Limited Predictive Value of the Instability Severity Index Score: Evaluation of 217 Consecutive Cases of Recurrent Anterior Shoulder Instability

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Purpose: To review the existing variables and their ability to predict recurrence of shoulder instability as it relates to the Instability Severity Index Score (ISIS), as well as evaluate any other pertinent imaging and patient history variables that may impact risk of recurrent anterior instability after arthroscopic Bankart repair. **Methods:** All consecutive patients with recurrent anterior shoulder instability and who had arthroscopic instability repair were identified. Exclusion criteria were prior surgery on the shoulder, posterior or multidirectional instability, instability caused by seizure disorder, or a rotator cuff tear. All ISIS variables were recorded (age <20 years, sport type and level, hyperlaxity, Hill-Sachs on anteroposterior external rotation radiograph, loss of glenoid contour on anteroposterior radiograph), as well as additional variables: (1) number of instability events; (2) total time of instability; (3) glenoid bone loss (GBL) percent; and (4) Hill-Sachs measures (H/L/W/D/Volume). Postoperative outcomes were assessed based on the Western Ontario Shoulder Instability Index (WOSI), Single Assessment Numeric Evaluation (SANE) scores, and American Shoulder and Elbow Surgeons (ASES) scores, and recurrent anterior instability. Regression analysis was used to determine preoperative variables that predicted outcomes and failures. **Results:** There were 217 consecutive patients (209 male patients [96.5%], 8 female patients [3.5%]) who met the inclusion criteria and were all treated with a primary arthroscopic shoulder stabilization during a 3.5-year period (2007−2011), with a mean follow-up time of 42 months (range, 26−58). The mean age at first instability event was 23.9 years (range, 16−48 years) and the mean cumulative ISIS score for the overall group was 3.6 (range, 1−6). Outcomes were improved from mean preoperative (WOSI = 1,050/2,100; ASES = 61.0; SANE = 52.5) to postoperative (WOSI = 305/2,100; ASES = 93.5; SANE = 95.5). A total of 11.5% (25/217) of patients had evidence of recurrent instability (subluxation or dislocation). Additionally, all 25 patients who failed postoperatively also had consistently inferior ASES, SANE, and WOSI outcome scores when compared with successfully treated patients. Factors associated with failure were GBL greater than 14.5% ($P < .001$), total time of instability symptoms greater than 3 months ($P = .03$), Hill-Sachs volume greater than 1.3 cm^3 ($P = .02$), contact sports participation ($P = .05$), and age 20 years or younger ($P < .01$). There was no correlation in outcomes with Hill-Sachs on presence of glenoid contour loss on radiograph ($P = .07$), participation sports, or ISIS (mean = 3.4 success vs 3.9 failure, $P > .05$). **Conclusions:** At a mean follow-up of 42 months was an 11.5% failure rate after arthroscopic Bankart stabilization surgery. This study shows no correlation between treatment outcome and the ISIS measure, given a mean score of 3.4 for the overall cohort with little difference identified in those who failed. However, several important parameters previously unidentified were detected including, GBL greater than 14.5%, Hill-Sachs volume greater than 1.3 cm^3, and duration of instability symptoms (>3 months). The ISIS may need to be redesigned to incorporate variables that more accurately portray the actual risk of failure after arthroscopic stabilization, including quantification of both glenoid and humeral head bone loss. **Level of Evidence:** III (Retrospective Case Series).

See commentaries on pages 1392 and 1397

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Anterior shoulder instability remains one of the most commonly seen pathologies by orthopaedic surgeons, with an incidence of 11.2 per 100,000 person-years or rate of 0.7% for men and 0.3% for women up to the age of 70 years.[1,2] Recurrent anterior shoulder instability is a common problem encountered by the clinician as well, with greater than 90% of first-time dislocators under the age of 20 years going on to have multiple incidences of subluxation and dislocation if treated nonoperatively.[3] In addition, patients who present with increased duration of symptoms and history of instability have higher rates of attritional glenoid bone loss (GBL).[4] Some 22% of first-time dislocators and up to 90% of patients with recurrent dislocations have GBL that directly influences their rate of both recurrence and treatment options.[5-8] As a result, both symptom duration and history of recurrent instability has known effects of increased rates of GBL, which has direct implications on both patient outcomes and ideal surgical treatment.[9,10]

In a prospective case−control study, Balg and Boileau[11] proposed the Instability Severity Index Score (ISIS) as a way of predicting arthroscopic Bankart repair success in the setting of anterior shoulder instability. On a 10-point preoperative-based scoring system, they found key risk factors that led to increased risk of arthroscopic Bankart failure: patient age younger than 20 years at the time of surgery; involvement in competitive or contact sports or those involving forced overhead activity; shoulder hyperlaxity; a Hill-Sachs lesion visible on an anteroposterior (AP) radiograph of the shoulder in external rotation, and/or loss of the sclerotic inferior glenoid contour. In their study, patients with a score greater than 6 had a recurrence risk of 70% and thus bone augmentation procedures were indicated for those individuals.[11]

Since the concept of the ISIS was introduced to predict risk of recurrence after arthroscopic Bankart repair, many studies have been performed to validate the ISIS predictive model with inconsistent results.[12-16] The purpose of this study was to review the existing variables and their ability to predict recurrence of shoulder instability as it relates to the ISIS, as well as evaluate any other pertinent imaging and patient history variables that may impact risk of recurrent anterior instability after arthroscopic Bankart repair. It was hypothesized that variables both within ISIS (age, sport type) and factors separate from ISIS (total number of instability events, GBL percent, and Hill-Sachs volume) will have prognostic implications on rates of recurrence.

Methods

Participant Enrollment

Approval for this study was obtained from the institutional review board (blinded for review) prior to patient enrollment. All consecutive patients at a military medical care facility from January 2007 to December 2011 with minimum 2-year follow-up who had arthroscopic Bankart repair for anterior shoulder instability performed by the senior author (M.T.P.) were identified. Patients were excluded from the present study if they presented with preexisting epileptic or neurologic disorder, humeral avulsion of glenohumeral ligament, acute glenoid fracture, GBL greater than 25%, or had any prior stabilization procedures. Remplissage was not performed in this military patient cohort. Latarjet was performed as a primary procedure when GBL exceeded 20% as calculated through 3-dimensional (3D)-CT reformatted en face glenoid views.[17] Additionally, occupation and history of multiple failed arthroscopic stabilization procedures were also used as factors requiring bony augmentation through a Latarjet coracoid transfer procedure. Demographic variables and instability-specific factors included: (1) age at initial dislocation; (2) signs of hyperlaxity; (3) total duration of instability symptoms (defined as the time from initial instability event until time of imaging or surgery, whichever is less, in months); (4) sport played; (5) presence of Hill-Sachs on AP radiograph (Fig 1); (6) loss of glenoid contour on AP radiograph (Fig 2); (7) GBL percent; and (8) Hill-Sachs volume (length x width x depth, units = cm^3) were recorded (see later text for measurement details).

Surgical Technique

The senior author (M.T.P.) performs primary arthroscopic anterior shoulder stabilization in the lateral decubitus position to facilitate visualization and working space at the anteroinferior aspect of the glenoid. All patients are treated with bone preserving debridement of the glenoid and labrum to facilitate a healthy bed of tissue for repair. Bankart repair is then performed using a minimum of 3 sutures. Posterolateral, mid-glenoid, and anterosuperior rotator interval portals are used throughout the case interchangeably as both visualization and working portal. The Bankart repair was performed through the posterolateral (7 o'clock) portal facilitating anchor placement, trajectory, and anatomic capsulolabral repair of the inferior glenoid at 6 o'clock on the glenoid clockface. Initial anchor placement begins at the 6-o'clock position extending superiorly, evenly spacing the anchors to span entirety of the labral tear. A SutureLasso device (Arthrex, Naples, FL) facilitates suture passage ensuring an anterior-superior shift of the anterior inferior glenohumeral ligament to provide adequate capsular tightening. Postoperatively, patients followed a rehabilitation protocol, which consists of full-time use of a sling for 6 weeks, with emphasis on passive and progressive range of motion exercises while performing physical therapy. Graduated motion

Fig 1. Anteroposterior radiograph of a right shoulder in external rotation shows the presence of a large Hill-Sachs lesion (red line/white arrows). This finding would add 2 points according to Instability Severity Index scoring criteria.

protocols allow for early limitations of external rotation to 30°, forward flexion to 120°, and abduction to 90° with aims of full passive range of motion by week 6. All range of motion restrictions cease after week 6, with initial strengthening exercises beginning by week 9, and return to full activities to included impact sports by 6 months after surgery.

Diagnostic Imaging

All patients had preoperative imaging workup of radiographs, computed tomography (CT) scans with 3D reconstructions of the glenoid using digital subtraction of the humeral head, and magnetic resonance arthrogram, and their findings were corroborated and recorded by the senior author and one sports medicine trained fellow (M.T.P. and T.J.D.). Any GBL present was measured using the best-fit circle technique to calculate the percentage of missing glenoid relative to the surface area of the glenoid on the en face axial 3D reconstruction view.[7,18,19] Hill-Sachs length, height, and width measures on 3D reconstructed CT scans are shown in (Fig 3). The height of the Hill-Sachs lesion was defined as the craniocaudal distance, parallel to the axis of the diaphysis; length was defined as the longest distance in a diagonal line following the longitudinal axis of the lesion; width was defined as the longest mediolateral distance of the lesion, perpendicular to the axis of the diaphysis. Hill-Sachs volume was calculated by multiplying the maximum length, width, and depth (Fig 4) when lesions were present.

Sports Participation

Sport activity and level of participation were recorded for each patient. The 3 categories for sport participation included contact athletes, overhead athletes, and "other" sports. Contact sports included high-impact activities such as football, rugby, and military exercises, whereas overhead sports included those such as weightlifting, tennis, and baseball. Military patients are routinely asked to perform military exercises to include push-ups, hand-to-hand combatant training exercises, self-defense maneuvers, and many of which routinely have to parachute out of airplanes. Level of sports participation was classified as competitive or recreational. Consistent participation in regular matches as part of a team regardless of level of sport was deemed "competitive."[11,15]

Hyperlaxity

Patients were stratified into a binary algorithm (yes/no) if they showed signs of hyperlaxity on physical examination. Anterior hyperlaxity was defined as external rotation of more than 85° with arms at the side

Fig 2. Anteroposterior radiograph of a right shoulder shows the loss of anterior glenoid bone contour owing to recurrent subluxation or dislocation (black arrows). This finding would add 2 points according to Instability Severity Index scoring criteria.

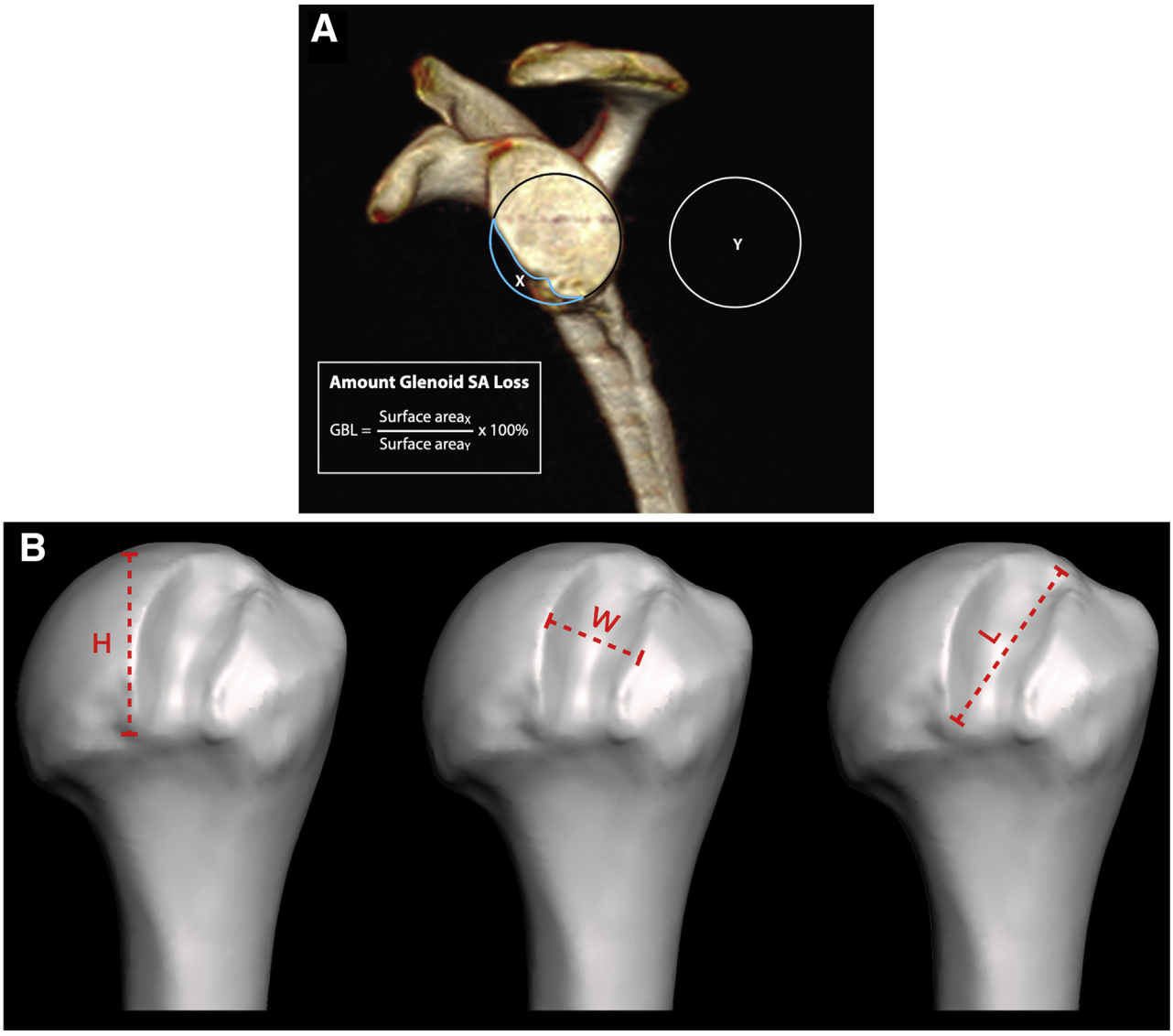

Fig 3. (A) Preoperative 3-dimensional (3D) computed tomography (CT) scan of glenoid with the humeral head subtracted to measure the amount of glenoid bone loss (GBL) present prior to arthroscopic Bankart repair. (B) 3D rendering of a preoperative right shoulder CT scan with the scapula removed, leaving only the humeral head for assessment. Preoperative CT scans with 3D renderings were performed for all patients enrolled and were used to measure the height (H), length (L), and width (W) of Hill-Sachs lesions, with these measurements being used to calculate the total volume of humeral head bone loss. SA, surface area.

(reaching the frontal plane), and inferior laxity was determined through use of the Gagey hyperabduction test.[20]

Functional Outcome Domains

The Western Ontario Shoulder Instability Index (WOSI), Single Assessment Numeric Evaluation (SANE) scores, and American Shoulder and Elbow Surgeons (ASES) scores were recorded both prior and after surgery at a minimum of 2-years follow-up.[21] The SANE is a simple, patient-based shoulder function assessment tool that allows patients to give objective outcomes on their perception of their post-surgical shoulder as a percentage of normal (0%−100% scale, 100% being normal).[22] The WOSI, the gold standard outcome score for shoulder instability, is comprised of 21 questions assessing (1) physical symptoms; (2) sports, recreation, and work; (3) lifestyle; and (4) emotions.[23] The score ranges from 0 to 2,100, with a higher score indicating a worse outcome with a minimal clinically important difference (MCID) of 220.[24] Finally, the ASES measures pain, instability, and levels of activities of daily living and can be used for all shoulder diagnoses with an MCID of 6.4.[24]

Defining Recurrence of Instability

At the time of follow-up, patients reported if they had experienced any recurrent instability in the form of

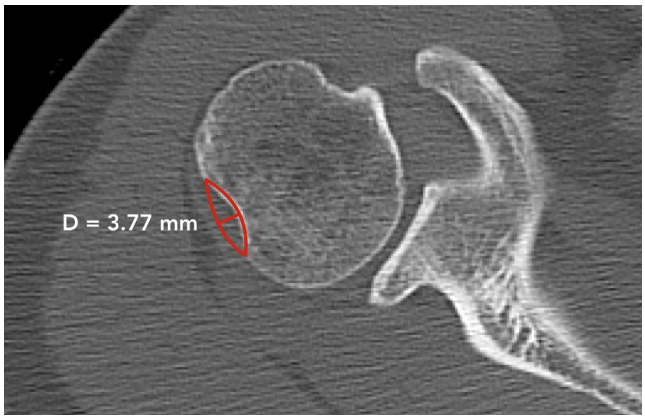

Fig 4. Axial view of a preoperative 2-dimensional computed tomography scan of a left shoulder demonstrating a Hill-Sachs lesion. Depth of the Hill-Sachs lesion was measured as the largest width of the bony defect visible on axial computed tomography (red line). This measurement was used along with the length and width measurements to calculate total Hill-Sachs lesion volume.

subluxation or dislocation, and they were formally assessed by the senior author (M.T.P.) with the same preoperative physical examinations described earlier. Recurrent instability was defined strictly as a glenohumeral subluxation or dislocation, which reduced spontaneously or that required manual reduction after anterior stabilization, the need for revision anterior stabilization, or if the patient experienced instability symptoms on examination of apprehension, surprise, and anterior translation tests. Although it is possible patients in the present study may have experienced recurrent instability after the 2-year follow-up mark, Ahmed et al.[25] showed that over half of patients who fail arthroscopic Bankart procedures do so within 1 year, owing to recurrent instability. Furthermore, over 90% of failures that happen owing to recurrent instability occur within the first 5 years and thus most patients who would have failed should be identified within the included timeframe.

Statistical Analysis

All variables were assessed and recorded in an Excel spreadsheet (Microsoft, Redmond, WA). The paired *t*-test was used to examine differences in clinical outcome scores from pre- to final postoperative follow-up across the cohort. Differences in continuous variables including age, clinical outcome score, duration of symptoms, and diagnostic imaging measurements between patients with stable shoulders and patients with recurrent instability were examined with independent *t*-tests. Differences in categorical variables including participation in contact athletics, the presence of a Hill-Sachs lesion, and loss of glenoid contour between the 2 groups were compared with the χ^2 test. Multivariate logistic and linear models were constructed to the extent to which potential risk factors contribute to recurrent instability and clinical outcome score. Variables were included in the model if they statistically differed between the 2 groups or were considered previous risk factors for failure. The alpha level for all analyses was set at 0.05. All statistical analyses were performed with SPSS version 9.4 (SPSS, Chicago, IL). A power analysis was performed with both WOSI and SANE scores as the main variables, as well as recurrent instability (yes or no). The MCID of 220 for WOSI and 15 for SANE was used with the alpha set at 0.5 and beta of 0.8. The minimal number of patients to detect a difference was between 90 and 110 for WOSI and SANE score to meet a beta of 0.8.

Results

Between 2004 and 2010, a total of 217 patients treated with arthroscopic shoulder stabilization, which included 8 female patients (3.5%) and 209 male patients (96.5%), with a mean age of 23.9 years (range, 16−48 years), were followed for a mean of 42 months (range, 26−48 months). A total of 25 patients (11.5%) experienced recurrent anterior glenohumeral instability as strictly determined by subluxation or dislocation (Table 1).

ISIS Criteria Findings

A total of 51 patients (23.5%) were under the age of 20 years at the time of initial presentation. The mean patient age was 20.7 years (range, 16−31 years) in the group that showed recurrence compared with 25.3 years (range, 17−48 years) in the group that reported no recurrent instability ($P = .01$). Signs of hyperlaxity were seen in a total of 5 patients (2.3%) with no significant difference in recurrence ($P = .89$). AP radiographs identified a total of 77 Hill-Sachs lesions (35.5%); the group without recurrence had a total of 63 of 192 (33%) Hill-Sachs lesions identified on radiographs compared with 14 of 25 (56%) in the failure group ($P = .61$). There were 11 of 25 (44%) patients without a Hill-Sachs lesion visible on AP external rotation radiographs that failed. Standard AP radiographs identified 41 glenoids with loss of contour (18.9%) with 8 glenoids demonstrating contour loss in the failure group compared with 33 in the successfully treated group ($P = .07$). There were 107 patients who presented as playing either a contact sport or overhead sport in the successfully treated group compared with 19 contact and 6 noncontact athletes in the recurrence group ($P = .047$). Of the overall 217 patient cohort, 110 (50.7%) reported participating in competitive athletics, whereas 107 (49.3%) patients qualified as recreational or nonathletes. Some 60% (15/25) of patients in the recurrent instability group participated at a competitive level compared with 49.5% (95/192) of the successfully treated patient cohort ($P = .69$). Finally, the mean ISIS

Table 1. Pre- and Postoperative Patient-Reported Outcome Scores According to WOSI, ASES, SANE, and Rates of Recurrent Anterior Glenohumeral Instability

WOSI	Mean
Preoperative score	1,050
Postoperative score	305
P value	<.05*
ASES	Mean
Preoperative score	61.0
Postoperative score	93.5
P value	<.05*
SANE	Mean
Preoperative score	52.5
Postoperative score	95.5
P value	<.05*
Recurrence	n (%)
Recurrent instability	25 (11.5%)
Stable	192 (88.5%)

ASES, American Shoulder and Elbow Surgeons shoulder score; SANE, Single Assessment Numeric Evaluation; WOSI, Western Ontario Shoulder Instability Index.
*Significance of $P < .05$.

calculated for the overall cohort was 3.6 (range, 1−6), which was determined to be an insignificant factor when comparing those who had recurrent anterior instability versus those successfully treated with scores of 3.9 and 3.4, respectively ($P = .71$). A summary of the ISIS criteria findings and a comparison of their influences on the postoperatively stable and recurrent instability groups in this study can be found in Tables 2 and 3.

Additional Factors

GBL average for the 217-patient cohort, which was calculated via the best-fit circle method, was found to be 11% (range, 5%−20%) (odds ratio [OR], 3.9; 95% confidence interval [CI], 3.6−4.2). Additionally, the GBL in the patients who failed was 14.5% compared with 6.5% in the patients treated successfully ($P < .02$). Furthermore, duration of instability symptoms was significantly ($P < .01$) greater in the group that failed (11.5 vs 2.7 months). A threshold of longer than 3 months of instability symptoms was associated with an increased risk of failure ($P < .01$; OR, 1.9; 95% CI, 1.2−2.6). Finally, Hill-Sachs volume was calculated for each patient with an average of 1.0 cm^3 (range = 0.5−3.6 cm^3) for the entire cohort. A Hill-Sachs lesion volume of greater than 1.3 cm^3 was independently associated with an increased risk of postoperative failure ($P < .01$; OR, 3.4; 95% CI, 3.1−3.7).

Regression Analysis

Multiple logistical and linear regression analyses were performed with all significant factors based on the determination of difference in averages with the use of the Student *t*-tests. When performed, the significant factors that influenced risk of recurrence identified were the following: GBL greater than 14.5% as the critical threshold, total time of instability symptoms greater than 3 months, Hill-Sachs volume greater than 1.3 cm^3, contact sports participation, and age younger than 20 years. Linear regression analysis found no correlation with outcomes based on Hill-Sachs identification or glenoid contour loss on AP radiographs, level of sports participation, or preoperative ISIS.

Clinical Outcome Scores

The WOSI scores for the overall patient population significantly ($P = .02$) improved from preoperative evaluation (1,050) to postoperative evaluation (305), far exceeding the MCID of 220.[26] Similarly, ASES outcome scores significantly improved from 61.0 to 93.5 ($P = .005$), once again exceeding the MCID of 6.4.[27] Finally, SANE scores, which gauge a patient's perception of general shoulder function, significantly improved from 52.5 preoperatively to 95.5 postoperatively ($P = .01$). As may be expected, patients in the successfully treated group (n = 192) reported significantly better outcome scores across all measures when compared with those in the failed treatment group (n = 25) ($P = .009$). Patients demonstrating no recurrent instability reported a mean WOSI score of 255.4 (range, 40−380), whereas those with recurrent instability postoperatively had a mean WOSI score of 686.0 (range, 510−1100) ($P = .002$). Similarly, successfully treated patients had, on average, postoperative ASES and SANE scores of 95.8 (range, 84−99) and 97 (range, 80−100), respectively, whereas those reporting postoperative failure had mean ASES and SANE scores

Table 2. Instability Severity Index Score Criteria Findings for the Overall 217 Patient Cohort

Age at Surgery	n (%)
≤20 years	51 (23.5%)
>20 years	166 (76.5%)
Type of Sport	n (%)
Contact/forced overhead	126 (58.1%)
Other/none	91 (41.9%)
Sports Participation Level	n (%)
Competitive	110 (50.7%)
Recreational/none	107 (49.3%)
Shoulder Hyperlaxity	n (%)
Confirmed	5 (2.3%)
Normal laxity	212 (97.7%)
Loss of Glenoid Sclerotic Line on AP Radiograph	n (%)
Yes	41 (18.9%)
No	176 (81.1%)
Hill-Sachs Lesion in ER on AP Radiograph	n (%)
Yes	77 (35.5%)
No	176 (81.1%)
Total ISIS Score	Score
Mean	3.6
Range	1 to 6

AP, anteroposterior; ER, external rotation; ISIS, Instability Severity Index Score.

Table 3. Comparison of Instability Severity Index Score Criteria Findings Between the Successfully Treated Patient Group and Those Patients who Experienced Recurrent Anterior Glenohumeral Instability After Arthroscopic Shoulder Stabilization

	Stable (n = 192)	Recurrence (n = 25)	*P* Value
Age at Surgery			.01*
Mean (years)	25.3	20.7	
Range (years)	17–48	16–31	
Type of Sport			.047*
Contact/forced overhead (n [%])	107 (55.7%)	19 (76.0%)	
Other/none (n [%])	85 (44.3%)	6 (24.0%)	
Sports Participation Level			.69
Competitive (n [%])	95 (49.5%)	15 (60.0%)	
Recreational/none (n [%])	97 (50.5%)	10 (40.0%)	
Shoulder Hyperlaxity			.89
Confirmed hyperlaxity (n [%])	4 (2.1%)	1 (4.0%)	
Normal laxity (n [%])	188 (97.9%)	24 (96%)	
Loss of Glenoid Sclerotic Line on AP Radiograph			.07
Yes (n [%])	33 (17.2%)	8 (32.0%)	
No (n [%])	159 (82.8%)	17 (68%)	
Hill-Sachs Lesion in ER on AP Radiograph			.61
Yes (n [%])	63 (32.8%)	14 (56%)	
No (n [%])	129 (67.2%)	11 (44.0%)	
Overall ISIS Score			.71
Mean	3.4	3.9	
Range	1–5	2–6	

AP, anteroposterior; ER, external rotation; ISIS, Instability Severity Index Score.
*Significance of $P < .05$.

of 76.5 (range, 51–80) and 70.9 (range, 35–80), respectively (Table 4) ($P = .003$).

Postoperative Complications

The complications of the study, outside of the 11.5% (25/217) recurrence rate, were 2 patients in the recurrent instability cohort who reported body sensations postoperatively. Both underwent revision arthroscopic stabilization at 19 and 29 months. Revision surgery included loose body removal along with retained, compromised suture anchors. Both patients recovered uneventfully and without any further complications. Two patients had superficial dehiscence of the mid glenoid portal that were treated with oral antibiotics for a 7-day cycle postoperatively, which resolved without complication. Finally, the mean loss of external rotation on the operative side was 5° (range, 0°–11°), and loss of motion in ABER (abducted external rotation) was 5.5° (range, 0°–9°).

Discussion

The principle finding of this study is that the ISIS was not predictive of instability recurrence in 217 consecutively enrolled and arthroscopically treated patients with anterior shoulder instability. Furthermore, individual components of the ISIS along with additional factors were determined to be significant and more comprehensive in the identification of risk of recurrence to include age under 20 years at time of initial instability event, duration of instability events prior to intervention (>3 months), amount of GBL (>14.5%), Hill-Sachs volume of greater than 1.3 cm^3, and participation in a contact sport. Although aspects of the ISIS were found to be significant, additional factors remain important in both the treatment and counseling of patients presenting with anterior shoulder instability and thus should be treated accordingly.

The ISIS has been evaluated through many studies with inconsistent results. The original description of the ISIS showed that patients who scored greater than 6 of 10 possible points were at a 70% risk of recurrence when treated with arthroscopic Bankart repair alone.[11] The authors of the original description of ISIS then went on to validate their scoring system in a multicenter study demonstrating both the reliability and use of the scoring system to help drive surgical decision-making.[16,28] More recently, some authors have more narrowly defined failure and poor outcomes as it relates to the ISIS, stating that scores of less than 4 are more predictive of surgical success than using a cutoff of 6.[14,15,29] Most recently, Loppini et al.[14] performed a large case–control study with 5-year outcomes demonstrating the protective effect of using ISIS with a score of less than 3 conferring a rate of success of 93.7%. However, this scoring system has been called into question by others as it may not be applicable to all patient populations. Bouliane et al.[12] classified failure as re-dislocation and found no association between the patients who failed versus those who had no recurrence of dislocation at 2 years postoperatively. Similarly, in this high demand military population, the cumulative ISIS or any of its individual factors had any association

Table 4. Comparison of Pre- and Postoperative WOSI, SANE, and ASES Outcome Scores Between the Successfully Treated Patient Group and Those Patients who Experienced Recurrent Anterior Glenohumeral Instability After Arthroscopic Shoulder Stabilization

	Stable (n = 192)	Recurrence (n = 25)	*P* Value
Postoperative WOSI			<.01*
Mean	255.4	686.0	
Range	40–380	510–1,100	
Postoperative ASES			<.01*
Mean	95.8	76.5	
Range	84–99	51–80	
Postoperative SANE			<.01*
Mean	97.0	70.9	
Range	80–100	35–80	

ASES, American Shoulder and Elbow Surgeons shoulder score; SANE, Single Assessment Numeric Evaluation; WOSI, Western Ontario Shoulder Instability Index.

*Significance of $P < .05$.

with successful arthroscopic repair versus those who failed having a composite score average of 3.41 compared with 3.5, respectively.[13] Similarly, in our article, this ISIS showed no significance in the group treated successfully compared with those who failed (3.4 vs 3.9, $P > .05$). However, unlike the study by Chan et al.,[13] this study found the individual components of age younger than 20 years and contact sports participation, which were in the original description of the ISIS, to be significantly associated with increased risk of failure after arthroscopic Bankart repair. However, additional individual factors were identified that should be carefully evaluated with any patient presenting with anterior shoulder instability as patients presenting with greater than 3 months of instability symptoms, GBL of greater than 14.5%, and Hill-Sachs volume of greater than 1.3 cm^3 are at significantly increased risk of recurrent instability episodes if treated with arthroscopic Bankart repair alone.

In the setting of isolated arthroscopic Bankart repair, young age has been found to portend to worse outcomes and increased risk of recurrence.[11,30-32] Although young age has been shown to have increased rates of recurrence and failure in patients treated nonoperatively, the literature evaluating young age as a sole risk factor for failure for arthroscopic treatment in the setting of minimal bone loss is less robust.[33-36] Furthermore, the independent factor of age within the ISIS has not been validated as an independent risk factor for failure.[13,37] In the setting of primary arthroscopic Bankart repair, Mahure et al.[30] showed that age of younger than 22 years predicted increased risk of failure at mean follow-up of 2.3 years. Similarly, Su et al.[31] evaluated revision arthroscopic Bankart repairs and found that age of younger than 22 years increased the OR by 2.8 compared with those who did not have failure with revision Bankart repair. In contrast, Chan et al.[13] showed that in a military population, age was not an independent risk factor for failure of arthroscopic Bankart repair. In this large series after regression analysis, age younger than 20 years was a significant risk factor for prediction of failure with average age of 20.7 years in the failure group compared with 25.3 years in the group that had no recurrence.

Although participation in contact and collision sports was found to increase risk of failure of arthroscopic Bankart repair in the original description of the ISIS, Bankart repair has been shown to reliably return young athletes participating in these at-risk sports at high rates, as well as full return to the same level of play.[38-40] Despite reports of high return to sport and activities, Torrance et al.[41] cautioned about the risk of recurrent instability in a young contact athlete population (rugby players), as the authors reported a recurrent instability event in greater than 50% of patients after arthroscopic repair for an isolated Bankart lesion. In a study that evaluated multiple contact sports and overhead sports, Nakagawa et al.[32] showed a 20.4% risk of recurrence in the contact athlete with rugby and American football players accounting for most recurrences in the act of tackling. In a young and active military population, patients who recreationally participate in contact sports had higher rates of recurrent shoulder instability after an arthroscopic Bankart repair. Patients who are treated with arthroscopic Bankart repair should be adequately counseled on risk of recurrence as the sport and specific activities that they desire to return to may drastically increase their risk of failure.

Use of radiographs as a screen for identifying bone loss of both the glenoid, as well as identifying Hill-Sachs lesions, was used within the ISIS system to infer increased risk of failure.[11] Although routine radiographs are easier to obtain on a day-to-day basis, they have been shown to be less sensitive and specific compared with advanced imaging modalities of CT or magnetic resonance imaging when assessing shoulder bone loss.[18,42-44] Other views have been proposed to identify GBL and the presence of Hill-Sachs, such as the Bernegeau, West Point, and Stryker Notch views, all of which are better than standard shoulder series radiographs (AP, axillary).[45,46] However, despite these advanced views, they still do not accurately identify nor quantify the size or specific location of the defect compared with the gold standard of 3D CT scans.[18] Clinically, our series showed that using loss of glenoid contour and identification of a Hill-Sachs lesion on an external rotation AP radiograph had no direct correlation to those who failed compared with those who had successful treatment with an arthroscopic Bankart repair alone ($P > .05$). As a result, the authors of this study recommend the use of 3D CT scans or magnetic resonance imaging to further evaluate and characterize any bony defect that may be present to guide the

clinician on the optimal treatment for each individual patient.

Although not directly incorporated into the original ISIS system, extent of bone loss remains one of the most controversial and discussed topics as it relates to both recurrence and failure in anterior shoulder instability. The total percent bone loss that portends to poor outcomes continues to decrease as more authors re-evaluate and establish the definitions of true failure in this high demand population. Itoi et al.,[47] Yamamoto et al.,[48] and Lo et al.,[5] all originally discussed a threshold of anterior GBL of 20% to 25% as significant both biomechanically and clinically, which would increase risk of failure with soft tissue Bankart repairs alone. More recently, Shin et al.[49,50] described both biomechanical studies and clinical outcome studies identifying a GBL threshold of 15% to 17.3% directly affecting outcomes and recurrence. When evaluating bone loss even more critically as it relates to function and patient satisfaction, Shaha et al.[10] found that 13.5% was a subcritical threshold that led to unacceptable WOSI scores and outcomes for patients treated with arthroscopic Bankart alone. Using a regression analysis, bone loss with a critical threshold of 14.5% was a single factor that had significantly increased recurrence of instability events. Critical evaluation by quantifying percent bone loss remains a key factor in determining optimal treatment for patients, as well as counseling patients on risk of recurrence.

Large and engaging Hill-Sachs lesions have been shown to portend to recurrent shoulder instability and worse outcomes when they engage or are considered "off-track."[48,51,52] Many methods have been described to measure area and volume on both 3D and 2D CT scans to help better classify the morphology of the Hill-Sachs lesion.[51] Using Yamamoto's original description and calculations to determine the glenoid track, Shaha et al.[52] clinically validated the use of the glenoid track model showing that a Hill-Sachs lesion as being either on- or off-track is more predictable in determining recurrence and patient satisfaction when comparing to bone loss alone. Although location of the Hill-Sachs lesion regardless of the size is important, volume has been shown to increase with each subsequent dislocation in the patient who is treated nonoperatively. This study also shows that the volume (height x width x depth) is a unique and independent risk factor for increased recurrent shoulder instability episodes. A total lesion volume of 1.3 cm^3 or greater was associated with increased risk of failure after arthroscopic stabilization. This additional factor can be easily calculated in the preoperative setting and can be used to adjust operation type, as well as counsel the patient on risk of recurrence if they choose to proceed with arthroscopic stabilization.

Treatment options for patients with recurrent shoulder instability are multifactorial. One key factor in the patient's history is the total number of instability events, as well as the duration of instability as it directly corresponds to patients having bony (GBL and Hill-Sachs lesions) pathology.[4,7,53] This study more narrowly focused on risks associated with failure of Bankart repair and thus found through regression analysis an increased risk of recurrent instability after Bankart repair if symptom duration exceeded 3 months. Knowing risks of recurrence in the first-time dislocator,[33,54,55] and specifically those in-season, this time cutoff may serve as a tool to optimize surgical repair outcomes when performing an arthroscopic Bankart repair.

Limitations

There are inherent limitations that may arise during any retrospective review process, and we acknowledge its potential for biases. There was a limited follow-up timeframe of minimum 2 years and thus it is possible that failure rates and satisfaction after these procedures would change. In addition, there are inherent limitations in single surgeon studies that can impact outcomes— further multicenter studies critically evaluating the use of ISIS are required to evaluate the use of each of its components. Additionally, true duration of instability is prone to recall bias, which can impact its accuracy as an individual factor of risk of recurrence. Finally, the results of this study are influenced by a largely male, military population and thus the outcomes and conclusions should be extrapolated to the general population with care.

Conclusions

At a mean follow-up of 42 months was an 11.5% failure rate after arthroscopic Bankart stabilization surgery. This study shows no correlation between treatment outcome and the ISIS measure, given a mean score of 3.4 for the overall cohort with little difference identified in those who failed. However, several important parameters previously unidentified were detected, including GBL greater than 14.5%, Hill-Sachs volume greater than 1.3 cm^3, and duration of instability symptoms (>3 months). The ISIS may need to be redesigned to incorporate variables that more accurately portray the actual risk of failure after arthroscopic stabilization, including quantification of both glenoid and humeral head bone loss.

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