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ORIGINAL ARTICLE

Assessment of Humerus Union and Shoulder Movement After Management of Humeral Shaft Fracture by Interlocking Nail.

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Abstract

Background: Humeral shaft fracture makes up approximately 3% of all fracture types. Advantages of intramedullary nailing in management is considered a minor invasive surgical procedure that can effectively shorten the operative time and hospital stay and reduce the intraoperative blood loss. This study aimed to assess if better management of humeral shaft fracture by intramedullary nail fixation.

Methods: This is a prospective clinical trial included 12 patients. All of them suffering from humeral shaft fracture with age ranged from 25 to 65 years. All patients were operated upon at Orthopedic Surgery Department, Zagazig University Hospitals. All patients were evaluated both clinically and radiologically. Assessment of shoulder movement was done by a constant score.

Results: Time of union was distributed as 11.50±1.78 with minimum 10 and maximum 18 weeks. Regarding shoulder movement, majority of patients were excellent with 66.7 % then good 33.4 %. Regarding elbow movement, majority was excellent with 83.3 % then Good 16.7 %. Ten cases were excellent in movement and two cases were good according to shoulder constant score.

Conclusion: Locked humeral nailing has proven to be a reliable therapeutic option for humeral diaphysis fractures, resulting in a satisfactory functional outcome and a high union rate. It also permitted early use of the limb, which is critical.

Key words: Humeral diaphysis fractures, Interlocking Nail, Constant-Murley scoring system.

Introduction

There is a lot of disagreement about the best way to treat humeral shaft fractures. There are numerous treatment options available, both conservative and surgical. The goal of management is to restore patients to their pre-traumatic level of function by establishing unions with an acceptable humeral alignment. Operative treatment for humerus fractures has usually been reserved for the treatment of nonunion, associated with fractures of forearm, for polytrauma patients, and for those with neuro-vascular complications **[1].** Near-anatomic alignment is frequently achieved with open reduction and internal fixation (ORIF) with direct fracture exposure. The percentage of non-union and hardware failures that necessitate adjustment ranges from 0 % to 7 %. After plate fixation, elbow and shoulder range of motion returns reliably; if total range of motion is not achieved, further skeletal or neurologic injuries are frequently present **[2].**

Intramedullary fixation has been increasingly popular in recent years. The earliest findings demonstrated a greater non-union rate than that seen with conservative therapy or ORIF with plates and screws. However, multiple studies have shown that using a newer implant and a better technique, such as locked intramedullary nailing, can achieve the same level of effectiveness as earlier approaches **[3].**

IM nails have certain potential advantages over plates and screws decreased risk of wound infection, blood loss, extensive muscle and soft tissue dissection and iatrogenic radial nerve palsy. If there is good cortical contact, the IM nail can operate as a load-shearing device since it is closer to the normal mechanical axis. Because they are subjected to lesser bending stresses, they are less likely to fail due to fatigue. Without direct fracture exposure and substantially less soft tissue incision, IM nails can be implanted. Furthermore, stress shielding reduces the risk of cortical osteoporosis **[3].**

The disadvantages of intramedullary nailing are impingement after injury of rotator cuff muscles and subsequent shoulder pain, associated with antegrade nailing **[4].** This study aimed to evaluate the results in terms of clinical and functional outcomes for surgical management of humeral shaft fractures by intramedullary nail.

Patients and Methods

This was a prospective study conducted at Orthopedic Surgery Department, Zagazig University Hospitals. Twelve patients suffering from humeral shaft fracture were included in the study. All patients with a fracture shaft humerus who presented to the orthopedics department at Zagazig university hospitals were included in the study if they met the following criteria: diaphyseal humeral fracture that required operative intervention and were treated with interlocking nail, skeletally mature patients, and for both male and female fractures.

Patients who had fracture dislocation, infection at operation site or elsewhere, skeletal immaturity, treated by plate osteosynthesis, open fracture humerus Gustilo III, radial nerve palsy and mid shaft fracture with extended intra-articular fracture were excluded from the study.

All patients underwent a complete medical history, clinical examination, and radiographic assessment (Anteroposterior and Lateral views). Any additional suspected injuries, such as the head, neck, chest, pelvis, spine, and any other limb injuries, will be subjected to an X-ray. Preoperative laboratory investigations (complete blood picture (CBC), liver function tests (ALT, AST, and albumin), serum urea and creatinine, and coagulation profiles) were done.

Method of Treatment:

ER Management: The fractured limb was splinted with a U-shaped slab. Analgesic and anti-edematous medications were provided. Patients were kept under surveillance in the hospital until surgery, with any accompanying injuries and other medical issues were managed.

Operative Stage: All patients underwent the surgical procedure under general anesthesia for every case according to general condition. Surgical intervention was done in 1 to 5 days after injury.

Operative Technique: Radiographs of the humerus were carefully studied. The fracture was examined for the degree of comminution and displacement. The width of the isthmus was measured. The isthmus of the humerus was usually located at the junction between the middle third and the distal third of the medullary canal. This measurement gave an idea about the expected diameter of the nail to be used and the need for reaming.

Steps of surgery: The operation was performed under general or regional anesthesia. All patients received intravenous 3rd generation cephalosporin 30 minutes prior to the skin incision. The patients were placed diagonally on the operating table with the injured arm resting on the radiolucent side table. Then, the patients were draped leaving only the affected arm exposed from the base of the neck to below the elbow. An incision antrolateral to the acromion and about 3 to 4 cm long was made, the fascia over the deltoid was incised, then the deltoid was split, retractors were applied to expose the supraspinatus tendon **(Figure1).** A modest 1.5 cm incision was made down to the bone, following the fibers. The point of an awl was positioned over the entrance point (medial to the greater tuberosity). After that, the medulla was opened with a medullary finding device or a straight hand reamer. The next step was to insert a 2.0 mm guide rod. Adducting the arm with mild traction was commonly used to reduce fractures. The humerus was reammed with reamers. The target device's T handle was attached to the selected nail, which was then screwed carefully over the guide rod rather than hammered. The nail was advanced by gently screwing while the reduction was maintained manually, and the guide rod was removed once the nail had entered the distal piece. The target device allowed accurate adjustment of the site of the proximal locking screw. After this one cm incision was made through the skin, the double sleeve was introduced, and then a 2.7 mm drill bit was introduced manually after insertion of the proximal locking screw, the target device was removed. Distal locking is done through inserting the first locking screw using a freehand technique and check for the correct position and length under image intensification in two planes **(Figure 2).** The wounds were closed in layers; the longitudinal incision in the supraspinatus tendon was meticulously sutured by absorbable suture material.

Figure 1: The incision, deltoid splitting, and exposure of supraspinatus tendon.

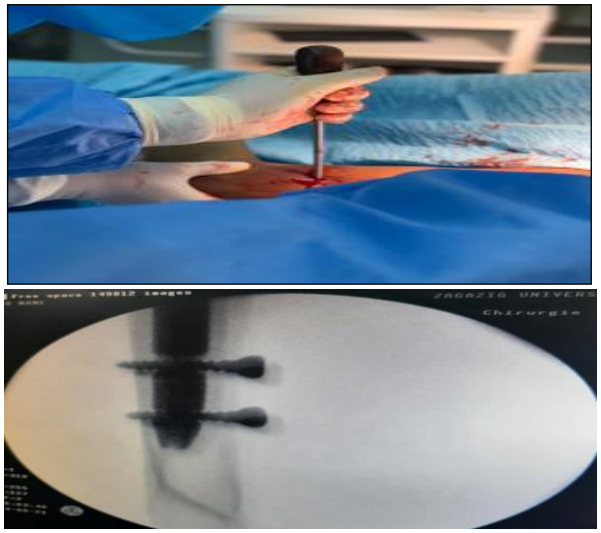

Figure 2 a, b: Distal locking screw.

Postoperative care: The vascular and neurological condition of each patient was checked. X-rays were taken to determine the extent of the reduction and the position of the nails. Anti-edematous and analgesic drugs were prescribed.

Functional Assessment of shoulder (Constant score): The Constant-Murley score was created to determine the functional outcome of shoulder injury treatment. Pain (15 points maximum), activities of daily life (20 points maximum), range of motion (40 points maximum), and strength are the four subscales that make up this score (25 points maximum). The greater the score, the better the function quality (minimum 0, maximum 100). The Constant-Murley shoulder scoring system is possibly the most widely utilized international shoulder scoring system. This method appealed to users since it had undergone significant psychometric validation. On a 100-point scale, the Constant-Murley scale is used. 35 points are attributed to subjective traits. The lack of discomfort is worth 15 points, whilst functional attributes like the ability to work are valued at up to 20. A maximum of 65 points are granted for objective measurements, including 40 points for range of motion and 25 points for strength. The active motion range objective parameter is based on the active range of composite movement, which allows for the placement of the upper limb in functionally relevant positions with a goniometer to measure forward and lateral elevation, as well as the positioning of the hand in relation to the head and trunk for rotation assessment. Pain is worth 15 points out of a possible 100. The total absence of pain receives a score of 15. The subjective ability to carry out all the patient's wishes receives a score of 20. The whole normal active range of the movement to be measured is worth 40 points. There are a total of ten points for forward and lateral elevation, as well as ten points for functional composite exterior and internal rotation. A goniometer is used to measure the angle of maximal active motion in these planes with the patient seated to avoid the incorrect measurement associated with trunk bending for forward and lateral elevation. The number of pounds of pull the patient can resist in abduction is used to determine power. The typical shoulder is assigned a score of 25 points **[5].**

Ethical approval: Approval was obtained through the Institutional Review Board (IRB) and informed written consent from patients and/or their carers. This research was carried out in accordance with the world medical association's code of ethics (Declaration of Helsinki) for human studies.

Statistical analysis: Microsoft Excel software was used to code, enter, and analyze data obtained during the history, basic clinical examination, laboratory investigations, and outcome measures. Statistical Package for the Social Sciences (SPSS version 20.0) software was used to analyze the data. The following tests were employed to examine differences for significance based on the kind of data: difference and association of quantitative variables by Chi square test (X2). The t test was used to compare differences between quantitative independent groups. For significant results, the P value was set at 0.05, and for high significant results, it was set at 0.001.

Results

Table 1; showed that the age was distributed as 43.41±13.13 with minimum 25 and maximum 65 years. As regard sex distribution, male was 58.3 % and female were 41.7 %. Many cases were left-sided injuries 58.35 % and right-side injuries were 41.7 %. As regards mechanism, FH was in 58.3 % of cases and RTA was in 41.7% of cases. As regards AO classification, majority of cases was A3 (66.7 %) then A2 (25.0 %) and finally A1 (8.3%).

Time of union was about 11.50±1.78 with minimum 10 and maximum 18 weeks **(Table 2).** Regarding shoulder movement, the majority were excellent (66.7 %) then good (33.4 %). Regarding elbow movement, the majority was excellent (83.3

%) then Good (16.7 %) **(Table 3).** Regarding outcome, shoulder constant score movement were excellent in 83.3 % of cases and good in 16.7 % of cases **(Table 4).** At final follow up; ten cases were excellent, and two cases were good **(Table 5).**

Table 1: Demographic data distribution among studied group: (N=12).

		Age	
Mean± SD		43.41±13.13	
Median (Range)		42.5 (25-65)	
		N	**%**
Sex	Female	5	41.7
	Male	7	58.3
	Total	12	100.0
Injury characters distribution		**N**	**%**
Side	LT	7	58.3
	RT	5	41.7
Mechanism	FH	7	58.3
	RTA	5	41.7
AO classification	A1	1	8.3
	A2	3	25.0
	A3	8	66.7
	Total	12	100.0

χ2 Chi square test**, **p ≤0.001** is statistically highly significant.

Table 2. Time of union/ W distribution among studied group.

	Time of union/ w
Mean± SD	11.50±1.78
Median (Range)	11.5 (10-18)

Table 3. Shoulder movement and Elbow movement distribution among studied group.

		N	**%**
Shoulder movement	Excellent	8	66.7
	Good	4	33.4
Elbow movement	Excellent	10	83.3
	Good	2	16.7
	Total	12	100.0

****p≤0.001** is statistically highly significant, independent sample t test

Table 4: Shoulder constant score movement

Strength of abduction	Mean± SD	21.33±1.55	
	Median (Range)	22.0 (19-24)	
Pain	Mean± SD	13.75±2.26	
	Median (Range)	15.0 (10-15)	
Activity level	Mean± SD	18.66±1.23	
	Median (Range)	18.50 (16-20)	
Forward flexion	Mean± SD	9.33±0.98	
	Median (Range)	10.0 (8-10)	
Abduction	Mean± SD	8.66±0.98	
	Median (Range)	8.0 (8-10)	
External rotation	Mean± SD	8.33±1.15	
	Median (Range)	8.0 (6-10)	
Internal rotation	Mean± SD	8.66±0.98	
	Median (Range)	8.0 (8-10)	
		N	**%**
Outcome	**Excellent**	8	66.7
	Good	4	33.4
Total		12	100.0

Table 5: Final follow up outcome distribution

		N	%
Out come	**Excellent**	10	83.3
	Good	2	16.7
	Total	12	100.0

Discussion

Because of its potential biomechanical and biological advantages, as well as recent technological developments in the implants utilized, there is increased interest in the use of locked intramedullary nailing for the treatment of humeral shaft fractures **[6].**

The current study was a prospective cohort study included 12 patients were operated up on at Orthopedic Surgery Department, Zagazig University Hospitals. All patients were suffering from humeral shaft fracture between March 2021 till September 2021.They were all evaluated both clinically and radiologically.

In this study, 12 patients underwent intramedullary nail surgery for humeral shaft fractures. The age distribution was 43.41±13.13, with a minimum of 25 and a maximum of 65 years. As regard sex distribution, males represented 58.3 % and females were 41.7 %.

Abdallah et al. **[7]** investigated the treatment of 40 patients with humeral shaft fractures. They were both men and women, ranging in age from 19 to 56 years. In terms of gender distribution, there were 33 (82.5%) men and seven (17.5%) women **[7].** Kodandapani et al. **[8]** conducted a study on 20 patients with diaphyseal humerus fractures ranging in age from 22 to 60 years (average being 37.28 years).

Most current operative methods for humeral shaft fracture stabilization have acceptable rates of union. In this study, time of union was 11.50±1.78 with minimum 10 and maximum 18 weeks. Venkata Naga *et al*. **[9]** conducted a study included of 13 adult patients complain of fracture shaft of humerus and treated by IMN, patients recovered completely and had no nonunion, also a study by Abdallah *et al*. **[7]** included 20 patients with humeral shaft fractures were treated by an antegrade interlocking nail after obtaining consent, three patients had delayed union, the healing was delayed after 5 months. Nonunion was recorded in three cases that needed further active intervention; the incidence was 15%. Similarly, Shobha *et al*. **[10]** included 20 patients operated with closed reduction and internal fixation with intramedullary nails. 1 patient was found to has delayed union. They were closely followed up and the fracture eventually united. There are no cases of non-union.

Kelany et al. **[11]** reported that the mean union time was 2.94±0.46 months in patients underwent surgical management of humeral shaft fractures by intramedullary nail. Pansey et al. **[12]** concluded that union time was 13±4.8 weeks in the nailing.

In contrast to our results, Sena et al. **[13]** reported union time was 41.73±7.00. in agreement with study of Pansey et al., **[12]** who found that there were 2 (9.09%) cases in the nailing which had delayed union.

In this series, the rate of union compared good with these results as we had no cases of non-union and only two cases of delayed union.

The most frequent criticism of antegrade humeral nailing has been its potentially deleterious effect on shoulder function.

In our study, recommended an antegrade insertion point lateral and distal to the rotator cuff. In a series of 12 humeral fractures treated with antegrade nails, regard shoulder constant score movement excellent result was in 66.7% and good & fair result in 16.7% each.

Shobha *et al*. **[10**] in their study included 20 patients operated with closed reduction and internal fixation with intramedullary nails. 10% of the cases was excellent, 15% was good, 40% was fair and 45% was poor regard to shoulder movement.

In the current study**,** the functional outcome was assessed through Stewart and Hundley's scoring system 2 cases had occasional pain, full movement was in 83.3%, all studied cases had good radiological alignment and 10 cases had excellent outcome and 2 cases had good. Regarding elbow movement, majority was excellent (83.3%) then good (16.7%).

Venkata Naga *et al*. **[9]** conducted their study on 13 patients treated with antegrade humeral nailing. They found 2 patients had suffered from restriction in elbow extension.

In terms of overall outcome, the current findings revealed that excellent results were represented in 10 patients, while good results were represented in 2 patients. This is consistent with the findings of Chandan et al. **[14],** who found that 3 patients (15%) were excellent, 10 patients (50%) were good, 3 patients (15%) were fair, and 2 patients (10%) were poor in the nail group. Sena et al. **[13]** discovered that 13 patients (65%) were excellent,

4 patients (20%) were good, and 3 patients (15%) were poor in patients who used interlocking nails.

Conclusion

In this series of patients, locked humeral nailing has provided a dependable solution for the treatment of humeral diaphysis fractures, providing a satisfactory functional outcome and a high union rate, while also allowing for early use of the limb, which is critical. Certain technical aspects, such as proper countersinking of the proximal end of the nail, avoidance of over distraction at the fracture site, and attainment of adequate fixation stability, must be prioritized in our effort to reduce delayed union.

CONFLICT OF INTEREST: None.

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