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# Internal Fixation for Diaphyseal Humeral Fractures: Intramedullary Nailing Versus Plating

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## Abstract

**Background:** Humeral diaphyseal fractures are more frequent in the younger population and account for 3–5% of all fractures. Open reduction with plate fixation and stabilization utilizing intramedullary nails are the two methods that are most frequently used to achieve stabilization.

**Aim and objectives:** To assess the pace and duration of healing, functional result, and complications related to plate fixation compared with interlocking nailing in the management of a diaphyseal humeral fracture.

**Patients and methods:** This prospective comparative research was done on 40 patients with humeral shaft fractures in Al-Hussein University Hospital and Al Helmeya Military Hospitals for Orthopedics and supplementation. Patients were separated into two groups.

**Results:** There was a statistically significant difference among the examined groups concerning radial nerve injury. There was no statically significant distinction among the examined groups concerning union time, time follow-up/months, delay union, nonunion and mal union, pain, elbow movement, shoulder movement, infection, and satisfaction.

**Conclusion:** Both interlocking nailing and dynamic compression plating help promote fracture union. They offer a reliable method for attaining fracture stabilization and ultimate healing.

**Keywords:** Humeral diaphyseal fractures, Interlocking nailing, Internal fixation, Plate fixation

## 1. Introduction

Diaphyseal fractures of the humerus represent 3–5% of all fractures. With increasing road traffic accidents, it is likely to be more in the future. Sixty percent of all humeral fractures occur in the middle-third of the humerus.<sup>1</sup>

The average age of a patient with a humeral diaphyseal fracture is 54.8 years, making them somewhat younger than the general population. In order to formulate an effective treatment plan, it is essential to conduct a thorough physical examination and take a thorough patient history.<sup>2</sup>

The optimal approach to treating humeral shaft fractures is a topic of heated debate. Recovering the patient's pre-injury level of function is the primary focus of treatment, which aims to achieve humeral alignment by union.<sup>3</sup>

Nonoperative treatment of humeral shaft fractures typically yields satisfactory results, suggesting that routine surgical therapy may not always be necessary. Nonetheless, there are numerous cases where surgical intervention is the best course of action.<sup>4</sup>

Because it is located closer to the normal mechanical axis, the intramedullary nail is an effective load-sharing device for reducing and fixing fractures. Locked intramedullary nailing, with its modern implant and enhanced technique, can achieve a success rate comparable to previous treatments.<sup>5</sup>

The gold standard for surgically treating diaphyseal humeral fractures is internal fixation with a plate. Minimally invasive plate osteosynthesis or open reduction with internal fixation are both options.<sup>6</sup>

The objective of this investigation was to evaluate the healing rate and time, functional outcome and

complications associated with plate fixation vs interlocking nailing for the treatment of a diaphyseal humeral fracture.

## 2. Patients and methods

This prospective comparative study was done on 40 patients with humeral shaft fractures in Al-Hussein University Hospital and Al Helmeya Military Hospitals for Orthopedics and Supplementation. Patients were separated into two groups: group 1 involved 20 cases managed by plate and screw and group 2 involved 20 cases managed by interlocking nailing.

The size of the sample was determined by calculating it based on the total number of patients with humeral shaft fracture coming in one month expected to be 40 cases in 6 months; so, all cases were involved in the research. They were operated under supervision of more than one consultant. All patients had radiological and clinical examinations. The clinical efficacy was evaluated using a score system developed by the American shoulder and elbow surgeons. Union, malunion, failure of fixation and implant failure was all rated by radiologists.

The study followed the ethical standards of our institute and Approval by ethical scientific. All patients provided informed consent.

Inclusion criteria: age: 18 years or above, sex: both sexes, a comminuted diaphyseal humeral fracture and a diaphyseal humeral fracture that necessitated surgery.

Exclusion criteria: patients under the age of 18, pathological fractures, fractures that are more than 2 weeks old, associated neurovascular injuries, a history of prior fractures of the humeral bone, associated neurovascular injuries and neglected cases.

## 3. Methods

### 3.1. Operative technique

#### 3.1.1. Plate and screw group

Proximal and mid-third shaft fractures were plated using an anterolateral approach, whereas distal shaft fractures were plated utilizing a posterior approach.<sup>7</sup>

#### 3.1.2. Interlocking nailing group

The radiographs of the humerus were meticulously examined. We assessed the fracture to determine the extent of comminution and displacement. The measurement of the isthmus' width was taken. The isthmus of the humerus often resides at the point where the middle third and the distal third of the medullary canal meet. This

measurement provided insight into the anticipated nail diameter and the necessity for reaming.

#### 3.1.3. Functional outcome assessment

Clinical examination and scoring systems were used to measure the functional result using the following scores: pain intensity as measured by the visual analogue scale (VAS) and the American Shoulder and Elbow Surgeons score of Eight Pain levels range from zero (no pain) to 10 (the worst conceivable pain).<sup>8</sup>

#### 3.1.4. Follow-up

Two weeks following the procedure, the stitches were removed. The patient was advised to avoid rotating their affected area until calluses formed. Following 2 or 3 days, they were told to take off the sling many times a day and begin passive range-of-motion exercises for their elbow and shoulder as soon as they felt pain. Active shoulder exercises were permitted after the arm sling was removed, which typically took 3–6 weeks. After radiological bone union is complete and solid, heavy-weight loading can be resumed. Check radiography were taken at 2, 6, and 12 weeks, then monthly until radiological union, and finally at the end of follow-up. The views were anterior-posterior and lateral. From 22 to 32 weeks, that was the range of the mean follow-up period.

### 3.2. Statistical analysis

Computer programs such as Microsoft Excel were used to code, enter, and analyze the data that was gathered throughout the history, basic clinical examination, laboratory tests, and outcome measurements. Data were then imported into Statistical Package for the Social Sciences (SPSS version 20.0) (Statistical Package for the Social Sciences) software for analysis. Quantitative data were presented in the form of groups based on mean  $\pm$  SD, whilst qualitative data were presented in the form of numbers and percentages.  $\chi^2$  test, analysis of variance (ANOVA), Pearson's correlation, and the  $P$  value ( $P < 0.05$  for significant results and  $P < 0.001$  for highly significant results) were the tests that were utilized to determine whether or not the differences should be considered significant. The mean SD,  $\chi^2$  test,  $t$  statistic, sensitivity specificity predictive value, and receiver operating characteristic curve were the statistical tests that were utilized in our study.

## 4. Results

Table 1 showed that there was no statistical significance between examined groups as regards

Table 1. Demographic data distribution between examined groups.

	Plate Group (N = 20)	Nail Group (N = 20)	P value
Age	38.2 ± 9.2	35.5 ± 9.53	0.003*
Sex			
Female N (%)	7 (35)	12 (60)	
Male N (%)	13 (65)	8 (40)	
Heavy work			
No N (%)	11 (55)	10 (50)	0.751
Yes N (%)	9 (45)	10 (50)	
Total N (%)	20 (100.0)	20 (100.0)	

heavy work, while there was statistical significance between examined groups as regards sex.

Table 2 showed that operation time was distributed as  $155.5 \pm 22.9$  and  $134.4 \pm 23.5$ , respectively among plate and nail groups; and the nail group was significantly shorter.

It also showed that excellent outcomes represented 70% of plate group and 75% in the nail group, good outcomes represented 10% of both groups, and fair outcomes were found in 15% in plate group and 5% in nail group. One case was poor outcome in plate group and 2 cases were poor outcome in nail group Table 3.

In the plate group, the blood loss (cc) during the surgery was recorded as  $232.8 \pm 77$ , with a range that extended from 150 to 400 ml<sup>3</sup>. In the nail group, the mean ± SD was  $87.78 \pm 15.17$ , with a range that extended from 50 to 110 ml<sup>3</sup>. A statistically significant difference in blood loss was seen between the nail group and the plate group ( $P < 0.05$ ) Table 4.

There was a statistically significant distinction amongst the examined groups concerning radial

Table 2. Operation time and overall outcome distribution between examined groups.

	Management		$\chi^2$	P
	Plate	Nail		
Operation time	155.5 ± 22.9	134.4 ± 23.5	2.85	0.008
Outcome				
Poor N (%)	1 (5)	2 (10)		
Fair N (%)	3 (15)	1 (5)		
Good N (%)	2 (10)	2 (10)	4.2	0.21
Excellent N (%)	14 (70)	15 (75)		
Total N (%)	20 (100.0)	20 (100.0)		

Table 3. Blood loss (cc) during operation between examined groups.

	Plate Group (N = 20)	Nail Group (N = 20)	T	P
Blood loss (CC) during operation				
Mean ± SD	232.78 ± 77	87.78 ± 15.17	7.6	0.0001 (S)
Range	(150–400)	(50–110)		

(t), test of significant (S);  $P < 0.05$  significant.

nerve injury. There was no statistically significant difference amongst the examined groups concerning union time, time follow-up per month, delayed union, Nonunion and mal union, pain, elbow movement, Shoulder movement, infection, and satisfaction.

#### 4.1. Case presentation

##### 4.1.1. Plate group (group 1)

History: female patient, 34 years old, arrived with right arm deformity and humeral edema after a traffic accident.

Examination: The arm was swollen, the skin was bruised, and mobility was restricted, but there was no evidence of neurovascular damage.

Radiology: After performing anteroposterior radiography on the right arm, it was discovered that the right humerus had a transverse fracture.

Classification: 12 type A1 along with AO classification.

Associated injury: No associated injury.

Preoperative: Applying analgesia and a U-shaped slap.

Treatment: Preoperative period was two days before operation.

Open reduction internal fixation done by DCP plate with seven screws, four proximal, and three distal to fracture through anterolateral approach.

Operative time: 140 min.

Follow-up: 6 months.

Table 4. Comparison between outcomes of different management.

	Plate group	Nail group	t/ $\chi^2$	P
Time union	3.5 ± 0.9	2.9 ± 0.5	-1.6	0.1
Time follow-up/months				
Mean ± SD	5.1 ± 1.3	5.2 ± 1.8	0.3	0.78
Range	(4–8)	(3–10)		
Shoulder movement				
Fair N (%)	1 (5)	6 (30)		
Good N (%)	6 (30)	9 (45)	6.2	0.2
Full N (%)	13 (65)	5 (25)		
Elbow movement				
Fair N (%)	1 (5)	2 (10)		
Good N (%)	5 (25)	2 (10)	3.6	0.2
Full N (%)	14 (70)	16 (80)		
Infection				
No N (%)	16 (80)	18 (90)	0.8	0.4
Yes N (%)	4 (20)	2 (10)		
Complications				
Radial nerve palsy N (%)	4 (20)	0	4.52	0.035
Delayed union N (%)	1 (5)	3 (15)	1.12	0.28
Nonunion N (%)	0	1 (5)	0.18	0.54
Satisfaction				
Satisfactory N (%)	16 (80)	20 (100.0)	2.25	0.13
Unsatisfactory N (%)	4 (20)	0		
Total N (%)	20 (100.0)	20 (100.0)		

American shoulder and elbow surgeon score: Excellent.

Time for full recovery to normal daily activity: 14 week.

No associated complications [Figs 1 and 2](#).

#### 4.2. Nail group (group 2)

History: A male patient who was 37 years old and had fallen from a height was admitted to the hospital with a deformity in his left arm and additionally had pain.

Examination: The arm was deformed edematous with intact neurovascular structures on examination and limitation of movement.

Radiology: Anteroposterior view of left arm revealed mid-shaft transverse humerus fracture.

Classification: AO classification system: 12–A1.

Preoperative shape slap applied with analgesia given.

Time before operation: The operation done two days after the trauma.

Treatment: surgically done using antegrade nail humeral technique.

Operative time: 90 min.

Follow-up: 5 months.

Union time: 16 weeks.

American shoulder and elbows surgeon score: good.

Complication: Left shoulder impingement post-operative [Fig. 3](#).



Fig. 2. A 6 months follow-up radiography.



(A)



(B)

Fig. 1. (A) Preoperative radiography. (B) Postoperative radiography.



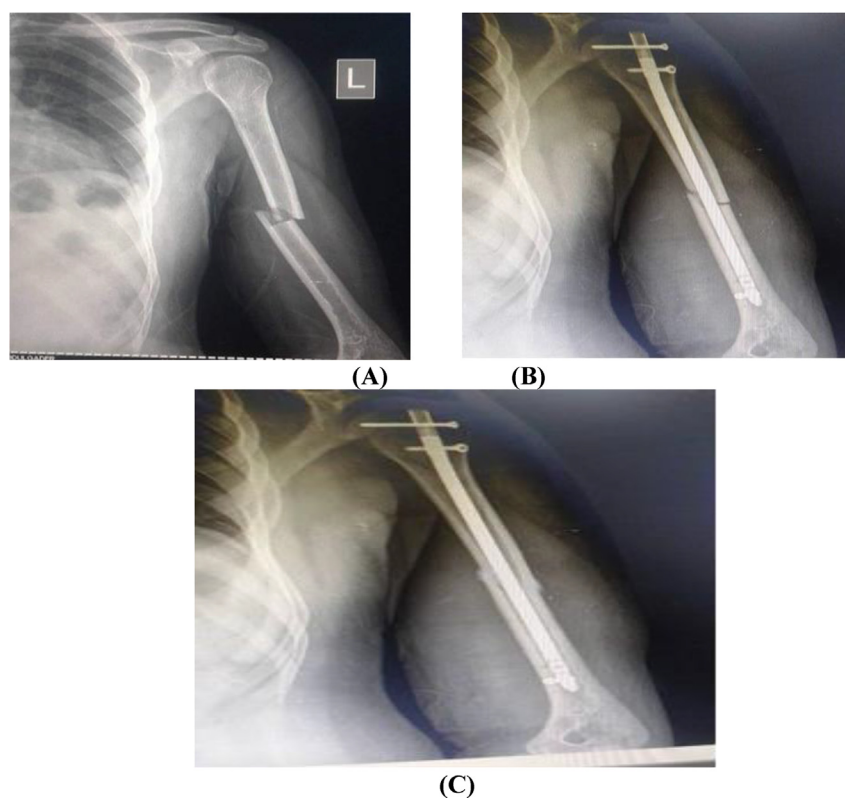


Fig. 3. (A) Preoperative radiography, (B) Postoperative radiography and (C) 16-week postoperative radiography.

## 5. Discussion

Forty cases that appeared for the present research had diaphyseal fractures of the humerus. The plating group comprised 20 cases, with an age distribution of 21–53 years (with an average age of 38 years). 9 cases were treated utilizing the posterior approach, 10 cases with the anterolateral approach, and 1 case with the anterior approach (MIPO). The age distribution of the 18 cases in the interlocking nail group was as follows: 21–51 years old, averaging 35.5 years of age. In 15 cases, a 7 ml nail was utilized, while in five patients, a 6 mm nail was employed. In the nailing group, only antegrade fastening was performed.

The present research revealed that the follow-up period for the plate group varied between 4 and 8 months, whereas for the nail group, it spanned 3–10 months.

The present investigation's intraoperative findings revealed that the plate and nail groups had operation times of  $134 \pm 23.5$  min and  $155 \pm 22.9$  min, respectively. The nail group had a significantly shorter operation time than the plate group, which experienced a blood loss of  $232.8 \pm 77$  ml, whereas the interlocking nail group suffered a blood loss of  $87.8 \pm 15.2$ . Blood loss was

significantly greater in the plate group than in the nail group ( $P < 0.05$ ).

This finding was by Saroj *et al.*, who stated that the interlocking fastening group completed the operation in an average of 70 min, while the plating group completed it in 82 min, the variance among the two groups was statistically significant.<sup>9</sup>

Regarding the radiological results, the duration of the plate group's union was rather brief, but not significantly so because it was dispersed as  $13.3 \pm 4$  weeks and  $1314.6 \pm 4$  weeks, respectively with no significant variance among examined groups ( $P = 0.1$ ), there were no malunion cases in the plate group, while there were 3 (15%) cases with malunion in the nail group with no significant difference ( $P = 0.23$ ). Delayed union developed in 1 (5%) case in plate group and 3 (15%) cases in the nail group with no significant difference ( $P = 0.28$ ).

Kulkarni *et al.* It was reported that the rates of delayed unions were 7% (2/31) and 4% (1/25) ( $P = 0.787$ ).<sup>10</sup>

About the clinical data that were evaluated in the current study, the ASES score and the VAS score for pain were utilized, A total of 13 patients, or 65%, were found to have shoulder mobility that was classified as complete, good in six (30%) patients, and poor in 1 (5%) case in the plate group. In the

nail group, six (30%) patients had full shoulder movement, nine (45%) patients had good shoulder movement, and five (25%) patients had poor shoulder movement. These results indicate a statistically significant difference among the examined groups ( $P = 0.04$ ). In terms of elbow movement, 13 (65%) patients in the plate group had full movement, six (30%) patients had good movement, and one (5%) patient had poor movement. In the nail group, 16 (80%) patients had full elbow movement, two (10%) patients had good movement, and two (5.6%) patients had poor movement. However, there was no statistically significant difference observed among the examined groups in terms of elbow movement ( $P = 0.41$ ). Concerning the pain score, the range was in the nail group (0–3) with a mean of  $0.5 \pm 1$ , while in the plate group, it was  $0.34 \pm 0.5$ , with no significant variance among both groups ( $P = 0.6$ ). This was consistent with the research of Naveen and Chaitanya the individual who made the statement claimed that there was a statistically significant difference between the group that received dynamic compression plating and the group that received interlocking nailing in terms of shoulder motion ( $P < 0.05$ , significant).<sup>11</sup>

Kelany *et al.* it was discovered that out of nine patients (one hundred percent) in the nail group, every single one had complete range of motion in their elbows. In contrast, out of six (66.7%) patients in the plate group, two (22.2%) shown an acceptable range of motion, and one (11.1%) had a fair range of motion. Regarding the motions of the shoulders and elbows, there was no statistically significant difference ( $P = 0.16$ ) between the two sets of participants. In addition, there were no statistically significant changes ( $P > 0.05$ ) in the elbow range of motions, according to Pansey *et al.* (49).<sup>12</sup>

In terms of complications the present study found that there was an infection in 5 (25%) patients in the plate group, while there was an infection in two (10%) patients in the nail group, with no statistically significant distinction among the analyzed groups ( $P = 0.4$ ). The current study found that the nail group did not exhibit any signs of postoperative radial nerve palsy. This was the case with regard to radial nerve palsy. On the other hand, in the group that received plates, a total of five patients, which is 25%, had postoperative radial nerve palsy. The data that was collected showed that there was a substantial difference between the groups that were being investigated, as demonstrated by a  $P$  value of 0.04 that was statistically significant. In addition, the current study discovered that there was a single instance of nonunion reported in the nail group, which accounted for 5% of the total incidents, but

there were no occurrences reported in the plate group.

Akaln and colleagues concluded that two patients in the plate group, who had superficial infections, were effectively treated with antibiotics and made full recovery. On the other hand, no infection was found in the nail group, and there was not a significant distinction among the groups that were analyzed ( $P = 0.493$ ).<sup>13</sup>

In terms of the final result, the findings that were presented showed that 14 (70%) patients' in the plate group and 15 (75%) patients in the nail group had excellent findings. Additionally, 2 (10%) patients in both groups had good findings, and three (15%) patients in the plate group had fair findings. Furthermore, 2 (10%) cases in the nail group were poor, and 1 (5%) case in the plate group was poor. There was no significant difference between the groups that were examined ( $P = 0.21$ ).

The following is a list of the findings that the nail group got: 13, or 65%, of the patients regarded the service as great, while four (20%) patients, rated it as good, and three (15%) patients, assessed it as terrible. Twenty-six (80%) patients, rated the plate group as excellent, three (15%) patients, rated it as good, and a single (5%) patient assessed it as poor.<sup>14</sup>

In the present research, 16 (80%) patients stated satisfaction and four (20%) patients indicated dissatisfaction with their plates, while all 20 (100%) patients in the nail group stated pleasure. Happiness related to the nail group significantly ( $P = 0.03$ ). Sahni *et al.*<sup>15</sup> stated that there was not a statistically significant distinction in patient satisfaction among the nail and plate groups, with 25 of 25 (96%) patients in the nail group reporting satisfaction and 27 of 27 (93.3%) patients reporting satisfaction.

### 5.1. Limitations

This study was limited by a small sample size, being a single-center study, and a short period of follow-up.

### 5.2. Conclusion

Techniques like interlocking nails and dynamic compression plating can speed up the fracture's union. It is possible to repair humeral shaft fractures safely and effectively without surgery in most cases. However, intramedullary nailing and plating both offer predictable means to achieve fracture stabilization and complete healing for the percentage of patients who require surgical procedures. Despite the fact that nails were associated with more frequent shoulder pain, this sample did not show

that one method was substantially more successful than the other.

### Disclosure

The authors have no financial interest to declare in relation to the content of this article.

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### Ethics

Its was approved by faculty.

### Authorship

All authors have a substantial contribution to the article.

### Conflicts of interest

The authors declared that there were no conflicts of Interest.

### References

1. Crean TE, Nallamotheu SV. Distal humerus fractures. In: *StatPearls*. Treasure Island (FL): StatPearls Publishing; July 17, 2023.
2. Jonsson EÖ. Proximal and distal humeral fractures. Outcome of primary arthroplasty. 2022;915–978. <https://hdl.handle.net/2077/70943>.
3. Cole PA, Horazdovsky R. Shoulder girdle injuries. *Orthopaedic trauma in the austere environment*. Springer; 2016:431–452. [https://doi.org/10.1007/978-3-319-29122-2\\_33](https://doi.org/10.1007/978-3-319-29122-2_33).
4. Karimi D, Brorson S, Midtgaard KS, et al. Surgical versus non-surgical treatment of humeral SHAFT fractures compared by a patient-reported outcome: the scandinavian humeral diaphyseal fracture trial (SHAFT)—a study protocol for a pragmatic randomized controlled trial. *Trials*. 2022;23: 453.
5. Lovell NC, Grauer AL. Analysis and interpretation of trauma in skeletal remains. *Biological anthropology of the human skeleton*. 2018:335–383. <https://doi.org/10.1002/9781119151647.ch10>.
6. Zhao D, Witte F, Lu F, et al. Current status on clinical applications of magnesium-based orthopaedic implants: a review from clinical translational perspective. *Biomaterials*. 2017;112: 287–302.
7. Karataglis D, Stavridis SI, Petsatodis G. New trends in fixation of proximal humeral fractures: a review. *Injury*. 2011;42: 330–338.
8. Maheshwari J, Mhaskar VA. *Essential orthopaedics: (including clinical methods)*. Jaypee Brothers Medical Publishers; 2019.
9. Saroj DK, Nagaich A, Gupta P. Comparative study of results of ORIF with plating vs. CRIF with nailing in fracture mid-shaft humerus. *Int J Orthop*. 2020;6:1–4.
10. Kulkarni SG, Varshneya A, Jain M. Antegrade interlocking nailing versus dynamic compression plating for humeral shaft fractures. *J Orthop Surg*. 2017;20:288–291.
11. Naveen PR, Chaitanya PR. Comparative study between the dynamic compression plating (DCP) and the intramedullary interlocking nailing in diaphyseal fractures of the humerus in adults. *J Evol Med Dent Sci*. 2013;2:8704–8713.
12. Kelany OA, Nafae WM, Holeil SM, Saleh AF. Interlocking medullary nail versus plate fixation in management of diaphyseal humeral fracture. *Egypt J Hosp Med*. 2020;80: 1067–1073.
13. Akalön Y, Şahin İG, Çevik N, Güler BO. Locking compression plate fixation versus intramedullary nailing of humeral shaft fractures: which one is better? A single-centre prospective randomized study. *Int Orthop*. 2020;44:2113–2121.
14. Sena WA, Elkhalfy AM, Shaheen MSR. Antegrade intramedullary nailing versus plating for treatment of humeral shaft fractures. *Indian J Pub Health Res Dev*. 2019;10: 1546–1552.
15. Sahni G, Mann HS, Singh R, Bhalla T. Comparative study of interlock nailing versus dynamic compression plating in fractures of tibia-A study of sixty cases. *Indian J Orthop*. 2015;1: 197–204.