

FUNCTIONAL OUTCOME OF SURGICALLY TREATED PROXIMAL HUMERUS FRACTURES: A PROSPECTIVE OBSERVATIONAL STUDY

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Abstract

Proximal humerus fractures are common injuries with diverse fracture patterns and treatment options. Although minimally displaced fractures can often be managed conservatively, displaced fractures frequently require surgical intervention to restore anatomy, achieve stable fixation, and facilitate early mobilization. The present prospective observational study was conducted to evaluate the functional outcome of surgically treated proximal humerus fractures and to assess fracture union and complications following operative management. Twenty adult patients with displaced proximal humerus fractures treated at Guntur Medical College and Government Hospital, Guntur, were included. Fractures were classified according to Neer's classification and managed using plate osteosynthesis, percutaneous Kirschner-wire fixation, open reduction and internal fixation with Kirschner wires, or cancellous screw fixation based on fracture configuration and bone quality.

Patients were followed for a mean duration of 24 weeks, and functional outcomes were assessed using the Neer shoulder scoring system. The mean patient age was 41.5 years (range, 18–85 years), with males comprising 70% of the study population. Road traffic accidents were the most common mechanism of injury (60%). All fractures achieved radiological union within 8–12 weeks, with a mean union time of 10 weeks. According to the Neer shoulder scoring system, excellent, satisfactory, and unsatisfactory outcomes were observed in 15%, 80%, and 5% of patients, respectively, with no treatment failures. Shoulder stiffness was the most frequent complication, followed by superficial infection, Kirschner-wire migration, malunion, and pin tract infection.

Surgical management of displaced proximal humerus fractures resulted in reliable fracture union, satisfactory functional outcomes, and an acceptable complication profile. Anatomical reduction, stable fixation, and early supervised rehabilitation remain essential for achieving optimal shoulder function.

KEYWORDS: Proximal humerus fracture; PHILOS plate; Neer classification; Internal fixation; Functional outcome; Neer shoulder score.

Introduction

Proximal humerus fractures account for approximately 4% to 5% of all fractures and are among the common injuries encountered by orthopaedic surgeons. Their incidence increases with advancing age owing to osteoporosis, although high-energy trauma remains an important cause in younger individuals.(1)

The management of proximal humerus fractures remains controversial because of the wide variability in fracture patterns, bone quality, patient age, and functional demands.(2) While minimally displaced fractures can often be managed nonoperatively, displaced fractures frequently require surgical intervention to restore anatomy and permit early mobilisation.

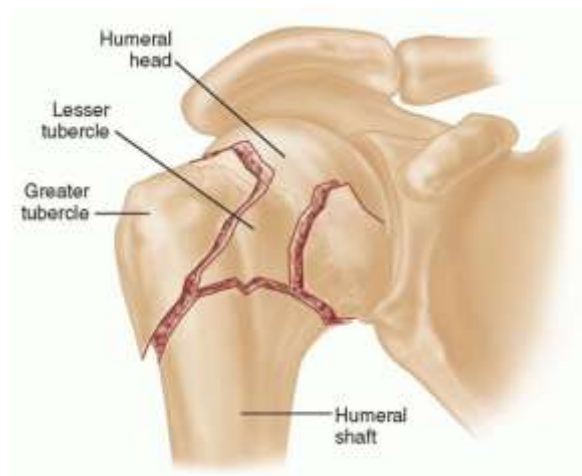


Figure 1. Proximal humerus fracture morphology

Several surgical techniques have been described, including percutaneous pinning, plate osteosynthesis, intramedullary fixation, and arthroplasty.(3) The goals of operative management are anatomical reduction, stable fixation, early mobilisation, and restoration of shoulder function while

minimizing complications such as stiffness, malunion, and avascular necrosis.(4)

The purpose of the present study was to evaluate the functional outcome of surgically treated proximal humerus fractures using the Neer shoulder scoring system and to assess union and complications following surgical management.

Methods

Study design

This prospective observational study was conducted in the Department of Orthopaedics, Guntur Medical College and Government Hospital, Guntur.

Inclusion criteria

- Patients aged ≥ 18 years.
- Displaced proximal humerus fractures.
- Fractures amenable to surgical treatment.
- Patients willing to participate and comply with follow-up.

Exclusion criteria

- Open fractures.
- Pathological fractures.
- Associated vascular injuries requiring repair.
- Polytrauma precluding definitive shoulder management.
- Patients unwilling for surgery or follow-up.

Clinical Evaluation

Proximal humerus fractures commonly occur following low-energy falls in elderly

patients with osteoporotic bone, whereas younger individuals usually sustain these injuries following high-energy trauma, particularly road traffic accidents.(2) Patients typically present with pain, swelling, and restriction of shoulder movements. Ecchymosis around the shoulder and upper arm is common, while open injuries are uncommon.

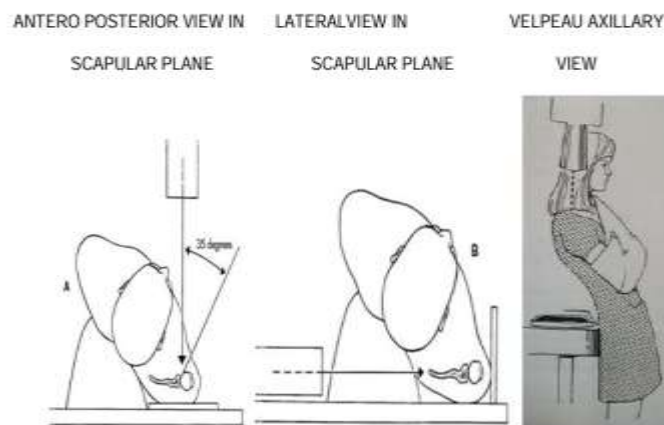
Clinical examination may reveal deformity depending on the fracture pattern and associated dislocation. An anterior prominence below the coracoid process may indicate anterior fracture-dislocation, whereas a posterior prominence with anterior flattening of the shoulder contour may suggest posterior dislocation. Tenderness around the proximal humerus and crepitus on attempted shoulder movement are frequently present.(4) A careful neurovascular examination is mandatory, with particular attention to the axillary nerve. Sensation over the lateral aspect of the shoulder (regimental badge area) should be assessed in all patients.

Imaging Evaluation

Radiographic assessment remains the cornerstone in the diagnosis and classification of proximal humerus fractures.(1) Inadequate radiographs may result in misclassification of the fracture pattern and inappropriate treatment planning.

All patients underwent standard trauma radiographs of the shoulder, including anteroposterior, scapular Y, and axillary views. The anteroposterior view is useful for assessing varus or valgus displacement of the surgical neck and superior displacement of the greater tuberosity.(2) The scapular Y view aids in evaluating flexion or extension deformity and posterior displacement of

fracture fragments. The axillary view is particularly valuable for identifying tuberosity displacement and confirming



glenohumeral joint congruity or associated dislocation.(7) In patients unable to abduct the arm because of pain, a Velpeau axillary view can be obtained.

Figure 2. Radiographic views for proper assessment of fracture

Computed tomography was performed in selected cases with complex fracture patterns, fracture-dislocations, head-splitting fractures, or suspected articular extension. CT provided additional information regarding fragment configuration, degree of displacement, impression defects, chronic fracture-dislocations, and associated glenoid injuries, thereby facilitating preoperative planning.

Surgical treatment

The choice of fixation depended on fracture pattern, patient age, bone quality, and surgeon preference. Surgical methods included:

- Plate osteosynthesis.
- Percutaneous Kirschner-wire fixation.
- Open reduction and internal fixation with Kirschner wires.
- Open reduction and internal fixation with cancellous screws.



Figure 3. Instruments used in fixation of proximal humerus fractures

Standard postoperative rehabilitation protocols were followed, with early passive and active-assisted range-of-motion exercises once fixation stability permitted.(6)

Open Reduction and Internal Fixation

Unstable two-part and three-part fractures underwent open reduction and internal fixation. The fracture fragments were anatomically reduced and stabilised using the most appropriate implant according to fracture morphology and bone quality. Fixation methods included Kirschner wires, cancellous screws, AO T-plates, and PHILOS plates.(7) In osteoporotic bone, locking plate fixation was preferred because

of its improved angular stability and fixation strength.

Following fixation, fracture stability and shoulder range of motion were assessed intraoperatively under fluoroscopic guidance before wound closure.



Figure 4. Postoperative radiograph demonstrating fracture reduction and fixation with a PHILOS plate

Surgical Technique

All procedures were performed under general anaesthesia with the patient in the supine position and a small sandbag placed beneath the ipsilateral shoulder to facilitate exposure. Intravenous prophylactic antibiotics (ceftriaxone 1 g with sulbactam) were administered preoperatively.

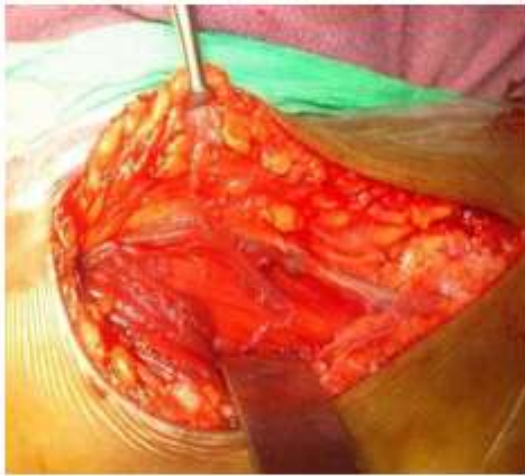


Figure 5. Intraoperative photograph showing surgical dissection and exposure of the proximal humerus fracture via the deltopectoral approach

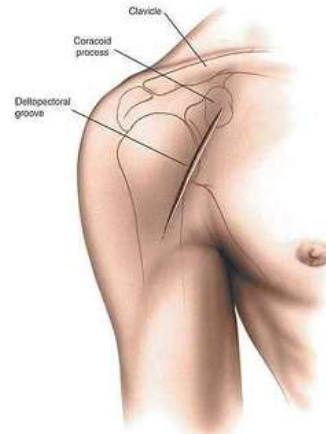


Figure 6. Diagrammatic representation of landmarks and incision for deltopectoral approach

Deltopectoral Approach

A standard deltopectoral approach was used in all patients requiring open reduction and internal fixation. An 8- to 10-cm skin incision was made from the coracoid process distally along the deltopectoral groove.(8) The interval between the deltoid and pectoralis major muscles was developed, and the cephalic vein was preserved and retracted as required. The conjoint tendon was retracted medially to expose the proximal humerus.

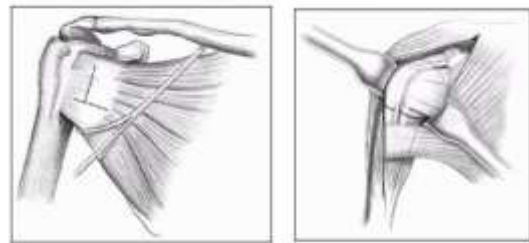


Figure 7. Diagrammatic representation of subscapularis tendon incision and exposure of the glenohumeral joint capsule

The long head of the biceps tendon served as an important landmark for identifying the interval between the greater and lesser tuberosities and for restoration of proximal humeral anatomy. Fracture fragments were reduced under direct vision and

provisionally stabilised with Kirschner wires when necessary.

Percutaneous Pinning

Selected two-part fractures and fracture-dislocations with satisfactory closed reduction were managed by percutaneous fixation using Kirschner wires. Following reduction under image intensifier guidance, two divergent pins were inserted from the lateral cortex into the humeral head and tuberosity fragments in perpendicular planes. An additional pin was inserted when required to improve rotational stability. Pins were removed after radiographic evidence of fracture union, usually between four and six weeks. **Cancellous screw fixation** was reserved for isolated tuberosity fractures or simple fracture patterns with large fragments amenable to screw fixation.



Figure 8. Postoperative radiograph showing reduction and fixation of a proximal humerus fracture with Kirschner wires

Plate Osteosynthesis and Fixation Principles

Proximal Humerus Locking Compression Plate

The proximal humerus locking compression plate (PHILOS) is a precontoured anatomical plate designed to accommodate the proximal humeral anatomy and facilitate stable fixation of complex fractures.(12) The proximal portion of the plate contains multiple threaded holes that accept locking screws in convergent and divergent orientations, thereby providing angular stability and secure fixation of the humeral head fragments.(13) Additional suture holes permit fixation of the rotator cuff and tuberosity fragments using non-absorbable sutures.



Figure 9. Proximal Humerus Internal Locking System (PHILOS) implant

The shaft portion of the plate contains combination holes that allow the insertion of either locking or conventional cortical screws.(14) Conventional screws may be used to achieve compression across the fracture site when appropriate.

Restoration of medial column support is essential for maintaining fracture reduction and preventing varus collapse. One or two inferomedial calcar screws were inserted

whenever possible to support the medial calcar and improve construct stability.(15)

The principles of locked plating differ from those of conventional plate osteosynthesis. Stability is achieved through the fixed-angle construct created by locking screws engaging with the plate, rather than by compression between the plate and bone.(16) This design preserves the periosteal blood supply and provides improved fixation in osteoporotic bone.

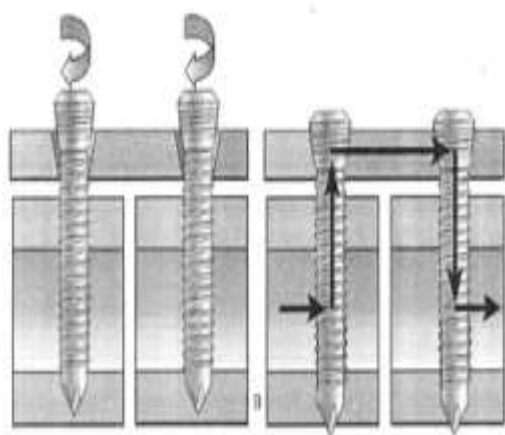


Figure 10. Biomechanical principles of conventional screws versus locking screws in a locking plate

Under fluoroscopic guidance, the plate was positioned approximately 5 to 8 mm distal to the tip of the greater tuberosity and slightly posterior to the bicipital groove to minimize the risk of subacromial impingement. Final reduction, screw length, and fixation stability were confirmed using intraoperative fluoroscopy.

Postoperative Management

All patients were immobilized using a shoulder immobilizer in the immediate

postoperative period. The rehabilitation protocol was individualized according to fracture configuration, stability of fixation, bone quality, and patient compliance.

Passive range-of-motion exercises, including pendulum exercises, passive forward elevation, and gentle external rotation, were initiated on the first postoperative day in patients with stable fixation.(7) Active movements of the elbow, wrist, and hand were also commenced on the first postoperative day.

Active-assisted and active shoulder mobilisation exercises were generally initiated at approximately six weeks postoperatively following radiographic evidence of progressive fracture healing. Strengthening and resistance exercises were introduced between 10 and 12 weeks after surgery.

Postoperative radiographs were obtained within 24 hours of surgery to assess fracture reduction, implant position, and fixation stability. Follow-up radiographs were performed at 4 weeks, 3 months, 6 months, and 12 months. Fracture union was assessed by the presence of bridging trabeculae across the fracture site, disappearance of the fracture line, maintenance of the neck-shaft angle, and preservation of reduction. Patients were also evaluated for complications including loss of reduction, screw penetration, screw cut-out, implant loosening, avascular necrosis, and nonunion.

Outcome assessment

Patients were followed for a mean duration of 24 weeks. Functional outcomes were assessed using the Neer shoulder scoring system. Radiological union and complications were also documented.

Results

Twenty patients with proximal humerus fractures were included. The mean age was 41.5 years (18 to 85). There were 14 males (70%) and six females (30%), giving a male-to-female ratio of 2.3:1.

The mechanism of injury was:

- Road traffic accident: 12 patients (60%)
- Domestic fall: six patients (30%)
- Electric shock: one patient (5%)
- Seizure episode: one patient (5%)

Fracture distribution according to Neer's classification was:

- Two-part surgical neck fractures: seven cases (35%)
- Two-part greater tuberosity fractures: three cases (15%)
- Three-part fractures: one case (5%)
- Two-part fracture dislocations: five cases (25%)
- Three-part fracture dislocations: four cases (20%)

All fractures united within three months. The mean time to union was 10 weeks (8 to 12).

According to Neer's shoulder scoring criteria:

- Excellent results: three patients (15%)
- Satisfactory results: 16 patients (80%)
- Unsatisfactory results: one patient (5%)
- Failures: none.

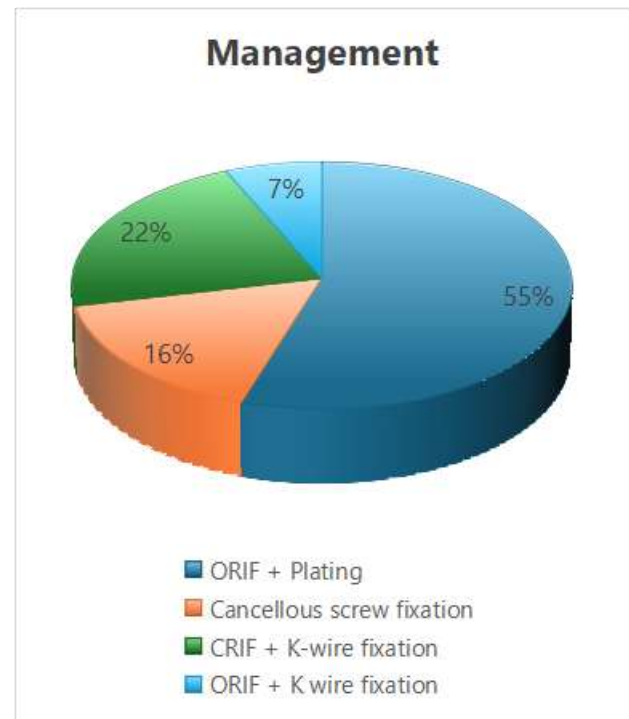


Figure 11. Surgical fixation methods employed in the study population

Patients with excellent and satisfactory outcomes demonstrated an average shoulder motion of:

- Forward flexion: 150°
- Abduction: 120°
- External rotation: 75°
- Internal rotation: 75°.



Figure 12. Postoperative clinical images demonstrating shoulder range of motion at final follow-up

Complications

Complications observed were:

- Shoulder stiffness.
- Superficial infection.
- Kirschner-wire migration
- Malunion
- Pin tract infection

<i>Complication</i>	<i>No. of cases</i>
<i>Stiffness</i>	6
<i>Superficial infection</i>	1
<i>K-wire migration</i>	2
<i>Malunion</i>	1
<i>Pin tract infection</i>	1

Table 2. Postoperative complications in the study population

No patient developed nonunion, implant failure, or avascular necrosis during the follow-up period. The percentage distribution of postoperative complications is shown in Figure 12.

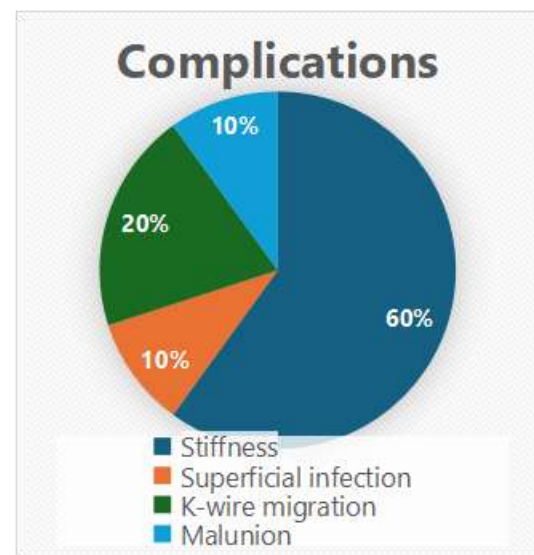


Figure 13. distribution of complications encountered following surgical treatment

Discussion

The present prospective observational study demonstrated satisfactory functional outcomes following surgical management of displaced proximal humerus fractures, with all fractures achieving radiological union and 95% of patients attaining excellent or satisfactory functional results according to the Neer shoulder scoring system. These findings support the role of operative

treatment in appropriately selected displaced proximal humerus fractures.

The mean age of the study population was 41.5 years, which is considerably younger than that reported in many Western series where proximal humerus fractures predominantly occur in elderly osteoporotic women following low-energy falls. This difference is likely attributable to the higher incidence of road traffic accidents in developing countries, which accounted for 60% of injuries in the present study. Similar epidemiological observations have been reported by Court-Brown and Caesar, who demonstrated differing injury patterns according to patient age and mechanism of trauma.

Stable anatomical reduction remains the cornerstone of successful treatment.(11) In the present study, fixation methods were selected according to fracture morphology and bone quality, with PHILOS plating reserved for unstable fractures requiring angular stability. Locking plate fixation has been shown to provide superior fixation in osteoporotic bone by creating a fixed-angle construct while preserving periosteal blood supply. Südkamp et al. reported satisfactory outcomes with locking plate fixation in displaced proximal humerus fractures, although complications remain common in complex fracture patterns.

Radiological union was achieved in all patients at a mean of 10 weeks, which compares favourably with previously published series. Solberg et al. similarly reported high union rates following locking plate fixation, emphasizing the importance of restoration of medial column support and appropriate implant positioning.(15) Gardner et al. further demonstrated that restoration of medial support significantly

reduces varus collapse and fixation failure.(10)

Shoulder stiffness was the most common complication encountered in the present study.(14) Similar observations have been reported in previous studies, highlighting the importance of early supervised rehabilitation once stable fixation has been achieved. No patient in our series developed avascular necrosis, implant failure, or nonunion during follow-up, although longer follow-up is necessary because osteonecrosis may become evident only after one to two years.

The present study has several limitations. The sample size was relatively small, follow-up was limited to 24 weeks, and different fracture patterns and fixation techniques were analysed together. These factors may influence the generalisability of the results. Nevertheless, the prospective study design and complete follow-up strengthen the validity of the findings.

Overall, the present study demonstrates that individualized surgical management based on fracture pattern, bone quality, and patient characteristics can provide reliable fracture union and satisfactory functional recovery with an acceptable complication profile.

Conclusion

Surgical management of displaced proximal humerus fractures resulted in satisfactory functional outcomes and reliable fracture union in the present study. Restoration of proximal humeral anatomy, achievement of stable fixation, and early supervised rehabilitation were the principal determinants of successful outcomes.

The choice of fixation should be individualized according to patient age, fracture pattern, bone quality, and associated injuries. Although complex fracture patterns and fracture-dislocations are associated with poorer prognosis and a higher risk of complications, appropriate surgical management and adherence to rehabilitation protocols can minimise complications and improve shoulder function.¹⁵

Declarations

Ethics approval

Institutional Ethics Committee approval was obtained prior to commencement of the study.

Informed consent

Written informed consent was obtained from all participants.

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