Hill-Sachs Injuries of the Shoulder
When Are These Important and How Should I Manage Them?

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Glenohumeral stability is dependent upon the close bony relationship of the humeral head with the glenoid and inherent congruency of these structures. Deficiencies in the native osseous topography of the glenoid or humerus are important to recognize, as they may contribute to early failure of instability repair. Bony loss or injury to the humerus, known as a Hill-Sachs lesion, is an example of the importance of the bony structure of the glenohumeral joint. Although many Hill-Sachs lesions can largely be ignored, there are several characteristics of the Hill-Sachs injury that need to be carefully evaluated in order to optimize glenohumeral instability treatment. The focus of this chapter is to identify when a Hill-Sachs injury becomes important to the management of instability, to present current surgical techniques that address the Hill-Sachs lesion, and to identify the advantages and disadvantages unique to each approach.

HOW DOES A HILL-SACHS INJURY OCCUR?

The Hill-Sachs lesion occurs when a dislocating force displaces the humeral head outside the concavity of the glenoid. Once the humeral head is dislocated from the glenoid, the ligamentous structures are tensioned, building potential energy that is released, thus sending the soft spongiform bone of the posterior humeral head back against the much harder cortical bone of the anterior glenoid rim. The frequency of these episodes in addition to the force generated upon dislocation determine the severity of the ultimate Hill-Sachs fracture. In addition, the position of the humerus at the time of injury is also important with regard to location, depth, and orientation of the Hill-Sachs injury. A Hill-Sachs lesion is felt to become important if it symptomatically engages the anterior rim at a position of function (abduction at 90 degrees and 0 to 135 degrees of external rotation) either by patient history during activities or examination findings. This is also supported by radiographic findings of the size and orientation of the Hill-Sachs deficiency. A Hill-Sachs injury pattern that is generally unstable will
be orthogonal to the long axis of the humerus and align itself longitudinally with the anterior glenoid rim when the humerus is in a position of function (Figure 18-1).  

The prevalence of a Hill-Sachs lesion occurring in a population with a history of anterior shoulder instability ranges from 40% to 90%.  

For the patient presenting with an initial anterior dislocation, the incidence is 25%. The presence and size of a Hill-Sachs injury also increases with recurrent instability episodes as well as total time of symptomatic instability. It should be kept in mind that the majority of Hill-Sachs injuries are not clinically significant; however, if a Hill-Sachs is moderately large and is associated with a combined glenoid bone defect, the Hill-Sachs defect becomes clinically more important.

**Specific Examination Findings in a Patient With a Clinically Important Hill-Sachs Injury**

On physical examination, in addition to positive apprehension test findings, crepitus and catching may be felt with ranging the shoulder through various positions of abduction and external rotation. The patient will likely find these motions uncomfortable and may resist the examiner during the physical exam. Palpable and audible crepitus may be present. The suspicion for an engaging defect is supported by findings of an audible or palpable clunk in abduction/external rotation or the patient's sensation of instability through mid-ranges of motion.

**Classification and Biomechanics of a Hill-Sachs Defect**

There are numerous proposed classification systems for the delineation of Hill-Sachs injuries to the shoulder. One of the classification systems used for Hill-Sachs lesions proposed by Rowe is graded as the following: mild is a defect that is 2.0-cm wide and 0.3-cm deep, a moderate defect is 4-cm wide and 0.5-cm deep, and a severe defect is 4-cm wide and 1-cm deep. Franceschi and colleagues proposed 3 classifications based upon the cranial bone, the bicipital groove, and the coracoid process of the scapula, which would impact the surface of the glenoid, with the sub-coracoid location being the most significant injury. Although the prevalence of the symptoms is frequent, decisions need to be made about which classification to use.

Because of the bone size of both humeral and glenoid, the harder the incision, the smaller the companies and the more unstable it is. Additionally, the aspect of the bone defect location can have a major impact on the pathology.
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Hill-Sachs lesions are described as a "hatchet fracture." Calandra and colleagues graded lesions arthroscopically on the 32 shoulders in their study, which was also based on the surface involvement. Grade I (8/32) lesions had articular surface involvement that did not include subchondral bone. Grade II (5/32) included the subchondral bone, and grade III (2/32) had large subchondral bone defects. Flatow and Warner felt that the significance of the lesion is related to the percentage of the articular cartilage involved. They described the following: clinically insignificant involved less than 20% of the articular surface, variably significant had 20% to 40%, and clinically significant were lesions with more than 40% articular involvement. Although these classification systems have been proposed, the relative infrequency of the symptomatic Hill-Sachs deficiency makes it difficult to make definitive treatment decisions regarding the use of the classification systems above. However, it has been advocated that the larger defects and those at the largest of size in each respective classification system may be more important to recognize and treat.

It is pretty well accepted that those patients with a long history of instability episodes or those who have had numerous dislocations have more extensive injuries to the glenoid, the labrum, and development of a Hill-Sachs. In a study that compared frequency of instability, one episode of instability versus 2 or more, the cohort with 2 or more instability episodes had moderate-to-severe Hill-Sachs lesions and greater inferior and middle glenohumeral ligament (IGHL and MGHL) laxity.

**IMPORTANCE OF GLENOID BONE DEFICIENCY**

Because the bony congruency of the glenohumeral joint is highly dependent upon both humeral and glenoid bone stock, the presence of glenoid bone loss may potentiate the effect of only a mild-to-moderate Hill-Sachs injury. Despite the glenoid being harder than the humeral head, traumatic bone loss to the anterior rim often accompanies a Hill-Sachs defect. Burkhart determined that anterior glenoid bone loss more than 25% of the normal width created an inverted pear shape that was inherently unstable. Often, pathology of the glenoid is the most notable finding and is usually the aspect of the bone loss equation that needs to be addressed. Depending on the location and significance of the humeral defect, glenoid bone loss might be the only pathology that needs to be addressed surgically.

**GLENOID TRACK CONCEPT**

Stability after a Hill-Sachs injury is also dependent upon the location of the bony humeral head injury. The track that the humerus glides within the glenoid has been identified as an important factor with shoulder instability. When the humerus is in a position of function, Yamamoto and colleagues have demonstrated that the humeral head is seated in 84% of the glenoid cavity as the posterior rim of the glenoid abuts the cuff tendon. Any anterior defect to the glenoid reduces the perch that the humeral head has upon the glenoid to less than 84%, decreasing the width of the glenoid track. When a Hill-Sachs lesion rotates outside the glenoid rim and engages the anterior rim of the glenoid, an unstable position for the shoulder occurs. If there is less than a normal glenoid bone stock, this ratio becomes increasingly more important as the
humeral head may engage easier and become symptomatic when it wouldn’t have been symptomatic if the glenoid was fully intact. Thus, the importance of the status of the glenoid in the setting of a Hill-Sachs injury cannot be overemphasized, as even small amounts of glenoid bone loss may make a humeral head Hill-Sachs deficiency much more important.

**DIAGNOSTIC RADIOLOGY**

A number of diagnostic plain film, ultrasound, computed tomography (CT), and magnetic resonance imaging (MRI) techniques have been described for detecting pathology of the humeral head, osseous glenoid, and labrum. The radiographic techniques most advantageous for initial evaluation of glenohumeral instability are the AP with internal and external views, axillary, axillary with exaggerated external rotation, apical oblique (Garth view), and West Point views. The combination of these views is an important first step at effectively evaluating both the glenohumeral relationship as well as osseous pathology on both the humerus and the glenoid (Figure 18-2).

Ultrasound has been suggested as a cost-effective method for screening patients with shoulder instability for Hill-Sachs lesions. This has the advantages of allowing the patient to remain in a position of comfort and minimizing exposure to excessive radiation that accompanies CT and the multiple radiographs specific to detecting a possible Hill-Sachs lesion. However, this practice remains to be validated for determining specific treatment.

MRI (or MR arthrogram) is advantageous as it allows for detection of soft tissue pathology that may need to be addressed during surgical intervention and can certainly be a tool to help delineate the amount of humeral and glenoid bone loss. In a double-blind, prospective study by Denti and colleagues, MRIs on 15 patients yielded a sensitivity of 60%, specificity of 100%, and accuracy of 87% compared to arthroscopy, which had a sensitivity of 80%, specificity of 100%, and accuracy of 87%.

The gold standard for the evaluation of a Hill-Sachs defect remains a CT scan, with the humeral head digitally subtracted in order to critically quantify the location and size of the humeral defect. In addition, the sagittal oblique view of the glenoid should be visualized in order to look at the amount of glenoid bone loss. The osseous deficits as visualized on CT scan can be precisely defined and are the most important findings for surgical decision making.

**SURGICAL TREATMENT AND DECISION MAKING**

In the setting of humeral bone loss (Hill-Sachs) injury, treatment can be directed at the restoration of the glenohumeral articular arc with either glenoid-based solutions, humeral-based strategies, or a combination. These can involve both arthroscopic and open repair techniques, and it is critical to have a surgical plan prior to the case in order to effectively treat the bone loss situation. Depending on the extent of pathology, the surgical procedure can include soft tissue repair, osseous autograft, or osseous allograft. It should be noted that addressing glenoid defects alone will often resolve the patient’s instability. However, there are certain situations, especially those in which the hard glenoid bone is not damaged, and with significant combined humeral and glenoid deficiencies, that humeral repair or reconstruction options should be considered (Figure 18-3).
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Figure 18-2. A 23-year-old man who sustained an anterior shoulder dislocation demonstrating 3 radiographic modalities for detection of the injury. (A) Plain axillary radiograph; (B) axial MR arthrogram; (C) axial CT scan.

Figure 18-3. Operative strategies for management of a Hill-Sachs injury consist of primarily glenoid-based solutions, followed by either humeral solutions, and rarely a combination of both.

Glenoid-Based Strategies

Humeral-Based Strategies

Both
The concept of an engaging versus nonengaging\textsuperscript{2} Hill-Sachs injury has been used in the past for delineating the extent of glenohumeral repair. In fact, Burkhart advocates that if the Hill-Sachs injury is engaging, a glenoid-based bone augmentation (ie, Latarjet) is sufficient for glenohumeral stability.\textsuperscript{27} However, others advocate that, at some point, the humeral head will engage in the presence of a Hill-Sachs injury. More than a small Hill-Sachs deficiency should be augmented with a glenoid bone graft, humeral bone graft, or both.

It should be noted that the vast majority of Hill-Sachs injuries can be ignored, especially in the setting of no to minimal glenoid bone loss and without significant involvement of the humeral head. A small impaction fracture is much different from a hatchet type of fracture\textsuperscript{17} due to the latter having a higher chance of glenoid engagement.

When choosing a strategy, it should be kept in mind that Hill-Sachs deficiencies can be effectively managed with glenoid bone augmentation procedures or all-arthroscopic techniques. In the severe humeral deficiency, or combined deficiency, humeral bone graft options should be considered.

**HILL-SACHS DEFICIENCY MANAGED WITH GLENOID AUGMENTATION**

It should be noted that the majority of Hill-Sachs injuries can be managed with glenoid-based bone augmentation procedures.\textsuperscript{2} Although the literature is not conclusively supportive, those patients who have presented with a Hill-Sachs injury have been successfully managed with a Latarjet procedure (or equivalent). However, it should be noted that humeral head defects are often accompanied with glenoid bone loss (Figure 18-4).

Open capsular repair without bone block remains a viable option for treating anterior instability, even with engaging Hill-Sachs defects. Pagnani performed a prospective study on 119 patients using an open capsular shift without osseous reinforcement.\textsuperscript{28} Nearly one-third of the study population had engaging Hill-Sachs lesions, and 14% had anterior glenoid deficits with 4% having greater than 20% missing.\textsuperscript{28} Through a deltopectoral approach, an anterior capsulotomy is used to access the anterior glenoid and identify any Bankart pathology. Depending on the osseous pathology and soft tissue laxity present, the anterior capsule is mobilized using a variety of capsulotomy incisions so that, at surgical closure, the capsule is reapproximated in a fashion that recreates the appropriate capsular tension. After a 2-year follow-up, 2% of the patients in this study had a recurrence of instability.\textsuperscript{28} The average loss of external rotation in 90 degrees of abduction was 5 degrees.\textsuperscript{28} Open capsular shift, as described by Pagnani, has the advantage of yielding excellent results and return to near-normal function.\textsuperscript{28} The imbrication of the anterior capsule has the benefit of having more anterior soft tissue reinforcement; however, it could potentially be restricting and cause loss of external rotation. Ideally, this procedure could be used for athletes with high demand on the repaired structures. It could also be used as a backup for a patient who desired arthroscopic surgery, but required a conversion to an open procedure. In addition, issues with subscapularis healing have been noted, with subscapularis insufficiency described after open instability repairs.

The workhorse for the majority of Hill-Sachs injuries remains the open Latarjet procedure. There are numerous methods used to perform the Latarjet procedure, with the common denominator being a coracoid bone augmentation to the anterior glenoid. The capsule can be managed with a variety of techniques, either open or, as of recent, arthroscopically.

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The Latarjet procedure is commonly used for glenoid bone loss that results in an inverted pear-shaped structure. The glenoid concavity and width are recreated so that a small to moderate Hill-Sachs defect does not engage the anterior glenoid rim of unstable shoulders. The coracobrachialis and short head of the biceps tendons are transferred on their bony coracoid origin to the anteroinferior glenoid, which reinforces the joint capsule at a site of potential laxity. The inferior limb of the split subscapularis is tensioned when the humerus moves into abduction and external rotation.

When compared to tricortical bone grafting of the anteroinferior glenoid, the Latarjet is biomechanically superior as well. In a controlled laboratory cadaveric biomechanical study, 8 fresh frozen shoulders had “all but the rotator cuff, the middle head of the deltoid, the biceps brachii, and the coracobrachialis dissected” and mounted to a
testing device.\textsuperscript{30} The specimens were then stressed after “anteroinferior capsulotomy, anteroinferior glenoid bone defect, transplantation of a tricortical bone graft, and after the Latarjet procedure.”\textsuperscript{30} Wellman and colleagues found the Latarjet models to significantly reduce anterior translation by an average of 354\% in 30 degrees of abduction and by 374\% in 60 degrees of abduction, while in neutral rotation. Comparatively, the tricortical bone block did not perform as well with an average reduced translation of 179\% at 30 degrees and 159\% at 60 degrees.\textsuperscript{30}

The Latarjet procedure is also well documented in its clinical success. Hovelius and colleagues found the Latarjet models to significantly reduce anterior translation by an average of 354\% in 30 degrees of abduction and by 374\% in 60 degrees of abduction, while in neutral rotation. Comparatively, the tricortical bone block did not perform as well with an average reduced translation of 179\% at 30 degrees and 159\% at 60 degrees.\textsuperscript{30}

A long-term study by Allain and colleagues also found the Latarjet procedure to be effective at preventing instability, with osteoarthritis of the glenohumeral joint as a consequence.\textsuperscript{33} Coracoid transfers that were too laterally placed and patients with pre-existing rotator cuff tears were identified as having more severe osteoarthritis at an average 14-year follow-up.\textsuperscript{33} As a result, patients need to be free of rotator-cuff tears, and proper placement of the autograft is critical to minimize osteoarthritis in the long term.\textsuperscript{34}

**PROCEDURES ADDRESSING HUMERAL PATHOLOGY**

Although the majority of Hill-Sachs injuries can successfully be managed with glenoid-based strategies, some of these injuries may require direct treatment of the Hill-Sachs defect. In general, the Hill-Sachs deformity can be addressed through both open and arthroscopic techniques. Arthroscopic techniques include filling the defect with soft tissue (usually the infraspinatus tendon),\textsuperscript{35} percutaneous humeroplasty,\textsuperscript{36,37} and a variety of small bone plug options.\textsuperscript{38,39} Open techniques include autologous bone plugs, size-matched osteoarticular allografts, the Connolly Procedure, and rotational humeral osteotomy, although the latter has fallen out of favor.

**ARTHROSCOPIC HUMERAL HEAD HILL-SACHS TECHNIQUES**

The most common scenario encountered is upon the completion of an arthroscopic instability repair—a concern arises for the Hill-Sachs injury engaging the anterior aspect of the glenoid.
The Remplissage procedure is performed by the following steps: after a Bankart repair, the posterior port is used to directly visualize the extent of the Hill-Sachs defect, then this is used as the working port for a posterior capsulodesis.35 The compacted defect is abraded to bleeding bone for the receipt of the infraspinatus tendon and posterior capsule that is fixated with 2 suture anchors.35 Effectively, this procedure limits the glenoid track and prevents engagement of the Hill-Sachs defect with the anterior rim of the glenoid. In the original article, Purchase and Wolf experienced a 7% (2/24) recurrence rate of instability on follow-up, with both occurring secondary to traumatic events, with full restoration of motion.35 The details of success are subjective as no formal postoperative questionnaire was mentioned, and the number of patients treated is limited to 24. This procedure has the advantage of being performed after a Bankart repair, using the same arthroscopic portals. Additionally, it does not expose the patient to the risk of infectious disease from cadaveric allografts.

An experimental cadaveric osseous disimpaction technique has been proposed by Kazel and colleagues by using a percutaneous bone tamp.36 This method involves percutaneously drilling an osseous window 180 degrees from the Hill-Sachs defect, followed by using a curved bone tamp to raise the lesion to its near anatomic position. Re and colleagues have clinically applied this idea via the use of an open technique through the deltopectoral interval. The capsule is opened, the posterior humeral head defect is palpated, and an anterior cruciate ligament tibia guide is used to center the drill behind the center of the Hill-Sachs lesion.37 A cortical window is opened with an 8-mm cannulated drill over a prepositioned K-wire.37 Both curved and footed bone tamps are used to disimpact the defect to a near anatomic position.37 The osseous void is then filled with cancellous bone chips prior to closure (see Figure 18-5).37 This procedure has the advantage of restoring the humeral head to a near native topography without transpositioning soft tissue structures or using a rotational osteotomy of the humeral head. However, it does not address the problem of any osteochondral defects that could be present, and it is limited to moderate-sized defects.


OPEN HUMERAL BONY AUGMENTATION TECHNIQUES

The osseous allograft bone plug technique was introduced by Kropf and Sekiya as a novel approach to filling a moderate Hill-Sachs defect. This procedure can be performed in a stepwise approach or in combination with an anterior soft tissue repair. A vertical 6-cm incision is made over the bony defect, and the capsule is approached by splitting and retracting the infraspinatus inline with its orientation. The infraspinatus is retracted, and the capsule is split over the Hill-Sachs defect. A guide pin and external guide system utilized for anterior cruciate ligament reconstruction is available to facilitate placement of the guidepin in the center of the lesion. Then, cut a hole with a calibrated blade. The subchondral bone is reamed to a bleeding bed in preparation for the allograft. The allograft bone plug is then cut from the donor that is size-matched in diameter of the defect, yet oversized in length. The allograft is inserted into the recipient site and tamped into place so that it is flush with the surrounding cartilage. This procedure has the advantage of being a resurfacing technique that can be performed in stages or at the time of an anterior repair. Additionally, it can be performed with a minimal exposure, and the humeral head remains in its capsule. The disadvantage is that it is limited to small to moderate lesions and has the risk of using cadaveric tissue.

Size-matched osteoarticular humeral allograft transplantation has promise as being a viable procedure for correcting large Hill-Sachs defects. A series of 18 size-matched osteoarticular allograft transplantations were performed by Miniaci and Gish. The typical patient who would be a candidate for this procedure will have previously undergone and failed repair of anterior structures of the glenoid, labrum, and/or capsule. Failure was judged by having symptomatic anterior instability. The size of the defect in this series was more than 25% of the humeral head measured by CT reconstruction. CT and/or MRI is ideal for planning this procedure as it gauges the size of allograft needed with 3-dimensional reconstruction (Figure 18-6).

A fresh frozen cadaver is obtained from a tissue bank and is released after appropriate viral and bacterial cultures have cleared. This leaves approximately 2 weeks from culture clearance until viable implantation, so the patient with a Hill-Sachs defect that is to be treated with a fresh allograft needs to understand the potential short notice of such a procedure in order to preserve graft viability. Although fresh grafts have been described, others have used irradiated allografts.

The technique of humeral head allograft can be performed through either a deltopectoral or a deltoid-splitting approach. Our preferred method is a deltopectoral approach, and the subscapularis tendon is vertically transected. A capsulotomy is extended superiorly in line with the subscapularis tendon transaction, and a laterally based capsulotomy is made. The anteroinferior glenoid is inspected for pathology, which is addressed at this point. The final securing of the anterior structures, however, are not finalized until wound closure. The Hill-Sachs defect is exposed by externalizing the humeral head with a flat-narrow retractor. The lesion is flattened and shaped in a "chevron pattern" with a small sagittal saw. A size-matched humeral head allograft is cut and integrated into the defect by making minor adjustments in only one plane at a time. Upon congruent fit, the allograft is initially secured with K-wires and finally fixed in place (Figure 18-7). A variety of implants may be used for implantation, including cortical bone screws (3.5 mm), headless compression screws, as well as bioabsorbable and plastic screws. The success rate for the population studied was 100% with no recurrences of instability during an average 50-month follow-up. This procedure is ideal for patients with large Hill-Sachs defects that are not amenable to humeroplasty (chronic injury) or bone plug allograft techniques outlined previously.
OTHER HUMERAL-BASED OPTIONS

There are metal implants that have the potential to be used for Hill-Sachs deficiency (HemiCap, Arthrosurface, Franklin, MA) and provide an easy solution for the management of patients who do not desire allograft or other bone grafting options. It should be noted that the round metal implant described above is not truly designed to fit into a Hill-Sachs deficiency, and this may prove to be problematic for obtaining a concentric fill of the Hill-Sachs injury. This is because the Hill-Sachs is not a round, cylindrical defect, but one that is linear and wedge-shaped.

The rotational humeral osteotomy, first performed in 1964 by Weber, is a procedure where an osteotomy of the surgical neck of the humerus is performed and the humeral head is rotated medially 25 degrees. The osteotomy is then fixated with a blade plate, and the subscapularis tendon and anterior capsule are shortened anteriorly. Fundamentally, the Hill-Sachs defect is being rotated out of the functional tract between the humeral head and the glenoid, converting an engaging lesion into a nonengaging lesion. Weber has accounted for a total of 207 of these procedures performed with 180 patients being followed. During this period, the redislocation rate was 5.7%, with the nontraumatic dislocation rate being 1.1%. The delayed union and nonunion rate
Figure 18-7. A case of a 21-year-old man with recurrent anterior instability, a large Hill-Sachs lesion, and no glenoid bone loss, demonstrated by MR arthrogram (A, axial; B, coronal) and (C) axial CT scan. The patient was treated with a humeral head fresh size-matched osteochondral allograft. (D) Through a deltopectoral approach, the Hill-Sachs lesion is exposed, and then (E-F) a fresh allograft is fixed into place with headless compression screws (continued).
combined was 2.8%, and 107 of the shoulders at follow-up had hardware removed.\textsuperscript{40} The success rate for this procedure is comparable to the procedures described earlier. However, the disadvantages are the larger incision for the approach, a recommended hardware removal after 2 years for patients younger than 50 years, and the risk of delayed union, nonunion, and malrotation of the humeral head.\textsuperscript{40} Given the initial success rate of more recent procedures and the risks related to rotational humeral osteotomy, this procedure has fallen out of favor for an initial approach to shoulder instability from a Hill-Sachs lesion.\textsuperscript{40} However, in the most severe cases (usually in seizures or electric shocks), a complete humeral resurfacing or hemiarthroplasty should be considered.

**Hill-Sachs Defects Managed With Combined Techniques**

Occasionally, a patient will present with severe pathology to both the posterior-lateral humerus and anteroinferior glenoid that are incompatible with a stable shoulder. The patient’s history of instability might be a result of a seizure disorder, multiple traumatic dislocations, or electrocution. The combination of posterior lateral humerus and the anterior glenoid pathology will be too significant for a traditional Bankart repair or a single approach to bony pathology. The patient could have a surgical history of repair to the anterior structures with no resolution of their instability. The key is to use
current knowledge of pathophysiology to anticipate when a single approach will fail. A deficit greater than 20% to 25% of the anterior glenoid and/or a large Hill-Sachs lesion will likely be unstable and will have a risk of failing a Bankart repair without bony augmentation.\textsuperscript{2,3,14,19} Patients with the combination of severe defects are relatively easy to predict when a single procedure will fail. The challenge arises when the humerus and glenoid together have marginal osseous deficits. Additionally, the functional goals and age of the patient are factors to consider (Figure 18-8).

The presentation of an unstable shoulder that has either a large Hill-Sachs defect or more than 25% glenoid loss in combination with minor pathology of the opposing structure will likely need a combined operation to reduce the risk of failure. The shoulder that has a large Hill-Sachs lesion and minor glenoid pathology (less than 25% of glenoid width) might need a size-matched osteoarticular allograft and an open capsule plication and soft tissue augmentation. The combined procedure is performed in an attempt to create a more stable environment and to safely shift the center of the humeral head.

The presentation of an unstable shoulder that has a large Hill-Sachs defect would likely need a combined approach using a partial or full bony augmentation, with a soft tissue shift and capsular plication. The combination of severe Hill-Sachs and/or glenoid bone loss will have a high risk of failing a Bankart repair and may require a combined procedure using an osteoarticular allograft.

Variations of the arthroscopic Bankart repair that have been described in the literature include the use of an arthroscopic Bankart repair with an anterior capsulorrhaphy, a Bankart repair with a remplissage procedure, and a Bankart repair with an open capsulorrhaphy. These procedures are selected based on the specific needs of the patient and the surgeon's preference. The use of an arthroscopic Bankart repair with a remplissage procedure is indicated in patients with a large Hill-Sachs defect and a small glenoid lesion. The arthroscopic Bankart repair with an open capsulorrhaphy is indicated in patients with a large Hill-Sachs defect and a large glenoid lesion. The use of an arthroscopic Bankart repair with an anterior capsulorrhaphy is indicated in patients with a small Hill-Sachs defect and a small glenoid lesion. The use of an arthroscopic Bankart repair with a remplissage procedure is indicated in patients with a large Hill-Sachs defect and a small glenoid lesion. The use of an arthroscopic Bankart repair with an anterior capsulorrhaphy is indicated in patients with a small Hill-Sachs defect and a small glenoid lesion.
capsular repair or Latarjet procedure. Given that both the glenoid and humeral bone augmentation are open procedures that release the subscapularis, they ideally can be performed in series under one exposure to anesthesia. Additionally, the vertical capsulotomy used for the osteoarticular allograft can be used with the T-plasty capsular shift used by Pagnani.\textsuperscript{4,28}

The glenohumeral joint that has more than 25% of anterior osseous deficit from the anterior glenoid rim and a small to moderate, yet engaging Hill-Sachs fracture would demand a different approach. The glenoid pathology would benefit from the bony augmentation of an arthroscopic Latarjet procedure, taking care to not lateralize the coracoid autograft. As an adjunct to the Latarjet, the Hill-Sachs lesion could be decompressed with the humeralplasty described by Re and colleagues or the osseous allograft bone plugs proposed by Kropf and Sekiya.\textsuperscript{37,39} Both of these can be performed after the completion of an arthroscopic procedure to correct the anterior structures and are intended to correct small to moderate Hill-Sachs defects that are engaging.

Various combinations of the selected procedures mentioned above can be used. Identifying overlaps in the various approaches and structures released so as to minimize the disruption of healthy native tissue is fundamental to planning combined procedures.

**CONCLUSION**

Although Hill-Sachs injury is a relatively common finding in recurrent anterior shoulder instability, the majority of these lesions can be largely ignored. However, as with the case in bone loss about the shoulder, larger Hill-Sachs lesions are often accompanied by various amounts of glenoid bone loss. One should be suspicious of a symptomatic Hill-Sachs deficiency in patients who present with multiple instability episodes, mechanical symptoms, an audible clunk, or examination findings of engagement of the humerus over the glenoid rim. Treatment options include both glenoid- and humeral-based strategies, including arthroscopic tenodesis of the defect with the infraspinatus (Remplissage), percutaneous humeroplasty, and a variety of glenoid and humeral bone grafting techniques (bone plugs, fresh allograft, and the Latarjet procedure). The majority of symptomatic Hill-Sachs injuries can be managed with arthroscopic Remplissage or glenoid bone grafting procedures. In the severe case, allografts or limited resurfacing or arthroplasty should be considered.

The views expressed in this chapter are those of the authors and do not reflect the official policy or position of the Department of the Navy, Department of Defense, or the US government.

**REFERENCES**


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