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Functional Outcome of Plating Versus Intramedullary Nailing in Shaft of Humerus Fracture: A Compartive Study

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Abstract
Humeral shaft fractures accounts for about 3%-5% of all fractures. Traditionally humeral shaft fractures are managed conservatively however rise in complications has moved towards surgical management of humeral shaft fracture. Most popular surgical management includes intramedullary nailing and plating. Yet, the ideal fixation method for the humeral shaft remains a topic of discussion hence we conducted this prospective study in department of orthopaedics, Sree Mookambika institute of medical sciences. 36 patients diagnosed clinically and radiologically with shaft of humerus fracture were included in this study. Patient were separated into two group randomly with 18 patients in each group. Patients treated with plating are included in the first group whereas Second group includes patient treated with intra medullary nail. Functional outcome between the two groups were assessed by using Rodriguez Merchan criteria. plating group had excellent outcome in 6 patients (33.3%), good outcome in 7 patients (38.8%), fair outcome among 4 patient (22.2%) and poor outcome in 1(5.5%). Where as in intramedullary nailing group had excellent outcome in 5 patients (27.8%), good outcome in 7 patients (38.8%), fair outcome among 5 patient (27.8%) and poor outcome in 1(5.5%). Our study suggests that plating provides better functional outcome compared to interlocking nailing.

INTRODUCTION

Orthopaedic surgeons in today's world often encounter humeral shaft fractures, which account for about 3%-5% of all fractures[1] Historically, humeral shaft fractures were primarily managed with conservative methods such as hanging casts and functional bracing. However, the rise in complications, including malunion, non-union and primary radial nerve injuries, has led to internal plating and nailing becoming the favoured techniques among surgeons today. Yet, the ideal fixation method for the humeral shaft remains a topic of ongoing debate. Numerous studies have been published over the years, comparing various fixation options like Dynamic Compression Plates, Limited Contact DCPs, Locking Compression Plates, External Fixation, Intramedullary Interlocking Nailing and the TENS flexible nailing system, but conclusive evidence has not emerged[2]. Plate fixation, which relies on load-bearing, achieves high union rates through the principle of compression during fracture healing. However, this method necessitates significant soft tissue dissection from the bone, increasing the risks of infection, implant failure, loss of fracture hematoma, damage to the radial nerve and potential failure in osteoporotic bones. Additionally, plate fixation can lead to stress shielding and lower union strength, as it fosters primary bone healing rather than the callus formation associated with biological fixation through intramedullary nailing. Recently introduced minimal invasive bridge plating osteosynthesis has shown promise as a secure technique with favourable outcomes. On the other hand, intramedullary nailing addresses many of the complications associated with plate fixation and offers biomechanical advantages as a load-sharing device. IM nailing involves less surgical trauma, preserves biologic fixation, avoids periosteal stripping, provides rotational and torsional stability, achieves anatomical reduction, allows for early immobilization and preserves fracture hematoma[2]. Nonetheless, intramedullary nailing has its own drawbacks, such as potential rotator cuff impingement and restricted elbow mobility. With the demonstrated success of intramedullary fixation in femoral and tibial fractures, there is speculation that it may be a more suitable option for humeral shaft fractures compared to locking compression plating. However, current research indicates that plating is the preferred method for humeral fractures. The locking compression plate is designed with screws that lock into threads within the plate's holes, preventing screw loosening and plate failure, particularly in cases of osteoporotic or suboptimal bone quality. This method offers a range of fixation options and has proven effective in complex fractures and revision surgeries following previous fixation failures. There is an increasing focus on treating even straightforward humeral shaft fractures through surgical methods to prevent complications and facilitate quicker mobility and a faster return to work[3]. The aim of this study is to compare and evaluate the outcomes of these two fixation methods-locking compression plating and interlocking nailing-for humeral shaft fractures, analysing any statistically significant differences in functional outcomes, union rates and complications.

MATERIALS AND METHODS

This prospective study was done in department of orthopaedics, Sree Mookambika Institute of Medical Sciences, Kanyakumari from April 2022 to August 2024. In this study 36 patients with shaft of humerus fracture attending OPD and causality were included. Patient diagnosed clinically and radiologically with shaft of humerus fracture and willing to participate in this study were included in this study. Inclusion criteria included patient aged 18-70 years, <3-week-old trauma and requiring surgery were included. Skeletally immature patients, pathological fractures, compound fractures, associated neurovascular injuries, radial nerve injury following closed reduction, non-cooperative patients, patients with other pathologies of the upper extremities and those not giving consent for this study were excluded from study. Patient were separated into two group randomly with 18 patients in each group. Patients treated with plating are included in the first group. Second group includes patient treated with intra medullary nail.

Surgical Technique:

Intramedullary Nailing: Most patients received general anesthesia in combination with an interscalene block. The patient was placed in a supine position with a bolster positioned between the scapulae. The affected arm was cleaned, draped and prepared. A 3 cm incision was made from the anterolateral edge of the acromion and extended downwards. After splitting and retracting the deltoid fibers, the supraspinatus tendon was incised along its length. An entry point was created using an awl just lateral to the articular cartilage in line with the medullary canal. A guide wire was then inserted and the fracture was reduced. Following initial reaming of the canal, a specialized humerus nail was mounted on a zig and inserted over the guide wire. Proximal locking was performed with the zig, while distal locking was conducted using a freehand technique. The nail's position was verified using a C-arm in both orthogonal views at critical stages of the procedure. Wound was carefully closed.

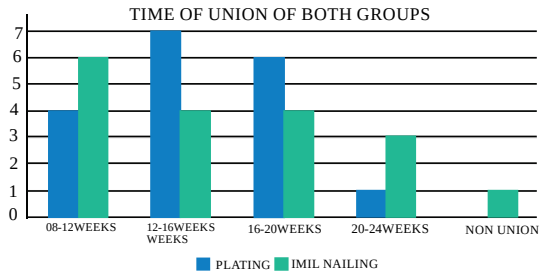
Plating: Similar to the nailing procedure, most cases involved general anesthesia coupled with an interscalene block. All patients were positioned laterally during the operation. The affected limb was scrubbed, draped and prepared. An 8-10 cm incision was made centring the fracture site. The interval

between the long and lateral heads of the triceps was identified, followed by careful isolation of the radial nerve and subperiosteal elevation of the medial head of the triceps. A 3.5 mm locking compression plate was applied in compression mode after the fracture was preliminarily reduced. The plate's position was evaluated in both orthogonal planes. The wound was then closed in layers.

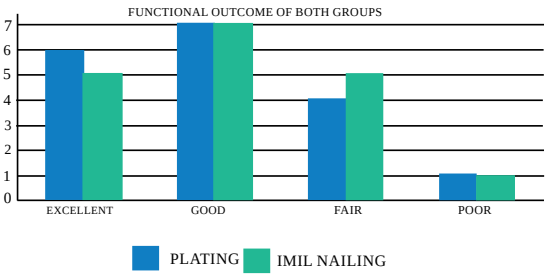
Standardized Post-Operative Protocol and Follow-up: Both groups received intravenous antibiotics for three days, which were then switched to oral antibiotics for an additional seven days. The operated arm was kept immobilized in an arm sling. The wound was assessed on the third post-operative day and an X-ray was performed to examine the alignment of the fracture fragments. Patients were discharged with their arm in the sling. Follow-up appointments were scheduled at two weeks, one month and six months. Rehabilitation for the affected arm commenced at the two-week mark. During this time, patients were allowed to engage in gentle pendulum exercises for the shoulder while still in the sling. Between four-and six-weeks post-surgery, patients could begin gentle range of motion exercises for the shoulder. From six to eight weeks, active range of motion was permitted in all directions. During each follow-up, the patients underwent a clinical examination to assess for any signs of infection, pain, the range of motion in the elbow and shoulder, neurovascular status and other potential complications. A radiological evaluation was performed using plain radiographs to determine the healing status of the fracture, alignment, hardware complications and any signs of malunion. Radiological union was indicated by the presence of bridging callus visible in two planes (AP and lateral). Healing was classified as union when it occurred within 4 months., delayed union was noted if no signs of healing were observed from 4-6 months post-injury, while non-union was determined if there were no indications of healing after 6 months. The final results were assessed using the Rodríguez-Merchán criteria, which takes into account the range of motion in the shoulder and elbow, pain levels and disability[4]. When the assessment falls into different categories, the outcome is classified according to the lower category (Table 1). Using SPSS software results were statistically analysed.

RESULTS AND DISCUSSIONS

In this research, a total of 36 participants were involved, with each group-plating and intramedullary nailing-comprising 18 individuals. (Table 2) indicates that the majority of injured patients were in the 18-40 age range in both the plating group and intramedullary nailing groups. According to (Table 3), the plating group had 12 males (66.7%) and 6 females (33.3%), while the intramedullary nailing group included 11 males (61.1%) and 7 females (38.8%). The male-to-female ratio in the plating group was 2:1, whereas in the intramedullary nailing group it was 1.6:1. This data clearly shows that males are more susceptible to shaft of humerus fractures due to their higher involvement in high-impact trauma. (Table 4) reveals that the right limb was the most frequently affected in both groups, accounting for 66.7% in the plating group



Graph 1: Time of Union



Graph 2: Comparative Graph of Functional Outcome in Both Groups

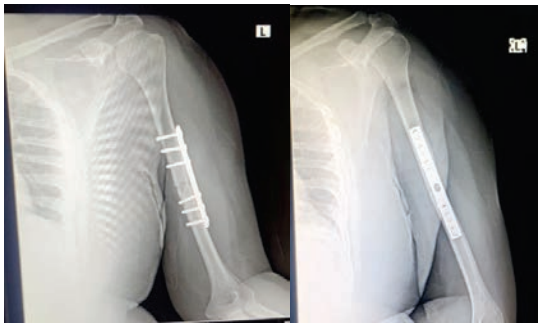


Fig 1: Post Operative Plate Fixation Image

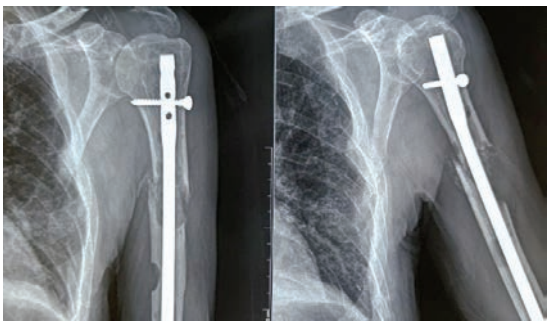


Fig 2: Post Operative Intramedullary Nailing Image

and 61.1% in the intramedullary nailing group. As shown in (Table 5), road traffic accidents were the leading cause of injury in both the plating group and intramedullary nailing group with 13 cases (66.7%) and

Table 1: Criteria for Evaluating Functional Results (Rodriguez Merchan Criteria)

Rating	Elbow range of motion	Shoulder range of motion	pain	Disability
Excellent	Extension in 5 degrees Flexion in 130 degrees	Full rang of motion	None	None
Good	Extension in 15 degrees Flexion in 120 degrees	<10% loss of total rang of motion	Occasional	Medium
Fair	Extension in 30 degrees Flexion in 110 degrees	10-30% degree loss of total rang of motion	with activity	Moderate
Poor	Extension in 40 degrees Flexion in 90 degrees	>30% loss of total rang of motion	Variable	Severe

Table 2: Age Distribution of Study Population

Age in Years	Plating Group	Intramedullary Nail Group	Total
18-30	6 (33.3%)	5(27.8%)	11 (30.5%)
31-40	5(27.8%)	7 (38.8%)	12 (33.3%)
41-50	4(22.2%)	4(22.2%)	8 (22.2%)
51-60	2(11.1%)	1(5.5%)	3(8.3%)
61-70	1(5.5%)	1(5.5%)	2(5.5 %)
TOTAL	18(100%)	18(100%)	36 (100%)

Table 3: Gender Distribution of Study Population

Gender	Plating Group	Intramedullary Nail Group	Total
Female	6 (33.3%)	7 (38.8%)	13 (36.1%)
Male	12(66.7%)	11(61.1%)	23 (63.9%)
Total	18(100%)	18(100%)	36 (100%)

Table 4: Side of Injury

Side of injury	Plating Group	Intramedullary Nail Group	Total
Right	12(66.7%)	11(61.1%)	23 (63.9%)
Left	6 (33.3%)	7 (38.8%)	13 (36.1%)
Total	18(100%)	18(100%)	36 (100%)

Table 5: Mode of Injury

Mode of Injury	Plating Group	Intramedullary Nail Group	Total
Rta	12(66.7%)	11(61.1%)	23 (63.9%)
Fall from height	4(22.2%)	6 (33.3%)	10 (27.8%)
Domestic trauma	2(11.1%)	1(5.5%)	3(8.3%)
Total	18(100%)	18(100%)	36 (100%)

Table 6: Fracture Type

Type of fracture	Plating Group	Intramedullary Nail Group	Total
Comminuted	6 (33.3%)	2(11.1%)	8 (22.2%)
Long spiral	1(5.5%)	6 (33.3%)	7 (19.4%)
Oblique	4(22.2%)	4(22.2%)	8 (22.2%)
Segmental	3(16.7%)	3(16.7%)	6(16.6%)
Transverse	4(22.2%)	3(16.7%)	7(19.4%)
Total	18(100%)	18(100%)	36 (100%)

Table 7: Time of Union

Time of Union (Weeks)	Plating Group	Intramedullary Nail Group	Total
8-12	4(22.2%)	6 (33.3%)	7(19.4%)
12-16	7 (38.8%)	4(22.2%)	11 (30.5%)
16-20	6 (33.3%)	4(22.2%)	10 (27.8%)
20-24	1(5.5%)	3(16.7%)	4(11.1%)
Non-union	0 (0%)	1(5.5%)	1(2.8%)

Table 8: Function Outcome Using Rodriguez Merchan Criteria

Results	Plating Group	Intramedullary Nail Group	Total
Excellent	6 (33.3%)	5(27.8%)	11 (30.5%)
Good	7 (38.8%)	7 (38.8%)	14 (38.9%)
Fair	4(22.2%)	5(27.8%)	10 (27.8%)
Poor	1(5.5%)	1(5.5%)	2 (5.5%)

Table 9: Post Operative Complications

Results	Plating Group	Intramedullary Nail Group	Total
Infections	2	1	3
Radial nerve palsy	1	0	1
Comminution at fracture site	0	0	0
Shoulder stiffness	1	3	4
Elbow stiffness	0	2	2
Non union	0	1	1

11 cases (61.7%) In both the groups falls from height were the second most common cause at 4 cases (22.2%) and 6 cases (33.3%) in the plating and intramedullary nailing group respectively. (Table 6) revels the type of fracture pattern in both the groups. Comminuted fracture pattern with 6 patient (33.3%) is the most common fracture pattern among plating group followed by oblique and transverse fracture with 4 patient (22.2%) each. Whereas long spiral fracture pattern with 6 patient (33.3%) is the most common fracture pattern among intramedullary nailing group followed by oblique with 4 patient (22.2%). (Table 7)

revels the rate of union of fracture among both groups. Union is defined as absence of pain and movement clinically and presence of callus radiologically. Most of the fractures united by 16 weeks in both groups. Delayed union was seen among 7 patients among both plating group and intramedullary nailing group but all of them got united withing 16-24 weeks. No cases of non-union were seen among patients in plating group whereas 1 patient was reported with non-union in intramedullary nailing group. Figure 1 and 2 shows preoperative and post operative Xray of plating and intramedullary nailing group respectively. Although average union rate among the plating group was earlier tha intramedullary nailing group the finding was not statistically significant. Graph 1 shows the rate of union among both the groups. (Table 8) revels the functional assessment after 6 months postoperatively. According to Rodriguez-Merchan criteria plating group had excellent outcome in 6 patients (33.3%), good outcome in 7 patients (38.8%), fair outcome among 4 patient (22.2%) and poor outcome in 1 (5.5%). Where as in intramedullary nailing group had excellent outcome in 5 patients (27.8%), good outcome in 7 patients (38.8%), fair outcome among 5 patient (27.8%) and poor outcome in 1(5.5%). Graph 2 shows Comparative graph of functional outcome in both groups. (Table 9) revels the complications in both the groups. Superficial skin infections were found among 2 patients in plating group and 1 patient in intramedullary nailing group which settled on antibiotics. One patient in plating group reported with radial nerve palsy which recovered spontaneously. Shoulder stiffness was found to be reported in 3 patients among intramedullary nailing group and 1 patient in plating group. Elbow stiffness was reported among 2 patients in intramedullary nailing group and 1 patient was reported with non-union in intramedullary nailing group. Humerus fractures stand out among long bone fractures due to their ability to tolerate less-than-perfect anatomical alignment. Accepted shortening can be up to 3 cm, a rotation of 30° and angulation of up to 20°[5]. Because of this tolerance, many humerus fractures are treated conservatively and often yield favourable functional outcomes. The primary reason for surgical intervention is the failure to achieve acceptable alignment, followed by complications like vascular injuries, open fractures, radial nerve damage, cases of polytrauma, floating elbow and pathological fractures[6]. Historically, open reduction and plating have been the preferred surgical technique and are recognized as the gold standard. However, the traditional plating approach requires extensive surgical exposure for fracture reduction, which may increase the risk of radial nerve injury and blood loss. The impressive success rates of intramedullary interlocking nails in treating tibia and femur fractures have sparked interest in their application for humeral fractures. Intramedullary nails experience smaller bending forces compared to plates because they are positioned closer to the mechanical axis than the conventional plates on the bone's surface. Additionally, intramedullary nails can function as load-sharing devices when there is contact with the cortex and they reduce the stress shielding often associated with plates and screws. The intramedullary nailing method offers advantages for biological healing by minimizing soft tissue disruption, preserving the fracture hematoma and reducing periosteal stripping, surgery duration and blood loss This makes it a more favourable treatment choice for patients but nailing has complications like insertion site morbidity like shoulder movement impairment, acromion impingement and rotator cuff injury[7]. However, there remains debate regarding the optimal method for fixation. In a meta-analysis of ten studies comparing plating and nailing, Ooyung[8] found that both techniques yield similar outcomes for humeral shaft fracture. Hence this present study was undertaken in Department of Orthopaedics, Sree Mookambika Institute of Medical Sciences from April 2022 to August 2024 to assess the functional outcome using Rodriguez Merchan score, union time and post operative complications. This study states that majority of injured patients were in the 18-40 age range in both the plating group and intramedullary nailing groups which is similar to study done by Nagaraju[9]. The male-to-female ratio in the plating group was 2:1, whereas in the intramedullary nailing group it was 1.6:1 which is similar to study done by Pansey[10]. In this study right limb is involved the most in both groups which is similar to study done by Naga Raju[9] and this is contradiction to study done by Pansey[10] where left limb is most commonly involved . RTA is most common cause of injury in both the groups which is similar to study done by Pansey *et al,* Naga Raju[9,10] Non-union in the DCP group often arises from excessive soft tissue dissection or misalignment and is frequently linked to implant failure. Although reaming could promote bone healing, non-union rates have been documented to range from 0-9% in cases[11,12] treated with reamed intramedullary nails. In contrast, non-union in interlocking nails usually results from distraction at the fracture site, indicating that the humerus is less accommodating than the tibia or femur in this regard. How ever in our study only one case of non-union reported in nailing group and no non-union case reported among plating group. The union rates among plating group is earlier than nailing group which is unlike study done by Naga raju *et al,* Pansey[9,10]. According to Rodriguez-Merchan criteria plating group has 72.2% Excellent to good outcome when compared with intramedullary interlocking nail with excellent to good outcome of 66.6%. Patient in plating group has better functional outcome in comparison with intramedullary nailing group. This is similar to study done by Mc Cormack[13]. The primary disadvantage of interlocking nailing is the impact on shoulder function. Patients may experience shoulder pain due to damage

to the rotator cuff, a protruding nail tip, adhesive capsulitis, or other unspecified factors[14,15] similarly in our study intermedullary interlocking nail has complications like shoulder and elbow stiffness. In our research, we found that nailing outperformed plating in terms of the average post-operative hospital stay and the duration of surgery. The longer hospital stay for patients in the plating group was primarily due to delays in their surgical procedures. We typically waited for the swelling to fully diminish before performing Dynamic Compression Plate (DCP) surgery. On the other hand, Intramedullary Nailing (ILN) does not require such a complete reduction of swelling. Many of our patients came from remote areas where sterile dressing facilities were lacking, which often resulted in longer hospital stays until their surgical wounds were deemed clean. Patients undergoing ILN benefitted from smaller incisions, allowing for earlier discharges. This shorter recovery period, combined with a less invasive approach like closed nailing, provides significant advantages in developing countries, where orthopaedics hospital beds are limited and resources are constrained. Additionally, the reduced operating time we reported is beneficial for the same reasons. While Chao *et al.* noted a shorter operative duration for ILN, the difference was not substantial, whereas Chaudhary *et al.* observed shorter operative times in the plating group[16,17]. Furthermore, ILN resulted in considerably lower blood loss compared to plating, a finding consistent across several studies[17]. Although this difference is statistically significant, it is often marginal in practical clinical scenarios.

CONCLUSION

Both intramedullary nailing and plating are effective for achieving fracture union. However, when evaluating functional outcomes and complication rates, our findings suggest that plating provides superior results compared to interlocking nailing concerning shoulder pain and function. While intramedullary nailing is advantageous in terms of reduced operation time, less blood loss and a lower incidence of radial nerve palsy, we prefer the plating method due to its more favourable outcomes compared to interlocking nailing. The principal limitation of our study is the small sample size and the abbreviated follow-up period, which hinder a more thorough analysis for a conclusive decision.

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