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Radiological External Picture of Proximal Humerus Fracture After Surgery at Haji Adam Malik Hospital

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ABSTRACT

Proximal humerus fractures are among the most common musculoskeletal injuries, particularly in elderly patients with decreased bone density. Open Reduction and Internal Fixation (ORIF) is a widely used surgical technique aimed at restoring anatomical alignment and achieving stable fixation. This study aimed to evaluate postoperative radiological outcomes of proximal humerus fractures treated with ORIF at H. Adam Malik Hospital, Medan.

This research employed a descriptive observational design with a cross-sectional approach using retrospective data from medical records of patients treated between January 2021 and December 2024. A total of 25 patients who met the inclusion criteria were analyzed. Radiological parameters assessed included neck-shaft angle (NSA), humeral head height (HHH), medial offset (MO), medial hinge gap (MHG), and acromiohumeral interval (AHI). Measurements were conducted by two independent observers, and inter-observer reliability was evaluated using the Intraclass Correlation Coefficient (ICC).

The results showed that the majority of patients were female (68%), with the largest age group being 18–49 years (44%). The inter-observer reliability demonstrated excellent agreement (ICC = 0.947). The mean values of radiological parameters were: NSA 127.83° ± 7.28°, HHH 8.87 ± 1.72 mm, MO 8.74 ± 2.97 mm, MHG 2.28 ± 0.73 mm, and AHI 7.60 ± 1.37 mm. These findings indicate that most parameters were within normal limits, although NSA tended toward mild varus alignment and MHG exceeded the ideal anatomical threshold.

In conclusion, postoperative radiological outcomes of proximal humerus fractures treated with ORIF generally showed acceptable alignment and fixation stability. However, attention to medial support restoration is necessary to prevent complications such as varus collapse. Radiological evaluation remains essential for assessing surgical success and predicting functional outcomes.

INTRODUCTION

Proximal humerus fractures are one of the most common musculoskeletal injuries, especially in the elderly population with osteopenia or osteoporosis. These injuries account for about 5–6% of all fractures in adults and are the third most common fracture after distal radius fractures and collum femoris fractures.[1] Most fractures occur as a result of low-energy blunt trauma, such as a fall with the hands supporting the body, but in young patients it can be caused by high-energy trauma such as a traffic accident. [1,2]

The proximal segment of the humerus has a high structural complexity involving the head of the humerus, the major and minor tuberosity, as well as the anatomical collum and the chirurgicum collum.[3] This area has a relatively limited blood supply, mainly through the anterior and posterior humeral circumflex arteries, which play an important role in maintaining the viability of the humeral head. Trauma-induced vascularization disorders can lead to serious complications such as avascular or non-union necrosis, so proper anatomical reconstruction is important in surgical management.[3]

The management of proximal humerus fracture depends on the fracture pattern, the degree of fragment dislocation, bone stability, and the patient's general condition. Most non-displaced fractures can be managed conservatively by immobilization, but fractures that are dislocated, comminutive, or involve more than two

fragments require operative intervention.[4] *Open Reduction and Internal Fixation* (ORIF) is one of the most widely used techniques because it allows for direct anatomical reduction and strong stabilization using *Plate* and *screw* such as *Locking Compression Plate* (LCP).[4] The success of ORIF relies heavily on reduction techniques, fixation quality, and restoration of sufficient mechanical stability to facilitate bone healing as well as shoulder joint function.

The primary goal of the action of ORIF in proximal humerus fractures is to achieve solid bone healing by maintaining anatomical alligmen and preventing long-term complications such as malunion, avascular necrosis, or joint stiffness.[5,6] Evaluation of postoperative radiological results is an important step in determining the success of the procedure, since radiology not only assesses bone healing but also assesses the position of the implant, *Humeral Neck-Shaft Angle*, the degree of varus or valgus, as well as the quality of fragment reduction. *Radiological outcome* A good one is a direct indicator of fixation stability and a strong predictor of shoulder functional outcomes.[7]

Interpretation of post-ORIF radiological outcomes is often the basis for evaluating therapy success and advanced decision-making.[8–10] Suboptimal radiological outcomes are often associated with poor clinical outcomes, especially in terms of chronic pain and limited shoulder movement, so short-term and long-term radiological monitoring is an integral part of postoperative management.

There was a large variation in the reporting of radiological outcomes in post-patients

and its correlation to clinical outcomes. Differences in fracture classification, fixation techniques, implant types, and experiences affect the final outcome. Therefore, a systematic and standardized radiological evaluation is needed to assess the success of bone reduction and healing, as well as to identify early complications that may affect shoulder function.

RESEARCH METHODS

Research Design

This study is a descriptive observational research with a cross-sectional design. This study was conducted by assessing the radiological results of patients with proximal humerus fractures who had undergone ORIF surgery at H Adam Malik Hospital, Medan.

Research Time and Place

This research will be carried out during the period of December 2025 to January 2026. The research site was conducted at H Adam Malik Hospital, Medan.

Population and Research Sample

The target population in this study is all patients who have experienced a proximal humerus fracture and have undergone ORIF at H Adam Malik Hospital, Medan from January 2021 – December 2024. The research sample is a part of the population taken from the population using *the non-probability sampling* method, namely by *the consecutive sampling technique*. This technique is carried out by recruiting subjects who are in accordance with the inclusion and exclusion criteria in order until the minimum sample size is met.

How Research Works

This study began with the collection of secondary data from the medical records of patients with a diagnosis of proximal humerus fracture who had undergone ORIF treatment at H Adam Malik Hospital. Data on patients who met the inclusion criteria were collected including age, sex, as well as anteroposterior projection (AP) postoperative radiography results. Furthermore, five main radiological parameters were measured, namely neck-shaft angle, humeral head height, acromiohumeral interval, medial hinge gap and medial offset which were read by 2 different observers. The collected data is then compiled into a research worksheet for further analysis.

Data Analysis

The data that has been collected will be analyzed using the *Statistical Package for the Social Sciences* (SPSS) version 30 program. Descriptive analysis was performed to describe the basic characteristics of the research subjects and the average values of each radiological parameter.

Research Ethics

This research will be carried out after obtaining approval from the Health Research Ethics Committee at H Adam Malik Hospital and the Faculty of Medicine of the University of North Sumatra. All patient data is kept confidential using an identification code without directly including the name or medical record number. Because this study is retrospective and uses secondary data, there is no immediate risk to patients.

RESULTS

In this study, using a research sample of 25 patient samples 1 year after proximal humerus ORIF, the number of male patients was 8 patients (32%) and 17 female patients (68%) with an age division of 18-49 years 11 patients (44%), 50-60 years 8 patients (32%), and >60 years 6 patients (24%) (Table 1).

Table 1. Demographic characteristics

Parameters	Quantity (%)
Age	
• 18-49 Years	11 (44%)
• 50-60 Years	8 (32%)
• >60 Years	6 (24%)
Total	25
Gender	
• Male	8 (32%)
• Women	17 (68%)

Before a descriptive analysis of the research variables was carried out, a reliability test was carried out to assess the consistency of measurements between two observers (inter-observer reliability). The test was carried out using *the Intraclass Correlation Coefficient* (ICC) with *a two-way mixed effects model* and the definition of *absolute agreement*.

Based on the results of the analysis, the ICC *single measures* value was 0.947 with a *95% confidence interval* range between 0.846 to 0.979. This value shows an excellent *level of reliability* between observers in measuring radiological parameters. A summary of the reliability test results is presented in Table 2.

Table 2. Inter-Observer Reliability Test Results

Inter-Observer Reliability Test	Intraclass Correlation (ICC)	Sig
Single Measures	0.947	<0.001

From the measurement of radiological parameters, the measurements (mean±SD) NSA were 127.83$^{o\pm}$7.28o, HHH 8.87±1.72 mm, MO 8.74±2.97 mm, MHG 5.44±1.95 mm, and AHI 7.60±1.37 mm (Table 2).

Table 3. Measurement of Radiological Parameters

Parameters	Mean±SD
NSA	127.83o±7.28o
HHH	8.87±1.72 mm
FOR	8.74±2.97 mm
MHG	2.28±0.73 mm
FIRE	7.60±1.37 mm

DISCUSSION

Demographic Characteristics of Research Subjects

This study was conducted on 25 patients who had undergone Open Reduction Internal Fixation (ORIF) after proximal humerus fracture at H. Adam Malik Hospital. Based on the results of the study, it was found that most of the patients were female, namely 17 people (68%), while 8 people (32%) were male. These findings are in line with global epidemiological data stating that proximal humerus fractures are more common in women, with a significantly increased incidence ratio in the postmenopausal population due to decreased bone mineral density.[18,27] Rudran et al., noted that this fracture is the third most frequent fracture in the elderly population, which is very closely related to decreased bone quality in women.[27]

Viewed in terms of age, the distribution of subjects in this study is quite varied. The 18-49 age group is the largest proportion (44%), followed by 50-60 years old (32%) and >60 years old (24%). Although the classical literature often associates these fractures with geriatric populations (>60 years) due to low-energy trauma In younger populations, the injury mechanism often involves high-energy trauma (such as a traffic accident) that causes a more complex fracture pattern, in contrast to the simple fall mechanism that is dominant in the elderly population.[27]

Post-ORIF Radiological Parameter Overview

Reliability of Radiological Measurements

The validity of radiological measurements is a crucial aspect in this study, considering that the assessment is done manually on plain X-ray photos. Based on the research method, the reading of radiological results was carried out by two different observers to minimize subjectivity bias. The results of the Intraclass Correlation Coefficient (ICC) statistical test showed that the value of the single measures coefficient was 0.947 (95% CI: 0.846 – 0.979), the ICC value above 0.90 was categorized as *excellent reliability*.

NSA

The average NSA score in this study subject was 127.83° with a standard deviation (SD) ± 7.28°. Theoretically, normal NSA values range from 130°–140°, with some literature mentioning an ideal average of around 135°.[29,31] Assunção et al., in their clinical study affirm that the maintenance of this angle is vital for shoulder biomechanics.[29,31] This average NSA value indicates that in general the reduction is at the lower limit of normal or slightly inclined towards mild varus. The standard deviation is quite wide (± 7.28°). A decrease in NSA values below 130° is often associated with a postoperative risk of varus collapse, which according to Jia et al,. is one of the most common forms of fixation failure if the medial support is inadequate.[7] Longo et al.,. also added that NSA deviation can affect the abductor muscle moment arm, potentially lowering long-term functional outcomes.[31] In the study of Dheenadhayalan J et al., an average NSA of 135 was obtained^{o}, with 14 patients having NSA <120^{o}, in this condition it is a risk factor for varus collapse, especially if MHG is not repaired.[41]

HHH

The HHH parameter shows an average value of 8.87 ± 1.72 mm, normal value of HHH 5-10mm. This average value is in a good range. HHH is an important indicator of the position of the plate towards the top of the humerus head. Suroto et al., emphasize the importance of accurate humerus head morphometry in anatomical restoration to prevent complications.[32] Sanjaya I et al., found that HHH is important for maintaining bone alignment and preventing complications such as malunion, in their study Sanjaya I et al., getting HHH within the normal range.[42]

FIRE

The average AHI obtained is 7.60 ± 1.37 mm. The normal reference value for AHI is 7–14 mm, this result is in line with Dheenadhayalan J et al., who obtained an average AHI of 7.2mm. High variability (SD ± 1.37 mm) suggests that some patients may experience subacromial space narrowing.[41] Ongbumrungphan et al.,. reminds that AHI measurements can also be affected by the angle of the X-ray ray, but consistent postoperative narrowing should be watched out for as a risk of subacromial impingement.[35]

MHG

One of the important findings in this study is the mean MHG value of 2.28 ± 0.73 mm, which is related to the NSA's findings which averaged 127.83° (tend to be mild varus). The presence of a small medial gap (> 2 mm) is often a precursor to a slight decrease in the angle of the humerus neck (varus) as the postoperative period progresses. The standard deviation of ± 0.73 mm indicates a variation in the reduction result; in which some patients manage to achieve ideal medial cortical contact (< 2 mm). In a study conducted by Dheenadhayalan J et al., 14 patients with medial gap >4mm experienced postoperative varus collapse with a reduction in NSA by 15^{o} from his post-operative. Gardenbroek et al., (2021) stated that the absence of medial support is a strong predictor of secondary varus collapse and fixation failure. [37,41] The MHG value in this study (2.28 mm) is logically correlated with the findings of the NSA which tends to be varus (127.83°). This confirms the technical challenges in achieving anatomical reduction of the medial pillar, especially in the case of comminutive fractures, where the gap on the medial side is difficult to close with only closed reduction.[37]

FOR

The average MO value was recorded at 8.74 ± 2.97 mm (Normal MO value is around 4–14 mm). This value is in line with the study of Barth J et al., which reported a medial offset range between 5.6 to 9.7mm.[43] Irlenbusch et al., explain that medial offset recovery is important for maintaining the moment arm of the deltoid muscle and rotator cuff. [39] Camus et al., added that failure to restore this offset can alter the kinematics of the glenohumeral joint.[40] The results of this study show that despite the challenges in MHG, the lateral translation of the humerus head in general can still be maintained within functional limits.

CONCLUSION

The distribution of proximal humerus fracture research subjects after ORIF at H. Adam Malik Hospital was dominated by female sex (68%) with the highest proportion of age groups in the productive age range of 18-49 years (44%).

The distribution of postoperative radiological parameters shows: NSA has an average of 127.83° ± 7.28°, which tends to be at the lower limit of normal/mild varus; HHH is well achieved, with an average of 8.87 ± 1.72 mm; MO is stationary within normal limits with an average of 8.74 ± 2.97 mm; AHI is at the lower limit of normal with an average of 7.60 ± 1.37 mm; MHG showed an average value of 2.28 ± 0.73 mm, which indicates a gap in the medial cortex support that exceeded the anatomical target (< 2 mm).

SUGGESTIONS

Research has been conducted that links these radiological parameters with clinical functioning. The study was conducted using other radiological modalities to compare with conventional radiological findings

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