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Comparision of functional outcome of shoulder range of motion treated with Interlocking medullary nail vs Locking plate used in patients with closed fracture shaft humerus

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Abstract

Background: Many studies are conducted on this topic but most of them conclude no difference in outcomes by as such. The treatment of humeral shaft is still controversial. Most are treated nonsurgically, but when indicated choosing between nail and plate is difficult. The aim of our study was to compare shoulder range of motion and complications after interlocking medullary nail(IMN) and locking plate (LP) in treatment of this kind of fracture.

Materials and Methods: We acquired a data on 57 patients with closed humerus shaft fractures and out of which 27 were treated with LP and 30 were treated with IMN. We compared in the 2 groups final range of motion, full recovery rate, functional outcomes, residual pain, complications and elbow flexion-extension range. The functional outcomes were measured at 1, 3, 4, and 6 months by using Rodríguez-Merchán scoring.

Results: No patient in the two groups developed a non-union. There was no difference in both groups in elbow flexion-extension. Group LP had a full shoulder range of motion (66.6% vs. 40.0%; $P^{1/4}$.02) and excellent Rodríguez-Merchan scoring (66% vs. 40.0%; $p < .01$), that was statistically better than in group IMN. In group LP, the Constant score was 95 (IQR 9).

Discussion: Our study results conclude a hierarchy of LP over IMN in terms of higher range of motion and a better anatomical and fixed reductions of the fracture and fewer complications. Whereas IMN appeared to be better over LP in terms of leading to a lower rate of infectious complications. The two treatments achieved comparable results in terms of operation time, hospital stay, union time and elbow flexion-extension. The Rodríguez-Merchan scores were significantly higher in patients with LP.

Conclusion: The study led to conclusion that Locking plate(LP)was more better and effective in terms of achieving higher ROM with optimal functional outcomes compared to Interlocking medullary nail (IMN) for closed shaft humerus fractures requiring surgical intervention. A larger sample size with equal representation in both groups is required for a p value with higher significance.

Keywords: Nail, plate, humerus shaft fracture, outcome, surgical management shaft humerus

Introduction

Shaft humerus fractures are common long bone fractures occurring in young individuals after high velocity injuries and older people after low impact trauma. Published data suggest an incidence of 7 to 11.3 per 100 000 person-years and 3-5% of all fractures with 20% of humerus fractures involving shaft. In most cases, they follow bimodal distribution with high energy injuries in young individuals and low impact trauma in older osteopenic people.

The surgical neck of the humerus is the narrow portion distal to the tubercles. This area is one of the most commonly involved site in humeral shaft fractures. Their management presents a series of problems because this kind of fractures could determine the damage of the surrounding soft tissues including muscles and neurovascular bundles; furthermore, Radial nerve palsies are seen in 2-17% of patients with humerus shaft fractures with presentation of wrist and finger extension weakness. An initial assessment of integrity of brachial artery should be examined by assessing distal radial and ulnar pulse and capillary refilling at baseline. The evaluation should be thorough with examining easily missed locations such as axilla and posterior arm.

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Several studies focusing on the methods of treatment of closed shaft humerus fractures have been published. Most of them are treated nonsurgically, but ones that needed surgical intervention were treated with IMN and LP each has been historically related to complications: reduced ROM comparatively have been associated with nailing; infections and wound complications are frequently reported after plating; prolonged fracture healing, frequent need of secondary operations and infections of the pin tract are inherent problems in external fixation.

The aim of our study was to compare the functional outcomes in patients with humeral shaft fractures treated with locking plates with a cases of patients treated with interlocking medullary nails, with a special focus on final shoulder ROM and complications.

Material and Methods

This is a retrospective comparative study of 57 patients who underwent operative fixation of shaft humerus fractures using intramedullary nail (IMN) & Locking plate(LP). This study was conducted between January 2023 to January 2025 with 2 year followup at B.J. Medical college, Ahmedabad. We obtained permission from Ethical Review Committee of B.J. Medical College, Ahmedabad. Written consent was taken from the patient before data collection.

Patients were divided into two groups: the IMN group included 30 patients who underwent IMN, whereas LP group included 27 patients who underwent LP. All the shaft humerus fractures were devoid of any neurovascular complications. In many patients we performed a stabilization with intramedullary nail because they presented with a comminuted fracture. We included skeletally mature patients with shaft humerus fracture who undergone surgical treatment. Patients with open fracture, polytrauma, and previous history of shoulder fractures, operated cases on same side of shoulder, arm or elbow were not included in our study. Surgical indication was for displaced fractures. Fracture healing status and final shoulder ROM, including forward elevation, external rotation, and internal rotation, were evaluated. The patients were also assessed by the Rodríguez-Merchan criteria, which simultaneously evaluates shoulder and elbow ROM. Subjective data, such as pain, were also

considered on a graded scale: none, occasional, pain with activity, and variable pain. Shoulder forward elevation and external rotation were measured with a manual goniometer. Internal rotation was determined by the highest spinal level reached by the thumb, graded as follows: T7, excellent; T12, good; L5, fair; and <L5, poor. The following variables were compared: gender, age, fracture type as per the AO classification, full shoulder ROM, Rodríguez-Merchan score, complications, and associated injuries. A full ROM was considered with shoulder flexion of 180, external rotation of 90, and internal rotation with the thumb reaching T7 or higher.

General subjective disability was given as severe, moderate, minimal and none. Final scores were given as poor, fair, good and excellent. Follow up was done at 4weeks, 8weeks, 3 months and 6 months postoperatively. Data was recorded in self-designed performa. Serial xrays were taken to look for other bony changes and hardware status in each follow up. Complications were noted in each follow up. Data was entered in excel sheets and analysed using SPSS v 25. Chi square test, student's t-test and ANOVA test were used to differentiate between both groups. Level of statistical significance was taken at 5%.

Inclusion criteria

1. Patients having shaft humerus fracture
2. Patients of any sex.
3. Age group: 18 years and above.
4. Patients who are fit for surgery.
5. Patient willing to participate in the study.
6. Closed fractures.

Exclusion criteria

1. Unwillingness to participate in the study.
2. Patients unfit for surgery and or anaesthesia.
3. Patients with shoulder or elbow intraarticular fracture.
4. Patients with open shaft humerusfractures and pathological fractures.
5. Patients with co-morbidities like diabetes mellitus.
6. Immature skeleton.
7. Rodríguez-Merchan criteria

Rating	Elbow range of movement	Shoulder range of movement	Pain	Disability
Excellent	Extension 5° flexion 130°	Full range of movement	None	None
Good	Extension 15° flexion 120°	<10 % loss of total range of movement	Occasional	Minimum
Fair	Extension 30° flexion 110°	10–30 % loss of total range of movement	With activity	Moderate
Poor	Extension 40° flexion 90°	>30 % loss of total range of movement	Variable	Severe

Post-operative protocol

Patients of both group 's Clinical and radiological follow-up was done at end of 1month, 3 months, 6months and 12 months after the surgery. Standard antero-posterior and lateral view radiographs of humerus were taken. All patients were

covered with 3 doses of intravenous broad-spectrum antibiotics. Dressing was removed and the wound was inspected on the 2 and 5 day after surgery and subsequently the sutures were removed on the 14 post-operative day. The functional outcome was assessed using the Rodríguez-

Merchan criteria.

Our patients were encouraged to perform elbow flexion and extension exercises after the operation; partial-weight lifting was allowed after three weeks in both group

Statistical analysis

We used Student’s t test to compare the inter-group parameters with quantitative data and descriptive statistical methods (mean, standard, frequency). We used the chi-square test and Fischer’s exact chi-square test to compare qualitative data. The significance level was set at $p < 0.05$.



Fig 1: Shaft humerus fracture AO 43-A1

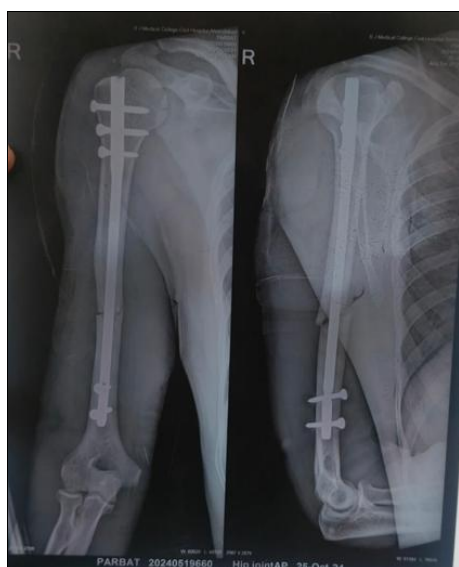


Fig 2(A): The same fracture of Figure 1 after postop day 1.

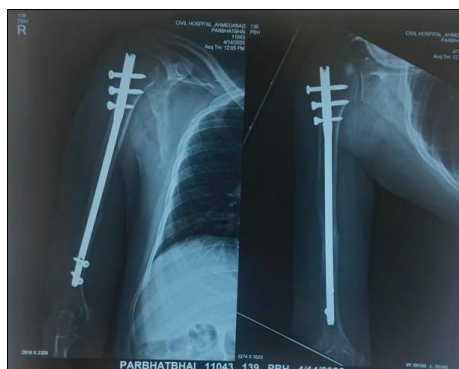


Fig 2(B): The same fracture of figure 1 after 6 months followup

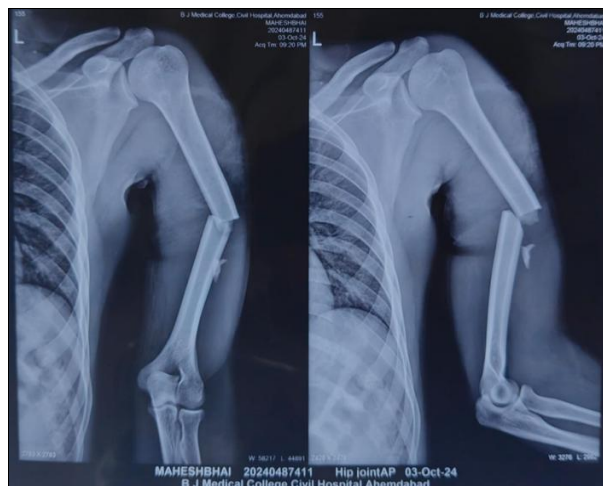


Fig 3: Tibial distal fracture AO 43-A1

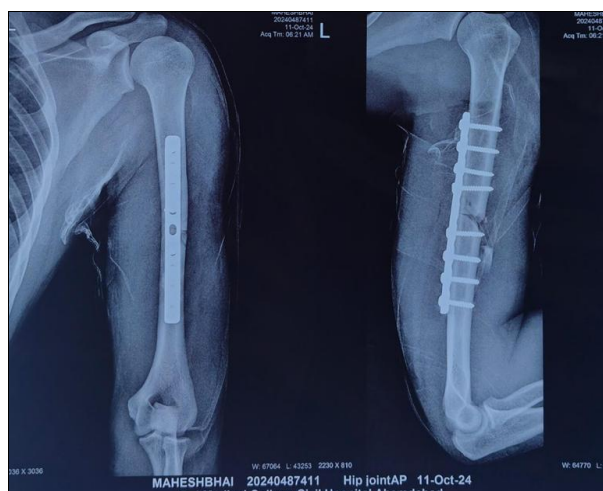


Fig 4: The same case of Figure 3 after surgery. We use a LCP plate for distal tibia and Nailing to stabilize the fibula.



Fig 5: Range of motion in followup after locking plate

Results

1. There were a total of 57 patients, 27 cases in the P group and 30 in the nail (N) group. The demographic characteristics were similar in both groups. Sixty-six percent of the patients treated with a nail and 63% of those treated with plates were men. The average age was 38 years (Interquartile rank [IQR] 28) in group N and 37 years (IQR 55) in group P (Table I).
2. There were no differences in follow-up between groups, which averaged 28 months (IQR 7) in group P and 30 months (IQR 2) in group N ($P = .385$). All fractures were healed in the P group and 28 of 30 in the N group (93%; $P = .273$).
3. There were no differences between groups in the elbow flexion/extension range and type of fractures (Table I).
4. The P group had a greater percentage of patients who reached 100% of shoulder ROM (66.6% vs. 40.0%; $P = .14$).

- .02). As per the Rodríguez-Merchan criteria in the P group, 18 patients achieved excellent results (66%), 7 good (26%), and 2 obtained poor outcomes (8%). On the other hand, in the N group, the Rodríguez-Merchan score was 12 patients excellent (40%), 7 good (23%), 6 regular (20%), and 5 poor (16.6%).
- The Constant score in the P group was 95 (IQR 9). There were fewer complications in the P group, but this variable was not statistically significant (7.4% vs. 20.0%; $P = .163$). These complications included 2 postsurgical infections that were treated with surgery and endovenous antibiotics.
 - The N group reported subacromial nail impingement (1-2 mm of protrusion) in 8 patients (26%), 5 complications including 2 cases of nonunion, 1 case of radial neuroapraxia, 1 granuloma and 1 tuberosity fracture (Table II, Fig. 1).
 - Treatment method, fracture type, and age were included in the multivariate analysis. It was observed that the chance to achieve a complete shoulder ROM was 6.50 times greater in patients treated with plates than those treated with nails (odds ratio, 6.50; confidence interval, 1.40-26.58; $P = .010$; Table III).

Table 1: Comparative demographics baseline data.

Demographic variables	Plate (n = 27)	Nail (n = 30)	P value
Sex, male, n (%)	17 (63.0%)	20 (66.7%)	.788
Age in yr, median (IQR)	37 (55)	38 (28)	.791
Fractures characteristics			.528
Side, n (%)			
Right	11 (40.7%)	13 (43.3%)	
Left	16 (59.3%)	17 (56.7%)	
Associated injuries, n (%)	0	8 (26.7%)	.004
Fracture type			.163
A	16 (59.3%)	22 (73.3%)	.021
B	7 (25.9%)	7 (23.3%)	.400
C	4 (14.8%)	1 (3.33%)	.196

IQR, interquartile range. Bold values indicate statistical significance.

Discussion

In the present study, we observed a clear difference in favor of the P group concerning the final rates of shoulder ROM.

The treatment of humeral shaft fractures remains controversial. The evidence is not clear in reference to outcomes and complications between methods. Comparative series and meta-analysis usually make little reference to the final shoulder function and objective measurement of ROM. In our opinion, the decrease in shoulder mobility is usually underestimated because of the scoring used.

In a previously published series of patients treated with nails, we identified a percentage of patients who had lost some mobility grades despite the good general scoring.¹⁵ This was related mainly to nail subacromial impingement. After that evaluation, we decided to make osteosynthesis with plates and screws for humeral shaft fractures. In the present study, we performed a comparison between methods with special attention to the final shoulder function.

In the P group, we obtained better functional outcomes. The average shoulder elevation was 169 with plates vs. 157 with nails ($P = .046$). Internal rotation was significantly better in

the P group ($P = .004$). On the other hand, the average external rotation was better in the P group (83 plate vs. 75 nail), but this difference was not significant ($P = .196$). As per the Rodríguez-Merchan criteria, we found a difference regarding the percentage of excellent results: 66% in patients treated with plates and 40% with nails ($P = .021$).

Concerning shoulder mobility, it is difficult to compare the literature because the studies typically do not report details of the final ROM with absolute values (in degrees).

Gracitelli *et al*^[11] compared nails and plates with the mini invasive plate osteosynthesis technique. They concluded that there are no differences between groups. In this article, the University of California, Los Angeles score was used in the comparison, so the final function can be underestimated because it gives a maximum score with 150 of anterior flexion and does not include shoulder rotations. In addition, they have not reported the final range in grades. This is why we did not consider the shoulder evaluation to be complete and objective. We decided to use the RodríguezMerchan score, which grants the excellent score only with a full ROM. We also divided the cases between those that achieved and did not achieve full ROM.

Regarding complications, in a meta-analysis, Wen *et al*^[21] reports that in multiple comparative studies between both methods, no significant differences were found. In our series treated with plates, we had 2 infections: a superficial infection treated with antibiotics and a deep infection treated with debridement and antibiotics. In another meta-analysis, Heineman *et al*^[9] did not find significant differences between implants in the total rate of complications, nonunion, infection, nerve injury, or revision surgeries.

With regards to the functional results and the risk of suffering shoulder movement restriction, the aforementioned meta-analysis has shown (in the same way as the present study) that open reduction and plate fixation yielded superior results over the group treated with intramedullary nails, and no significant difference between mini invasive plate osteosynthesis and nail groups was found. Other meta-analyses suggested that the plates could reduce the incidence of shoulder deficit.

Some studies have related the decrease of shoulder function in cases treated with intramedullary nails to a nerve injury, accidental proximal nail migration, rotator cuff injury, capsulitis, and other factors.

The current literature remains inconclusive when comparing surgery complications between plates and nails. Treatment with the humeral nail has been associated with a higher incidence of shoulder impingement, pain, and hardware removal. On the other hand, open reduction and internal fixation through an anterolateral or posterior approach requires significant soft-tissue dissection and local vascularization damage, which could decrease the potential of healing, with a higher risk of deep infection and iatrogenic nerve injury.

We acknowledge as limitations those of any retrospective study: the number of cases and different fracture types. But, we find some strengths, such as the control group with a special focus on the final shoulder function, long-term follow-up, and having the same surgical team. We consider that our findings add information to the knowledge about final clinical results in these fractures.

Table 2: Comparative results

Variable	P group	N group	P value
Healing rate (%)	27 (100%)	28 (93.3%)	0.273
Complications (%)	2 (7.4%)	5 (20.0%)	0.163
Full shoulder ROM 100%, n (%)	18 (66.6%)	12 (40%)	0.021
Forward elevation median (IQR)	180° (RIQ 20)	170° (RIQ 40)	0.046
External rotation median (IQR)	90° (RIQ 10)	85° (RIQ 20)	0.196
Internal rotation vertebrae level, n (%)			0.004
D7	14 (51.9%)	16 (53.3%)	
D10	7 (25.9%)	-(0%)	
D12	5 (18.5%)	6 (20%)	
L5	-(0%)	6 (20%)	
S1	1 (3.7%)	2 (6.7%)	
Elbow extension, median(RIQ)	0° (RIQ 5)	0° (RIQ 5)	0.451
Elbow flexion, median(IQR)	140° (RIQ 15)	137.5° (RIQ 10)	0.311
Pain n (%)	1 (3.7%)	5 (16.7%)	0.122
Rodríguez-Merchán score			0.005
Excellent	18 (67%)	12 (40.0%)	
Good	7 (26%)	7 (23%)	
Fair	-(0%)	6 (20%)	
Poor	2 (7%)	5 (16%)	

IQR, interquartile range. Bold values indicate statistical significance.

Table 3: Variables association with full shoulder ROM. Logistic regression model.

Variables association with full shoulder ROM	OR*	CI 95%	P value
Type of treatment			
Nails	1.00	-	-
Plate	6.50	1.56-27.09	.010
Fracture type			
A	1.00	-	-
B [†]	1.16	0.26-5.11	.846
C [‡]	2.81	0.23-34.15	.417
Age	0.95	0.92-0.98	.002

CI, confidence interval; IQR, interquartile range; OR, odds ratio; ROM, range of motion. * Odds ratio adjusted to the other variables included in the model. † Compare A vs. B. ‡ Compare A vs. C.

Conclusion

The study concludes extra medullary plating as more better and effective in terms of achieving good ROM with fewer complications compared to the intra medullary nailing for closed extra-articular shaft humerus fractures. Although healing rate can be good and efficient in both techniques. A loss of ROM is expected after humeral shaft osteosynthesis. A larger sample size with equal representation in both groups is required for a p value with higher significance.

Conflict of interest

The authors declare no conflict of interest.

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