range of motion. Our idea is to fill the lesion in a different way.

Our HSF technique aims to restore the anatomy of the humeral head by a purely arthroscopic technique using absorbable interference screws (Biosure Regenesorb). The concept is based on the bone-integrating capacity of these screws. The Biosure Regenesorb Interference Screw is the first interference screw made out of an advanced biocomposite material with an open-architecture design to allow bone ingrowth. In vivo animal testing has shown that Regenesorb material is bioabsorbable and is replaced by bone.[22] According to this report, the screw material mixture is designed to remain mechanically stable for a minimum of 6 months before subsequently being absorbed and replaced by bone within 24 months. This led to the idea of filling the humeral bone defect with screws that will be replaced by bone over time. A CT study shows that after 1 year—and, even better, after 2 years—the HS lesion is less evident, with significant restoration of the original anatomy (Fig 10).

We perform the HSF technique in patients with glenohumeral instability associated with HS lesions (grade II-III per the Calandra classification) and glenoid defects not exceeding 25%. The advantages and disadvantages of this technique are summarized in Table 1. The main risk is incorrect positioning of the screws. A possible conflict owing to a screw head in repeated contact with the glenoid surface, in fact, could be harmful, with consequent iatrogenic damage.

The HSF technique is an alternative, entirely arthroscopic procedure that is simple to perform for an experienced surgeon and that allows restoration of the humeral anatomy in bipolar bone defects. This prototype will benefit from a more suitable device to fill the HS lesion even more accurately. Although clinical trials with long-term follow-up are needed, we believe that the described arthroscopic procedure is safe, is easily reproducible, does not require a long learning curve, and allows restoration of joint stability.

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