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EVALUATION OF THE FUNCTIONAL OUTCOME OF INTRAMEDULLARY INTERLOCKING NAIL FIXATIONS FOR HUMERAL SHAFT FRACTURES

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ABSTRACT

Background And Objective: Humeral shaft fractures are commonly treated by orthopaedic surgeons and account for approximately 3% of all fractures. Antegrade interlocked humerus nailing for stabilisation of humerus fractures was introduced many years ago and is a valid treatment option for stabilising the shaft of humerus fractures. As complications, such as non-union, malunion, fracture disease, and difficulty in nursing and rehabilitation in polytrauma cases, are less likely with this procedure, intramedullary interlocking (IMIL) nailing successfully bridges the gap between functional bracing and plating. The scoring system of the University of California Los Angeles (UCLA) is used to assess the functional outcome of intramedullary interlocking nailing for humerus shaft fractures and any associated complications of the above-mentioned procedure. **Method:** Thirty patients between the ages of 18 and 65 who were admitted to the orthopaedics department in R.L. Jalappa Hospital, part of the Sri Devaraj Urs Medical College, with a fracture of the humerus shaft and met the inclusion and exclusion criteria were included in the study. Their demographic data, history, clinical examination, and details of investigations were recorded in study proforma, and they were then taken for anterograde IMIL nailing. The recovery and ambulation time as well as complications of the procedure, such as pain, infection, joint stiffness, iatrogenic fractures, and radial nerve palsy, were documented, and the patients were followed up with one, three, and six months after surgery. **Result:** Among the 30 patients treated with IMIL nailing, the complications were as follows: Two patients showed shoulder stiffness and delayed union, one patient had a surgical site infection and shoulder stiffness, one patient had only shoulder stiffness, one patient had an iatrogenic fracture of the lateral epicondyle of the humerus, and one patient had implant breakage secondary to trauma after fixation. Functional outcomes were evaluated using the UCLA scoring, in which 24 (80%) patients had a good outcome regarding pain relief, 24 (80%) had an excellent functional outcome, and 24 (80%) patients had excellent post-surgery muscle power and motion at their six-month follow-up. **Conclusion:** Intramedullary interlocking nailing is a safe and effective treatment modality for humeral shaft fractures with an excellent functional outcome. This is shown by a mean UCLA score of 31.73 ± 3.609 at follow-ups six months after surgery. In addition, IMIL nailing is associated with a low incidence of complications, with the most likely complication being shoulder stiffness.

KEYWORDS

INTRODUCTION

Nonoperative treatments are usually successful in mending acute humeral fractures due to the generous blood supply of the adjoining muscles. Therefore, functional bracing is still the main treatment modality in many trauma centers [1,2]. Humeral shaft fractures are commonly treated by orthopedic surgeons and account for approximately 3% of all fractures [3-5].

Nonoperative treatment of humeral shaft fractures is usually effective, with healing typically occurring within 10–12 weeks. However, these fractures can be complicated in polytrauma cases, leading to a high risk of nonunion, malunion, fracture disease, and difficulties in care and rehabilitation. Recent developments in internal fixation techniques and instrumentation have made surgery an attractive option for these fractures, creating a dilemma as to which procedure should be chosen. Screw and plate osteosynthesis has been the main modality of treatment in many places where surgical treatment is needed [6,7]. Although dynamic compression plating is usually considered the gold standard for humeral surgery, intramedullary fixation has certain benefits. As it is closer to the bone's natural mechanical axis, it is able to distribute the load more effectively and reduce fatigue failure due to bending forces. Furthermore, since no direct exposure to the fracture is needed and less soft tissue needs to be exposed during surgery, this method can be more beneficial for preserving hematoma and reducing the risks of nerve damage caused by iatrogenic stress shielding. Interlocking nails offer rotational stability, eliminating the need for postoperative bracing and allowing quick extremity movement without disrupting the fracture hematoma [8,9].

However, the procedure has its pitfalls. Failed closed reduction, failed locking, iatrogenic fractures, nerve injuries in the intraoperative period, adhesive capsulitis, nonunion, nail protrusion, and impingement in the postoperative period have been reported [10].

MATERIALS AND METHODS

Study Setting

The study was conducted in the orthopedic department of R. L. Jalappa Hospital, affiliated with Sri Devaraj Urs Medical College, Tamaka, Karnataka, India.

Study Design

The study design followed a prospective hospital-based observational study.

Study Subjects

The study included 30 cases of humeral shaft fractures admitted to the orthopedic department of R.L. Jalappa Hospital, affiliated with Sri Devaraj Urs Medical College, Tamaka.

Inclusion Criteria

- Patients between 18 and 65 years of age with humeral shaft fracture
- Fracture of the humerus: >2 cm distal to the surgical neck and 3 cm proximal to the olecranon fossa
- Closed/Open (type-1) fractures of the humerus shaft

Exclusion Criteria

- Humerus shaft fractures associated with neurovascular injury
- History of previous humeral fracture on the same side
- Pathological fractures

Study Period

October 2019 to June 2021.

Data Collection

The research was presented to the Institutional Ethics Committee (IEC) for ethical authorization. After the IEC sanctioned it (IEC No: SDUMC/KLR/IEC/161/2019-20), the study began. Following gaining informed consent, a comprehensive questionnaire was provided to the chosen patients to complete independently. Strict confidentiality was maintained while conducting the survey and utilizing the data given by each respondent.

Measurement Tool

The UCLA outcome measure was developed when little information was available on the appropriate methodology for instrument

development. The UCLA score is still commonly used for certain situations, such as post-treatment for shoulder instability or rotator cuff disease.

UCLA Shoulder Rating Scale

	Score
Pain	
Present always and unbearable; strong medication frequently	1
Present always but bearable; strong medication occasionally	2
None or little at rest, present during light activities; salicylates frequently	4
Present during heavy or particular activities only; salicylates frequently	6
Occasional and slight	8
None	10
Function	
Unable to use limb	1
Only light activities possible	2
Able to do housework or most activities of daily living	4
Most housework, shopping and driving possible; able to do hair and to dress and undress, including fastening brassiere	6
Slight restriction only; able to work above shoulder level	8
Normal activities	10
Active forward flexion	
> 150°	5
120°–150°	4
90°–120°	3
45°–90°	2
30°–45°	1
< 30°	0
Strength of forward flexion (manual muscle testing)	
Grade 5 (normal)	5
Grade 4 (good)	4
Grade 3 (fair)	3
Grade 2 (poor)	2
Grade 1 (poor muscle contraction)	1
Grade 0 (nothing)	0
Satisfaction of the patient	
Satisfied and better	5
Not satisfied	0

Maximum Score = 35 points
Excellent = 30–35 points
Good = 28–33 points
Fair = 21–27 points
Poor = 0–20 points

The UCLA score can be given a numerical value of up to 35, with higher scores signifying better results. This can be adjusted to a 100-point scale for comparison with other shoulder quality assessment tools [11].

Sampling Method

All eligible patients with humeral shaft fractures fulfilling the inclusion criteria were approached and assessed in the following phase.

1. Informed consent from the patient was obtained.
2. Inclusion and exclusion criteria were applied to the patient.
3. Sociodemographic data were obtained from patients.
4. Patients were followed up at the first, third, and sixth months after surgery. Serial X-rays were taken at each follow-up. Radiological and clinical healing of the fracture was assessed, along with the shoulder and elbow range of motion.

The final assessment was done in the sixth month.

Data Analysis

The collected data were entered into an MS Excel data sheet, and data analysis was performed using IBM SPSS 22 software.

Statistical Method

Descriptive analysis was performed using mean and standard deviation for quantitative and frequent variables and proportions for categorical variables. Data can also be presented using bar graphs, pie charts, and boxplots.

The relationship between explanatory variables and categorical outcomes was assessed by cross-tabulation and comparison of percentages. IBM SPSS 22 was used for the statistical analysis.

RESULT

In this study, the number of patients aged up to 20 years was 1 (3.3%); the number aged between 20 and 40 years was 13 (43.3%); 41 to 60 years was 12 (40%); and over 60 years was 4 (13.3%). There were 22 males (73.3%) and 8 females (26.7%). There were 3 (10%) patients with a humerus shaft fracture due to assault; 20 (66.7%) from road traffic accidents; 7 (23.3%) from slips and falls; and 28 (93.3%) from direct injury. There were 2 cases of indirect injury, accounting for 6.7%.

The results of the study showed that out of 30 patients, 18 (60%) had an injury on their right side, while the remaining 12 (40%) had an injury on their left. Regarding the fracture location, 7 (23.3%) patients had a fracture in the lower third of their humerus, 17 (56.7%) in the middle third, and 6 in the upper third of their humeral shaft. Additionally, 1 patient (3.3%) experienced an open fracture, while 29 (96.7%) sustained a closed fracture. The study duration between trauma and surgery ranged from 1–5 days in 25 (83.4%) patients, 5–10 days in 1 (3.3%) patient, and >10 days in 4 (13.3%) patients.

In this study, 6 (20%) patients were initially immobilized using an arm pouch, while 24 (80%) were immobilized using a U-slab. For 3 (10%) patients, the period of immobilization was <5 days; for 26 (86.7%), it was 5–10 days; and for 1 (3.3%), it lasted for >10 days. Further, 8 (26.7%) patients underwent surgery under general anesthesia, while the remaining 21 (73.3%) received regional anesthesia. Postoperative complications, such as shoulder stiffness and delayed union, were observed in 2 (6.7%) patients, whereas only shoulder stiffness, implant breakage, iatrogenic fracture, surgical site infection, and shoulder stiffness were observed in 1 (3.3%) patient in each category.

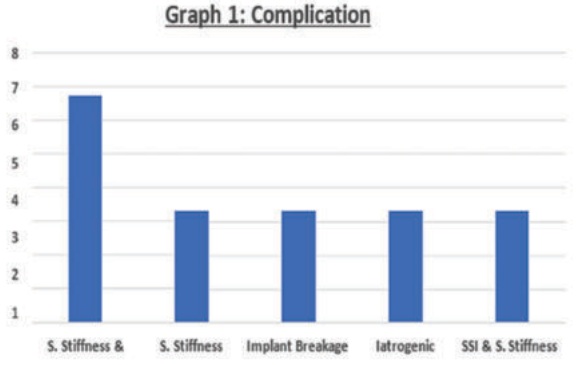
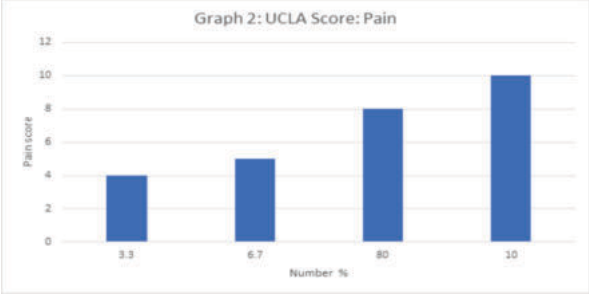
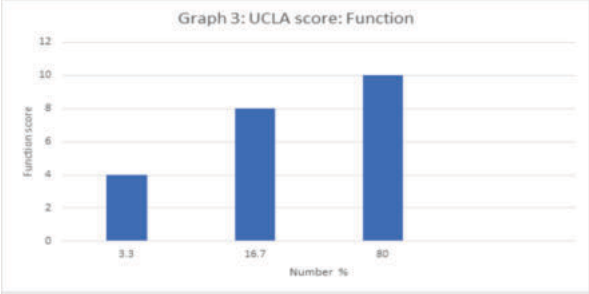
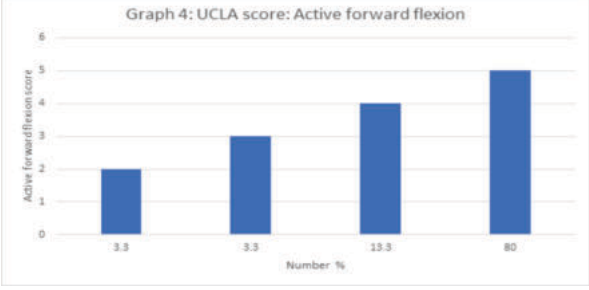


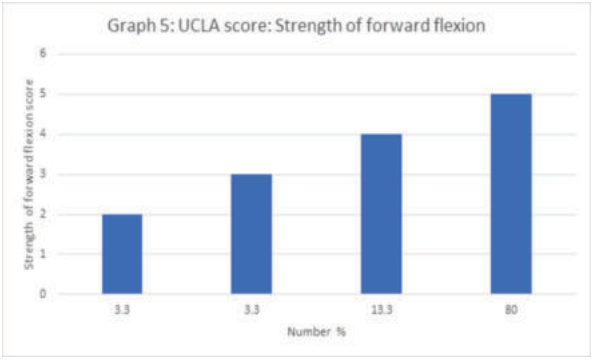
Figure 1: *Descriptive analysis of complications in the study population (N=30)*

The UCLA scoring system showed that 3.3%, 6.7%, 80%, and 10% of the participants had pain scores of 4, 5, 8, and 10, respectively; likewise, 3.3%, 16.7%, and 80% had functional scores of 4, 8, and 10, respectively; and active forward flexion and strength forward flexion scores were 2, 3, 4, and 5 in 3.3%, 3.3%, 13.3%, and 80% of the participants, respectively. All 30 patients reported a satisfaction score of 5, with an overall average UCLA score of 31.73 with a standard deviation of 3.609.









According to the UCLA scoring system, >27 points are graded as good to excellent and <27 as fair to poor. According to the UCLA score, in our study, 4 (13.33%) patients had good to excellent scores at the 1-month mark, 25 (83.33%) patients had fair scores, and 1 (3.33%) patient had poor scores. At the 3-month mark, 26 (86.366%) had good to excellent scores, 3 (10%) had fair scores, and 1 (3.33%) had poor scores. At the 6-month follow-up, 26 (86.66%) patients had good to excellent scores, while 3 (10%) had fair and 1 (3.33%) had poor scores.

Table 1: Descriptive Analysis Of UCLA Score At Each Follow-up (postoperative UCLA Score At 1 Month, 3 Months, And 6 Months) In The Study Population (N=30)

	Good to excellent (28–35%)	Fair (21–27%)	Poor (0–20%)
At 1 month	4 (13.33%)	25 (83.33%)	1 (3.33%)
At 3 months	26 (86.66%)	3 (10%)	1 (3.33%)
At 6 months	26 (86.66%)	3 (10%)	1 (3.33%)

In this study, 1 (3.3%) patient had an associated open type 2 injury, namely a fracture of both bones of the right leg, 1 (3.3%) had a fracture of both bones of the left forearm, 1 (3.3%) had a fracture of the left iliac wing with ipsilateral anterior column fracture of the hip, and 1 (3.3%) had a fracture of the first, second, and third metatarsals of the right leg.

DISCUSSION:

The humeral shaft is cylindrical, and the extension between the proximal insertion of the pectoralis major and the distal metaphyseal flare of the humerus provides resistance to torsional and bending forces and provides strength. An adequate soft tissue envelope promotes a good prognosis for the healing of uncomplicated fractures [12]. Humeral shaft fractures account for 5–8% of all extremity fractures, with an annual incidence of 13/100,000. These fractures are managed with either conservative or surgical approaches [13]. Conservative methods include functional bracing, spica cast, Velpeau bandage, and coaptation splint. Surgical methods include plate screw fixation, intramedullary nailing, and an external fixator [14].

The present study showed that most participants (83%) were from the age group 20–60 years, and the average age was 43.1 years. This result is consistent with the studies of Chun-Hao et al. [15], Rajagopal et al. [12], Cocco et al. [16], and Patino et al. [17]. In a study by Yuce et al. [18], a higher mean age (70 years) was observed, while Mahmoud et al. [19] found a lower mean age (34 years).

In the present study, the male-to-female ratio was 1:0.4, whereas in studies by Yuce et al. [18], Rajagopal et al. [12], Cocco et al. [16], and Mahmoud et al. [19], the male-to-female ratios were 1:1, 1:0.5, 1:0.6, and 1:0.3, respectively.

Chun-Hao et al. [15], Rose et al. [20], and Tytherleigh-Strong et al. [21] found a bimodal age distribution, with a small peak in the third decade consisting mainly of males who sustained high-energy trauma and a second large peak in the eighth decade affecting mainly females with osteoporotic fractures resulting from simple falls.

The present study found that many participants (66.7%) were injured in road traffic accidents, and most participants (93.3%) were injured by direct injury. In the present study, three-fifth of the participants (60%) were injured on the right side. These results are comparable with the studies of Rajagopal et al. [12], Cocco et al. [16], Mehraj et al. [22], and Mahmoud et al. [19].

In the present study, the middle third of the humeral shaft was found to be the most frequently injured of the study participants. These results are comparable to the studies of Rajagopal et al. [12] and Mahmoud et al. [19].

The present study found that most cases (83.4%) underwent surgery 5 days after injury. The average duration between trauma and surgery was 3.6 days, which correlates with the study by Yuce et al. [18]. In a study by Mahmoud et al. [19], the mean duration was 1.9 days. A study by Rajagopal et al. [12] found that 50% of patients underwent their operation on the same day, 40% after 2 days, and 10% after 5 days.

The present study found that most participants (73.3%) underwent surgery under regional anesthesia and 26.7% under general anesthesia. In contrast, in the study by Sahu et al. [23], all cases were operated on under general anesthesia.

The present study found that postoperative stiffness and delayed union were the most common complications observed in the study participants. Chapman et al. [24], Flinkkila et al. [25], and Raghavendra et al. [26] noted that shoulder pain, limitation of shoulder motion, and the risk of delayed union were mentioned as disadvantages of antegrade intramedullary fixation.

In the present study, the mean UCLA score was 31.73 ± 3.609, indicating a good functional outcome, compared with the study by Mahmoud et al. [19]. In a study by Chun-Yan et al. [27], a mean UCLA score of 31.2 was obtained.

The table below shows an improvement in UCLA scores from the first to the sixth month of follow-up, which is comparable to the study by Kumar et al. [28]. In our study, the UCLA score was good to excellent in 26 (86.66%) cases and fair in 3 (10%) cases, which is comparable to the study of Mehraj et al. [22], in which 33 (82.5%) cases had a good to excellent score, and 6 (15%) cases had a fair score.

Table 2: Postoperative UCLA Score at each follow-up

In our study	Good to excellent (%)	Fair (%)	Poor (%)
At 1 month	13.33%	83.33%	3.33%
At 3 months	86.66%	10%	3.33%
At 6 months	86.66%	10%	3.33%
Kumar et al. study	Good to excellent (%)	Fair (%)	Poor (%)
At 1 month	86.7%	13.3%	0
At 3 months	93.33%	6.66%	0
At 6 months	96.7%	3.33%	0

In the present study, associated injuries were found in 13.3% of the participants, whereas in a study by Patino et al. [17], associated injuries were found in 26% of the participants.

LIMITATIONS

The limitations of the study were the small sample size and the short follow-up period. In addition, this study did not compare other modalities, such as nonoperative treatment or fixation with plates and screws. Therefore, further comparative studies with larger sample sizes and longer follow-up periods are recommended.

CONCLUSION

Intramedullary interlocking nailing is a safe and effective treatment modality for humeral shaft fracture with an excellent functional outcome, with a mean UCLA score of 31.73 ± 3.609 at a 6-month follow-up. At the 1-month to 6-month follow-up, the UCLA score improved from fair to good and excellent in most participants. In addition, IMIL nailing is associated with a low incidence of complications (the highest of which is shoulder stiffness).

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