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Anterior glenohumeral instability: Current review with technical pearls and pitfalls of arthroscopic soft-tissue stabilization

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Abstract

The glenohumeral joint (GHJ) allows for a wide range of motion, but is also particularly vulnerable to episodes of instability. Anterior GHJ instability is especially frequent among young, athletic populations during contact sporting events. Many first time dislocators can be managed non-operatively with a period of immobilization and rehabilitation, however certain patient populations are at higher risk for recurrent instability and may require surgical intervention for adequate stabilization. Determination of the optimal treatment strategy should be made on a case-by-case basis while weighing both patient specific factors and injury patterns (*i.e.*, bone loss). The purpose of this review is to describe the relevant anatomical stabilizers of the GHJ, risk factors for recurrent instability including bony lesions, indications for arthroscopic *vs* open surgical management, clinical history and physical examination techniques, imaging modalities, and pearls/pitfalls of arthroscopic soft-tissue stabilization for anterior glenohumeral instability.

Key Words: Arthroscopic; Soft-tissue; Anterior instability; Glenohumeral; Functional anatomy; Recurrent instability

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Core Tip: Management of the patient with anterior shoulder instability is a common yet complex condition for the orthopaedic clinician. To optimize the evaluation and management of these patients the clinician must ensure a detailed and thorough clinical and radiographic workup, have a thorough understanding of the dynamic, static, and bony stabilizers of the glenohumeral joint, and understand the common causes of failed surgical intervention in order to address these concerns when appropriate. This review

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describes the current evidence on anterior glenohumeral instability including functional anatomy, risk factors for recurrent instability, clinical history and physical examination techniques, imaging modalities, and operative pearls and pitfalls.

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INTRODUCTION

The unique structure of the glenohumeral joint (GHJ) allows for a wide range of motion, but also makes the joint particularly vulnerable to episodes of instability^[1]. Anterior instability is the most common form, accounting for 80%-98% of all GHJ instability events among young, athletic populations particularly during contact sporting events with the shoulder in the abducted and externally rotated position^[2-10]. In 2018, the MOON Shoulder Instability Study reported on the descriptive epidemiology of 863 patients who underwent surgical intervention for GHJ instability^[11]. They found the mean age for the cohort was 24 years with males representing 82% of all patients. The primary direction of instability was most commonly anterior for male (74%) and female (73%) patients with football (24%) and basketball (13%) the most common sports during which the injury occurred. The etiology of instability events ranges from ligamentous laxity to traumatic dislocation events, with the latter being the most common with an overall incidence of 1.7%^[7,12].

Many first time dislocators can be managed non-operatively with a period of immobilization and rehabilitation, however, certain patient populations are at higher risk for recurrent instability which can lead to substantial time loss from active participation/training and may require surgical intervention for adequate stabilization^[4,13,14]. Operative techniques aimed at addressing GHJ instability are variable and range from arthroscopic soft-tissue stabilization, open soft-tissue stabilization, as well as techniques aimed at addressing bone loss such as the Latarjet procedure, autologous bone graft transfer, and allograft bone transfers. Determination of the optimal treatment strategy should be made on a case-by-case basis while weighing patient specific factors such as age, activity/sport/working status, goals, and previous history of instability events. Additionally, injury specific factors should also be considered such as acuity of injury and the degree of bone loss which will be discussed in more detail later in this text.

The purpose of this review is to describe the relevant anatomical stabilizers of the GHJ, risk factors for recurrent instability including bony lesions, indications for arthroscopic *vs* open surgical management, clinical history and physical examination techniques, imaging modalities, and pearls/pitfalls of arthroscopic soft-tissue stabilization for anterior glenohumeral instability.

FUNCTIONAL ANATOMY

GHJ stability is provided through a complex interplay of passive and dynamic stabilizers^[1,15-19]. Passive stabilizers include the rotator interval [superior glenohumeral ligament (SGHL), coracohumeral ligament, and joint capsule], the middle glenohumeral ligament (MGHL), and most importantly the inferior glenohumeral ligament complex (IGHL)^[20]. The glenoid labrum runs circumferentially along the glenoid rim and serves as the point of insertion for all of the GH ligaments^[1]. The SGHL prevents inferior translation of the adducted shoulder, the MGHL resists anterior translation in the externally rotated shoulder in abduction up to 45 degrees, and the IGH can be broken down into the anterior band which is the major restraint to anteroinferior translation in external rotation with abduction > 45 degrees and the posterior band which resists posterior translation in the flexed and internally rotated shoulder^[1,20-25]. The labrum deepens the glenoid socket and acts as a physiologic bumper to prevent GHJ instability^[1]. Furthermore, the fibrocartilaginous labrum which



circumferentially surrounds the glenoid and provides stabilization to the GHJ is tight in its anteroinferior attachment and loose in the superior attachment with a great deal of anatomic variation^[1,21]. Acting in accordance with these ligamentous and capsular stabilizers are surrounding muscles providing dynamic stabilization which include the deltoid, biceps brachii, and the rotator cuff muscles. The basis for dynamic stability is the theory that instability occurs at end-range positions which place the GHJ at its maximum vulnerability in regards to dislocation. Muscular activity acts to compress the humeral head against the center of the glenoid fossa thereby stabilizing during these end-range motions^[15,17-19,26].

While there are several ligamentous and muscular components to stability, the glenoid and humeral head add an additional osseous component for stabilization. Therefore, in the evaluation of GHJ instability a proper understanding of the bony anatomy and pathoanatomy is critical to determine an accurate diagnosis and treatment plan. When considering the size of the glenoid in comparison to the humeral head it is clear that even a small bony lesion can lead to significant instability by altering the bony articulation of the glenoid and humeral head^[21,27-29]. The glenoid is a pear shaped bone which is widest in the inferior half and is tilted anteriorly^[1,26]. Wide variability in the size and inclination of the glenoid make bony lesions related to instability especially challenging to treat. The articulation between the glenoid and humeral head is important to consider in the patient with recurrent anterior instability. Burkhart and Danaceau^[30] described the “articular arc” between these bones and determined that defects in this arc could lead to engaging lesions and instability events.

A proper understanding of the anatomy related to the GHJ is critical to properly evaluate, diagnose, and treat anterior GHJ instability. The surgeon needs to have a precise understanding of both the normal and variant anatomy of the capsulolabral complex as well as the dynamic muscular stabilizers to properly evaluate and surgically manage injury. Additionally, an understanding of the bony anatomy of the glenoid and humeral head come into play as the clinician needs to thoroughly evaluate and manage these defects. These challenges will be described further in later sections of this text.

RISK FACTORS FOR RECURRENT GLENOHUMERAL INSTABILITY

Although GHJ instability is considered a relatively common event in young athletes and physically active patient populations, oftentimes first-time dislocators can be effectively managed non-operatively^[3-6,31]. However, several proposed risk factors associated with recurrent instability events have been described. Of these reported risk factors, the most closely associated with recurrence include a history of instability events, age at the time of initial injury, contact sports, overhead athletes, and those with ligamentous laxity^[4,7,21,32-36]. In addition, the most challenging injuries to treat are those with concomitant bony pathologies. During an anterior GHJ instability event there can be bony injury to the glenoid (referred to as a bony Bankart lesion), the humeral head (referred to as a Hill-Sachs lesions), or to both structures (bipolar lesions). Several studies have reported on the relationship between GHJ instability and bony deficits with recurrent instability rates in correlation with the size of the bony lesion^[34,37]. In the past these injuries were managed with isolated soft tissue repairs, however growing evidence of recurrent instability raised questions as to the appropriate management of these injuries. An investigation performed by Burkhart *et al*^[29] reported on 194 consecutive arthroscopic Bankart cases and found recurrence rates of 4% in those without significant bone defects as compared to 67% in those with humeral and/or glenoid lesions. These findings added evidence to the recurrent instability in those with untreated bony lesions and increased the awareness and treatment of these pathologies. In the management of patients with anterior GHJ instability it is important to think about the bony risk factors for recurrent instability and to modify these risk factors when possible to improve clinical results. Some of these potential risk factors related to bony defects have been researched in the literature and include.

Glenoid defects: The bony Bankart

Glenoid lesions have been reported to occur in 22%-41% of first time dislocation events and up to 86% of recurrent events^[28,32,38,39]. Bony Bankart lesions occur during anterior GHJ instability as the dislocation of the humeral head creates a bony lesion on the anteroinferior aspect of the glenoid in addition to avulsion of the anteroinferior

labrum. Burkhart *et al*^[29] described the normal glenoid to appear pear shaped with a wider diameter in the inferior aspect as compared to the superior aspect. They went on to describe the “inverted pear” phenomenon which was in reference to the pathologic appearance of the glenoid resulting from a bony Bankart injury where the superior aspect of the glenoid appeared wider in diameter as compared to the inferior aspect. This change disrupts the arc of motion while the arm is abducted and externally which places the GHJ at a higher risk of redislocation. This theory was then confirmed by the biomechanical work of Gerber *et al*^[40] who reported that increasing loss of the anteroinferior glenoid arc was associated with decreased resistance to dislocation. Bigliani *et al*^[28] further categorized glenoid lesions and provided prognostic factors as follows: Type 1 Lesions involve a non-displaced anterior glenoid fragment, type 2 Lesions involve a small anterior fragment detached from the labrum, type 3a lesions involve < 25% anterior glenoid deficiency, and type 3b lesions involve > 25% anterior glenoid deficiency.

Humeral head defects: The Hill-Sachs lesion

In addition to glenoid sided lesions, a bony lesion to the posterolateral aspect of the humeral head is referred to as a “Hill-Sachs” lesion and can also lead to GHJ instability. These bony defects following first time GHJ dislocation have been reported to be found in up to 70% of patients^[32,41]. In their review of 91 patients, Boileau *et al*^[35] found Hill-Sachs lesions to be significantly related to failure. The failures resulting from Hill-Sachs lesions are theorized to result secondary to the articular arc defect which causes engagement of the humerus against the anterior glenoid rim referred to as the “engaging Hill-Sachs” lesion^[29,35]. In their investigation, Burkhart *et al*^[29] reported recurrent anterior GHJ instability in 100% ($n = 3$) of patients found to have an “engaging” Hill-Sachs lesion treated with arthroscopic Bankart repairs for traumatic anteroinferior instability. Although the clinical correlation between humeral defects and recurrent dislocation has been reported, there is a lack of current information regarding the size of the defect and relation to instability.

The combined bony Bankart and Hill-Sachs injury

While bony Bankart and Hill-Sachs lesions can occur in isolation, these injuries may also occur concurrently. A recent cadaveric study by Arciero *et al*^[42] reported on these combined injuries. The study developed models for bony lesions based on computed tomography (CT) scans from 142 consecutive patients presenting with GHJ instability. The authors found that combined glenoid and humeral lesions displayed an additive and negative effect on GHJ stability. More specifically, they found that in patients with moderate sized Hill-Sachs lesions (defined as 50th percentile within the population of 142 consecutive patients), a glenoid lesion as small as 2 mm significantly compromised the stability of a soft tissue Bankart repair. These findings led to the conclusion that combined glenoid and humeral head defects have an additive and negative effect on glenohumeral stability.

The “glenoid track” concept

This description of the zone of contact between the glenoid and humeral head during elevation of the arm is termed the “glenoid track”^[43]. This concept was initially described by Yamamoto *et al*^[43] in a cadaveric study focused on the location and width of this “glenoid track” during various degrees of abduction while maintaining maximum external rotation and horizontal extension. The investigators found that the zone of contact shifted from the inferomedial to the superolateral portion aspect of the humeral head. They determined the width of the track from the rotator cuff attachment site of the greater tuberosity to be $84\% \pm 14\%$ of the width of the glenoid (assuming no bone injury to the glenoid) and used this concept to determine the risk of a Hill-Sachs lesion engaging the glenoid rim in cases with and without bony injury. If the bony injury to the humeral head is located within the width of the glenoid track then there is no opportunity for the Hill-Sachs lesion to over-ride the glenoid creating a potential instability event. However, in cases where the Hill-Sachs lesion extends beyond the width of the glenoid track this creates an opportunity for instability. Another important aspect of this concept is that the width of the glenoid track is determined solely on the width of the glenoid meaning that a bony Bankart directly correlates with a decrease in width of the glenoid track. This concept was not the first to describe bony lesions as they relate to anterior glenohumeral instability, however this provided a new concept to evaluate both humeral and glenoid sided lesions simultaneously as the authors concluded that if the medial margin of a Hill-Sachs lesion is more medial than the glenoid track then standard stabilization techniques are

unlikely to adequately address the bony sources of instability. Several investigations have identified “off-track” lesions to be at higher risk for recurrent instability^[44-48]. Most recently, in a 2020 investigation by Yian *et al*^[36] the authors reported on 540 patients undergoing primary arthroscopic Bankart repair and found “off-track” glenoid lesions to be statistically significantly associated with higher rates of recurrent instability (odds ratio, OR 2.86).

INDICATIONS FOR ARTHROSCOPIC VS OPEN SURGICAL MANAGEMENT

The purpose of surgical management of anteroinferior labral injuries is to reduce the risk of recurrent instability events. Historically, the rate of recurrent glenohumeral dislocations following open surgical repair have been lower (5%-9%)^[49-51] as compared to arthroscopic interventions (5%-33%)^[52-54]. Traditionally, open Bankart repair performed simultaneously with a capsular shift was considered the preferred management option, however improvements in arthroscopic techniques and implants have resulted in arthroscopic stabilization becoming the currently preferred technique for management of recurrent anterior GHJ instability^[55-57]. One of the major advantages of the arthroscopic technique is that it does not violate the subscapularis which could potentially lead to functional deficits in external rotation^[49]. Several high level investigations have reported similar rates of recurrent instability following arthroscopic *vs* open surgical intervention^[53,55,58,59]. While these investigations found similar outcomes in results following both arthroscopic and open stabilization procedures, only short term outcomes were reported. Others have argued that outcomes between arthroscopic and open stabilization cannot be established in 2-3 years of followup^[56]. Supporting this argument, longer-term studies have found much higher rates of recurrent shoulder instability following arthroscopic repair ranging from 17%-35% at 5-10 years^[60-63]. This is in comparison to longer-term studies reporting on outcomes of open Bankart repairs with recurrence rates of 15%-17.5% at 10-20 years^[61,62,64]. Although it may seem reasonable to utilize an open Bankart repair following initial failure of an arthroscopic technique, the current literature shows inferior outcomes in patients undergoing revision open Bankart compared to primary open Bankart^[65-67]. Despite the abundance of clinical outcomes on this topic, indications for primary open Bankart repair remain controversial^[56]. Some advocate for open Bankart repair in the setting of male collision athletes younger than 20 years, patients with subcritical (10%-20%) glenoid bone loss, patients with 10 or more shoulder dislocations, patients who have failed arthroscopic Bankart repair with less than 20% glenoid bone loss, and those with poor capsulolabral tissue^[56].

When considering operative intervention it is also critical to evaluate associated bony injuries as discussed in previous sections of this manuscript. Amounts of bone loss initially thought to be adequately treated with Bankart repair is shrinking. Historically, anteroinferior glenoid bone loss of $\geq 25\%$ of the inferior glenoid diameter is managed with glenoid bone grafting with a coracoid autograft (Latarjet), iliac autograft, or allograft^[29,35,40,54,68-71]. Cadaveric investigations have shown that bone loss of $> 21\%$ has resulted in residual instability, resulting in some advocating for a threshold of 20% glenoid bone defect to be an indication for bony stabilization^[54,72]. A 2015 investigation by Shaha *et al*^[73] reported increased shoulder pain and decreased function in patients after arthroscopic Bankart repair with bone loss of 13.5%-19.8% of the inferior glenoid which they termed “subcritical” bone loss. This investigation led to the potential role of bony augmentation in patients with this “subcritical” bone loss of the glenoid. More recently, Pickett and Svoboda^[54] reported their threshold for a Latarjet procedure to be 20% glenoid bone loss while also considering the procedure in contact athletes with “subcritical” (13%-19%) glenoid bone loss.

The clinical implications of Hill-Sachs lesions is not completely understood, original thought was that lesions $> 16\%$ of the humeral head diameter, those whose volume exceed 1000 mm³, or patients who experienced a clunking sensation with the arm in 90 degrees of abduction and 90 degrees of external rotation required operative intervention^[54,74]. Others advocated that defects $> 20\%$ -25% of the humeral head diameter required management with an allograft^[54,75]. These investigations preceded the concept of the glenoid track by Yamamoto *et al*^[43] which was discussed earlier in this text.

While many investigations have reported on glenoid or humeral sided bone lesions, in practice these injuries can occur concurrently. Di Giacomo *et al*^[68] proposed an algorithm in patients with bipolar lesions with varying degrees of glenoid and humeral head involvement. The authors broke patients down into the following four

groups with their associated treatment: (1) Group 1: < 25% glenoid bone loss and on-track Hill-Sachs defect can be treated with an arthroscopic Bankart repair; (2) Group 2: < 25% glenoid bone loss and off-track Hill-Sachs defect can be treated with an arthroscopic Bankart repair and remplissage; (3) Group 3: > 25% glenoid bone loss and on-track Hill-Sachs defect require a Latarjet procedure; and (4) Group 4: > 25% glenoid bone loss and off-track Hill-Sachs defect require a Latarjet procedure and may need an additional bony procedure to address the humeral head.

It would seem practical to utilize the glenoid track concept to assist in surgical planning as it incorporates bony lesions to both the glenoid and humeral head. Due to the fact that this initial concept was described *in vitro*, some theorized it may not represent true conditions of recurrent instability due to its lack of including factors such as laxity of the capsulolabral complex. In theory, this could lead to a smaller sized Hill-Sachs lesion facilitating an engaging bipolar lesion causing recurrent instability^[44,76]. However, there is growing evidence supporting clinical outcomes using the glenoid track concept while lowering the threshold for glenoid bone loss^[48,77]. More specifically, Metzger *et al*^[77] reported on 205 patients with recurrent anterior shoulder instability. The patients had a mean glenoid bone loss of 7.6% (range 0%-29%) with 22% of patients engaging on clinical exam under anesthesia (EUA). When comparing clinical EUA findings with radiographic findings, 84.5% of patients with radiographic findings suggestive of an engaging lesion displayed clinical evidence of an engaging lesion on EUA while only 12.4% clinically engaged during EUA without radiographic evidence of engagement ($P < 0.001$). The investigation demonstrated that glenohumeral engagement was well predicted based on preoperative glenoid and humeral head bone loss measurements using the glenoid track concept. Supporting these findings, a 2016 investigation by Shaha *et al*^[48] reported on 57 shoulders over a two year period treated with a primary arthroscopic Bankart reconstruction. The authors reported 10 instability recurrences (18%) with 4 (8%) failures in the on-track patients as compared to 6 (75%) in the off-track group ($P = 0.0001$). Importantly, they reported the positive predictive value (PPV) of an off-track measurement was 75% compared to a 44% PPV in those with glenoid bone loss of > 20%. They concluded that the application of the glenoid track concept was superior to using glenoid bone loss alone when predicting post-operative stability.

More recently, a 2018 Yang *et al*^[76] investigated the relationship between the Hill-Sachs interval and the glenoid track. The investigators retrospectively reviewed 160 patients who underwent an arthroscopic Bankart repair with a minimum of 24 mo follow up. They reported that a Hill-Sachs interval to glenoid track width ratio (H/G ratio) of ≥ 0.7 was a significant predictor of higher risk for recurrent instability. This value was validated by the recent findings of Chen *et al*^[44] who found the H/G ratio of ≥ 0.7 to be comparable to the instability severity index score (ISIS) for predicting an increased risk of recurrent instability after arthroscopic Bankart repair. The ISIS was initially developed by Balg *et al*^[78] and utilizes a combination of clinical characteristics and radiographic findings to predict risk for recurrent instability. It has been validated by several studies as a useful tool in predicting recurrent instability^[44,79-83].

CLINICAL HISTORY AND PHYSICAL EXAM

The history of injury should include a description of the position of the arm, force applied, and point of force^[84]. The typical mechanism for an anterior GHJ dislocation is a force to an extended, abducted, and externally rotated upper extremity^[84]. Clinical history elicited during the initial encounter should also include evaluation of other sources of instability such as connective tissue disorders or generalized joint laxity. Connective tissue disorders such as Ehlers Danlos or Marfan's syndrome should be ruled out by inspecting for skin hyper-extensibility, widened atrophic scarring, family history, personal history of instability events, and evaluation of joint hypermobility utilizing the Beighton criteria when clinically appropriate^[85]. Evaluation should always include comparison to the contralateral shoulder.

Examination of the shoulder should include evaluation of the cervical spine, visualization of bilateral shoulders for evidence of muscular atrophy or deformities, active and passive range of motion, and a neurovascular exam with careful evaluation of the axillary nerve^[32]. Finally, evaluation should include specific laxity and instability testing. It is important for the clinician to differentiate GHJ instability which is described as symptomatic and reproducible dislocation of the joint as compared to generalized joint laxity which is characterized by loose ligamentous tissue causing chronic pain and instability during minor events.

Tests specific to joint laxity include the load and shift test and the sulcus test. In the load and shift test an axial load is placed on the shoulder to center the humeral head onto the glenoid cavity and the examiner stabilizes the shoulder girdle with one hand while applying an anterior or posterior load to the proximal humerus with the other hand^[32]. Increased translation in the anterior or posterior directions indicates joint laxity in that plane. The sulcus test is performed while the patient stands with their arm at the side while the examiner places a downward force onto the arm. It can be indicative of inferior laxity if a sulcus, or hollowing, occurs inferior to the acromion. Both of these tests should be performed in comparison to the contralateral side. In regards to testing for joint stability the clinician may perform the apprehension test and the jerk test. The apprehension test is performed with the patient in a supine or standing position. The arm is held in 90 degrees of abduction and in external rotation. The examiner places one hand behind the scapula for stabilization while simultaneously pulling back on the wrist putting the patient into further external rotation. The patient with anterior instability becomes apprehensive during this maneuver^[84]. The jerk test is performed with the patient in internal rotation and flexed to 90 degrees. With one hand stabilizing the scapula the examiner grasps the elbow and places an axial load onto the humerus while simultaneously moving the arm horizontally across the body. The clinician is evaluating for a sudden “jerk” of the humeral head sliding off of the posterior glenoid followed by a “clunk” when the arm is brought back to the original positioning^[84]. A positive jerk test is indicative of posterior instability.

Imaging

Initial radiographic workup of GHJ dislocation should include plain radiographs with anteroposterior (AP), infrapinatus outlet, and axillary views to evaluate for bony pathology and the version of the glenoid. Angled views such as the apical oblique view, Stryker notch view, and the West Point view could also be obtained to better visualize bony defects to the glenoid and posterolateral humeral head^[84]. If there is further clinical or radiographic concern for bony pathology, or in cases of recurrent episodes of instability, computed tomography (CT) imaging with 3D reconstruction remains the gold standard for evaluation of bony injury^[28,32]. In addition to evaluation of bony deficits, magnetic resonance imaging (MRI) is the preferred method for evaluation of the soft tissues of the shoulder joint, specifically for evaluation of the glenoid labrum and rotator cuff. Based on its location, the GHJ is inherently difficult to image and the best positioning is with the arm in a neutral or externally rotated position as internal rotation of the shoulder can cause labral and/or anteroinferior capsule redundancy which obscures tears^[1,86]. In general, several consecutive images should be reviewed when evaluating an MRI and MR arthrography may also be utilized to increase visualization^[1,87].

OPERATIVE PEARLS AND PITFALLS OF ARTHROSCOPIC BANKART REPAIR

Patient positioning

Based on the importance of the inferior anchor placement the clinician should consider the benefits and disadvantages of beach chair *vs* lateral decubitus positions. In regards to the beach chair positioning the benefits include easier conversion from arthroscopic to open, anatomic orientation of the joint, rotational control of the shoulder, and optimal visualization of the subacromial joint. Despite these advantages, the major difficulty with beach chair orientation is decreased visualization of the inferior aspects of the joint. In comparison, the lateral decubitus positioning allows for increased joint space as traction can be applied in addition to improved access and visualization to the inferior GHJ. Despite this advantage it's important to note that the disadvantages of lateral decubitus positioning include non-anatomic orientation, difficult conversion from arthroscopic to open, challenging positioning for the anesthesia team, and the possibility of traction related injury.

In regards to the optimized visualization/access to the inferior joint, a systematic review with meta-regression analysis conducted by Frank *et al*^[88] on outcomes of arthroscopic anterior shoulder instability cases in beach chair *vs* lateral positioning. The study reported on 64 studies including 3668 shoulders and found the overall recurrent instability rates were 14.65% in the beach chair positioning patients as compared to 8.5% in the lateral decubitus positioning. Although the study reported

decreased recurrence rates within the lateral decubitus group the differences in range of motion, return to activity, and Rowe scores between groups were not significant. Although patient positioning may be related to recurrent instability events it is important to recognize that these results do not necessarily suggest a more or less successful surgery as clinical outcome scores were similar and the fact that recurrence is a difficult measure of operative success based on the wide spectrum inherent to the term “instability.”

Portal placement

Optimal portal placement is crucial during the operative management of GHJ instability. With incorrect or inadequate portal placement the visualization into the joint can be severely compromised and can also dramatically increase the technical difficulty. Ideal placement of the portals allows for adequate visualization for proper diagnostic arthroscopy and eases the technical demands of anchor placement. Initial portal placement begins with standard posterior portal located roughly 2 cm inferior and 1 cm medial to the posterolateral corner of the acromion. Next, the anterosuperior (AS) portal is placed anterolateral to the edge of the acromion and lateral to the coracoid under direct visualization. Ideal intraarticular placement of this portal is just posterior to the insertion of the long head of the biceps. The primary purpose of the AS portal is to visualize the inferior, anterior, and posterior capsule while allowing for a thorough diagnostic scope to evaluate and recognize the anatomy of the shoulder. During this stage of the procedure the surgeon will evaluate the capsular volume, biceps tendon, glenohumeral ligaments, rotator cuff, and the anterior, posterior, and inferior labrum. Next, the anterior and posterior working portals can be created under direct visualization. During creation of these portals an “outside in” technique is utilized meaning a spinal needle is used to ensure ideal placement. For the anterior portal the needle should be placed between the acromioclavicular joint and the lateral coracoid. Intraarticularly the needle will ideally pierce the capsule just superior to the subscapularis tendon directly parallel to the surface of the glenoid. The posterior portal is created slightly inferior to the arch of the acromion and directed towards the coracoid process. Proper placement of these portals will allow the surgeon to visually appreciate the entire capsulolabral complex.

Labrum and glenoid preparation

Adequate labral preparation is a critical component of anterior GHJ instability repairs as error during this step may lead to recurrent instability due to inadequate capsulolabral plication. An elevator device can be used during this step to peel the labrum off the glenoid surface. After elevating the labrum from the glenoid neck a small shaver can be used to prepare the surface of the glenoid for anchor placement. Preparation of the labrum should be completed prior to preparation of the glenoid surface and anchor placement.

Anchor placement

Ideal anchor placement is below the 3 o'clock position placed 2-3 mm from the glenoid rim at a 45 degree angle relative to the anterior glenoid rim^[21]. Anchors can then be placed approximately 7 mm apart. Based on the study performed by Boileau *et al*^[35] at least 4 suture anchors should be utilized as 3 or fewer were found to be at higher risk for recurrent instability. During this stage of the procedure it is critical to achieve inferior anchor placement onto the glenoid. There are several portal positions and guides available to the surgeon to achieve this low placement however there remains no perfect option. A biomechanical study by Frank *et al*^[89] reported on inferior anchor placement in 30 cadavers which were randomized into 3 test groups based on portal location and drill guide. The study found that there was no significant difference in ultimate load to failure among anchors placed *via* the 3 techniques. However, the authors did conclude that midglenoid portal anchors drilled with a straight or curved guide placed at the 5 o'clock position displayed significantly increased risk of opposite cortex perforation. Although the clinical applicability of these findings remained unclear, the study prompted discussion regarding ideal patient positioning in order to visualize the inferior glenoid in order to place the inferior anchor.

Rehabilitation

The authors prefer an abduction sling post-operatively in order to keep the shoulder in neutral positioning. Physical therapy then begins 7-10 d post-operatively with passive and active range of motion (ROM) for 4 wk (forward flexion to 130 degrees, external rotation to 30 degrees), ROM progression from 4-6 wk (forward flexion to 180 degrees,

external rotation to 60 degrees), followed by resistive strengthening from 8-12 wk, and return to full sports and activities at 4-6 mo^[21].

CONCLUSION

Management of the patient with anterior shoulder instability is a common yet complex condition for the orthopaedic surgeon. To optimize the evaluation and management of these patients the provider must ensure a detailed and thorough clinical and radiographic workup, have a thorough understanding of the dynamic, static, and bony stabilizers of the GHJ, and understand the common causes of failed surgical intervention in order to address these concerns when appropriate.

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