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Comparison of Anteroposterior Vs. Axial X-rays for Assessing Bone Loss in Recurrent Shoulder Dislocation

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ABSTRACT

Background: Recurrent shoulder dislocation frequently causes the glenoid and humeral head to gradually lose bone, which decreases joint stability and raises the risk of another dislocation. Treating bone loss accurately is crucial, especially when it comes to surgical procedures. The diagnostic precision of axial and anteroposterior (AP) X-rays in identifying and measuring bone loss in patients with repeated shoulder dislocations was examined in this study. **Methods:** 30 individuals who experienced recurrent shoulder dislocations had axial and anteroposterior (AP) radiography. The humeral head bone loss was measured in millimeters, whereas the glenoid bone loss was expressed as a percentage of the total glenoid surface area. The images were evaluated by two separate radiologists who determined the images' sensitivity, specificity, and accuracy for both modalities. The Intraclass Correlation Coefficient (ICC) was utilized to assess inter-observer reliability, and Receiver Operating Characteristic (ROC) curve analysis was employed to assess overall diagnostic performance. **Results:** The sensitivity of axial X-rays was found to be much higher (85%) than that of AP X-rays (70%; $p < 0.05$). Additionally, axial X-rays demonstrated higher accuracy (83% vs.68%) and specificity (80% vs. 65%). Using Axial X-rays, the mean glenoid bone loss was 16.5%, whereas using AP X-rays, it was 14.2%. For axial X-rays, the humeral head bone loss was 5.6 mm, but for AP X-rays, it was 4.8 mm. Compared to AP X-rays, the ICC for inter-observer reliability was greater for axial X-rays (0.88 and 0.85). Axial X-rays performed better diagnostically than AP X-rays (AUC = 0.71), according to ROC analysis. However, Gold standard investigation for bone loss in recurrent sholder dislocation is always a CT scan. **Conclusion:** When it comes to identifying and measuring bone loss in repeated shoulder dislocations, axial X-rays provide better diagnostic accuracy than AP X-rays, which is why they are the preferred imaging modality for preoperative evaluation.

INTRODUCTION

Since the glenohumeral joint is the most movable joint in the human body, recurrent shoulder dislocation is a complex disorder that seriously compromises the integrity and functionality of the shoulder joint (1,2). The humeral head (the ball) and the glenoid cavity (the socket) make up ball-and-socket joint, which is the foundation of the shoulder's extensive range of motion. But stability is sacrificed in favor of mobility, making the shoulder joint more prone to dislocations, especially after trauma or high-impact exercises (1). Recurrent shoulder dislocation patients frequently experience gradual structural deterioration, especially bone loss in the glenoid and humeral head, as a result of their repeated episodes of instability (3,1). Determining the right treatment plans is dependent on precisely recognizing and measuring this bone loss, particularly when considering surgical intervention (4).

Ninety-five percent of dislocations are caused by anterior shoulder instability, which is categorized as instability of the glenohumeral joint (3,5). This type of instability happens when the humeral head dislocates anteriorly, usually as a result of an external rotation paired with strong abduction from trauma. Orthopedic surgeons are particularly concerned about bone loss when recurrent anterior instability is linked to both soft tissue and osseous diseases. The glenoid concavity and the compressive stress applied by the soft tissues around it are what allow this biomechanical phenomenon to keep the humeral head in its socket (6,7).

The erosion or fracture of the anterior side of the glenoid rim, which is crucial for supporting the shoulder joint, is known as glenoid bone loss. It is the glenoid cavity that provides the shoulder joint's socket, and it is shaped like a shallow pear-shaped fossa (3,8). A bony Bankart lesion, or avulsion fracture of the anterior glenoid rim, can result from a humeral head dislocation, especially during anterior dislocations. This bone loss can become extensive over time with repeated dislocations, resulting in a loss of concavity and a marked decrease in joint stability (1,9).

The glenoid bone loss is sometimes expressed as a percentage of the entire glenoid surface area, with a crucial threshold being reached by bone loss higher than 20–25%. This level significantly compromises the glenoid capacity to keep the humeral head in its socket, increasing the risk of additional dislocations (10,11). The Latarjet treatment, which entails moving a portion of the coracoid process to the anterior glenoid rim in order to restore bone volume and stop further dislocations, is frequently used in the surgical repair of this instability (1,10).

Patients with recurrent shoulder dislocation frequently have a deformity on the humeral side called a Hill-Sachs lesion. When the humeral head hits the anterior margin of the glenoid during dislocation, it can cause a compression fracture of the posterolateral aspect of the humeral head. When certain arm movements, especially abduction and external rotation, are performed, the defect that results can be observed as a groove or dent on the humeral head's surface. This interaction may result in a locking mechanism that facilitates the humeral head's slipping out of the socket and causes repeated dislocations (11,5).

The size and level of involvement of Hill-Sachs lesions determine their classification, Large, engaged Hill-Sachs lesions increase the risk of instability by increasing the likelihood that, during shoulder motions, the humeral head will come into contact with the glenoid rim, which could result in additional dislocations. Imaging can be used to quantify the size of the lesion, which is important in choosing the right course of treatment (3,10). When a lesion is minor and not actively healing, non-surgical interventions like physical therapy could be adequate. Surgical intervention, such as remplissage, is frequently necessary for bigger lesions. This treatment entails filling the defect with soft tissue in order to prevent the glenoid from engaging with it (6,1). Because Hill-Sachs lesions frequently coincide with glenoid bone loss, a combined defect that exacerbates the instability of the shoulder joint, they are an important factor to consider in the overall evaluation of shoulder instability. The relationship between glenoid and humeral head bone loss is a crucial consideration when choosing a treatment plan, especially when significant bone loss necessitates surgery (1,9).

When surgical intervention is being considered for recurrent shoulder dislocations, accurate assessment of bone loss is crucial for directing treatment. Although sophisticated imaging techniques like CT and MRI offer comprehensive assessments of both soft tissue and bone structures, plain radiographs are still often utilized in clinical practice because of their affordability and ease of use. Though their diagnostic value varies, AP and Axial X-rays are two of the most often used radiographic images for evaluating bone loss in the setting of shoulder instability (1,4).

Anteroposterior (AP) X-rays are helpful in determining fracture presence, evaluating general anatomical alignment, and analyzing the amount of bone loss. They also give a frontal image of the shoulder joint. Nevertheless, the superimposition of structures limits the capabilities of AP X-rays and can mask important details, especially when glenoid bone loss is present. Because of this, it is challenging to determine the precise amount of bone loss, particularly in the anterior area of the glenoid rim, where the majority of bone loss happens when there is anterior instability (7,3).

In shoulder Arthroplasty the Axial view is the best way to evaluate humeral head deformities and glenoid rim erosion. This is especially crucial when there is repeated shoulder dislocation since precise imaging is required to assess the degree of bone loss and direct the surgical procedure. Axial X-rays are crucial for the diagnosis of shoulder instability because they can identify small fractures and bone abnormalities that may not be seen on AP X-rays (7,9)

The Latarjet method is commonly used to treat glenoid bone loss. It is most useful when bone loss surpasses 25% of the glenoid surface area. Through this surgery, the anterior glenoid rim is essentially made larger and more stable by means of the transfer of a portion of the coracoid process and the muscles that are linked to it. "Orthopedic Surgery: Principles of Diagnosis and Treatment" states that the Learjet treatment further improves joint stability by creating a sling-like effect through the relocated muscles in addition to restoring the glenoid bony structure.

The size and engagement of a Hill-Sachs lesion determine the available therapeutic choices. Larger, engaging lesions may necessitate surgical intervention, whereas smaller, non-engaging lesions are typically manageable conservatively (1,10). The remplissage technique is frequently used when the Hill-Sachs lesion is big and likely to interact with the glenoid rim. Using this method, the infraspinatus tendon is usually used to fill the defect and avoid joint engagement while also restoring joint stability (4,3).

Young people are more likely to experience recurrent shoulder dislocations over time,which puts a heavy strains on patients and healthcare syestem and highlights the importance of prompt and precise diagnosis.In this process,the imaging modality selection is crucial.In order to improve patient outcomes and clinical decision-making,this study attempts to offer insightful information about the diagnostic accuracy of AP vs axial X-rays in patients with recurrent shoulder dislocation

METHODS

In patients with recurrent shoulder dislocations, this study compared the diagnostic accuracy of axial and anteroposterior (AP) X-rays in identifying and measuring bone loss. In all, thirty individuals with recurrent anterior shoulder dislocations between the ages of eighteen and fifty were included in the research. A minimum of two documented shoulder dislocations were experienced by all patients, who also displayed clinical indications of shoulder instability, such as discomfort and a sensation of the shoulder slipping out. Individuals who had infections, fractures, or other illnesses unrelated to dislocation were not accepted.

AP and axial shoulder X-rays were taken of each subject after informed consent was obtained. Axial X-rays were taken in a 90-degree abduction to offer a lateral view of the glenoid and

humeral head, and AP X-rays were taken in a neutral position according to usual protocol. Two separate radiologists evaluated the pictures and estimated glenoid bone loss and humeral head abnormalities while remaining blind to the clinical specifics. The Pico method, which uses measurements of the glenoid length and the defect area, was used to determine the proportion of glenoid bone loss relative to the total glenoid surface area. Millimeters of humeral head bone loss were determined by measuring the breadth and depth of Hill-Sachs lesions.

The main results of the statistical study were the overall accuracy, sensitivity, and specificity of each imaging modality in identifying bone loss. The ability of the X-ray to accurately identify individuals with bone loss was referred to as sensitivity, while the ability to correctly identify those without considerable bone loss was referred to as specificity. The inter-observer reliability for both AP and Axial X-ray readings was assessed using the Intraclass Correlation Coefficient (ICC). In order to evaluate the diagnostic performance of both imaging modalities in terms of Area Under the Curve (AUC), Receiver Operating Characteristic (ROC) curves were finally plotted.

RESULTS

Anteroposterior (AP) and axial X-rays were used to analyze a total of thirty recurrent shoulder dislocations in the study's thirty participants (mean age 35 ± 8 years). The main objective was to evaluate the amount of bone loss in the glenoid and humeral head. Sensitivity, specificity, accuracy, and inter-observer reliability of the two imaging modalities were compared.

Using Axial X-rays, the average percentage of glenoid bone loss was 16.5% ± 3.1%, whereas AP X-rays showed an average of 14.2% ± 3.4%. When glenoid bone loss was detected, axial X-rays had a considerably better sensitivity of 85% compared to AP X-rays' 70% ($p < 0.05$). Additionally, Axial X-rays had a higher specificity (80% vs. 65%).

Table 1

Glenoid Bone Loss Detection	Axial X-ray	AP X-ray
Sensitivity (%)	85%	70%
Specificity (%)	80%	65%
Mean Bone Loss (%)	16.5 ± 3.1%	14.2 ± 3.4%

Using Axial X-rays, the average humeral head bone loss (Hill-Sachs lesion) was 5.6 mm ± 1.5 mm, whereas AP X-rays showed an average of 4.8 mm ± 1.8 mm. AP X-rays demonstrated a sensitivity of 75% in identifying Hill-Sachs lesions, while axial X-rays had an 88% sensitivity. For Axial X-rays, specificity was higher (82% vs. 68%).

Table 2

Humeral Head Bone Loss Detection	Axial X-ray	AP X-ray
Sensitivity (%)	88%	75%
Specificity (%)	82%	68%
Mean Bone Loss (mm)	5.6 ± 1.5 mm	4.8 ± 1.8 mm

For both glenoid and humeral head bone loss, the Intraclass Correlation Coefficient (ICC) was used to determine the inter-observer reliability. Excellent reliability was shown by the ICC for Axial X-rays, which was 0.88 for glenoid bone loss and 0.85 for humeral head bone loss. The ICC for AP X-rays was lower, 0.70 for humeral head bone loss and 0.75 for glenoid bone loss, indicating moderate dependability.

Table 3

Inter-observer Reliability (ICC)	Axial X-ray	AP X-ray
Glenoid Bone Loss	0.88	0.75
Humeral Head Bone Loss	0.85	0.70

Utilizing Receiver Operating Characteristic (ROC) curve analysis, each imaging modality's overall diagnostic performance was assessed. Whereas the Area Under the Curve (AUC) for AP X-rays was 0.71, suggesting moderate diagnostic performance, the AUC for axial X-rays was 0.85, indicating great diagnostic accuracy.

Table 4

ROC Curve Analysis (AUC)	Axial X-ray	AP X-ray
Glenoid Bone Loss	0.85	0.71
Humeral Head Bone Loss	0.82	0.69

There was no marked variation found in the duration required to get AP X-rays (2.5 ± 0.6 minutes) in comparison to Axial X-rays (2.8 ± 0.7 minutes) ($p > 0.05$). Axial X-rays did, however, expose patients to a little bit more radiation than AP X-rays, however this difference was not statistically significant.

Table 5

Additional Metrics	Axial X-ray	AP X-ray
Operating Time (minutes)	2.8 ± 0.7	2.5 ± 0.6
Radiation Exposure (mSv)	0.10 ± 0.02	0.08 ± 0.01

Overall, the findings show that when it comes to the identification and measurement of bone loss in cases of recurrent shoulder dislocation, axial X-rays outperform AP X-rays in terms of diagnostic accuracy and inter-observer reliability. When bone loss is a significant factor, preoperative examination using Axial X-rays is advised.

DISCUSSION

The results of this study, which took place between April and September 2024, offer important new information about how well Anteroposterior (AP) and Axial X-rays compare in terms of their ability to identify bone loss in repeated shoulder dislocations. The study underlines the therapeutic importance of these results in preoperative assessment and underscores the critical diagnostic differences between glenoid and humeral head bone loss.

The findings show that axial radiography performs better than AP radiography in terms of sensitivity and specificity, particularly in cases of glenoid bone loss. The 85% sensitivity of axial X-rays was found to be substantially higher than the 70% sensitivity of AP X-rays ($p < 0.05$). Sensitivity is essential for spotting even little amounts of bone loss, and the 15% discrepancy suggests that Axial X-rays are far better at spotting bone loss that AP views could overlook. This confirms the idea that, when bone loss is suspected, more precise imaging—like the axial view—is essential for assessing the joint structures. Additionally, axial X-rays had significantly higher specificity (80%) than AP X-rays (65%). The capacity to accurately identify patients who do not have bone loss is measured by specificity. Axial X-rays' increased specificity lowers the possibility of false positive results, preventing needless procedures brought on by an exaggerated perception of bone loss. The information below demonstrates this contrast:

Table 6

Glenoid Bone Loss Detection	Axial X-ray	AP X-ray
Sensitivity (%)	85%	70%
Specificity (%)	80%	65%

As can be seen from the table, axial X-rays are the best option for imaging when bone loss is suspected since they not only offer more precise diagnoses but also reduce the possibility of missed cases and false positives.

Determining the amount of bone loss is crucial for choosing a course of therapy, especially surgery. When glenoid bone loss was estimated using axial X-rays, the results were more accurate, with a mean measurement of 16.5% ± 3.1%, while AP X-rays yielded a measurement of 14.2% ± 3.4%. Even though a 2.3% variation in average bone loss might not seem like much, it becomes quite important when making therapeutic decisions. When the loss of glenoid bone reaches 20–25%, surgery, like a Latarjet treatment, is frequently necessary. Underestimating bone loss could lead to a delay in critical interventions and an increased risk of subsequent dislocations, as is more likely to occur with AP X-rays.

Table 7

Glenoid Bone Loss (Mean)	Axial X-ray	AP X-ray
Mean Bone Loss (%)	16.5 ± 3.1%	14.2 ± 3.4%

The average lesion depth for humeral head bone loss (Hill-Sachs lesions) was 5.6 mm ± 1.5 mm using Axial X-rays, versus 4.8 mm ± 1.8 mm using AP X-rays. Axial X-rays' higher size detection suggests that AP X-rays frequently underestimate lesion depth. This is especially important since there is a higher chance that deeper Hill-Sachs lesions would interact with the glenoid margin and result in recurrent instability. Thus, it is essential to precisely detect these lesions in order to assess whether surgical procedures such as remplissage are necessary. The information highlights even more how crucial it is to use axial X-rays for accurate measurement.

Table 8

Humeral Head Bone Loss Detection	Axial X-ray	AP X-ray
Sensitivity (%)	88%	75%
Specificity (%)	82%	68%
Mean Bone Loss (mm)	5.6 ± 1.5 mm	4.8 ± 1.8 mm

Treatment planning is greatly impacted by Axial X-rays' enhanced capacity to precisely estimate bone loss in both the glenoid and humeral heads, which further supports the modality's better clinical value (12).

The values of the Intraclass Correlation Coefficient (ICC) offer still another level of clarification. Excellent inter-observer reliability was shown by axial X-rays, which showed ICC values of 0.88 for glenoid bone loss and 0.85 for humeral head bone loss. Conversely, AP X-rays had ICC values of 0.75 and 0.70, respectively, indicating reasonable reliability. High ICC values indicate uniformity in readings from several radiologists, which is essential for guaranteeing results' repeatability in clinical settings.

Table 9

Inter-observer Reliability (ICC)	Axial X-ray	AP X-ray
Glenoid Bone Loss	0.88	0.75
Humeral Head Bone Loss	0.85	0.70

Axial X-rays have far higher ICC values, which suggests that they are a more dependable modality for identifying bone loss, lowering diagnostic variability, and guaranteeing more consistent treatment recommendations.

Axial X-rays were shown to have superior diagnostic accuracy by Receiver Operating Characteristic (ROC) curve analysis, with an Area Under the Curve (AUC) of 0.82 for humeral head bone loss and 0.85 for glenoid bone loss. This stands in contrast to the AP X-rays' AUC values of 0.71 and 0.69, respectively. Higher accuracy in classifying patients with and without bone loss is shown by a higher AUC for Axial X-rays. When making surgical decisions based on an accurate diagnosis in preoperative circumstances, a higher AUC value is very beneficial.

Table 10

ROC Curve Analysis (AUC)	Axial X-ray	AP X-ray
Glenoid Bone Loss	0.85	0.71
Humeral Head Bone Loss	0.82	0.69

Axial X-rays perform better in terms of diagnostic accuracy than AP X-rays, as further supported by the ROC analysis. Axial X-rays appear to be more suitable for detecting clinically significant bone loss, based on the considerable difference in AUC values. This means that patients will receive the best possible care.

While diagnostic precision is the main goal, clinical practice also needs to take time efficiency and radiation exposure into account. The study found that obtaining Axial X-rays took somewhat longer (2.8 ± 0.7 minutes) than AP X-rays (2.5 ± 0.6 minutes), but the difference was not statistically significant. The little time difference is surpassed in a hectic clinical scenario by the improved diagnostic performance of Axial X-rays. Similarly, compared to AP X-rays (0.08 ± 0.01 mSv), axial X-rays were linked to a marginally greater radiation exposure (0.10 ± 0.02 mSv). From a clinical standpoint, this radiation dosage differential is insignificant and well under acceptable exposure limits.

Table 11

Additional Metrics	Axial X-ray	AP X-ray
Operating Time (minutes)	2.8 ± 0.7	2.5 ± 0.6
Radiation Exposure (mSv)	0.10 ± 0.02	0.08 ± 0.01

The slightly higher radiation exposure of Axial X-rays is a minor consideration, especially when weighed against the significantly improved accuracy in detecting bone loss.

The results of this study strongly imply that the best imaging modality for determining bone loss in patients who have repeated shoulder dislocations is axial X-rays. Preoperative assessment is made more reliable by their superior sensitivity, specificity, diagnostic accuracy, and inter-observer reliability. Axial X-rays yield the most reliable results for glenoid bone loss, where even minute errors can change treatment strategies. Furthermore, the identification of Hill-Sachs lesions is essential for establishing the necessity of remplissage treatments in cases of humeral head bone loss. Underestimating the extent of these lesions, which is more likely to occur with AP X-rays, may cause treatment to be administered incorrectly or be delayed.

The results of this investigation are consistent with earlier studies that highlight the diagnostic advantage of axial X-rays over AP X-rays for determining bone loss in repeated shoulder dislocations. Because axial X-rays may capture the true anatomic position of the shoulder joint, they can provide a more thorough picture of both glenoid and humeral head bone loss, as previously proven by studies like Anderson and Chen (2018). These investigations revealed noticeably greater sensitivity and specificity for axial X-rays as compared to AP X-rays, which is consistent with our findings. For example, our result of 85% closely matches the sensitivity of 82% reported by Millett and Cole (2020) for Axial X-rays in diagnosing glenoid bone loss. These older studies improved diagnostic accuracy is in line with our findings, which showed that Axial X-rays performed better in terms of sensitivity and specificity across a variety of criteria.

However, some research, as that done by Weiss and Dunn (2020), discovered that although AP X-rays are still a dependable and widely used imaging modality, their diagnostic efficacy is inferior to that of Axial X-rays, especially when it comes to measuring bone loss (13,14). Our study further supports this gap, showing that AP X-rays were less accurate (68%) than Axial X-rays (83%), in diagnosing glenoid bone loss. Despite the fact that AP X-rays are easy to use and need less radiation exposure, which has led to their long-standing use in clinical settings, the current study's findings also show that AP X-rays are not always reliable at measuring bone loss (15,16). The comparison information supports the suggestion that axial X-rays are the most efficient modality.

CONCLUSION

This study examines the diagnostic efficacy of axial and anteroposterior (AP) X-rays in identifying and measuring bone loss in repeated shoulder dislocations. It was carried out between April and September of 2024. The sensitivity, specificity, and accuracy of each imaging modalities for glenoid and humeral head bone loss are assessed in this study, which included thirty patients.

Principal results demonstrate that Axial X-rays perform better than AP X-rays in every important diagnostic category. When it came to identifying glenoid bone loss, axial X-rays showed noticeably greater sensitivity (85% vs. 70%) and specificity (80% vs. 65%). Axial X-rays also shown better specificity (82% vs.68%) and sensitivity (88% vs.75%) for humeral head bone loss.

Additionally, axial X-rays offered more reliable bone loss estimates across radiologists. Excellent inter-observer reliability was demonstrated by the much higher intraclass correlation coefficients (ICC) for axial X-rays. The diagnostic superiority of axial X-rays was further supported by Receiver Operating Characteristic (ROC) analysis, which showed greater Area Under the Curve (AUC) values for glenoid bone loss (0.85 vs. 0.71) and humeral head bone loss (0.82 vs. 0.69). The advantages of diagnosis were greater than the minor increase in time (2.8 vs. 2.5 minutes) and radiation dose (0.10 vs. 0.08 mSv) that came with axial X-rays. In conclusion, axial radiography is the preferable imaging modality for evaluating bone loss in patients with repeated shoulder dislocations because it provides better sensitivity, accuracy, and dependability than AP radiography.

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