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Original Article

Arthroscopic Assessment of Glenoid Bone Loss

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Abstract

Background: Clinical decision-making for treating anterior shoulder instability relies on accurate glenoid bone loss quantification precision. This study aimed to assess the accuracy of the axial view of a 2-D CT scan compared with arthroscopy to measure glenoid bone loss following 3-D CT scanning.

Method: This study was performed from March 2019 to February 2020 on patients who presented to the shoulder clinic of a referral teaching hospital in Tehran, Iran. Eighteen patients with at least one history of unilateral anterior shoulder dislocation without shoulder surgery participated in the study. Before surgery, the qualified participants had their injured and uninjured shoulders CT scanned. The Griffiths index was used to estimate the size of glenoid bone loss in CT scan imaging. Subsequently, the affected shoulders were arthroscopically evaluated, and glenoid bone loss was measured using a standard probe.

Results: Among the 18 participants, glenoid bone loss was underestimated for 11 patients (61.1%) in CT scans compared to arthroscopy. The mean ± SD of glenoid bone loss percentage on CT scan (9.5% ± 4.9%) was significantly lower than on arthroscopy (11.7% ± 3.9%, $p = 0.04$). Nevertheless, Pearson's correlation showed a significantly moderate correlation ($r = 0.55$, $p = 0.01$) between arthroscopic and CT scan measurements of glenoid bone loss.

Conclusion: Our findings indicate that glenoid bone loss width measurement via the axial view of a CT scan should not be considered a reliable method to measure glenoid bone loss.

Keywords: Glenoid; Arthroscopy; Bone loss; Shoulder dislocation; CT.

Introduction

Chronic and recurrent anterior instability of the shoulder, associated with a lack of glenohumeral joint integrity, is a significant concern for patients and physicians in orthopedic clinics. Although various structures, including dynamics and statistics, aid in the stability of the glenohumeral joint, the glenoid, as a statistical structure, plays an essential role in capsular laxity [1]. Loss of glenoid bone is a consequence of anterior shoulder dislocation occurring in the anteroinferior direction. It is strongly associated with recurrent glenohumeral joint instability [2].

There are two widely used repair methods for the loss of glenoid bone, including arthroscopy and open shoulder surgery. Arthroscopic surgery is more effective in treating smaller incisions with fewer soft tissue damages, whereas open surgery may be the gold standard for significant bone defects [3]. The definition of considerable bone loss varies from more than 20-30% loss of width or greater than 21% loss of length of the glenoid [4-6]. Moreover, it has previously been reported that patients with more than 25% loss of glenoid bone showed a 75% recurrence rate using arthroscopic stabilization. In contrast, only a 4% recurrence rate was reported for the patients with a <25% loss of the glenoid bone [7]. Therefore, a suitable method for the preoperative measurement of the loss of glenoid bone should be found to make the optimal surgical decision.

Various imaging techniques, such as X-ray radiography, fluoroscopy, 2-D computer tomography (2-D CT) scanning, 3-D CT scanning with software algorithms, and magnetic resonance imaging (MRI), are used in clinical settings to calculate the loss of glenoid bone [8]. The 3-D CT scan has been endorsed by experienced surgeons as the best modality available [9]. However, specific investigational software tools are needed to analyze 3-D CT scans to detect glenoid bone loss [10]. Routinely, the possibilities mentioned are not extensively available in various clinical settings, particularly in the case of patient presentations with CT scan CDs from other imaging facilities. On the other hand, 3-D MRI has significant drawbacks, such as its high cost and limited availability. It has lately been thought of as a new technique for evaluating the loss of glenoid bone [11]. Therefore, finding an alternative modality to employ in varied contexts appears vital.

This study aimed to assess the accuracy of an axial view CT scan for measuring glenoid bone loss in patients with glenohumeral instability. Arthroscopic assessment using a bare spot was considered an objective measurement method to assess the percentage of failure in the glenoid bone [12].

Methods

Ethical Considerations

The present manuscript has been approved by the ethics committees of the authors' affiliated institutions. Researchers kept all of the participants' identities and personal information private. Moreover, informed consent was obtained from all of the volunteers before the study.

Patients and Setting

This study was performed from March 2019 to February 2020 on patients who presented to the shoulder clinic of a referral and teaching hospital in Tehran, Iran. All patients older than 18 with a history of unilateral anterior instability of the shoulder were eligible to participate in the study. Patients with a history of bilateral anterior shoulder instability, a significant Hill-Sachs lesion in the shoulder, a garishly view, prior shoulder surgery, a prior glenoid or scapular fracture, or connective tissue disorders associated with joint hypermobility, such as Ehlers-Danlos or Marfan syndrome, as well as patients who were candidates for open surgery, were excluded from the study. Moreover, pregnant women were not allowed to participate in the study.

Evaluation of Loss of Glenoid Bone

First, all patients underwent CT scanning of injured and unaffected shoulders preoperatively. The Griffiths index was used to estimate the glenoid bone loss percentage [13]. According to this method, the width of the affected shoulders (W1) was measured perpendicular to the line crossing the axis of the glenoid cavity (H1), and the obtained value was compared with the width of the contralateral, uninjured shoulder (W2) with ([W2-W1]/W2) ×100 formula (Figure 1).

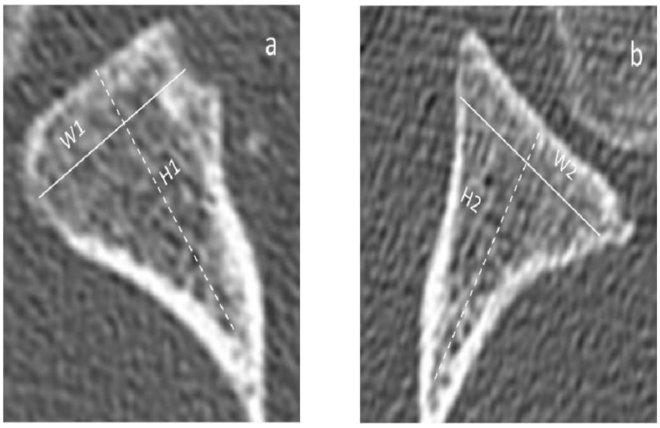

Figure 1: Computed tomography of affected (a) and non-affected (b) shoulders of a middle-aged patient. W1: Width of affected glenoid; H1: Axis of affected glenoid; W2: Width of unaffected glenoid; H2: Axis of unaffected glenoid.

The width measurement was conducted using 2-mm slices of an axial view CT scan, and the measuring level was considered ten slices (20 mm) lower than the supraglenoid tubercle. The CT scans were evaluated to reduce errors by four trained physicians, including two experienced orthopedic surgeons and two radiologists.

After imaging, a 5-mm standard arthroscope was used to assess the damaged shoulders arthroscopically. Before arthroscopic measurement, the patients were put under general anesthesia for sedation. After waking up from anesthesia, the subjects underwent several types of shoulder instability, including anterior, inferior, posterior, and multidirectional instability. According to Burkhart et al.'s technique, the patients were then placed in the lateral decubitus position. And the arthroscopy was carried out on a flexed, abducted, and tractioned shoulder [12-13], two anterosuperior and posterior portals were made for viewing and measuring, respectively. Afterward, the physician passed the mentioned probe through the posterior portal and put the probe tip on the central bare spot of the glenoid. Subsequently, the distances between the empty place and the anterior (D1) and posterior (D2) rims of the glenoid cavity were measured (Figure 2). Then, the percentage of loss in the glenoid bone was measured for the patients using the (1-[D1+D2]/ [D2×2]) ×100 formula. The arthroscopy was performed to compare the measurement accuracy by two expert orthopedic surgeons. Finally, arthroscopic or Latarjet repair was performed on participants with a repair indication.

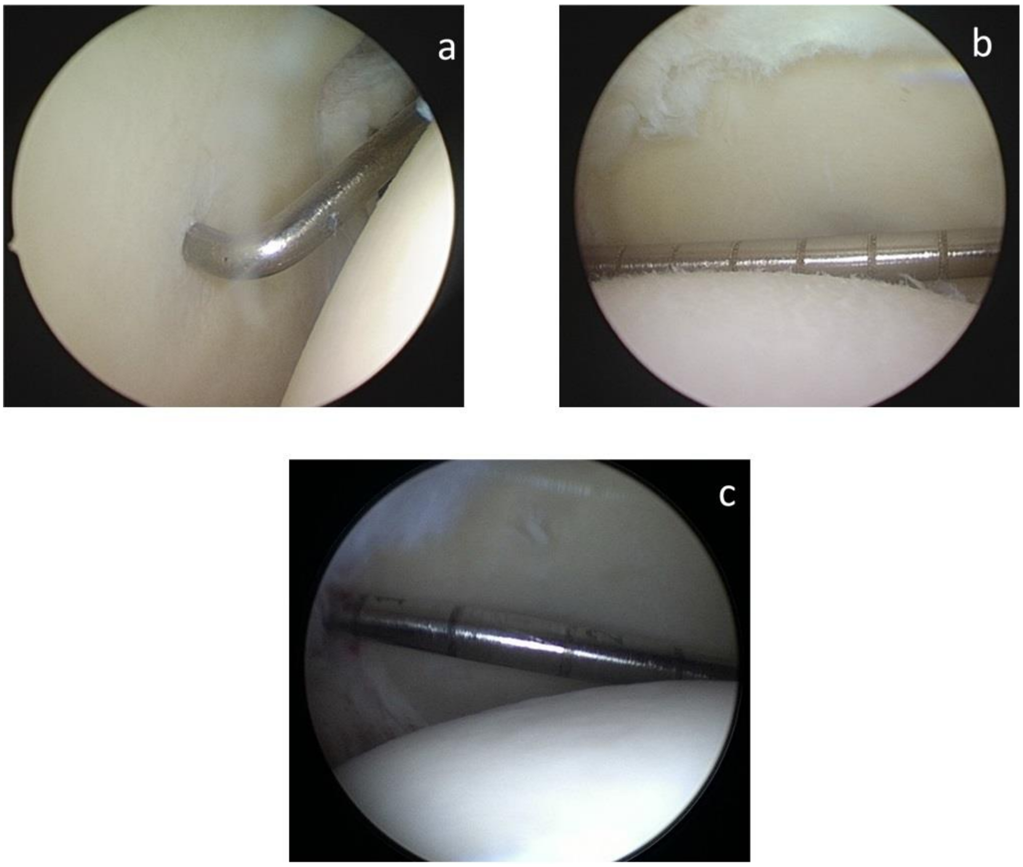

Figure 2: Arthroscopic measurement of glenoid bone loss middle-aged patient. (a) The probe tip in the bare spot. (b) Distance between the anterior rim (D1) and bare spot. (c) Distance between the posterior rim (D2) and bare spot.

Statistical Analysis

SPSS version 26.0 was used for the statistical analysis. The variables were presented as mean ± SD, and the paired samples t-test was used to evaluate the differences between the percentages of loss in the glenoid bone that were estimated by CT scan and arthroscopy. Moreover, the correlation between the rate of failure in the glenoid bone measured by CT scan and arthroscopy was investigated using Pearson's correlation coefficient. The significant level was set at 0.05.

Result

Among all 25 patients who met our study criteria, 20 agreed to participate (80% response rate). However, two patients were excluded from the study due to incomplete data. The study flowchart is presented in detail in Figure 3. Among all 18 participants, 12 (66.7%) were male, and 6 (44.3%) were female. The mean ± SD of age among all patients was 32.2 ± 9.1, ranging from 19 to 43. The mean age was not significantly different between men and women: 31.8 ± 8.8 versus 33.1 ± 10.6 (P = 0.78). Moreover, the frequency of shoulder dislocation ranged from 3 times to an unknown number of times.

Even though all of the subjects had glenoid bone loss after the measurement was completed, a CT scan could not detect it in one patient. Four patients (21.1%) out of the 18 patients had a glenoid bone loss percentage prediction error of more than 5%. The mean ± SD of the percentage of glenoid bone loss across all patients undergoing arthroscopy and CT scanning was 9.5% ± 4.9% (ranging from 0% to 20%), and the respective values of 11.7% ± 3.9% (ranging from 8% to 15%) were statistically significant (P = 0.04). The percentage of loss in the glenoid bone was underestimated in the CT scan for 11 patients (61.1%) compared to arthroscopy. However, there was a significant, moderate correlation between the CT scan and arthroscopic measurement of the loss in the glenoid bone using Pearson's correlation coefficient (r= 0.55, P= 0.01) (Figure 4).

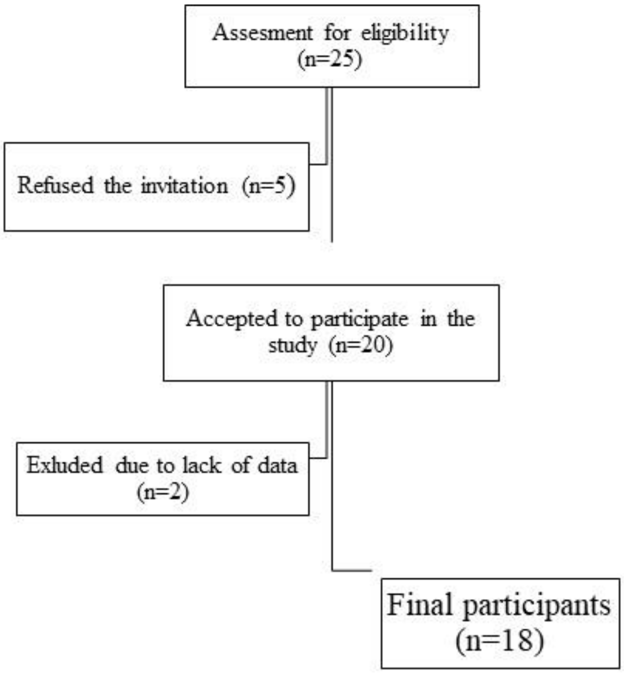

Figure 3: The study flowchart.

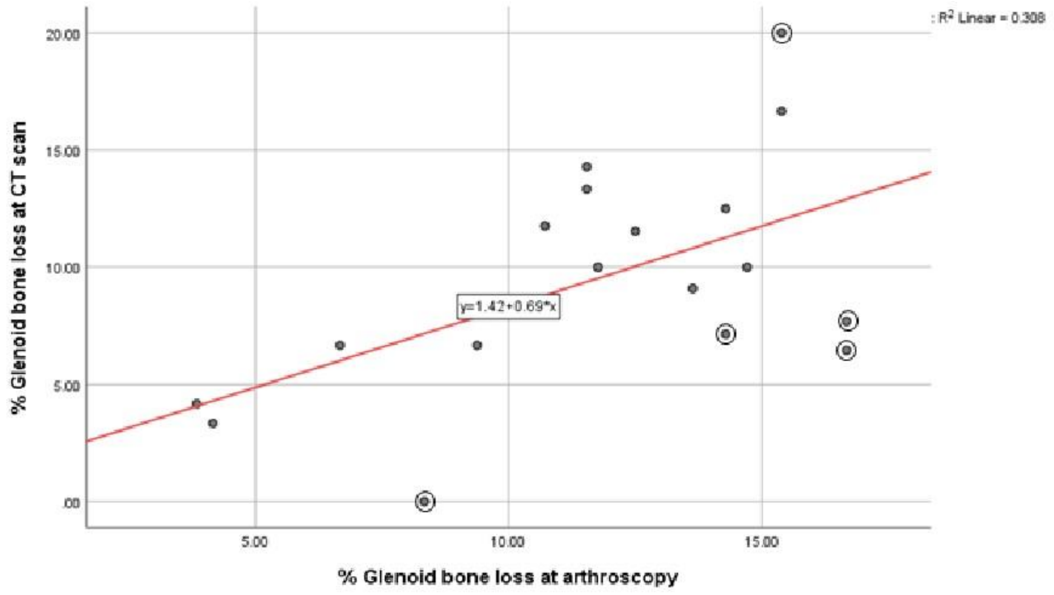

Figure 4: Pearson's correlation graph shows a significant (P=0.01), moderate (r=0.55) correlation between arthroscopic and CT scan among study participants (N=18). The 4 selected amounts (21.1%) had more than a 5% prediction error between 2-D CT scan and arthroscopy.

Discussion

As the main finding of the present study, it has been shown that the 2-D CT scan cannot be considered a reliable method for measuring the loss of the glenoid bone preoperatively. According to the results, the mean percentage of failure in the glenoid bone measured by the 2-D CT scan was significantly lower than the arthroscopic measurement. 61.1% of the predicted loss in the glenoid bone by a 2-D CT scan was underestimated compared to arthroscopy. Moreover, the loss of glenoid bone could not be distinguished in the CT scan in one patient, whereas it was detected arthroscopically. Since the loss measurement in the glenoid bone plays a prominent role in pre-surgical decision-making, other accurate methods, including a 3-D CT scan and an MRI, are more reliable. Nevertheless, a positive, significant correlation was seen in the predicted amounts of loss of glenoid bone by 2-D CT scan and arthroscopy, although the relationship was moderate.

Compared to other studies, cadaveric and non-cadaveric studies attempt to investigate the accuracy of a 2-D CT scan in anterior shoulder instability. In non-cadaveric investigations, arthroscopic measurement and 3-D CT were almost always considered reference tests. Lee et al. [14] investigated the accuracy of MRI and 2-D CT scan measurements of the loss in the glenoid bone and reported a strong correlation between arthroscopy and CT scan measurements. Although the mentioned study's connection was more substantial than ours (r = 0.55 versus r = 0.91), their findings are supported by ours due to the significant positive correlation that they found. Nevertheless, neither arthroscopy nor CT scans, nor their comparison, revealed the precise expected value of the glenoid bone loss. In a different investigation, Griffith et al. [15] found that there was no significant difference between the mean projected percentage of the two measurement modalities and the estimated amounts of glenoid bone loss in a 2-D CT scan, despite a strong positive correlation between the two (r = 0.79). However, among all 50 patients, there were 5 (10%) false assessments in the CT scan, including three false-negative and two false-positive cases.

Moreover, 17 patients (34%) had a prediction error higher than 5% in the CT scan compared to arthroscopy. Although Griffith et al. found no significant difference in the predicted mean loss of glenoid bone, the false assessment cases and a higher rate of prediction errors should be considered. In a cadaveric study, Rerko et al.[10] compared different measurement modalities, including 2-D and 3-D CT scans. All the evaluated modalities under predicted the actual loss of glenoid bone; however, they found that the 3-D CT scan had the highest correlation (r = 0.87) compared to the 2-D CT scan (r = 0.83) lower variability.

Similar to our study, all mentioned studies used a width measurement method to assess the loss of glenoid bone in the 2-D CT scan. Rouleau et al. [16] used a novel measurement method, called the clock method, to predict the loss of the glenoid bone in the 2-D CT scan. This method assessed both glenoid and humeral lesions at the same time. Their results demonstrated that the clock method in the 2-D CT scan had a strong positive correlation with the Pico method in the 3-D CT scan (r= 0.79), which was a standard reference test. However, we could not locate any research comparing the clock method measurement to the arthroscopic assessment. Altogether, the current evidence about the pre-surgical assessment of the loss in glenoid bone is heterogeneous. Therefore, further evaluations are needed, especially in the clinical setting [17].

Despite our results, this study faced three limitations. First, in one patient, side-to-side variations of the glenoid led to a prediction error in the CT scan. However, it was not considerable [13]. Second, there was no blindness to the results of the CT scan predictions of the loss in the glenoid bone by the surgeons performing the arthroscopies. Third, compared to other facilities, the prevalence of patients with shoulder instability without prior interventions or surgeries is significantly lower at our clinic because it is a third-level referral center in Iran. Future research should examine the precision of these two assessment techniques for glenoid bone loss in populations with higher caseloads.

Conclusion

The current investigation results indicated that determining the width of the anterior shoulder instability before surgery could not be done using the 2-D CT scan's reliable and precise width assessment. Although Pearson's correlation coefficient indicated a moderately positive correlation between the measurement methods of arthroscopy and the 2-D CT scan, the 2-D CT scan does not appear reliable because the slight variation in glenoid bone loss prediction has a significant impact on decision-making. It is advised to conduct more research to assess different measurement strategies, such as the clock approach, which estimates glenoid bone loss using a 2-D CT scan.

Patients Constant

All of the identity and personal information of participants remained confidential among researchers. Moreover, informed consent was obtained from all of the volunteers prior to the study.

Disclosure statement

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Authors' contributions

Designed research and wrote the manuscript: HB, SA. Collected and analyzed data.: MB. Designed research and performed study: HB. The authors read and approved the final manuscript.

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Ethical Statement

The Ethics Committee of Shahid Beheshti University of Medical Sciences (IR.SBMU.MSP.REC.1398.440) approved the study protocol. All participants signed a written informed consent before the treatment.

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