

Original Research Article

# Comparative study of functional outcome of dynamic compression plating with interlocking nailing for fracture shaft humerus in adults

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## Abstract

The present study evaluates the comparative analysis in patients with diaphyseal fractures of the humerus in the adults operated with dynamic compression plating and intramedullary interlocking nailing with focus on their functional outcome results using DASH score and complications. The present study was conducted at the Department of Orthopedics, Government general Hospital, Rangaraya medical college, Kakinada, Andhra Pradesh, India for, a period of two years. The study subjects consisted of n = 38 adult patients of fracture shaft of the humerus with indications for surgical management. Among n = 38 subjects, n = 10 (26.31%) cases showed excellent results, n = 12 (31.57%) good, n = 10 (26.31%) fair and n = 6 (15.78%) poor results. Among n = 10 subjects with excellent results, n = 8 (44.44%) were of plating group and 2 (10%) interlocking nailing. In intramedullary nailing group, 6 (30%) patients showed good results, 8 (40%) fair and 4 (20%) poor results. In patients treated by plate fixation, 6 (33.33%) cases showed good results, 2 (11.11%) fair and, 2 (11.11%) poor results. For all the subjects, DASH scoring was in the range of 21-30 in 50% subjects followed by 10 - 20 in 32.14%, 51 - 60 in 10.72% and 31 - 40 in 7.14% cases. In this series, both the methods of treatment (i.e., dynamic compression plating and interlocking nailing showed good functional outcome results. We prefer dynamic compression plating method as the complications are less compared to the interlocking nailing method and also concerning pain and function of the shoulder joint.

## Key words

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Diaphyseal fractures, Dynamic compression plate, Humerus, Intramedullary interlocking nailing.

## Introduction

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Fractures of humerus shaft are very commonly seen in the modern World accounting about 3% of all the fractures [1]. Treatment methods are also advancing for these fracture in both operative and non-operative methods, initially they were treated with the help of hanging casts, cuff and collar slings, then functional cast bracing, U casts, shoulder spica with improved results but the long duration of treatment results in adverse effect on economy of the patients [2]. Nonunion, malunion, limitation of joint motion and, progressive degenerative arthritis are the common complications in conservative methods; hence, the need for operative intervention. The fracture usually occurs with direct trauma, but indirect forces like fall on outstretched hand or elbow are also common causes of humerus shaft fracture. The encouraging results that have been reported with recent advances in internal fixation techniques and the latest instrumentation have led to an expansion of surgical indications for such fractures.

The present study covers the comparison of results of open reduction and internal fixation by dynamic compression plate with closed interlocking nailing in fracture shaft of the humerus.

## Aim and objectives

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To compare the results of compression plating and interlocking nailing in the treatment of fracture shaft of humerus with reference to

- Rate of healing
- Functional outcome
- Complications and
- Morbidity.

## Materials and methods

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The present study was conducted in the Department of Orthopedics, Rangaraya medical

college, Kakinada, Andhra Pradesh, India, for a period of two years (July 2015-June 2017).

The patients with an acute humeral shaft fracture in adults admitted and treated in the Orthopedic Ward of Government General Hospital, Kakinada, Andhra Pradesh, India, were included in this study.

The study subjects consisted of  $n = 38$  adult patients of fracture shaft of the humerus with indications for surgical management. The inclusion criteria included all fractures of diaphysis of humerus indicated for surgical treatment, patients of age 20 years and above. Exclusion criteria included patients with open fracture of shaft humerus, polytrauma, patient not willing for surgery and patient with other injuries of the same limb, fracture of upper and lower ends of humerus, patients with pre-existing shoulder and elbow problems, pathological fractures, patients who were not available for follow up before the fracture union, patients with segmental fractures.

Ethical Committee approval was taken from the Institutional Ethical Committee Board. All the  $n = 38$  subjects were studied by taking a detailed history, clinical examination to know the nature of the fracture and followed by a routine examination consisting of an anteroposterior and a lateral radiograph of the affected arm to confirm the diagnosis. The presence or absence of radial nerve injury was recorded. The fracture was temporarily immobilized using a U-slab and arm pouch application.

All the cases ( $n = 38$ ) of the study group were prospectively randomized into two categories viz., plating (open reduction and internal fixation with dynamic compression plating) group and intramedullary nailing (closed reduction and internal fixation with antegrade intramedullary interlocking nail) group for surgical management

of fracture of the humeral diaphysis. The informed consent was taken from all the patients. Most of the patients were subjected to surgery within a week following admission after obtaining the fitness for surgery. Delay in surgery was either due to the late presentation or for seeking physician fitness for undergoing the procedure. Pre-operative planning and investigations were done and the patients were operated by open reduction and internal fixation with DCP or interlocking nailing.

### **Case description**

This study series comprised of n = 38 subjects with acute humeral shaft fractures. The cases were adults with age ranging from 22 to 70 years with, the mean age being 37.28 years. The right side was the most commonly involved in n = 23 (60.5%) compared to left side in n = 15 (39.5%). In this series, majority of the subjects were males n = 27 (71.1%) and n = 11(28.9%) females. Road traffic accident (RTA) was the most common mode of injury n = 27 (71.1%) cases followed by fall from height in n=7 (18.4%), domestic and others.

### **Site of fracture**

The fractures of the humerus were classified according to the AO classification system into Type A (A1, A2, A3), Type B (B1, B2, B3), Type C (C1, C2, and C3). There were 20 patients with type A-fracture (AO Classification), 12 with type B fractures and 6 with type C fracture.

### **Operative Technique**

In the first group, we used a 4.5 mm narrow dynamic compression plate (DCP), and in second group standard intramedullary interlocking nail (IMN) was used.

### **Plate Osteosynthesis**

This is the gold standard for fixation of humeral shaft fractures. Plating is associated with a high union rate, low complications, less hospital stay and, rapid return to work. The most commonly used dynamic compression plates were used in the fractures of present series.

### **Intra Medullary Interlocking Nail Fixation**

Closed medullary nailing of fractures of the humeral shaft is rapidly becoming the treatment of choice in multiple trauma patients, patients with osteoporotic bone, pathological fractures and, 3sc segmental fractures.

Out of n = 38 subjects, n = 18 (47%) were fixed with DCP and n = 20 (53%) were fixed with standard interlocking nail (IMN). All n = 18 adult subjects with fractures of the humeral shaft were treated surgically by open reduction and plating technique. Most of the fractures were treated within a week after trauma except n = 1 with closed simple short oblique fracture of shaft of left humerus with left radial nerve palsy and n = 1 patient with late presentation.

The patients were subjected to surgery by plating technique following standard Henry's anterolateral approach in patients with fractures of the upper and middle thirds of the humerus shaft. A Posterior approach was used in patients with fractures of the lower thirds of the shaft. Surgery was done within a week following admission after obtaining fitness for surgery. The patients were placed in the supine position on a fracture table with a pack below the scapula in anterolateral plating. All the procedures were carried out under general anesthesia. Through six-inch skin incision (Henry's approach), the deep fascia cut, biceps and, brachioradialis retracted. The radial nerve was isolated and retracted. The fracture site was exposed, and the reduction obtained with bone holding forceps. After adequate reduction, fixation was done with a 4.5 mm six-holed dynamic compression plate with lag screws based on the fracture morphology. Hemostasis was secured, and the wound was closed in layers. A Romovac suction drain was kept, and pressure bandage was applied.

The operated limb was immobilized for an initial 48 hours, following which range of motion exercises were encouraged. On the 12<sup>th</sup> post-operative day, sutures were removed, and full

range of motion was allowed. Patients were discharged with the arm pouch.

In one case of closed simple short oblique fracture shaft of left humerus with posttraumatic radial nerve palsy at the junction of the mid and lower third, The incision was made between triceps and brachioradialis, and the fracture site was exposed. This patient was operated by a plating technique following Henry's posterolateral approach. The butterfly fragment was fixed with a six holed plate and screws, and the wound was closed in layers. X-ray imaging was used to verify proper plate placement.

Second group of subjects undergoing intramedullary nailing, a 3cm longitudinal incision was made from lateral tip of acromion, entry point was made medial to the greater tuberosity. Two locking bolts proximally and two distally were inserted. The Nail was locked using self-tapping screws, the proximal one from lateral to medial using Jig and Distal from anterior to posterior by a freehand technique. Only antegrade nailing was done in case of IMN group. AO type interlocking nails of 6, 7 and 8mm diameter were used. After surgery, all the patients were given U-slab in the post-operative period and elbow mobilization with slab started from the 3<sup>rd</sup> or 4<sup>th</sup> postoperative day.

Sutures were removed on the 10<sup>th</sup> post-operative day and functional humerus bracing applied. Patients were given physiotherapy in the form of strengthening exercises, static and dynamic along with shoulder pendular exercises with the humerus braces.

#### **Follow up and criteria for evaluation**

At every follow up clinical examination was done for the assessment of surgical wound healing, pain, tenderness at the fracture site with free shoulder and elbow activity, the stability of the fracture and clinical union. The clinical union was confirmed when the fracture site had become stable and pain free. X-rays were taken at each follow up visit to assess fracture union.

The time taken for clinical and radiological union was noted. If no clinical and radiological signs of union were observed by 16 weeks, the fracture was regarded as delayed union and absence of fracture union after 32 weeks after injury was categorized as nonunion.

The patient rehabilitation protocol was followed by shoulder, elbow, forearm and wrist exercises that were done according to the stage of fracture union and duration of time from the day of surgery. Patients were advised to avoid lifting weight or putting stress on the affected limb. Patients were followed up till radiological union was confirmed.

#### **Functional outcome**

The patients in both the plating and intramedullary nailing groups were followed up every month until the radiological union was confirmed up to 34 weeks. Absence of functional pain and local tenderness at the fracture site and the presence of bridging callus in 3 of the 4 cortices seen on AP and lateral views were considered as union. The time taken for union in both these groups was recorded and the functional outcome were then compared in both the groups. Complications such as malunion, non-union, nerve injury, residual deformity and infections were recorded at each follow up. The functional outcome on each follow up was measured according to the "Disabilities of arm, shoulder and hand (DASH)" Questionnaire at the time of 6 months or at full recovery whichever was earlier in both these groups [9]. The Dash scoring system is a very useful tool for measuring the function of the upper limb developed by the American Academy of Orthopaedic Surgeons (AAOS) and has been validated by various researchers [10, 11]. The DASH questionnaire has thirty self-rated questions, the answers of which are graded from 1 - 5 points. The scoring varies from 0-100. A higher score indicates more disability. The DASH scoring system is as below.

The functional score is calculated by the formula

$$\text{DASH Disability / Symptom Score} = \frac{\{(Sum\ of\ n\ responses) - 1\}}{N} \times 25$$

Where 'n' is the number of completed responses. The best possible score is '0' and the worst possible score is '100'. The functional outcome decreases as the score increases. The result was

then graded as Excellent when the score is 0 to 20 points, 21 to 40 points as Good, 41 – 60 points as Fair and  $\geq 61$  as Poor. The time taken for radiological union and the functional outcome was then compared in both groups.

### THE DASH SCORING SYSTEM

DASH Score (Disabilities of arm, shoulder and hand questionnaire);

		No difficulty	Mild difficulty	Moderate difficulty	Severe difficulty	Unable
1	Open a tight or a new jar	1	2	3	4	5
2	Write	1	2	3	4	5
3	Turn a key	1	2	3	4	5
4	Prepare a meal	1	2	3	4	5
5	Push open a heavy door	1	2	3	4	5
6	Place an object on a shelf above your head	1	2	3	4	5
7	Doing heavy household chores	1	2	3	4	5
8	Gardening or doing yard work	1	2	3	4	5
9	Making a bed	1	2	3	4	5
10	Carrying a shopping bag or briefcase	1	2	3	4	5
11	Carrying a heavy object(over 5 kilograms)	1	2	3	4	5
12	Changing a light bulb overhead	1	2	3	4	5
13	Washing or blowing drying the hair	1	2	3	4	5
14	Washing the back	1	2	3	4	5
15	Putting on a pullover sweater	1	2	3	4	5
16	Using a knife to cut food	1	2	3	4	5
17	Recreational activities that require little efforts	1	2	3	4	5
18	Recreational activities in which you take some force or impact through Your arm soulder or hand (e.g hammering tennis,golf)	1	2	3	4	5
19	Recreational activities in which you move your arm freely (e.gbadminton,throwball,etc)	1	2	3	4	5

20	Manage transportation needs	1	2	3	4	5
		No difficulty	Mild difficulty	Moderate difficulty	Severe difficulty	Unable
21	Sexual activities	1	2	3	4	5
22	During the past week, to what extent has your arm shoulder or hand problem interfered with your normal social activities with family, friends, neighbors or groups.	1	2	3	4	5
23	During the past week, were you limited in your work, or otherdaily activity as a result of your arm, shoulder or hand problem	1	2	3	4	5
24	Arm shoulder or hand pain	1	2	3	4	5
25	Arm shoulder or hand pain whenyou perform any specific activity	1	2	3	4	5
26	Tingling in your arm shoulder or hand	1	2	3	4	5
27	Weakness in arm, shoulder or hand.	1	2	3	4	5
28	Stiffness in your Arm shoulder or hand pain	1	2	3	4	5
29	During the past week, how much difficulty have you had sleeping because of pain in your arm, shoulder and arm	1	2	3	4	5
30	I feel less capable, less confident or less useful because of my arm, shoulder, and hand	1	2	3	4	5

## Results

In plating group, the anterolateral approach was followed in the patients with fractures of the upper and middle thirds of the shaft of the humerus and posterior approach in cases with fractures of the lower thirds of the shaft. Only antegrade nailing was done in case of interlocking nailing group. In the plating group, 4.5 mm narrow DCP was used, and in second group standard intramedullary interlocking nail was used. Out of total n = 38 patients surgically treated, n = 18 (47%) cases were operated by plate fixation and n = 13 (53%) with intramedullary interlock nail insertion. The age of the patients in the plating group ranged from

22 to 60 years with a mean age 37.28 years and in the interlocking group age range was from 23 to 70 years with a mean age 35.05 years. In this study series, according to the AO Group classification system, n = 20 (52.63%) patients had Type A fracture, n = 12 (31.57%) patients had type B and n = 6 (15.78%) patients presented fracture type C. The right side n = 23(60.5%) was the most commonly involved compared to left side n = 15 (39.5%). In both the groups, the majority of the subjects were males n = 27(71.1%). In the plating group n = 13 (72.2%) patients were male and n = 5 (27.8%) were female. In the nailing group, n = 14 (70%) cases were male and n = 6 (30%) were female (**Table – 1**).

**Table 1: Sex of Patients**

Sex	Group		Total
	ILN	DCP	
Female	6 30.0%	5 27.8%	11 28.9%
Male	14 70.0%	13 72.2%	27 71.1%
Total	20 100.0%	18 100.0%	38 100.0%

$X^2=0.023$ ,  $p=0.880$ , NS

**Table 2: Side of Injury**

Side	Group		Total
	ILN	DCP	
Left	8 (40.0%)	7 (38.9%)	15 (39.5%)
Right	12 (60.0%)	11 (61.1%)	23 (60.5%)
Total	20 (100.0%)	18 (100.0%)	38 (100.0%)

$X^2 = 0.005$ ,  $p=0.944$ , NS

**Table 3: Mode of Injury**

Mode of Injury	Group		Total
	ILN	DCP	
Domestic	1 (5.0%)	2 (11.1%)	3 (7.9%)
Fall	3 (15.0%)	4 (22.2%)	7 (18.4%)
RTA	16 (80.0%)	11 (61.1%)	27 (71.1%)
Other	0 (0%)	1 (5.6%)	1 (2.6%)
Total	20 (100.0%)	18 (100.0%)	38 (100.0%)

$X^2= 2.69$ ,  $p=0.441$ , NS

#### Mode of injury

Road traffic accident (RTA) was the most common mode of injury in both the groups with  $n = 11$  (61.1%) and  $n = 16$  (80%) cases in plating and IMN groups respectively followed by fall from height, domestic and others (**Table - 2**).

#### Site of fracture

The most common site of fracture in both the groups was the middle third of the diaphysis with

$n = 21$  (55.3%), i.e.  $n = 10$  (55.6%) in plating group and  $n = 11$  (55%) in IMN group. 9 (23.7%) fractures were in lower third,  $n = 3$  (7.9%) fractures in the middle third and lower third junction,  $n = 3$  (7.9%) in the upper third,  $n = 1$  (2.6%) between upper third and middle third junction. 1segmental fracture extending between upper third and lower third junction in IM nailing group respectively (**Table - 3**).

The Fracture union in the plating group was seen at 16 weeks and in the IMN group 14 weeks. The average time taken for radiological union was 15 weeks and the range was 8 - 34 weeks. In the plating group, the average time taken for fracture union was 16.06 weeks (range 8-24 weeks), and

in the IMN group, the average was 14.05 weeks (range 8-18 weeks). The healing rate was relatively faster in the IMN group compared to the plating group. Level of injury was as per **Table – 4**. Time taken for radiological healing was as per **Table – 5**.

**Table 4 : Level of Injury**

Site	Group		Total
	ILN	DCP	
L/3	5 (25.0%)	4 (22.2%)	9 (23.7%)
M/3	11 (55.0%)	10 (55.6%)	21 (55.3%)
M/3 L/3	1 (5.0%)	2(11.1%)	3(7.9%)
U/3	2 (10.0%)	1 (5.6%)	3 (7.9%)
U/3 L/3	1 (5.0%)	0 (0%)	1 (2.6%)
U/3 M/3	0 (0%)	1 (5.6%)	1 (2.6%)
Total	20 ( 100.0%)	18 (100.0%)	38 (100.0%)

$X^2=3.506, p=0.623, NS$

**Table 5 : Time taken for radiological healing**

Group		N	Mean	Std. Deviation	
Union in	ILN	20	14.05	3.187	T=1.903, P=0.065, NS
Weeks	DCP	16	16.06	3.108	

**Photo – 1:** Pre-operative X-ray.



**Photo – 2:** Post-operative X-ray.



**Photo – 3:** Post-operative X-ray at 14 week.



DASH scores 0 - 20 points rated as excellent, 21 – 40 points as good, 41-60 points as fair and  $\geq 61$  points as poor. The mean DASH score in the whole series was 34.1 / 100 (lower the score better the function). The average DASH score in the plating group was 24.1, and in the interlocking nailing group, it was 43.1.

#### Functional outcome results

Among  $n = 38$  subjects,  $n = 10$  (26.31%) cases showed excellent results,  $n = 12$  (31.57%) good,  $n = 10$  (26.31%) fair and  $n = 6$  (15.78%) showed poor results. Among the  $n = 10$  subjects with excellent results,  $n = 8$  (44.44%) cases were of plating group and  $n = 2$  (10%) were interlocking nailing group. In the patients treated by intramedullary nailing,  $n = 6$  (30%) patients showed good results,  $n = 8$  (40%) patients showed fair results and  $n = 4$  (20%) poor results. In patients treated by plate fixation,  $n = 6$  (33.33%) cases showed good results,  $n = 2$  (11.11%) fair and  $n = 2$  (11.11%) cases showed poor results.

A case of spiral humerus shaft fracture (with a third fragment) treated by dynamic compression plating (**Photo – 1 to 5**).

**Photo – 4:** Movement after Operation.



Full abduction



Full external rotation



Full internal rotation

#### Complications

In plating group, 12 (66.66%) patients recovered completely and  $n = 6$  (33.33%) cases had complications. There was an incidence of postoperative radial nerve palsy and fully recovered following the use of neurotrophic drugs for 3 and 6 weeks after surgery. 1 (5.55%) case had non-union as the patient lifted heavyweight leading to hypertrophic non-union and resulted in a poor result (**Table – 6**).

In the interlocking nailing group,  $n = 7$  (35%) patients recovered satisfactorily, and  $n = 13$  (65%) cases had complications. 2 patients suffered additional comminution at the fracture site during nail insertion. However, later the fracture showed union and had no effect on the final outcome giving good result. 1 (7.7%) subject had superficial infection at the fracture site and later the wound healed well,  $n = 2$  (15.4%) patients had some residual pain in the shoulder but the patient had fair result. In  $n = 1$  (7.7%) case the patient was non-cooperative not following instructions of physiotherapy properly and the patient had severe shoulder stiffness giving a poor functional result.

The IMN group had more complications (65%) compared to the plating group (33.33%). No complications like fracture displacement, plate fracture, vascular injury, infection, screw extrusion, plate breakage or screw loosening were observed in either of the groups.

**Photo – 5:** A case of humerus shaft # (middle 1/3<sup>rd</sup>) treated with intramedullary nailing.



**Dash score results**

In most of the subjects, functional outcome was satisfactory. Restriction of joint motion is seen in patients who didn't follow physiotherapy

properly, but later joint movements were restored after 32 weeks on strict physiotherapy exercises (**Table – 7**).

**Table 6: Postoperative Complications**

	Group		Total
	ILN	DCP	
Impingement	8(61.5%)	0(0%)	8(42.1%)
Implant failure	1 (7.7%)	1 (16.6%)	2(10.5%)
Radial nerve injury	0(0%)	1(16.6%)	1(5.3%)
Non union	0(0%)	2(33.4%)	2 (10.5%)
Shoulder pain	2 (15.4%)	0(0%)	2 (10.5%)
Shoulder stiffness	1(7.7%)	2(33.4%)	3(15.8%)
Superficial infection	1(7.7%)	0(0%)	1 (2.6%)
Total	13(100%)	6(100%)	19(100%)

**Table 7: Comparison of DASH scores**

Results	Group		Total
	ILN	DCP	
Excellent	2	8	10
Good	6	6	12
Fair	8	2	10
Poor	4	2	6
Total	20	18	38

$X^2=8.284, p=0.040$ -Sig.

**Table 8: Statistical analysis of DASH scores**

	N	Minimum	Maximum	Mean	Std. Deviation	Mann-whitney Z value	P value
ILN	20	.00	92.00	43.1000	28.12921	2.255	.024 Sig
DCP	18	.00	65.00	24.0556	19.44668		
Total	38	.00	92.00	34.0789	25.94108		

For all the subjects (n = 38), the DASH scoring was calculated after the fracture was clinically united, according to the questionnaire and the score was found in the range of 21- 30 in n = 19 (50%) subjects followed by 10 - 20 in n = 12 (32.14%), 51 - 60 in n = 4 (10.72%) and 31 - 40 in n = 2 (7.14%) cases (**Table – 8**).

### Discussion

Both, the compression plating and intramedullary nailing methods are considered methods of choice of treatment in most of the humeral diaphyseal fractures. Mauch and his associates [12] regarded compression plating as the gold standard of surgical treatment yielding high

union rates, low complications, and early return to work. It is reported to be used effectively even in fractures with proximal and distal extensions. On the contrary, it is associated with extensive soft-tissue handling, longer durations of surgery, periosteal stripping, high infection rate, and radial nerve palsy [13-15].

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 [14, 15], thus making it much preferable choice of treatment in these injured patients. However, nailing has certain disadvantages like insertion site morbidity such as impairment of shoulder movements [15], impingement at acromion [14] and the incursion of the rotator cuff [14, 15]. Likewise, in this series, we observed shoulder pain in n = 2 (15.35%) cases operated with IMN.

In a randomized controlled trial, Changulani, et al. [16] in their study on 47 patients reported union rates were similar in both the groups, but shorter healing time and lesser shoulder mobility in nailing and plating group respectively. In the present study, n = 1 patient had nonunion in plating group.

However, we found not many dissimilarities between both the groups in terms of union time and functional outcome. Though IMN has more complications but later realized that it is superior to plating in terms of less surgical time and less blood loss. Whereas, we observed more shoulder morbidity compared to the plating. Romens, et al. [17] reported union in 95% cases with meantime 13.7 weeks and Crates, et al. [18] reported union in 97% of fractures with meantime 3.2 months. In our study, union was achieved in all cases (except 1 case) with an average period of 16weeks.

Robinson, et al. [19] reported 3.3%, Crates, et al. [18] reported 2.7% and Lin [20] reported 0% iatrogenic radial nerve palsy. In the plating group, the incidence of postoperative radial nerve

palsy in previous studies was reported to vary between 2 - 14.3%, similarly we observed radial nerve palsy in n = 1 (6.67%) in this series, later recovered fully in 16 weeks.

The most frequent problem encountered in antegrade humeral nailing has been its deleterious effect on shoulder function. Crates, et al. [18] reported 90% patients regaining full shoulder function. In the present series, residual pain in the shoulder was found in n = 2 patients but restored later giving good result. 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. 2 patients had developed shoulder pain/stiffness giving poor results in the IMN group. This study, confirms that antegrade insertion of the nail can lead to problems like shoulder function and range of movement probably due to damage to the rotator cuff. The complications were more in the IMN group pertaining to poor shoulder function or pain, additional comminution, and superficial infection.

Most of our findings such as the period of fracture healing, union rates, and functional results are comparable with earlier studies where IMN was used to treat humeral shaft fractures.

Though most surgeons agree that intramedullary nailing is the best internal fixation for femoral and tibial shaft fractures, there is no conclusive agreement about the ideal procedure for fractures of the humeral shaft. Plate osteosynthesis requires extensive soft tissue dissection with the risk of radial nerve damage [21]. The incidence of nonunion after plating in our series was in 1 (6.67%) patient and in IMN fixation was 0%. In earlier studies, the incidence of nonunion after plating was reported in the range of 2-4% [22, 23] and in the IMN fixation ranged from 0 - 8% [13, 17, 24]. In the interlocking group, there was only 1 (7.69%) patient having superficial infection, which responded well to debridement and intravenous antibiotics for 3 weeks.

Though interlocking IMN is good, we still consider plate osteosynthesis is better than interlocking nailing in treating fractures of the diaphysis of the humerus.

Ante-grade nailing in the humerus has always been reported with complications of shoulder impingement or rotator cuff damage. In our study, there were only two patients who had complained of shoulder pain and stiffness, however restored later; other patients achieved painless full range of shoulder movement. Therefore, we emphasize that care has to be taken for proper insertion of the nail in order to avoid damage to the rotator cuff and burying of the nail in the proximal humerus to minimize impingement.

Therefore, plate fixation is considered the gold standard for shaft fractures of the humerus [7, 8, 25]. The Anterolateral approach is widely accepted for treatment of these injuries [3, 4, 20], and posterior plating is also commonly accepted.

The management of diaphyseal fractures of the humerus has always been a problem as these fractures are associated with complications like nonunion, malunion, delayed union and shortening. Operative treatment should be the choice of treatment and early mobilization is to be followed to avoid complications such as malunion, delayed union, control rotational instability, shoulder and elbow stiffness, limb length discrepancies and poor compliance. In 3 studies comprising of 155 patients, Bhandari, et al. [6] could not establish a conclusive method. In a study on 84 such fractures treated either with plating or intramedullary nailing, Chapman, et al. [26] concluded both as predictable methods for fracture stabilization and ultimate healing. In this series, the operative treatment for humeral shaft fractures by plate fixation resulted in no risk of further operations and also noted that the risk of reoperation might be decreased by internal fixation [6].

## **Conclusion**

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Both intramedullary nailing and plating are good as far as the union of the fracture is concerned but considering the functional outcome and rate of complications. According to our results, we are of the opinion that plating offers better result than interlocking nailing in terms of pain and function of the shoulder joint. Though intramedullary nailing is better over plating in terms of less operative time and lesser blood loss and less incidence of radial nerve palsy, we, therefore, would prefer plate fixation method, as the results are better over interlocking nailing method. The main limitation of the study is small sample size and follow up period is less to enable for effective analysis for a better conclusion.

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