



**ORIGINAL RESEARCH PAPER**

**Orthopaedics**

**FUNCTIONAL OUTCOME OF HUMERAL SHAFT FRACTURE MANAGED WITH INTRAMEDULLARY INTERLOCKING NAIL AND PLATE FIXATION : A COMPARATIVE STUDY**

**KEY WORDS:** Humeral shaft fracture, Internal fixation, Plating , Intramedullary interlocking nail

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**ABSTRACT**

**Objective:** To compare the results of the intramedullary interlocking nail (IMN) and compression plate fixation performed for humerus shaft fracture as to determine a better option out of the two method. **Material And Method:** This prospective study was conducted upon 112 patients at American international institute of medical science, Udaipur (Rajasthan). Patients treated with IMN (n=52) or plate fixation (n=60) for humeral shaft fracture were included in this study. this study were carried out from june 2019 to april 2022 and follow up was done for minimum one year of duration for each patient. Assessment was done in terms of perioperative parameters, complications, union time, and functional outcomes. Functional outcome were compared between the two groups at each follow-up (6 weeks, 3, 6, and 12 months). **Results:** Intraoperative blood loss, operative time, hospital stay, and union time were significantly lower in the IMN group. There was no significant difference in the functional outcomes when it was compared between the two groups at each follow-up . However, when it was compared between subsequent follow-ups, a significant improvement was observed in both groups. Increase incidence of individual complication and reoperation were established in the plating group, but without a significant difference. Yet, the overall complications rate was significantly higher in the plating group. **Conclusion:** IMN fixation led to a significant decrease in intraoperative blood loss, shorter operating time, hospital stay, union time, and a lower rate of overall complications. Thus, IMN may be a better choice of internal fixation as it also accelerates the patients' recovery, and increases their satisfaction.

**INTRODUCTION**

Fractures of humeral shaft have traditionally been regarded benign, with high percentage of primary healing with conservative methods, using either a hanging arm cast or a functional brace.

The advantages of operative management are early mobilization and patient comfort. But, operative management carries the risk of technical errors and post-operative complications like infections, nerve injuries etc. The optimal method of humeral shaft fracture fixation remains in debate. Two techniques under study include intramedullary nailing and dynamic compression plate fixation. Open reduction and internal fixation (ORIF) with plates and screws continues to be considered the gold standard for surgical treatment. It is associated with a high union rate, low complication rate, and rapid return to function. It provides satisfactory results but requires extensive soft tissue dissection, and meticulous radial nerve protection.

With the dynamic success of intramedullary fixation of fractures of the femur and tibia, there was speculation that intramedullary nailing might be more appropriate for humeral shaft fractures than dynamic compression plating. The theoretical advantage of intramedullary nailing included less invasive surgery, an undisturbed fracture hematoma and reaming can yield auto graft material. The biomechanics are improved, with higher amounts of inertia and load-sharing device support.

With this background current study was planned to compare the outcomes of each method of fixation (dynamic compression plating and interlocking nailing) for the fracture shaft of humerus.

**MATERIAL AND METHOD**

This comparative study on the treatment of humeral shaft fracture using antegrade IMN (n=52) and compression plate (n=60) fixation was conducted at the American international institute of medical science, Udaipur (Rajasthan). this study were carried out from june 2019 to april 2022 and follow up

was done for minimum one year of duration for each patient . The study was approved by the Institutional ethics committee.

**Inclusion criteria :** patients of age 18 years or above, closed or open humeral shaft fracture of Gustilo-Anderson grades I and II, fracture of <2 weeks duration, humeral shaft fracture treated with IMN fixation or compression plate fixation.

**Exclusion criteria :** age <18 years, pathological fractures, open fracture grade III , patient with preoperative neurovascular injury.

Informed written consent for surgery were taken in all cases with explanation of the treatment, its risk and complications Study design to be conducted was also explained to the patient.

Precisely, the fractures were situated 2 cm distal to the surgical neck of the humerus or 3 cm proximal to the olecranon fossa.

Only antegrade nailing was performed in the IMN group and In ORIF with plate fixation, the commonly used approach was the posterior approach. Locking compression plate (LCP) was Used in this study .

.A standard plain radiograph was obtained in the follow-up at 6 weeks, 3 months, 6 months and 12 months postoperatively. Functional outcome of the upper limb was assessed at each follow-up using the Visual Analogue Scale (VAS) score . Complications, if present, were recorded from the postoperative period until 12 months for comparison later. In the plating group, four patients lost to follow-up and two case had implant failure that was managed by reoperation with plating and bone graft. Thus, the final evaluation was done in 54 cases of plating and 52 cases of nailing.

The implant failure case was considered and included as a complication later on in this study.

Fisher's exact test or Chi-square test was used to examine the

relationship between qualitative variables. Continuous data with normal distribution were presented as mean ± SD and was compared using t-tests. A p-value of less than 0.05 was considered statistically significant.

**RESULTS**

The mean age of the patient was 45.69 ± 16.27 years in the IMN group and 45.40 ± 16.94 years in the plating group (p=0.948). In IMN group, 32 were males (61.53%) and 20 were females (38.24%). Whereas, in the plating group, 34 were males (56.66%) and 26 were females (43.33%), indicating the increase in the number of male patients in both groups, but no statistically significant difference was found when compared (p=0.712). No statistically significant difference was found between the two groups regarding MOI, affected side, fracture type; open or closed, fracture classification and position (p>0.05). The intraoperative blood loss, operative time, duration of hospital stay were significantly lower (p<.001) in the IMN group than in the plate group.

**Table I: Comparison of intraoperative blood loss, operative time, hospital stays, union time and union rate**

Variables	IMN (n= 52)	PLATING (n =60)	STATISTICS	P-VALUE
Intraoperative blood loss in ML (mean±SD)	31.04 ±6.82	150.53 ±6.66	t=49.54	<.001*
Operative time in minutes (mean±SD)	47.65 ±4.30	91.27 ±11.72	t=22.80	<.001*
Hospital stay in days (mean±SD)	4.31 ±1.46	7.60 ±2.85	t=10.85	<.001*
Union time in month (mean±SD)	2.56 ±1.29	3.52 ±2.10		0.022*
Union rate	50/52 (96.15%)	50/54(92.59%)	X2=0.315	1.0a

\* significant difference, a Fisher's exact test.

**Table II: Functional outcome.**

VAS	IMN	PLATING	VALUES
At 6 weeks	4.96 ±1.11	4.92 ±0.78	f1=1.518, p1=0.224, f2=331.068, p2<0.001*
At 3 months	3.46 ±0.81	3.00 ±0.67	
At 6 months	1.73 ±0.82	1.59 ±0.84	
At 12 months	0.88 ±0.99	0.74 ±0.71	

The fracture healed significantly earlier in the IMN group compared to those in the plating group (p=0.022) (Table I). However, there was no significant difference in the union rate while comparing between the two groups (p=1.0, Table I).

No significant difference was noted when the mean VAS scores were compared between the two groups at each follow-up (p1>0.05) (Table II). However, when these were compared between subsequent follow-ups from 6 weeks to 12 weeks, a significant increase indicating the improvement in functional outcome was observed in both groups (p2<.001, Table II). Individually, except restriction of shoulder joint function, the incidence of other complications was found to be higher in the plating group without a statistically significant difference. However, the total number of overall complications was significantly lower in the IMN group (p=0.041, Table III).

**Table III: Comparison of postoperative complications.**

complications	IMN	PLATING	P-VALUE
1)Implant failure	0/52	2/56 (3.6%)	1.0
2)Iatrogenic radial Nerve palsy (transient)	1/52	4/56 (7.1%)	0.491
3)Infection	0/52	4/54 (7.4%)	0.491
4)Non union	2/52 (3.8%)	4/54 (7.4%)	1.0
5)Shoulder pain and restriction	4/52 (7.7 %)	1/54 (1.85 %)	0.610
6)Reoperation due to complications	2/52 (3.8%)	6/56 (10.7%)	0.612

**DISCUSSION**

Fixation with IMN is a much simpler technique than plating as there was minimal exposure, which results in shorter operative time and less intraoperative blood loss. Due to its minimal invasive procedure and its simpler technique, the length of hospital stay after definitive management in IMN group was also significantly shorter than in the plating group, A similar result was established in this study. An earlier union time with a significant difference after plating was mentioned. A higher union rate was observed in IMN group as compared to plating group with an insignificant difference in this study, which matches with the findings from previous reports. Due to the minimally invasive procedure during IMN fixation with the prevention of fracture hematomas, soft tissues, blood vessels and periosteum around the fracture, it allows higher rates of union and good results as observed in our study. Literature has also shown that cases with a shorter healing time were those treated with closed reduction, as in the setting of IMN fixation which rarely requires open reduction. In the present study when we compared the mean VAS scores between the two groups at each follow-up, no significant difference was found, But when these were compared between the subsequent follow-ups in both groups, a significant difference was noted, only to indicate a significant progressive improvement in function over a period of time in both groups. Bauze et al. has suggested a medial starting point that avoided the avascular area of the rotator cuff without compromising its healing, that can lead to a good functional outcome of the shoulder joint later on. In this study also the nail was inserted medially to the tip of the greater tuberosity, 0.5 cm posterior to the bicipital groove to minimize damage to the rotator cuff and also properly countersinking the tip of the nail was done. Many studies in the past have highlighted numerous disadvantages of ORIF with plate fixation since it requires extensive open dissection which increases the risk of radial nerve damage, infection, delayed union and nonunion. Iatrogenic radial nerve palsy was higher with 4/56 cases (7.1%) in the plating group and 1/52 in the IMN group in this study, with an insignificant difference as in the previous study. Those five cases were managed conservatively and recovered well in a mean time of two months indicating a neuropraxia type of injury. Infection was also higher with 4/54 cases of superficial infection in the plating group, also without a significant difference as in earlier studies. This may be explained by a wide open surgery, soft tissue and periosteal stripping from the bone, and the prolonged exposure with a longer operating time during plate fixation.

In the previous reports on plating, the incidence of nonunion has ranged from 2% to 10%. Retrospectives studies of IMN fixation reported lower incidence of nonunion ranging from 0 to 8%. Higher nonunion after plating was observed in this study; which may again be explained by the preservation of the fracture site biology during IMN fixation which was not possible with plate fixation procedure. In contrary, plate fixation showed fewer non-unions than IMN in other studies. The narrow medullary canal may cause jamming of the nail and contribute to distraction at the fracture site during nailing. We disagree to this as appropriate reaming, and then

carefully tapping the insertion handle attached to the tip of the nail with a bone hammer proximally after the nail insertion and the distal locking screw properly placed can counteract the distracting force and minimize the gap between the fracture fragments.

Earlier in this study, the authors had found that there was no significant difference in the functional outcome of the shoulder function between the two groups although slightly higher incidence of restriction of the shoulder joint movement after antegrade IMN fixation was established. Impaired function of the shoulder joint with antegrade IMN may be a result of impingement due to proximal migration, rotator cuff violation, and adhesive capsulitis.<sup>23</sup> When performed properly, as explained earlier with a medial starting point and countersinking the nail head, a minimal restriction was observed in this study with an insignificant difference between the two groups.

The present study revealed a higher incidence of implant failures with plating, without a significant difference; one with a broken plate seen in the follow-up. This case was reoperated with bone graft and plate fixation. This result is consistent with the previous study with a higher incidence of implant failure in plating. Implant failure in plating may be explained by the stress rising at the end of the plate, as well as the stress shielding of the bone by the plate at the fracture site which reduces the strength of the union and, it also provides less secure fixation especially in the osteopenic bone.

### Conclusion

The application of the IMN was simple and minimally invasive that preserved the biology of the fracture site, which resulted in a significant decrease in intra-operative blood loss, shorter operation time, shorter hospital stays, union times, and a lower rate of overall complications.

Despite no significant difference between the two methods in terms of functional outcome and union rate of the fracture, significant progressive improvement in the functional outcome over a course of time was assured with both methods. The patients treated with plating underwent more reoperations with secondary bone graft procedures in this study. Therefore, IMN may be a better choice of internal fixation, as it also accelerates the patient's recovery and increases their satisfaction.

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