RESEARCH PAPER

A Prospective Study on the Functional Outcome of Shaft of Humerus Fracture Treated with Intramedullary Interlocking Nailing in a Tertiary Care Centre in Chengalpattu District

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ABSTRACT

Background: Humeral shaft fractures represent a major part of upper limb fractures which affect both active adults and elderly people. Surgical fixation has become the preferred method for treating unstable fractures because it allows patients to start rehabilitation work sooner and achieve better functional results than traditional treatment methods. The technique of intramedullary interlocking nailing (IMIL) enables surgeons to create stable bone connections while maintaining natural healing processes through its less invasive surgical method.

Aim: The study investigates how intramedullary interlocking nailing surgery affects the functional results and fracture healing process and complication rates of patients with humeral shaft fractures.

Materials and Methods: The research team studied 35 patients who suffered humeral shaft fractures and received intramedullary interlocking nailing treatment at a tertiary care hospital. The study included patients who were 18 years or older and had closed fractures or certain types of open fractures. The research team gathered demographic information together with details about the injury and the fracture damage and the side of the body which was affected and the condition of the soft tissues. The research team monitored patients through scheduled visits to track fracture healing and assess their pain levels using the Visual Analogue Scale (VAS) and evaluate their shoulder and elbow abilities through standard clinical assessment procedures. The researchers conducted statistical analysis by using suitable testing methods which determined statistical significance at p-values below 0.05.

Results: The patient population had an average age of 44.6 years with 57.1 percent of patients being female. The most frequent cause of injuries occurred through road traffic accidents which accounted for 51.4 percent of cases. The majority of fractures showed AO/OTA classification as 12 diaphyseal fractures which occurred in 60 percent of cases and 68.6 percent of cases showed closed injuries. Fracture union achieved successful results when 97.1 percent of patients reached 12 to 16 weeks.

The study recorded only one instance of delayed union while all other cases achieved successful union. The study showed excellent functional outcomes for 85.7 percent of shoulders and 94.3 percent of elbows. VAS scores demonstrated statistical significance through their time-based reduction which reached $p < 0.001$. The study showed only minimal postoperative complications because there were no incidents of iatrogenic radial nerve palsy or implant failure.

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Conclusion: Intramedullary interlocking nailing serves as a safe and effective treatment approach for humeral shaft fractures. The procedure achieves high union rates with outstanding functional results and produces few complications while enabling patients to begin movement soon after. IMIL nailing provides specific benefits for diaphyseal humeral fractures which makes it the ideal surgical method for patients who meet the right selection criteria.
Keywords: Humeral Shaft Fractures, Upper Limb Fractures, Surgical Fixation, Intramedullary Interlocking Nailing
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INTRODUCTION

Fractures of the shaft of the humerus represent frequent orthopedic injuries which create major difficulties for both treatment methods and the process of returning patients to their normal activities. The humerus serves as an essential component for upper limb movement because it functions as the primary connector between the shoulder and elbow joints. Any disruption to its structural continuity can result in impairment of arm movement, strength, and coordination, thereby affecting activities of daily living and occupational performance.[1]

Humeral shaft fractures account for approximately 3% of all fractures and about 20% of fractures involving the humerus. Fractures occur in people of all ages through multiple injury mechanisms. Young people sustain their most common injuries from high-energy traumatic events which include road traffic accidents and sports injuries and falls from height. Elderly patients commonly experience these fractures when they undergo low-energy trauma which results from their existing osteoporosis and decreased bone density. Developing countries experience higher rates of road traffic accidents which have resulted in more people suffering from humeral shaft fractures requiring treatment at tertiary care facilities.[2,3]

Surgical management has become more accepted because surgical techniques and implant designs and perioperative treatment methods have progressed together with their implementation in treating unstable fractures and patients who need to start moving immediately. The surgical procedure establishes stable bone fixation while restoring normal bone structure and permitting initial rehabilitation and decreasing health risks. The two main surgical methods that surgeons use in their work are plate osteosynthesis and intramedullary interlocking nailing.[4]

Intramedullary interlocking nailing has emerged as an attractive alternative to plating due to its minimally invasive nature and biological advantages. The load-sharing device enables precise control of slight movements which occur at the fracture zone and this leads to the development of bone tissue that heals the fracture. The technique preserves fracture hematoma and periosteal blood supply, which are critical for bone regeneration. The use of intramedullary fixation leads to reduced soft tissue exposure while minimizing potential infection risks.[5]

The main challenge that doctors encounter when treating humeral shaft fractures involves protecting the radial nerve from damage. The radial nerve traverses the spiral groove of the humerus and is particularly vulnerable in shaft fractures. Radial nerve palsy may occur at the time of injury or as an iatrogenic complication during surgical intervention. The use of surgical methods that restrict visibility and handling of the fracture area will result in fewer cases of nerve damage caused by medical staff.[6,7]

The clinical results which follow humeral shaft fractures depend on two factors: whether the fracture has healed and whether the patient has regained full shoulder and elbow movement together with muscle strength and freedom from medical problems. The process of early mobilization serves as a vital mechanism which helps patients avoid joint stiffness while they improve their functional abilities. The technique of intramedullary interlocking nailing delivers adequate stability which enables patients to begin physiotherapy earlier thus resulting in quicker recovery times.[8]

The application of intramedullary interlocking nailing has grown more common but there remains a discrepancy between actual outcomes and reported results which include union rates and functional restoration and complication rates. The differences between patient demographics and fracture characteristics together with surgical expertise and rehabilitation protocols create this outcome variability. The Indian population needs prospective studies which will assess the functional results of intramedullary interlocking nailing treatments for humeral shaft fractures.[9]

The study investigates how intramedullary interlocking nailing impacts fracture healing and patient outcomes and resulting medical complications in adult patients who suffer from shaft of humerus fractures. The study results will help create evidence-based guidelines which determine the best methods for treating these specific fractures.[10]

The management of humeral shaft fractures has evolved considerably over the past several decades. Doctors used to treat most of these fractures through non-surgical methods which included functional bracing and hanging casts and splints. Conservative treatment relies on the principle of relative stability and functional alignment maintained by surrounding soft tissues. Although this

method eliminates the dangers of surgery, it brings about other issues which include extended times of immobilization and problems with bone healing and shoulder and elbow joint stiffness and failure to follow medical advice by patients.[11,12]

MATERIALS AND METHODS

3.1 Study Design
This study was designed as a prospective clinical observational study conducted to evaluate outcomes following intramedullary interlocking nailing for shaft of humerus fractures.

3.2 Study Area
The study was conducted in the Department of Orthopaedics at a tertiary care teaching hospital in Chengalpattu District, Tamil Nadu.

3.3 Study Duration
The study was carried out over a period of 18 months, following approval from the Institutional Ethics Committee.

3.4 Study Population
The study population consisted of adult patients aged above 18 years who were admitted with shaft of humerus fractures and treated surgically with intramedullary interlocking nailing.

3.5 Sample Size
A total of 35 patients were included in the study.

Sample Size Calculation

The sample size was calculated based on a previous comparative study evaluating radial nerve palsy in plating versus intramedullary nailing. Considering:
- A confidence level of 95%
- Power of 80%
- Expected difference in radial nerve palsy incidence
- A 10% non-response rate

The final sample size was determined to be 35 patients.

3.6 Inclusion Criteria
- Acute fractures of the shaft of humerus
- Patients aged above 18 years
- Closed fractures and selected low-grade open fractures
- Polytrauma patients with associated humeral shaft fracture
- Patients willing to give written informed consent

3.7 Exclusion Criteria
- Open fractures with severe soft tissue injury
- Pre-existing neurological deficits affecting functional outcome
- Segmental fractures of the humerus
- Pathological fractures
- Established radial nerve palsy following fracture
- Osteoporotic fractures
- History of previous fracture or surgery involving the same humerus

3.8 Preoperative Evaluation
All patients underwent a thorough clinical and radiological evaluation.

Clinical Assessment

- **Detailed history including:**
  - Mode of injury
  - Duration of injury
  - Associated injuries
  - Medical comorbidities
- General physical examination
- **Local examination assessing:**
  - Swelling, deformity, and tenderness
  - Skin condition and soft tissue status
  - Neurovascular status with special emphasis on radial nerve function

Radiological Assessment
- Plain radiographs of the affected humerus:
  - Anteroposterior view
  - Lateral view
- CT scan was performed when required to assess fracture complexity.

Fractures were classified according to the AO/OTA classification system.

3.9 Anaesthetic Assessment
All patients were evaluated preoperatively by the anaesthesia team and classified according to the American Society of Anesthesiologists (ASA) grading. Only patients belonging to ASA Grade I and II were included.

3.10 Surgical Technique

Anaesthesia and Positioning
Surgery was performed under general anaesthesia or regional anaesthesia.Patients were positioned in a supine or beach chair position depending on the surgical approach.

Surgical Approach
Antegrade intramedullary nailing was the preferred approach.

Retrograde nailing was used in selected cases where antegrade entry was contraindicated.

Procedure
A small incision was made at the appropriate entry point.Entry into the medullary canal was achieved under fluoroscopic guidance.A guide wire was inserted across

the fracture site.Sequential reaming was performed where required.The appropriate length and diameter intramedullary nail was inserted.Proximal and distal locking screws were placed to provide rotational and axial stability.Care was taken throughout the procedure to avoid excessive soft tissue dissection and protect the radial nerve.

3.11 Postoperative Management
Postoperative radiographs were taken to confirm implant position and fracture alignment.Arm was supported in a sling for comfort.

Early mobilization of shoulder and elbow joints was initiated as pain permitted.Antibiotics and analgesics were administered as per hospital protocol.

3.12 Rehabilitation Protocol
Passive and active-assisted shoulder and elbow exercises were started early.Gradual progression to active range of motion and strengthening exercises.Physiotherapy was continued throughout the follow-up period.

3.13 Follow-up Protocol

Patients were followed up at:
3 weeks,6 weeks,12 weeks,24 weeks

At each follow-up visit:
Clinical assessment

Radiological evaluation for fracture union

Pain assessment using VAS

Functional assessment of shoulder and elbow

3.14 Outcome Measures
Primary Outcome

Functional outcome of shoulder and elbow joints

Secondary Outcomes

Time to radiological union

Pain relief assessed using VAS

Incidence of complications

Occurrence of radial nerve palsy

3.15 Statistical Analysis
Data were entered into Microsoft Excel.Statistical analysis was performed using SPSS version 17.Descriptive statistics were used for demographic data.Appropriate inferential tests were applied.A p-value < 0.05was considered statistically significant.

3.16 Ethical Considerations

Approval was obtained from the Institutional Ethics Committee.Written informed consent was obtained from all patients

Confidentiality of patient data was strictly maintained

DISCUSSION

The management of fractures of the shaft of humerus continues to be a subject of debate in orthopaedic practice. The treatment of displaced fractures and polytrauma patients and pathological fractures and patients who require early mobilization needs surgical fixation although conservative treatment produces acceptable outcomes for certain patients. The most common surgical methods which doctors use today include plate osteosynthesis and intramedullary interlocking (IMIL) nailing.[4,27]

The present prospective study evaluated the functional outcome, fracture union, pain relief, and complication profile of humeral shaft fractures treated with IMIL nailing in 35 adult patients.

The current study showed a mean age of 44.6 years, which matches McCormack et al. who reported a mid-forties average age of patients who received surgical treatment for humeral shaft fractures. The research by Chapman et al. showed that active adults represented the majority of patients who received surgical treatment for humeral shaft fractures.[40,45]

The present study found a female majority of 57.1%, which differs from earlier research including the study by Bell et al. that showed a higher male presence. Recent studies by Putti et al. and Raghavendra et al. have shown that fracture rates among females have increased because of domestic falls and osteoporosis and more active lifestyles of middle-aged and elderly women. The present study shows demographic patterns that demonstrate changing patterns of disease spread.[2,23]

The study identified road traffic accidents as the primary cause of injuries which affected 51.4% of participants. The results match the research findings of Sarmiento et al. and McKee et al. which showed that high-energy trauma served as the main cause of surgically treated humeral shaft fractures.[22,27]

Elderly patients experienced more slip and fall injuries which matched the findings of Court-Brown et al. who identified low-energy falls as the main reason older people sustain fractures. The present study found a statistically significant link between age and mode of injury which shows that older people have distinct patterns of injuries ($p = 0.021$).[23,26]

In the present study, AO/OTA type 12A/B/C diaphyseal fractures accounted for 60% of cases. Singisetti and Ambedkar reported similar distributions because they found that diaphyseal fractures represented the majority of patients who received IMIL nailing treatment.[19,45]

Multiple researchers including Brumback et al. have shown that intramedullary nailing works best for diaphyseal fractures because it shares load capacity while maintaining blood flow through the periosteum. The present studyfound shaft fractures occurred more frequently than other fracture types which shows that IMIL nailing should be used to treat this specific fracture pattern.[46,47]

The study found that left-sided dominance was not significant. This finding matches the results of Sharma et al. and Kumar et al. who demonstrated that fracture laterality had no impact on functional results. Most authors agree that laterality does not influence union rates or postoperative function.[39]

The study found that 68.6% of its cases involved closed fractures. The research conducted by Gadegone and Salphale showed that closed fractures treated with IMIL nailing achieved superior union rates and experienced fewer complications. The study achieved excellent healing outcomes because it had a low occurrence of high-grade open fractures.[12,47]

The study found that most patients belonged to ASA Grade I which matched the results of Dabezies et al. who discovered that medically fit patients received surgical treatment for humeral shaft fractures. Patients with lower anaesthetic risk can begin their rehabilitation process sooner. This leads to decreased perioperative complications which results in improved functional recovery.[35]

The present study achieved a 97.1% union rate which exceeds the results of previous studies. Chapman et al. reported union rates of approximately 94% with IMIL nailing, while McCormack et al. reported union rates exceeding 90% for both nailing and plating.[40,45]

The present study shows that patients need 13.8 weeks to achieve bone union which matches the results from Rommens et al. who reported that patients achieved union between 12 and 16 weeks. The absence of non-union and the statistically significant union outcome ($p < 0.001$) demonstrate that IMIL nailing successfully establishes stable fixation while supporting biological healing.[30,46]

The current research study achieved excellent functional results for 86 percent of its enrolled patients. Singisetti et al. reported similar results which showed that more than 80 percent of patients who received IMIL nailing treatment achieved good to excellent results.[45]

Patients demonstrated better elbow function according to the findings which Brumback et al. and McKee et al. both observed. Riemer et al. documented that shoulder stiffness represents a known problem which accompanies antegrade nailing procedures. The research study found low rates of shoulder stiffness because doctors used precise surgical methods combined with prompt physical therapy beginning after surgery.[48,52]

The research study conducted by Chapman et al. demonstrated that IMIL nailing produces equivalent total functional results compared to plating which provides slightly improved shoulder performance but causes more damage to soft tissues.[40]

The study found that VAS scores decreased progressively throughout the research period. Putti et al. demonstrated that stable intramedullary fixation resulted in substantial pain reduction according to their research findings. The study found a significant reduction in pain scores which reached statistical significance at ($p < 0.001$) showing that fracture stabilization succeeded and rehabilitation process achieved its goal.[49]

The present study demonstrated a low complication rate which did not reach statistical significance ($p = 0.684$). The study found that no patients experienced iatrogenic radial nerve palsy. The study results establish clinical relevance because plate fixation research conducted by Bell et al. and McKee et al. found that radial nerve palsy occurred in 5% to 12% of cases.[43,57]

The most frequent complications for the study appeared as nail impingement and shoulder stiffness which showed the same results as Rommens et al. The study results were treated through non-surgical methods which did not change the final results.[55]

The present study shows that intramedullary interlocking nailing provides similar or superior results to plate osteosynthesis based on its union rates functional outcomes and complication profiles when used for diaphyseal fractures.[45,46]

CONCLUSION

The current prospective study findings lead to three main conclusions which were reached after researchers conducted their observations and analyses.Intramedullary interlocking nailing serves as a safe and effective treatment method for adult patients who sustain shaft of humerus fractures.[45]

The technique produces excellent results for fracture healing because most fractures heal within a normal healing period while very few cases experience delayed healing or complete healing failure.[30]The functional outcome at shoulder and elbow joints produces satisfactory results because most patients achieve excellent motion range and they quickly return to their regular activities.[48]

IMIL nailing enables patients to start moving again because the method provides secure bone fixation which decreases their postoperative discomfort and helps them recover faster.[46]The surgical method creates only minor damage to soft tissues which leads to a low rate of complications.[47]

The current study demonstrated that no patients in the study developed iatrogenic radial nerve palsy which demonstrates the neurovascular safety of intramedullary interlocking nailing when performed with correct surgical techniques.[43,57]

IMIL nailing provides advantages over plate osteosynthesis because it maintains fracture biological functions while requiring less surgical space and producing superior visual results particularly for diaphyseal fractures. The intramedullary interlocking nailing technique serves as the optimal surgical method for treating selected cases of humeral shaft fractures because it ensures complete bone healing and enables patients to

achieve excellent functional results with minimal surgical risks.[45,46]

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