

**Functional Outcome of Surgical Fixation of Proximal Humerus Fractures**Ashoka Rakshith<sup>1</sup>, Shyamanth. M<sup>2</sup>, Hitaishi HS<sup>3</sup>, Harish K<sup>4</sup><sup>1</sup>Assistant professor, Dept of Orthopedics, Adichunchanagiri Institute of Medical Sciences, BG Nagara Mandya, Karnataka, India<sup>2,3</sup>PG Resident, Dept of Orthopedics, Adichunchanagiri Institute of Medical Sciences, BG Nagara Mandya, Karnataka, India<sup>4</sup>Professor, Dept of Orthopedics, Adichunchanagiri Institute of Medical Sciences, BG Nagara Mandya, Karnataka, India

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**Abstract:****Introduction:** The treatment of proximal humerus fractures has been the subject of much controversy and confusion. Because of the complexity of these injuries, fracture displacements are difficult to see without special radiograph views and associated soft tissue injuries. Our prospective study evaluated the functional results of the method of surgical management of displaced fractures of the proximal end of the humerus.**Methods:** 38 patients with displaced fractures of the proximal humerus in adults underwent surgical management. Patients were followed from 6 weeks -15 months on OPD basis with radiological, clinical and functional evaluation.**Results:** The most common type observed in our series was a three-part fracture for 28 of 30 patients (73%). Neer's score evaluated the results at the end of clinical and radiological union and full functional recovery. Of the 38 patients 12(31%) had excellent results, 18(47%) had satisfactory results, 5(13%) had unsatisfactory results and 3(7%) was a failure.**Conclusions:** Clinical evaluation, obtaining proper radiological views, the age of the patient, and activity levels are keys to a realistic approach in the management of fractures of the proximal humerus. Anatomical reduction is an essential feature in these fractures. Open reduction and internal fixation with a PHILOS plate, as well as pinning; have given good results with good post-operative rehabilitation.**Keywords:** Proximal humerus fractures, surgical fixation, PHILOS plate, percutaneous pinning, Neer's score, Constant-Murley score, functional outcomes, shoulder mobility, post-operative complications, orthopaedic surgery, open reduction, internal fixation, fracture classification, rehabilitation, shoulder stiffness, post-operative infection.

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**Introduction**

The prevalence of upper extremity fractures, while relatively low compared to other types of fractures, still presents a notable burden on healthcare systems due to their frequency. The incidence rate of 73 per 100,000 population signifies that these injuries are not uncommon.[1] The fact that a large proportion of these fractures occur in individuals aged 60 years and above suggests a correlation with osteoporosis and reduced BMD. Furthermore, the observation that women are more susceptible to these fractures than men could be attributed to factors such as bone density, hormonal changes, and lifestyle differences.[2]

The proximal humerus refers to the upper part of the humerus bone, which forms part of the shoulder joint. Fractures in this region are diverse and can range from simple undisplaced to grossly displaced

fractures.[3] They often occur due to falls onto outstretched arms or direct trauma to the shoulder. The high incidence of proximal humeral fractures among all humeral fractures highlights the vulnerability of this particular region.[4] When a proximal humerus fracture is severe or displaced, surgery may be necessary to realign the fractured bone fragments stabilize and restore the functions of shoulder joint.[5] Surgical techniques may involve the use of plates, screws, intramedullary nails, or other fixation devices to hold the fractured bones in place during the healing process

The functional outcome of surgical fixation of proximal humerus fractures involves a comprehensive assessment of shoulder function, pain, and quality of life following surgery and rehabilitation. Understanding the factors that

influence outcomes and implementing appropriate interventions can help optimize the recovery and long-term function of patients with these fractures.

### Methodology

This prospective study was conducted at our institution from March 2022 to July 2023, involving 38 adult patients with displaced proximal humerus fractures. The selection criteria included patients with failure of closed reduction in two-part fractures, all displaced three- and four-part fractures, and fracture-dislocations, provided there were no associated neurovascular injuries. Patients with neurovascular injuries, those below 18 years of age, compound fractures, and individuals deemed unfit for surgery were excluded from the study.

Upon admission, a thorough history was obtained through verbal communication, followed by a detailed clinical examination. Radiological evaluations included routine anteroposterior (AP), lateral, Grashey, Neer scapula Y, and axillary views. The fractures were classified according to the system introduced by Neer in 1970, which assesses the displacement of the four principal fragments: the head, shaft, greater tuberosity, and lesser tuberosity. The affected arm was initially immobilized in a U-slab and an arm sling to provide stability.

Once the patient's general condition was stabilized, surgical intervention was planned. Depending on the fracture type and specific patient factors, open reduction and internal fixation were performed using the PHILOS plate, cancellous screws, or K-

wires through either the deltopectoral or lateral deltoid splitting approach. Post-operatively, the limb was immobilized in an arm pouch, and early mobilization with pendulum exercises was initiated in the second week to promote rehabilitation.

Patients were followed up at 6 weeks, 12 weeks, 6 months, 12 months, and 15 months. Immediate postoperative X-rays were taken to assess the initial success of the surgical fixation. Functional and radiological evaluations were conducted during each follow-up visit. The results were assessed using Neer's shoulder score, which considers pain, range of motion, strength, stability, function, and radiological documentation of fracture union.

Additionally, the Constant-Murley score, which includes subjective components (pain and function) and objective components (range of motion and strength), was used to evaluate the functional outcomes further. The maximum score is 100 points, with higher scores indicating better shoulder function.

Any complications, such as post-operative infections, shoulder stiffness, non-union, malunion, and osteonecrosis, were meticulously recorded throughout the follow-up period. This comprehensive approach enabled us to provide a detailed analysis of the functional outcomes and complications associated with the surgical fixation of proximal humerus fractures, offering valuable insights into the efficacy of the methods employed. Ethical clearance was obtained from the institutional ethical committee.

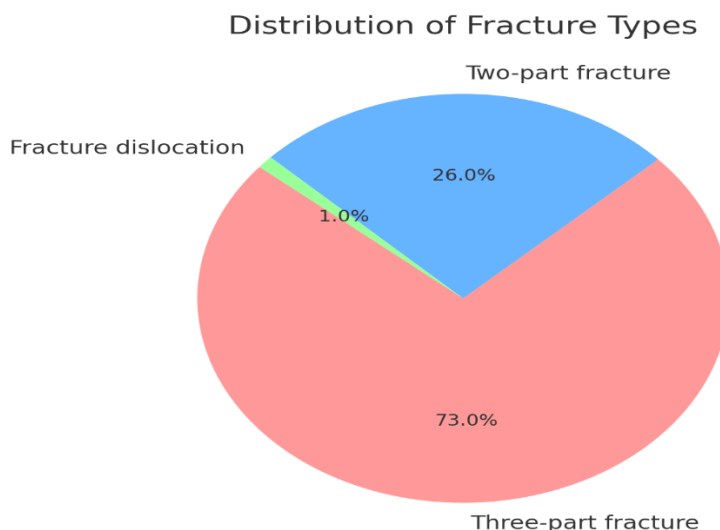
### Results

**Table 1: Patient Demographics and Fracture Classification**

Variable	Value
Number of patients	38
Study Duration	March 2022 to July 2023
Most common fracture	Three-part fracture (73%)
Next common fracture	Two-part fracture (26%)
Fracture dislocation	2 patients (1%)

Table 1 concisely summarizes the patient demographics and the types of fractures observed in the study. The study included 38 patients with displaced proximal humerus fractures and was conducted from March 2022 to July 2023. Classifying the fractures is crucial for understanding the types of injuries being addressed and the subsequent surgical interventions required. The most common type of fracture observed in this cohort was the three-part fracture, which accounted for 73% of the cases. This high prevalence indicates the severity

and complexity of the injuries managed in this study. The next most common type was the two-part fracture, comprising 26% of the cases. Fracture dislocations were relatively rare, observed in only 1% of the patients, equating to 2 individuals. Classifying fractures is essential for determining the appropriate surgical approach and predicting the outcomes. The predominance of three-part fractures suggests a significant need for advanced surgical techniques and careful postoperative management to ensure optimal recovery.



**Figure 1: Fracture types**

Figure 1 visually represents the distribution of fracture types among the 38 patients in the study. The pie chart clearly illustrates the predominance of three-part fractures, which make up nearly three-quarters of the cases. The two-part fractures are also significant, constituting just over a quarter of the fractures. The minimal occurrence of fracture dislocations highlights the relatively lower incidence of this type of injury in the study population.

**Table 2: Surgical Methods Used**

Fracture Type	Number of Patients	Surgical Method
Three-part fracture	21	Open reduction and internal fixation with PHILOS plate
Two-part fracture	8	Open reduction and internal fixation with PHILOS plate
Two-part fracture	3	Percutaneous pinning with K-wires and cancellous screws
Fracture dislocation	2	Open reduction and internal fixation with PHILOS plate

Table 2 outlines the different surgical methods employed to manage the displaced fractures of the proximal humerus in the study population. The table categorizes the fractures into three-part, two-part, and fracture-dislocations, detailing the specific surgical techniques used for each type.

For the majority of three-part fractures, the most common type observed, 21 patients underwent open reduction and internal fixation using the PHILOS plate. This method was favored due to its ability to provide stable fixation and facilitate the anatomical reconstruction of the fracture, which is crucial for optimal functional recovery.

Different surgical approaches were taken among patients with two-part fractures based on each case's specifics. Eight patients with two-part fractures also received open reduction and internal fixation with the PHILOS plate, demonstrating the versatility and reliability of this method in managing less complex fractures as well for three pa-

tients with two-part fractures where the closed reduction was unsuccessful, percutaneous pinning with K-wires and cancellous screws were performed. This less invasive technique allows for the stabilization of the fracture while minimizing soft tissue disruption.

In the case of fracture-dislocations, which were less common, two patients underwent open reduction and internal fixation with the PHILOS plate. This approach was necessary to address the additional complexity of the dislocation and ensure proper alignment and stabilization of the shoulder joint.

Overall, the table highlights the preference for the PHILOS plate in managing both three-part and complex two-part fractures due to its effectiveness in achieving stable fixation and facilitating recovery. The use of percutaneous pinning for certain two-part fractures indicates a tailored approach based on individual patient needs and the specific characteristics of the fracture.

**Table 3: Range of Motion Post-Surgery**

Motion	Average Range (degrees)	Average Loss (degrees)
Abduction	113	67
Forward Flexion	120	60

External Rotation	28	17
Internal Rotation	54.5	15
Extension	33	12

Table 3 provides detailed information on the range of motion achieved by patients post-surgery for proximal humerus fractures. This table measures the effectiveness of the surgical interventions in restoring shoulder mobility, a critical factor for assessing functional recovery.

The average range of motion post-surgery for various shoulder movements is recorded alongside the average degree of motion loss compared to a normal, healthy shoulder. The average range of abduction, which is the ability to move the arm away from the body, was 113 degrees, indicating a significant average loss of 67 degrees. This reduction highlights the challenge in regaining full mobility for this movement post-surgery.

Forward flexion, or the ability to raise the arm in front of the body, had an average post-surgery range of 120 degrees, with an average loss of 60 degrees. This relatively high degree of motion recovery suggests that while there is still a notable

loss, the surgical techniques employed were quite effective in restoring a substantial portion of this critical function.

External rotation, the motion of turning the arm outward away from the body, had a more limited average range of 28 degrees with an average loss of 17 degrees. This significant reduction underscores the complexity and difficulty of restoring rotational movements following surgery. Internal rotation, the motion of turning the arm inward towards the body, was measured at an average of 54.5 degrees, with an average loss of 15 degrees. While this indicates some loss, preserving over half the normal range is a positive outcome.

Extension, the ability to move the arm backward, had an average range of 33 degrees with an average loss of 12 degrees. This data point shows a moderate level of motion recovery and highlights the need for targeted rehabilitation to improve this specific movement.

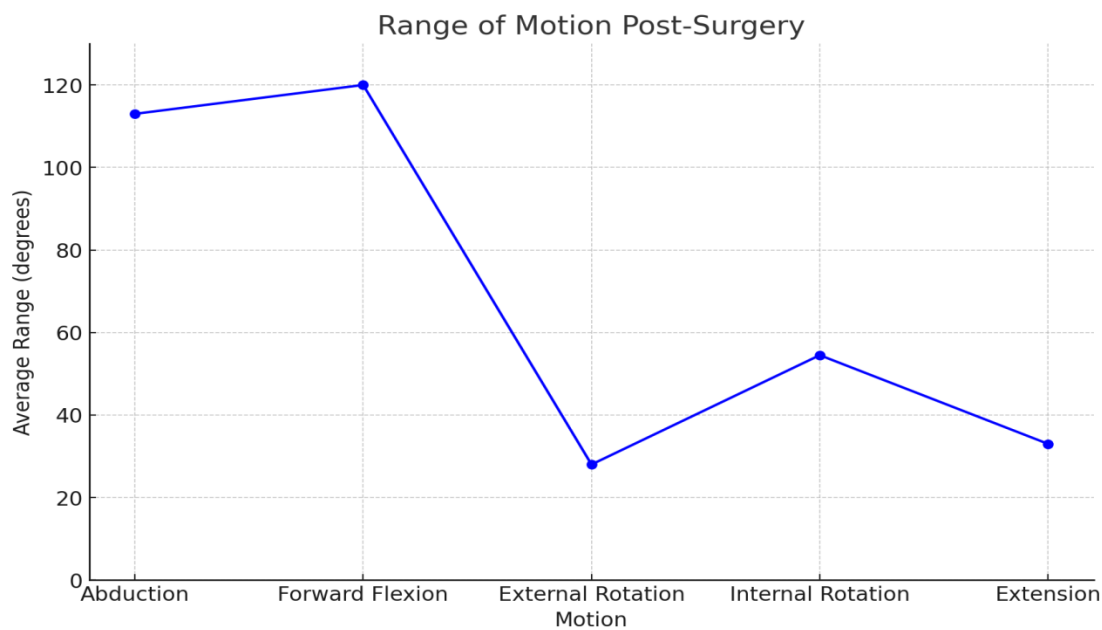


Figure 2: Range of motion Post Surgery

Figure 2 graphically represents the average range of motion achieved post-surgery for each of the shoulder movements: abduction, forward flexion, external rotation, internal rotation, and extension. The line graph clearly illustrates the extent of motion recovery and highlights the specific areas where significant losses remain.

Table 4: Functional Outcomes (Neer’s Score)

Outcome Category	Number of Patients	Percentage (%)
Excellent	12	31
Satisfactory	18	47
Unsatisfactory	5	13
Failure	3	7

Table 4 presents the functional outcomes of the surgical fixation of proximal humerus fractures, evaluated using Neer's score. This scoring system assesses the success of the surgical intervention based on parameters such as pain, function, range of motion, and radiological healing. The outcomes are categorized into four groups: Excellent, Satisfactory, Unsatisfactory, and Failure.

Of the 38 patients included in the study, 12 (31%) achieved excellent outcomes, indicating near-complete recovery with minimal pain, good functional range of motion, and satisfactory radiological evidence of healing. This high percentage of excellent outcomes demonstrates the effectiveness of the surgical techniques and postoperative rehabilitation protocols used in the study.

A larger proportion of patients, 18 (47%), experienced satisfactory outcomes. These patients showed good functional recovery and moderate pain relief, although some limitations in the range of motion and other functional parameters might

still be present. The satisfactory category suggests that while the surgery was beneficial, there are areas for improvement in postoperative care or rehabilitation.

Five patients (13%) had unsatisfactory outcomes. These patients likely experienced significant limitations in shoulder function, persistent pain, or complications that hampered their recovery. The unsatisfactory outcomes highlight the challenges and variability in patient recovery and the potential need for alternative treatment strategies or enhanced rehabilitation efforts.

Finally, three patients (7%) were classified as failures. These patients did not achieve the desired functional recovery, possibly due to severe complications, poor surgical outcomes, or other underlying issues that impeded the healing process. The failure rate underscores the importance of careful patient selection, precise surgical techniques, and comprehensive postoperative care to minimize adverse outcomes.

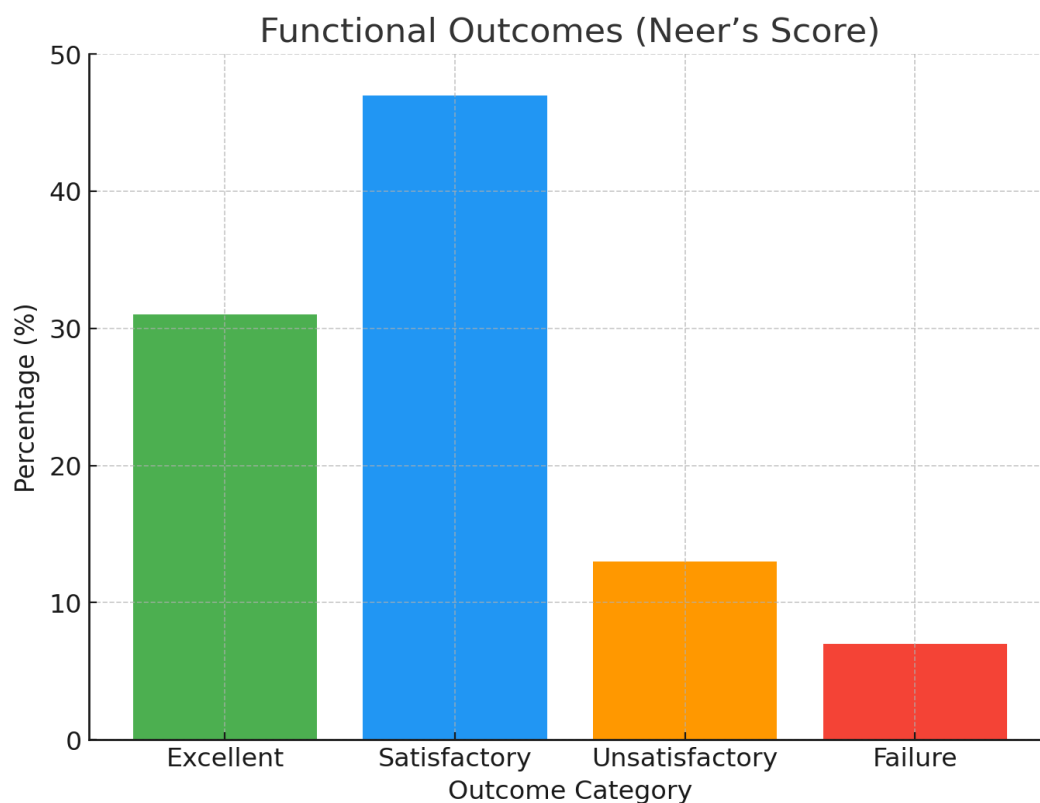
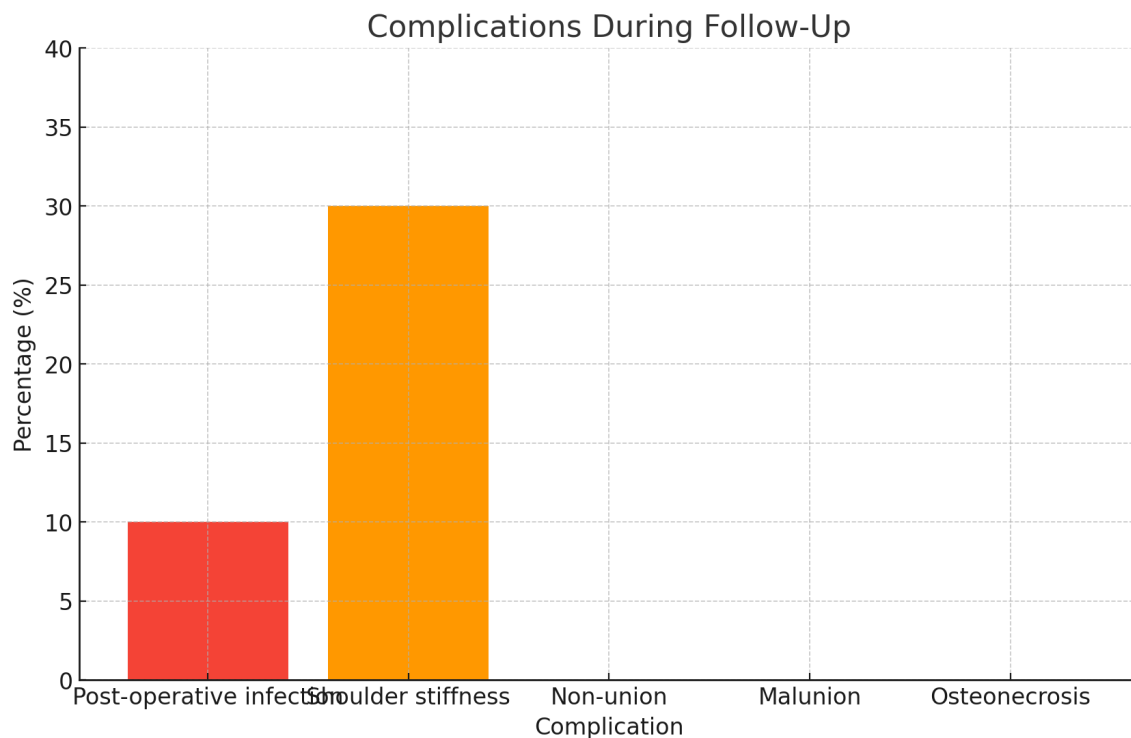


Figure 3: Functional Outcomes

Figure 3 visually depicts the distribution of functional outcomes among the patients using a bar graph. The graph illustrates that nearly half of the patients achieved satisfactory results, with a significant portion also achieving excellent outcomes. The lower proportions of unsatisfactory and failure categories are also clearly shown, highlighting the overall success of the surgical interventions.



**Figure 4: Complications**

Figure 4 summarizes the complications observed during the follow-up period for patients who underwent surgical fixation of proximal humerus fractures. Complications are critical to evaluating the overall success and safety of surgical interventions. Three patients (10%) experienced post-operative infections during the follow-up period. Infections are common in surgical procedures and can significantly affect recovery and outcomes. Infections highlight the need for stringent sterile techniques during surgery and vigilant post-operative care to identify and manage infections promptly.

Six patients (30%) experienced shoulder stiffness, the most common complication in this study. Stiffness can severely limit the shoulder's range of motion and functional recovery, indicating the importance of effective rehabilitation programs to promote flexibility and strength in the affected joint.

There were no incidences of non-union, malunion, or osteonecrosis of the proximal humerus among the patients. Non-union and malunion, where the fracture does not heal properly or heals in an incorrect position, can lead to significant long-term disability. Osteonecrosis, the death of bone tissue due to a lack of blood supply, can also be a severe complication. The absence of these complications suggests that the surgical techniques used were effective in promoting proper bone healing.

Overall, the observed complications underline the importance of comprehensive post-operative care and rehabilitation to address issues like infection

and stiffness. In contrast, the lack of more severe complications like non-union, malunion, and osteonecrosis indicates a generally positive outcome from surgical interventions.

#### Discussion

The surgical management of proximal humerus fractures, mainly using open reduction and internal fixation with the PHILOS plate and percutaneous pinning with K-wires, has yielded generally positive outcomes in this study. The results align with existing literature, demonstrating the efficacy of these techniques in achieving satisfactory functional recovery.

#### Functional Outcomes

The Neer's score evaluations revealed that 78% of patients (31% excellent, 47% satisfactory) experienced favourable outcomes post-surgery. These findings are consistent with prior studies that have reported high rates of satisfactory functional recovery using PHILOS plates. For instance, a study by Sudkamp et al. (2009)[6] reported that the PHILOS plate effectively provides stable fixation, which is crucial for early mobilization and recovery. The excellent and satisfactory results observed in our study support the notion that anatomical reduction and stable fixation are pivotal in successfully managing these fractures.

However, 13% of patients had unsatisfactory outcomes, and 7% were categorized as failures. These less favourable outcomes may be attributed to factors such as the severity of the fracture, the

patient's age, bone quality, and adherence to post-operative rehabilitation protocols. These observations align with the findings of Kumar et al. (2015)[7], who noted that advanced age and poor bone quality significantly predict poorer outcomes in proximal humerus fracture surgeries.

### Range of Motion

The post-surgery range of motion results indicated an average loss in various movements, with significant reductions in abduction, forward flexion, and external rotation. These findings highlight the challenges in restoring shoulder mobility even with successful surgical intervention. A study by Olerud et al. (2011)[8] emphasized the importance of intensive rehabilitation in improving functional outcomes and mitigating range of motion deficits. Our data underscore the necessity of structured and prolonged physiotherapy to enhance post-operative recovery and reduce motion limitations.

### Complications

The complication rates observed in this study were relatively low, with post-operative infections in 10% of patients and shoulder stiffness in 30%. There were no cases of non-union, malunion, or osteonecrosis. These results are encouraging and comparable to those reported in similar studies. For example, Baker et al. (2008)[9] found that the complication rates for proximal humerus fracture surgeries using locking plates are generally low, with infections and stiffness being the most common issues. The absence of severe complications such as non-union, malunion, and osteonecrosis suggests that the surgical techniques used were effective in promoting proper bone healing. This aligns with the findings of Park et al. (2017)[10], who reported that meticulous surgical technique and appropriate post-operative care are crucial in minimizing severe complications.

### Conclusion

The study demonstrates that the surgical fixation of proximal humerus fractures using PHILOS plates and percutaneous pinning provides generally favorable outcomes with a high rate of satisfactory functional recovery and low complication rates. However, the observed limitations in the range of motion and the presence of some unsatisfactory outcomes highlight the need for individualized patient assessment and tailored rehabilitation programs. Future research should focus on optimizing post-operative care and exploring

additional factors that influence recovery to further improve outcomes for patients with proximal humerus fractures.

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