When to Abandon the Arthroscopic Bankart Repair: A Systematic Review

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Context: Bone loss is a major factor in determining surgical choice in patients with anterior glenohumeral instability. Although bone loss has been described, there is no consensus on glenoid, humeral head, and bipolar bone loss limits for which arthroscopic-only management with Bankart repair can be performed.

Objective: To provide guidelines for selecting a more complex repair or reconstruction (in lieu of arthroscopic-only Bankart repair) in the setting of glenohumeral instability based on available literature.

Data Sources: An electronic search of the literature for the period from 2000 to 2019 was performed using PubMed (MEDLINE).

Study Selection: Studies were included if they quantified bone loss (humeral head or glenoid) in the setting of anterior instability treated with arthroscopic Bankart repair.

Study Design: Systematic review.

Level of Evidence: Level 4.

Data Extraction: Study design, level of evidence, patient demographics, follow-up, recurrence rates, and measures of bone loss (glenoid, humeral head, bipolar).

Results: A total of 14 studies met the inclusion criteria. Of these, 10 measured glenoid bone loss, 5 measured humeral head bone loss, and 2 measured "tracking" without explicit measurement of humeral head bone loss. Measurement techniques for glenoid and humeral head bone loss varied widely. Recommendations for maximum glenoid bone loss for arthroscopic repair were largely <15% of glenoid width in recent studies. Recommendations regarding humeral head loss were more variable (many authors providing only qualitative descriptions) with increasing attention on glenohumeral tracking.

Conclusion: It is essential that a standardized method of glenoid and humeral head bone loss measurements be performed preoperatively to assess which patients will have successful stabilization after arthroscopic Bankart repair. Glenoid bone loss should be <15%, and humeral head lesions should be "on track" if an arthroscopic-only Bankart is planned. If there is greater bone loss, adjunct or open procedures should be performed.

Keywords: arthroscopic Bankart; shoulder instability; glenoid bone loss; Hill-Sachs lesion

The arthroscopic Bankart procedure has proven to be a largely dependable operation. However, there is cause for concern regarding management of patients with bone loss (glenoid, humeral head, or both). Failed index procedures leading to recurrent instability have portended poor outcomes when managing these patients.[13,16] As with any procedure, avoidance of revision surgery is key to positive outcomes. There remains significant debate as to proper indications for the arthroscopic Bankart.

One of the chief factors in determining failure rates for the procedure is adequate glenoid and/or humeral head bone stock. Many previous studies have recommended alternative or adjunct procedures, including the open Bankart,[8,13,17] supplemental remplissage,[4,11,34] and bony augmentation procedures[36,61,64] for patients with bone loss. Glenoid bone augmentation procedures include the Latarjet, Bristow-Latarjet, and Bristow procedures; use of various allograft techniques have also been described to address humeral head bone loss.[6,18,37,64] The question of when to perform stabilization beyond arthroscopic Bankart repair alone, in favor of a more complex stabilization technique, remains relevant, and one that shoulder surgeons grapple with regularly. The question remains, exactly how much and what type of bone

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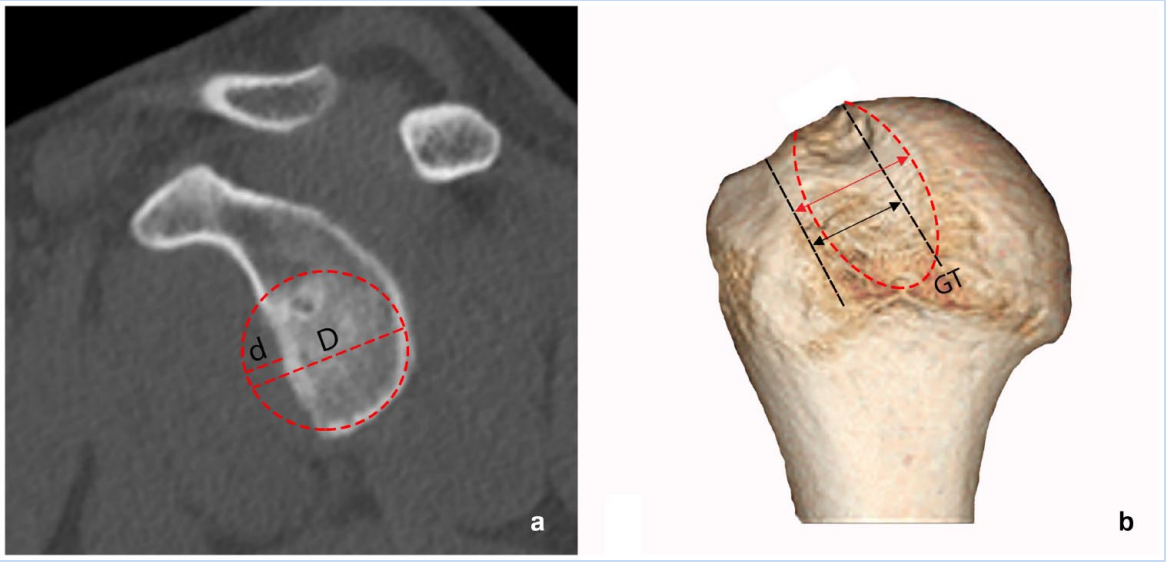

Figure 1. (a) Calculation of the *glenoid track* (GT) in a glenoid with bone loss, as described by Yamamoto et al,[62] involves measurement of the diameter of the best fit circle, *D*, × 0.83 and then subtracting the width of bone loss, *d* (GT = 0.83*D* – *d*). (b) Determination of "on-track" versus "off-track" lesion involves comparing the Hill-Sachs interval (HSI; red double-head arrow) with the GT (black double-head arrow). If GT < HSI then the lesion is "off track," as is the case here. If GT > HSI then the lesion is "on track."[14]

loss is "too much" to perform an isolated arthroscopic Bankart stabilization procedure?

Specific attention has been paid to quantifying glenoid bone loss to help make these decisions. The combination of humeral head and glenoid defects has also garnered attention. The descriptor of humeral head bone loss in relation to the glenoid is described as "on-track" (nonengaging) or "off-track" (engaging) lesions[14,62] (Figure 1). This description has gained importance in surgeons' decision-making algorithms. The terminology delineates between Hill-Sachs lesions that do ("off-track") or do not ("on-track") contact the glenoid during the arc of motion.[22,41,62]

Regardless of method of measurement, it is clear that bony deficiency is a source of potential objective and subjective surgical failure. The purpose of this study was to determine when a more complex repair or reconstruction may be indicated and, subsequently, when to potentially abandon the arthroscopic-only Bankart repair without adjunct operations, which has become the mainstay of many providers. This is paramount to achieving success in these often difficult-to-treat patients. The combination of overlooked bone loss and suboptimal surgical technique are likely major culprits in surgical failure. The authors hypothesize that underestimation of the amount of bone loss, which is relevant to decision making, is a major cause of these failures.

METHODS

A systematic review of the literature was performed utilizing the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines.[38] We searched for those articles that discussed bone loss in the setting of arthroscopic Bankart procedures. An electronic querying of the literature was performed utilizing the PubMed (MEDLINE) database. We separated our search into 2 separate search groups—articles quantifying glenoid bone loss and those quantifying humeral head bone loss. The following search terms were used for our glenoid bone loss search: "(bone loss OR glenoid bone loss OR glenoid defect) AND (Bankart OR arthroscopic Bankart OR anterior stabilization) AND (failure rates OR outcomes OR recurrent dislocation)." The following search terms were used for our humeral head bone loss search: "(bone loss OR humeral bone loss OR humeral defect OR Hill-Sachs OR Hill Sachs) AND (Bankart OR arthroscopic Bankart OR anterior stabilization) AND (failure rates OR outcomes OR recurrent dislocation)." We also performed an additional manual search of the reference list of the articles included above to obtain a comprehensive listing of the current published literature. The final date of our search was December 25, 2019.

Inclusion for our review was based on articles meeting the following criteria: published in English, full text available, including patients who underwent an index isolated arthroscopic Bankart procedure for anterior glenohumeral instability (without adjunct procedures), using a consistent/described manner to measure or quantify glenoid or humeral head bone loss, minimum of 24 months of follow-up, and stated instability recurrence rates after index procedures. We included those papers published since 2000 in an effort to best include modern surgical techniques and management. We did not

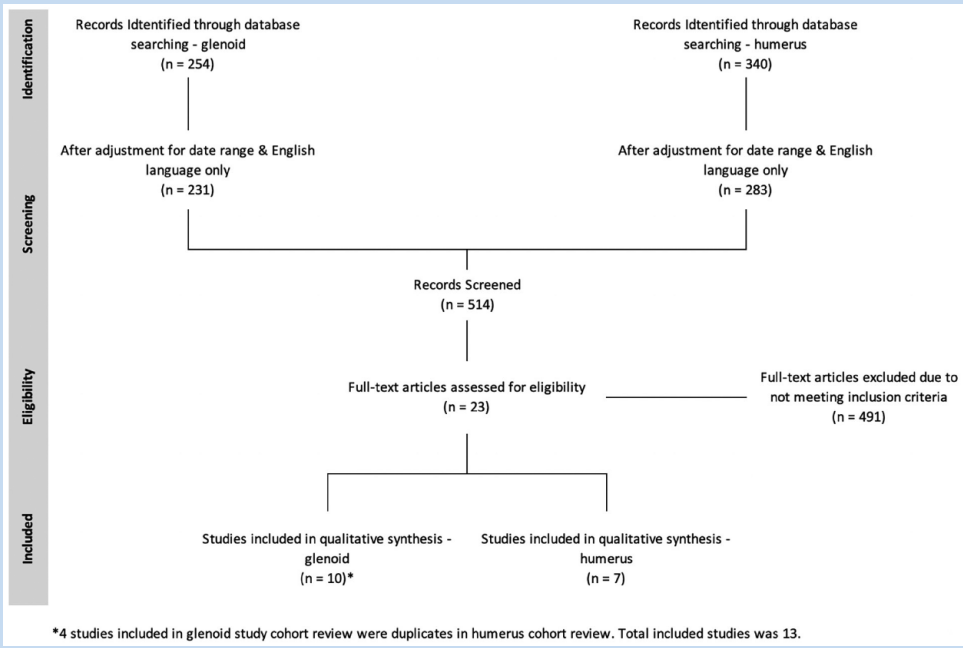

Figure 2. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram.

include case reports, small case series (<10 patients), and expert opinions in our data collection.

Our initial search for articles concerning glenoid bone loss yielded 254 results and was narrowed down as noted in Figure 2. After exclusion of articles that did not meet the aforementioned criteria of patient selection, treatment protocol, and data collection, via individual analysis of article texts, we identified 10 articles[7,27,28,30,39,42,52,53,55,58] to perform our review.

Our initial search for articles concerning humeral head bone loss yielded 340 results and was narrowed down as noted in Figure 2. We identified 5 articles[7,42,45,58,59] to perform our review on humeral head bone loss, and an additional 2 articles[35,51] to discuss the presence of "on-track" and "off-track" lesions without discrete quantification of humeral head defect size, which the authors chose to present given their relevance to the ongoing discussion of this topic.

The Methodological Index for Non-Randomized Studies (MINORS) was utilized to assess the quality of studies included in our analysis. A score of 16 is the maximum for noncomparative studies, and 24 for comparative studies. These values can be viewed in Appendices 1, 4, and 5 (available in the online version of this article).[54]

RESULTS

Glenoid Bone Loss Results

The 10 included studies[7,27,28,30,39,42,52,53,55,58] identified for glenoid bone loss encompassed 799 patients who underwent arthroscopic Bankart repair and were followed for a minimum of 24 months postoperatively. The basic study design information and patient demographic data can be viewed in Appendices 1 and 2 (available online).

There was significant variability in terms of glenoid bone loss measurement techniques and study design. The overall recurrence rates for shoulder instability, as well as measurements of glenoid bone loss in these studies, are represented in Appendix 3 (available online). Some studies[27,39,52] reported recurrent instability rates with different "cutoffs," as indicated in Appendix 3, while only 2 of the 10 included[27,52] articles reported the average glenoid bone loss amount in patients with recurrence as compared with those without recurrent instability.

Humeral Head Bone Loss Results

The 5 studies[7,42,45,58,59] on humeral head bone loss encompassed 332 patients who underwent arthroscopic Bankart repair and were followed for a minimum of 24 months postoperatively. An additional 2 studies[35,51] that discussed "on- and off-track" lesions but not specific humeral head measurements encompassed 227 patients. The basic study design information and patient demographic data can be viewed in Appendices 4 to 7 (available online).

As with glenoid bone loss measurements, there was significant variation in terms of measurement techniques for quantifying the humeral head bone loss. There was virtually no overlap in measurement techniques for those that did quantify bone loss. Furthermore, as with glenoid bone loss, most studies (4 out of 5 included)[7,42,45,58] did not compare the rate of humeral head bone loss in patients with recurrence to those without recurrence. However, there was some noted similarity in protocol for the 2 studies[35,51] that assessed "on- and off-track" lesions. Appendices 8 and 9 (available online) illustrate the conclusions of each of the above studies.

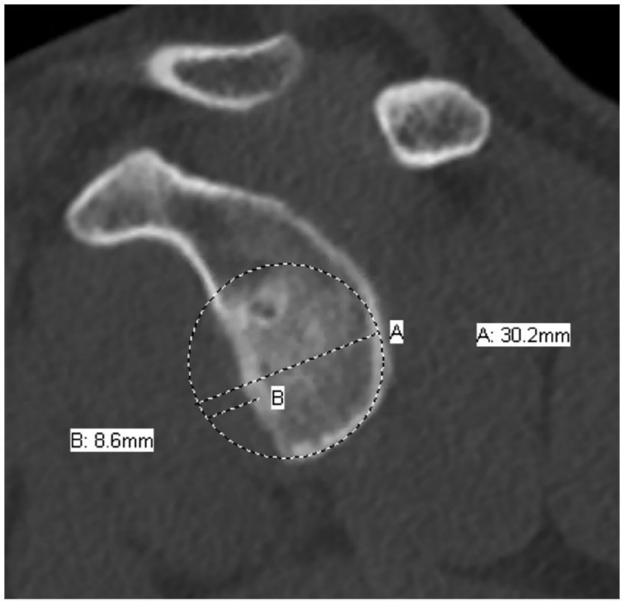

Figure 3. Calculation of percentage of bone loss based on the "best-fit" circle of the glenoid face. Percentage is calculated by width of bone loss divided by diameter of best-fit circle ([8.6/30.2] × 100% = 28.5%).

DISCUSSION

Despite the significant variation in measurement of bony defects, there is a clear consensus that significant glenoid and humeral head bone loss are major risk factors for failure of arthroscopic Bankart procedures. A proposed cutoff of >25%,[7,9,39] and more recently 15%, glenoid bone loss as a marker for determining when to abandon the arthroscopic-only procedure has been cited.[15,52] This sentiment has been echoed by others, suggesting arthroscopic Bankart should be abandoned in patients with a history of multiple dislocations, significant glenoid bone loss, and humeral head bone loss.[48] In recent years, increased glenoid bone loss has shifted many surgeons away from performing arthroscopic-only Bankart procedures.[6] Contrary to the above evidence, others have shown some success with arthroscopic-only management in patients with glenoid bone deficiency >20%, if the patients have low to moderate shoulder demand.[30]

Methods of quantification of glenoid bone loss remain variable, leading to confusion in determining management. Classic discussions employ qualitative descriptions of glenoid morphology, including the "inverted pear" appearance in patients with a significant defect.[9] Bigliani et al[5] described a novel classification based on type of bone loss, emphasizing historical underreporting of lesions. Owens et al[43] compared the glenoid height and width to deduce the amount of bone loss. Huysmans et al[26] taught us that the inferior glenoid shape is a "perfect circle." Their group and others described methods of utilizing a "circle tool" on sagittal imaging to quantify bone loss[25,26,56] (Figure 3). Bakshi et al[3] calculated that surface area is more accurate in measuring defect size than linear measurements. Three-dimensional imaging has improved our precision, with more direct assessments of the defect.[60] Adaptations by Lansdown et al[33] have employed a simplified "flat anterior glenoid" model for measurement, suggesting that bone loss anterior to a given line should be considered "critical." Others have described the utility of intraoperative measurements with focus on quadrants of bony defects.[7,29] Regardless of technique, it is evident that a consistent, accurate method of measurement must be used.[10,19,21,57]

More significantly than with glenoid bone loss, there is tremendous inconsistency noted in measurement of humeral head defects (Hill-Sachs lesions).[49,50] Hill-Sachs lesions are present in 36% to 100% of patients with anterior instability.[30,32,45] Some authors have used highly subjective terms for bone loss, via descriptive terms, indicating the lack of a described measurement tool.[7,28,42] Others have simply measured the widest diameter of the lesion on imaging.[47] Similar to glenoid measurements, computed tomography and magnetic resonance imaging studies have improved reliability of humeral head measurements.[44,58] Ho et al[24] noted improved accuracy in humeral head lesion size measurement by utilizing 3-dimensional computed tomography scans. Published literature to date has shown virtually no agreement in terms of humeral head bone loss measurement techniques.

Several studies touched on similar points of glenoid bone loss but did not meet inclusion criteria. Dickens et al[15] reported a similar cutoff to that used by Shaha et al[51] in their group of intercollegiate football players, recommending a cutoff of 13.5% bone loss at which to abandon the arthroscopic repair. Su et al[56] reported similar high rates of postoperative instability correlated with increasing amounts of glenoid bone loss with the revision arthroscopic Bankart procedure. Klemt et al[31] utilized a finite element model for simulating the stability of the glenohumeral joint under varying conditions and stressors. Their results support the above, indicating a cutoff of 16% glenoid bone loss for arthroscopic Bankart repairs to maintain stability.[31]

The concept of assessing both glenoid and humeral head bone loss appears promising.[2,21,35,51] Ahmed et al[1] reported a nearly 4-fold increase in recurrent dislocation in patients with <25% glenoid bone loss and nonengaging Hill-Sachs lesion compared with patients with >25% glenoid bone loss and engaging Hill-Sachs lesions. Cadaveric studies have demonstrated that even small Hill-Sachs lesions (<20% of articular surface) may clinically contribute to instability in the setting of small glenoid defects.[20] There remains significant debate as to the procedure of choice for patients with bipolar lesions, with some authors favoring bony augmentation of the glenoid and others suggesting that remplissage may be a solution.[4,11,34,46,65] Determining if lesions are "on track" or "off track" is likely crucial to determining procedure of choice.[12,23,40] Recent work indicates that there is variation among "on-track" lesions, with larger, "peripheral-track" lesions having worse outcomes than "central" lesions, indicating the presence of subcritical but significant Hill-Sachs lesions.[63]

To better develop consistent treatment algorithms, there must be a push to simplify and add consistency to measurement techniques.[19] Three-dimensional magnetic resonance imaging and using the "tracking" concept may be best to appreciate bone loss in these patients.

The study has several limitations. Many authors excluded patients with larger glenoid or humeral head lesions from the "arthroscopic-only" treatment arm, thus the outcomes of patients with larger lesions are likely not captured, potentially underestimating the importance of defect sizes. Follow-up was set at a minimum of 2 years, despite many articles presenting patients with significantly longer follow-up; therefore, recurrence/failure rates may be underrepresented. Given the lack of consistency in study design, bony deficit measurement techniques, and surgical technique/instrumentation utilized, it is difficult to draw precise, numeric conclusions from our data. Last, the majority of the studies in this area are not randomized, but are case series performed retrospectively, which does weaken their statistical conclusions.

CONCLUSION

It is important to evaluate the amount of bone loss present in a patient with glenohumeral instability in a consistent and reliable fashion, *prior* to undergoing any surgical procedure. Historically, arthroscopic Bankart procedures have been performed in isolation for patients with anterior instability with glenoid bone loss up to or even >25% of the glenoid surface and with variable attention paid to humeral-sided bone loss. Based on this review, the threshold to supplement an arthroscopic Bankart procedure with adjunct treatments or to abandon it entirely in favor of more complex repairs or reconstruction techniques should occur at a much lower threshold of glenoid bone loss, likely <15%. An even lower threshold in patients with concomitant humeral head defects should be used. Standardizing measurement techniques throughout the orthopaedic community will allow for more significant progress of the knowledge of this topic.

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