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### **Comparative study of intramedullary nailing versus plating for shaft fractures of humerus in adults**

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#### **Abstract**

The present study was conducted from September 2017 to October 2019 over a period of two years consisting of 30 patients to compare the results in terms of functional outcome, rate of union and complications of plating versus nailing in treatment of diaphyseal fractures of humerus. 12 patients had undergone nailing and 18 patients had undergone plating. The youngest patient was 21 years old and eldest patient was 75 years old. Maximum number of patients belonged to the age group of 21 to 40 years (46.66%). Most of the patients were male (70%). Road traffic accident was the most common mode of injury (53.33%). Right sided injury was more than left. Majority of the patient's sustained closed injury (90%) compared to open injury (30%). A total of 3(10%) patients had 12A1 type, 5(16.66%) patients had 12A2 type, 8(26.66%) patients had 12A3 type, 7(23.33%) patients had 12B2 type, 5(16.66%) patients had 12B3 type and 2(6.66%) patients had 12C3 type. The minimum follow up among nailing patients were minimum of 10 months and maximum of 20 months with a mean of 16 months the minimum follow up was for 8 months and maximum of 20 months with a mean of 16 months. Two (6.66%) patients came with concomitant radial nerve palsy which was recovered completely within 6 months after surgery. The average time taken for union is 13.8 weeks and 15.1 weeks for nailing and plating respectively. There were 2 cases (16.66%) of delayed union among the nailing category and 4 cases (22.22%) of delayed union among the plating group. There were 2 case (11.11%) of non-union among the plating group and no non-union was seen among the nailing group. Functional outcome was assessed using DASH score analysis. The mean DASH score in nailing group is 30.20 and for plating group is 26.71 which is a good functional outcome in both case. 2 (16.66%) patients had shoulder impingement among the nailing group. 1 (5.55%) patient had implant failure among the plating group. 2 (11.11%) patient among the nailing group had post op radial nerve palsy. 2 (11.11%) patients had superficial infection and 1 (5.55%) patient had deep infection among the plating group. There was no case of infection among the nailing group. 2 (11.11%) patients had non-union among the plating group.

**Keywords:** Intramedullary nailing, plating, shaft fractures of humerus

#### **Introduction**

Trauma is the leading cause of mortality and morbidity and is on the rise in the current scenario. The victim of bony injury faces many hindrances like prolonged immobilization, loss of wages and tough time for the entire family. Besides, the patient has often to live with the sequelae of stiff joints and functional disability. Early restoration of joint motion, return to the normal physiologic function and minimal morbidity is now regarded as the ideal fracture treatment. In this modern era of industrialization there has been increase in number of vehicles on and thereby increase in road traffic accidents resulting in trauma. Fractures of humerus are no exception. Fractures of the humeral diaphysis comprise approximately 3% of all fractures<sup>[1]</sup>. Fracture of humerus is the most challenging fracture of upper limb to be treated. However, irreparable damages can occur if fractures are not understood and treated properly. The uniqueness in the anatomy, the fracture configuration and the functional significance of the region influences the treatment options. The humerus is covered by sleeve of muscles and has rich vascularity which helps in fracture union. As the limb does not take part in weight bearing or ambulation, some amount of shortening is functionally acceptable. But rotational deformity is not tolerated well. Because of all these inherent advantages of the region, Conservative management results in very gratifying outcome. Traditionally humeral shaft fractures have been treated non operatively with hanging cast or brace.

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Sarmento *et al.* reported use of plastic sleeve with early introduction of functional activity. The proportion of these fractures being treated conservatively reportedly varies from 33% to 95% [2,3]. Sir John Charnley [4] in his thesis, the closed treatment of common fractures states, it is perhaps one of the easiest major long bone fractures, to be treated by conservative methods. Different conservative methods include Coaptation splint, Velpaeau bandage, hanging arm cast, Functional bracing but the non-operative treatment has disadvantages of prolonged immobilization in cast Or brace which sometimes may be required as long as 6 months resulting in huge morbidity. However all humerus fractures cannot be treated conservatively.

Conservative treatment has got its disadvantages such as long time limb immobilization, the need for constant co-operation and repeated hospital visits. Secondly it cannot be recommended in every case. Some of the indications of operative treatment include unacceptable closed reduction like unstable fractures (spiral/long oblique), comminuted fractures, segmental fractures, pathological fractures, fractures with delayed union or nonunion, cases associated with polytrauma, those associated with neurovascular injury and compound fractures

**Objective:** The aim of this study was to compare the results of the intramedullary interlocking nail and plating for the treatment of humeral shaft fractures in terms of time to achieve union, functional outcome(DASH score) and complications of surgery in adults.

**Methodology:** It is a prospective comparative study of 30 patients with humeral shaft fractures treated with Intramedullary interlocking nailing and Plate osteosynthesis done in the Department of Orthopedics, AIMS, B.G nagar, from september 2017 to october 2019

**Source of Data:** Patients admitted at Department of Orthopedics Adichunchanagiri Hospital and Research Centre B.G Nagara from september 2017 to october 2019 • Follow up in outpatient Department.

**Study Period:** 24 months

**Sample Size:** 30 Cases (12 nailing&18 plating) proximally develop the interval between the two heads by blunt dissection, retracting the lateral head laterally and the long head medially. Distally split their common tendon along the line of the skin incision by sharp dissection. Identify the radial nerve and the accompanying profunda brachii artery Incise the medial head of the triceps in the midline. Strip the muscle off the bone subperiosteally.

The radial nerve, which runs just proximal to the origin of the muscle in the spiral groove, must be identified and preserved. The muscle must be stripped from the bone below the level of the periosteum to avoid damaging the ulnar nerve, which pierces the medial intermuscular.

**Statistical Analysis:** Data was entered into Microsoft excel data sheet and was analyzed using SPSS 22 version software. Categorical data was represented in the form of Frequencies and proportions. Chi-square test or Fischer's exact test (for 2x2 tables only) was used as test of significance for qualitative data.

## Results

**Table 1:** Distribution of Patients

Plating	Nailing	Total
18 (60%)	12 (40%)	30 (100%)

Of the total 30 patients in our study 18 patients underwent plate osteosynthesis and 12 patients underwent intramedullary interlocking nail.

**Table 2:** Sex Wise Distribution of Cases

Sex	Nailing	Plating	Total
Male	10 (83.33%)	11 (61.11%)	21 (70%)
Female	2 (16.66%)	7 (38.88%)	9 (30%)

Of the total 30 patient 21(70%) were male and 9 (30%) were female and among 12 patients in nailing 10 patients were male and 2 were female and 11 patients were male in plating group and 7 were females. The distribution of sex in each group is statistically insignificant.

**Table 3:** Age Wise Distribution of Cases

Age	Nailing	Plating	Total
21-40	6 (50%)	8 (44.44%)	14 (46.66%)
41-60	5 (41.66%)	7 (33.33%)	12 (40%)
61-80	1 (8.33%)	3 (16.66%)	4 (13.33%)

Of the total 30 patients 14 (46.66%) patients belonged to the age group of 21 to 40 yrs, 12(40%) patients belonged to the age group of 41-60 yrs and 4(13.33%) patients belonged to the age group of 61-80 yrs. Of the 12 patients in nailing 6 patients were between 21 to 40 yrs, 5 patients in between 41 to 60yrs and 1 patient were above 60 yrs. Of the 18 patients in nailing 8 patients were between 21 to 40 yrs, 7 patients were between 41 to 60 yrs and 3 patients were above 60 yrs. The age distribution is statistically insignificant in two groups.

**Table 4:** Distribution of Cases Based On Type of Injury

Type of injury	nailing	Plating	Total
Closed	11 (91.66%)	16 (88.88%)	27 (90%)
Open	1 (8.33%)	2 (11.11%)	3 (10%)
Total	12 (100%)	18 (100%)	30 (100%)

Majority of the patients sustained closed injury (90%) compared to open injury (30%). 1(8.33%) patient in nailing and 2(11.11%) patient sustained open fracture of humerus. The results being statistically insignificant.

**Table 5:** Fracture Pattern - AO Classification

AO type	nailing	plating	Total
12A1	2 (16.66%)	1 (5.55%)	3 (10%)
12A2	1 (8.33%)	4 (22.22%)	5 (16.66%)
12A3	3 (25%)	5 (27.77%)	8 (26.66%)
12B2	3 (25%)	4 (22.22%)	7 (23.33%)
12B3	1 (8.33%)	4 (22.22%)	5 (16.66%)
12C2	2 (16.66%)	-	2 (6.66%)
12C3	0 (0%)	-	-
Total	12(100%)	18(100%)	30(100%)

A total of 3(10%) patients had 12A1 type, 5(16.66%) patients had 12A2 type, 8(26.66%) patients had 12A3 type, 7(23.33%) patients had 12B2 type, 5(16.66%) patients had 12B3 type and 2(6.66%) patients had 12C3 type.

**Table 6:** Comparison of Functional Outcome

Result	nailing	plating	Total
excellent	5 (41.66%)	7(38.88%)	12 (40%)
good	6 (50%)	6 (33.33%)	12 (40%)
fair	1 (8.33%)	4 (22.22%)	5 (16.66%)
poor	-	1 (5.55%)	1(3.33%)
Total	12(100%)	18(100%)	30(100%)

The mean DASH score in nailing group is 30.28(SD-12.1248) and for plating group is 26.71(SD-13.298) with P value-0.468 which is statistically insignificant. Of the 12 patients in nailing group 5(41.66%) patients had excellent results, 6(50%) patients had good functional outcome and 1(8.33%) patient had fair result. Among the 18 patients in plating group 7(38.88%) patients had excellent functional outcome, 6 (33.33%) patients had good functional outcome, 4 (22.22%) patients had good functional outcome and 1 (5.55%) patient had poor results. The results are not statistically significant ( $P > 0.05$ ).

## Discussion

Humerus fracture is one fracture where there is good tolerance to anatomical reduction. Surgical treatment is indicated when there is shortening more than 3 cm and rotation greater than 30°. Inability to achieve acceptable reduction, vascular lesions, radial nerve palsy, polytrauma, and pathological fractures are indications for surgery. Open reduction and internal fixation was the most commonly done procedure in the past and still continues to be. The aim of operative reduction and internal fixation of fracture of humerus is to attain and maintain a stable reduction so as to mobilize the patient's limb in the shortest possible time and that the fracture healing is ensured [4].

However open reduction requires extensive soft tissue dissection and is theoretically associated with high risk of radial nerve injury and more blood loss. It is proven in many studies that intramedullary nailing is ideal for fixation of long bone like tibia and femur. This led to application of similar methods in fixation of humerus fractures. Dynamic compression plating has stood the test of time as an excellent method of stabilizing transverse diaphyseal fractures of humerus [5].

In our study, the age group of the patients in both the groups ranges from 20 to 70 years with a mean age of 43.53 years. This study can be compared to Rommens *et al.* series where in their study the mean age was 43.8 yrs as has been reported by other similar studies. Majority of the patients in our series are males 83.33% in nailing and 61.11% in plating which is comparable to the series of McCormack60, Rommens and Lin. The male population was more involved because most of the times mode of injury was high velocity injury like RTA.

Road traffic accident is the most common mode of injury (53.33%), especially in younger patients. Rommens *et al.* in their series reported RTA as the commonest cause of injury to humerus which is also 53%. In this study the right side (70%) of the humerus was involved more often, which corresponds with the study of Lin. The right side involvement in this series can be due to the right sided dominance or merely incidental. Findings of study conducted by Ingmann *et al.* [6] is consistent with our study 10 16.66 26.66 0 23.33 16.66 0 6.66 0. In our study, the commonest type was A3 which is simple transverse fracture and then was B2 which is a bending wedge fracture more than 30°. The data are similar to most of the reported series. The average time taken for nailing group is 13.8 weeks which is similar in the case of studies by rommens *et al.*

where the union time was reported to be 13.7 weeks. There was no case of non-union therefore the results being rate of union to be 100%. The average time take for palting group is 15.1 weeks which is similar to the series by Robert Vander *et al.* and Robert J Foster *et al.* who reported 16 and 14 weeks of union respectively.

Rate of union is less than that of interlocking intra medullary nailing as there is extensive stripping of periostium, drainage of fracture haematoma and late mobilization. Even though nailing group showed earlier union the results are not significant ( $P > 0.05$ ) Average time taken for union in our study were comparable between the two groups, nonunion being seen in 11.11% in plating group. Similar rates of non-union have been observed in most of the studies.

Non-union in the plating group is usually due to extensive soft tissue dissection or not proper reduction and is mostly associated with implant failure as in our case series one case of non-union was due to implant failure. Non-union has been reported in 0–9% of cases [7, 8] managed with reamed intramedullary nails which is similar to our finding of 0% in nailing. Even though the effect of reaming might facilitate bone healing, whether to use reamed or unreamed nails is still a controversial topic among surgeons. The advantages of reaming is the significant increase in the blood flow to the muscles and surrounding soft tissues, and this increase persists for up to 6 weeks. The increase in soft tissue blood flow may increase the cortical blood flow and thereby increasing chances of union. The disadvantage of reaming is the chances of radial nerve injury, especially when there is a gap at the fracture site. Further, some studies have shown extensive heat necrosis from nailing in narrow canals. Reaming in narrow canals may lead to distraction at the fracture site. Non-union in both the patients were managed by open reduction and plating with bone graft, as has been suggested in the literature. Thus the present series results are comparable with those of others.

In the series by Robert Vander [9] *et al.* on plating he encountered 13.8% of cases with delayed union. In the present series, in plating there were 4 patients (22.22%) who showed delayed union. In the series by LMPH Crolla [10] *et al.* on interlocking nailing, he encountered 9% cases of delayed union. In the present series of interlocking intramedullary nailing where there were 2 patient (16.66%) with delayed union. Our study shows no significant difference between the time of union with an average of 16 weeks in the Interlocking Nailing group and an average of 15 weeks in the Plating group. The results are statistically not significant ( $P$  value-0.124). This is similar to Ragavendra S *et al.* in their study found no significant difference in bony union between plating group and nailing group in a series of 31 cases. The incidence of radial nerve palsy with fracture shaft humerus varies from 6% to 15%. In our series 2 patients had preoperative radial nerve palsy the incidence was 6.66%. both patients belonged to the plating group. radial nerve exploration was done in both the patients. Both patients recovered completely within 6 months of index surgery. The rate of radial nerve palsy in this study is thus comparable with other series. The management of the radial nerve palsy associated with a humeral shaft fractures still remains controversial. Holstein and Levis described oblique fracture of the distal third of the humerus in which radial nerve palsy occurred due to displaced spike of the distal bone fragment. The nerve is least mobile in this place where it pierces the lateral intermuscular septum. He strongly advised against manipulation in this fracture pattern and advocated the need of exploration of the nerve with



internal fixation to avoid further damage to the nerve.

In a study done by Pollock *et al.* of 24 cases of fracture shaft humerus with associated radial nerve injury, the initial treatment was non invasive in all but one patient in whom, debridement of a penetrating wound revealed laceration of the nerve. Except for 2 cases which did not show complete recovery and required exploration, the rest 22 cases completely returned to function with conservative management. In two cases delayed exploration and delayed repair was done and both did well later. Exploration should be done at 31/2 to 4 months after injury if there is still no clinical or electromyographic evidence of months after injury if there is still no clinical or electromyographic evidence of recovery. Infection, iatrogenic radial nerve palsy and hardware failure are most important complications associated with plating. We had higher rates of infection and iatrogenic radial nerve palsy in the plating group, as has been seen by Changulani *et al.*

In our study we had 2 patients (11.11%) among the plating group who developed superficial infection and none of the patients among the nailing group. The infection subsided with appropriate antibiotic therapy. There was one case (5.55%) of deep infection among the plating group which was controlled by debridement and appropriate antibiotic therapy. Plating group is more prone for infection because of excessive exposure required for the procedure. In our study there were no cases of iatrogenic radial nerve palsy in the interlocking group but there were 2 patients (11.11%) among the plating group who developed post op radial nerve palsy. It was mainly neuropraxia both the patient recovered completely within 4 months after surgery supplemented with steroids and neurotropic drugs along with dynamic cock up splint. The cause for the neuropraxia can be attributed to the intra-operative retraction and extensive exposure which was required due to complex fracture geometry. Radial nerve is at a very high risk in plating, care should be taken to prevent nerve from coming under the plate. Although radial nerve injury after nailing is rare, the risk can be further minimized by ensuring accurate reduction of the fracture (no gap) before passage of the reamers or the nail and by avoiding reaming in areas of comminution where the nerve is closely opposed to the bone. There was 1 patient (5.5%) among the plating group who had implant failure. The failure of fixation in a case of DCP was due to poor technique due to inadequate hold. When this fracture was fixed with longer plate and bone graft, the fracture united at 6 months without complications. There was no case of implant failure among the nailing group. Impairment of shoulder function is the main disadvantage of interlocking nailing. Shoulder pain in these patients is mainly because of injury to the rotator cuff, prominent nail end, adhesive capsulitis or unknown causes. In our study there were 2 (16.66%) patients among the nailing group who had shoulder pain due to impingement. But this restriction can be corrected by the removal of nail after consolidation followed by mobilization and physiotherapy. From our study the incidence of shoulder impingement can be reduced by proper exposure of the rotator cuff and its adequate repair at the end of the procedure. Also, the tip of the nail should be buried in the Subchondral bone to avoid the proximal migration which is the most important cause for impingement. In our study 1 (8.33%) patient among the nailing group and 1 (5.55%) had shoulder stiffness. It was observed that the movements and the functional ability of the shoulder regained due to the patients' adherence to early rehabilitation and intensive physical exercises attributed to early recovery of shoulder function.

Robinsons *et al.* reported 17% of patient with shoulder stiffness. In the series of Srivastava *et al.* they report 15% of shoulder stiffness and 11% of shoulder stiffness was reported in Lin's series. Some report increased incidence of elbow stiffness with the plating group. In our study we came across one patient (5.55%) among the plating group who had elbow stiffness post operatively. The rate of intra operative comminution during interlocking nail insertion with various studies varied from 7.7% to 10%. In our series there were no intra operative comminutions out of 12 patients treated with interlocking nailing. The mean DASH score in nailing group is 30.28 (SD-12.1248) and for plating group is 26.71(SD-13.298) with P value-0.468 which is statistically insignificant. Of the 12 patients in nailing group 5(41.66%) patients had excellent results, 6(50%) patients had good functional outcome and 1(8.33%) patient had fair result. Among the 18 patients in plating group 7 (38.88%) patients had excellent functional outcome, 6 (33.33%) patients had good functional outcome, 4 (22.22%) patients had good functional outcome and 1 (5.55%) patient had poor results. The results are not statistically significant ( $P > 0.05$ ). There were 24 (80%) cases with excellent to good results in the present study which were similar to studies by McCormack *et al.*, Gongol *et al.* and Tingstad *et al.* There were more number of fair poor results in plating group compared to the nailing group. The most important factors in obtaining fracture healing are anatomical reduction, stable fixation and adequate blood supply. Although internal fixation with DCP may result in a better reduction, it also carries a more extensive soft tissue dissection with risk of radial nerve lesion and infection. Intra-medullary nailing method provides with the advantage of biological fracture healing such as minimal handling of soft tissue, preservation of fracture hematoma, and stripping of periosteum, lesser operative time and decreased blood loss, thus making it much preferable choice of treatment in these injured patients. In our study complications which include both intra op and post op were found to be more in plating group especially pertaining to radial nerve injury and infections.

## Conclusion

The present study was aimed to evaluate and compare the results of plating and interlocking nailing in the treatment of the fracture of the shaft of the humerus in terms of time to achieve union, functional outcome(DASH scoring) and complications. From our study we conclude that both intramedullary nailing and plating are good as far as the union of the fracture, time to achieve union and functional outcome is concerned, but complications were found to be more in plating group of which the main concerns are about the radial nerve injury and rate of infections. Though the patients of dynamic compression plating have a better shoulder function than the patients undergoing ante-grade humeral interlocking, it is to some degree due to uncooperative patients, pain and impingement of rotator cuff by nail and fibrosis. But this restriction can be corrected by the removal of nail after consolidation followed by mobilization and physiotherapy. Although internal fixation with DCP may result in a better reduction, it also carries a more extensive soft tissue dissection with risk of radial nerve lesion and infection. ILN provides secure and rigid fixation with less soft tissue damage and maintaining the biology. From our study we conclude that interlocking nailing has following advantages over plating.

1. Lower rate of infection

2. Lower incidence of post op radial nerve palsy
3. Lower incidence of non-union due to biological fixation
4. Early mobilization
5. Cosmetically better procedure
6. Preserves the fracture hematoma and requires less surgical dissection

In conclusion, neither plating nor nailing is superior in all circumstances for a particular fracture and each case has to be individualized. Nailing is ideal for patients with segmental fractures, comminuted fractures, pathological fractures, and patients with gross osteoporosis, patients in which Dynamic Compression Plating cannot be done, distal end fractures and implant failures. There is less chance of radial nerve damage and the patient undergoes early mobilization. The removal of the implant is much easier than removal of dynamic compression plate and lesser chances of nerve injury whereas plating can be done in those with narrow medullary canal, transverse fractures requiring stable fixation and where radial nerve exploration is contemplated.

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