

Comparative Study between Use of Interlock Nailing and Dynamic Compression Plate for the Management of Diaphyseal Fracture of Humerus

Sam Singh¹, Sanjay Gupta², S K Kaushik³

¹Presenting Author, Department of Orthopedics Surgery, Shri Ram Murti Smarak Institute of Medical Sciences, Bareilly, Uttar Pradesh, India,

²Professor and Head, Department of Orthopedics Surgery, Shri Ram Murti Smarak Institute of Medical Sciences, Bareilly, Uttar Pradesh, India,

³Assistant Professor, Department of Orthopedics Surgery, Shri Ram Murti Smarak Institute of Medical Sciences, Bareilly, Uttar Pradesh, India

Abstract

Introduction: Fractures of the humeral shaft are commonly encountered by the orthopedic surgeons. This study compares the functional outcome and radiological union in diaphyseal fractures of shaft humerus by intramedullary interlock nailing versus dynamic compression plate fixation.

Methods: This study was conducted during the period between November 2015 and July 2017 on 30 patients having diaphyseal fractures shaft humerus with a minimum follow-up of 6 months. Of these, 15 cases in Group A underwent dynamic compression plating and 15 cases in Group B underwent interlock nailing. Interlock nailing was done by antegrade approach, and plating was done either by anterolateral or posterior approach. Patients were assessed functionally by the American Shoulder and Elbow Surgeons (ASES) score and Rodriguez–Merchan criteria and radiologically by union time.

Result: At 6 months' follow-up, we found that the mean ASES score in Group A was 45.07 with standard deviation (SD) of 2.28 and in Group B was 44 with SD of 2.54. *P* value was not statistically significant ($P > 0.05$). According to Rodriguez–Merchan criteria, the difference between the two groups was also not statistically significant ($P < 0.05$). Patients in interlock nailing group had shorter operative time and hospital stay, and there was no statistically significant difference in terms of time of the union of fractures. Both the groups had one case (6.66%) of superficial infection at the surgical site. There were one case (6.66%) in Group A and 3 cases (20%) in Group B who developed shoulder stiffness post-operatively.

Conclusion: Internal fixation with dynamic compression plate may result in a better fracture reduction but has increased risk radial nerve lesion and infection. Intramedullary interlock nailing is an effective alternative to dynamic compression plating as it has comparable results in terms of functional score, union time, and complications. No single treatment is superior in all circumstances for a particular fracture, and each case has to be individualized.

Key words: Compression Plate, Fracture, Humerus

INTRODUCTION

Fractures of the humeral shaft are commonly encountered by the orthopedic surgeons. According to Mast *et al.* (1975) and Varley (1995), the diaphysis or shaft can be defined as that part of the humerus situated between the superior

margin of pectoralis major tendon insertion and 2 cm above the olecranon fossa.^[1]

The causes in younger patients are commonly represented by high-energy trauma (car accident or sports injury), while in older patients by lower energy trauma (such as an accidental fall), but they are often associated with osteoporosis.

The goals of humeral shaft fracture management are to establish union with acceptable humeral alignment and restore patients to their prior level of function. Many methods have been described for the management of humeral shaft fractures. Good-to-excellent results have been reported in most series of humeral shaft fractures

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Corresponding Author: Sam Singh, Shri Ram Murti Smarak Institute of Medical Sciences, Bareilly, Uttar Pradesh, India.

Phone: +91-9458707275/+91-9750354764. E-mail: samsingh784@gmail.com

treated by closed or with open reduction and internal fixation. Both patient and fracture characteristics, associated injuries, soft tissue status, and fracture pattern need to be considered to select appropriate treatment.

Fractures of the shaft of humerus have been treated conservatively by reduction and subsequent immobilization of the arm, and successful healing occurs in 90% of cases.^[2] The methods include the hanging cast, functional brace, Velpeau dressing, and shoulder spica cast.^[3,4]

Many options were available to treat fractures conservatively, but taking into consideration pitfalls of it, an era of fixation was evolved, the aim of which was early restoration of joint motion and return to normal physiological function and minimal morbidity.

While there are several methods of operative intervention for diaphyseal fractures of humerus, the internal fixation methods can be broadly grouped as plating or intramedullary nailing techniques. Interlocking nailing is preferable in comminuted, segmental, and pathological fractures while plating may be the preferred option where radial nerve exploration is contemplated infection, and nonunion and radial nerve palsy are general concerns suggested in the plating group.

Selecting the right implant for internal fixations remains a controversy, so we want to conduct a prospective, comparative study for the management of diaphyseal fractures of the humerus to find the ideal mode of surgical management with their functional outcome.

MATERIALS AND METHODS

The present study was conducted in the Department of Orthopedics Surgery of SRMS-IMS, Bareilly, from November 2015 to July 2017 on 30 patients, 15 each group having diaphyseal fractures and shaft humerus, after obtaining approval from hospital ethics committee.

Inclusion Criteria

The following criteria were included in the study:

1. Age of the patient more than 18 years
2. Patient presenting within 2 weeks of injury
3. All closed type of displaced diaphyseal fractures of the humerus
4. Patients with Grades 1 and 2 open diaphyseal fractures of humerus presenting within 8 h of injury.

Exclusion Criteria

The following criteria were excluded from the study:

1. Age of the patient <18 years
2. Pathological fractures

3. Grade 3 compound diaphyseal fractures of humerus
4. Fractures within 4 cm from proximal and distal end of humerus
5. Neglected diaphyseal fractures of humerus
6. Refracture of diaphyseal fractures of humerus.

All protocols and procedures applied in this study were as per the Guidelines of Ethics Committee of this institution.

Technique

The antegrade approach was taken for humeral interlock nailing to minimize soft tissue damage to rotator cuff. Incision was made diagonally from the anterolateral corner of the acromion, splitting the deltoid in line with its fibers in the raphe between the anterior and middle-thirds of the deltoid. Using a curved bone awl, an entry portal was made just medial to the tip of greater tuberosity approximately 0.5 cm posterior to bicipital groove. The guidewire was inserted after fracture reduction and proximal reaming was done. The nail was inserted with jig, and after confirming, reduction on X-ray proximal and distal locking of screws was done.

- In the dynamic compression plate group, the anterolateral approach was used for upper-shaft and middle-shaft fractures. Posterior approach with intraoperative identification and protection of the radial nerve was performed for distal one-third shaft fractures. The length of the plate was dependent on the pattern of fracture, comminution, and at the discretion of the surgeon. Intravenous antibiotics were started immediately after the surgery for 2 days after which patient was put on oral antibiotics for next 5 days.
- Post-operatively, the limb was placed in an arm sling and pendulum and elbow movements were allowed on the 2nd post-operative day, as tolerated by the patient, but resistance and rotational motion were allowed only when callus formation was observed in the radiography. The patient was checked for pre- as well as post-operative radial nerve palsy.

The patient was followed up at 2 weeks for suture removal, 6 weeks, 3 months, and 6 months. Radiological outcome on the basis of callus formation and functional outcome on the basis of Rodriguez–Merchan criteria and the American Shoulder and Elbow Surgeons (ASES) score were assessed at final follow-up [Tables 1-3 and Figures 1-10].

The ASES Scoring System of Upper Limb Function Scoring

- 4 = Normal
- 3 = Mild compromise
- 2 = With difficulty
- 1 = With aid
- 0 = Unable.

Criteria

- Reaching back pocket
- Wash opposite axilla
- Comb hair
- Carry 10 pounds weight on side
- Sleep on affected side
- Use hand overhead
- Lift weights
- Perineal care
- Eat with utensil
- Use arm at shoulder level

- Dress
- Pull
- Throw.



Figure 1: (a) Nail insertion. (b) Dynamic compression plate



Figure 2: Case 1 - (a) Pre-operative X-ray. (b) Immediate pre-operative X-ray



Figure 3: Case 1 - 12 weeks post-operative X-ray



Figure 4: (a) Abduction at shoulder joint. (b) Extension at shoulder joint



Figure 5: (a) Internal rotation at shoulder joint. (b) Extension at elbow joint

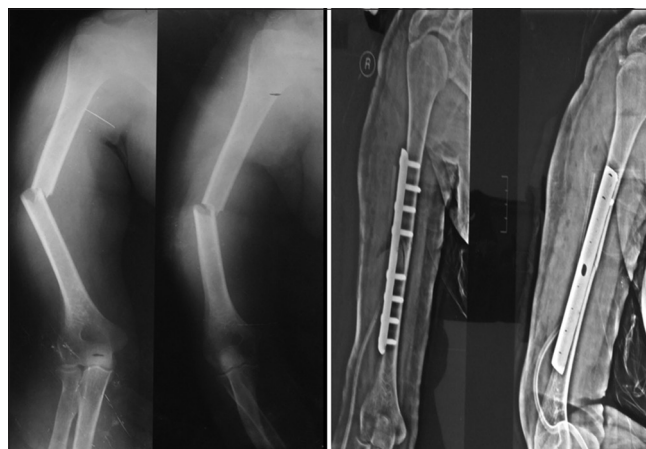


Figure 6: (a) Case 2 - Pre-operative X-ray. (b) Immediate pre-operative X-ray

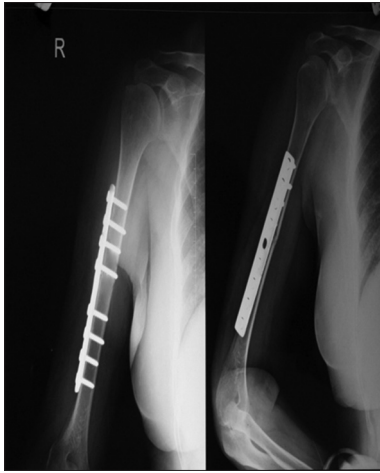


Figure 7: Case 2 - 12 weeks post-operative X-ray

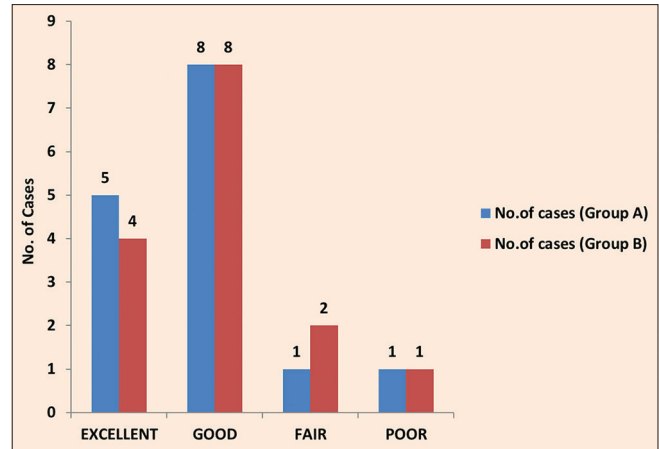


Figure 10: Distribution of rating



Figure 8: (a) Abduction at shoulder joint. (b) Extension at shoulder joint



Figure 9: (a) Internal rotation at shoulder joint. (b) Extension at elbow joint

OBSERVATIONS AND RESULTS

The mean age of patients in our study was 37.2 years with standard deviation (SD) of 16.95 and males outnumbered females.

Mode of injury by road traffic accident (RTA) was the major cause of diaphyseal fracture of humerus (80%) followed by fall on the ground (16.66%). Most of the patients, 27 cases, (93.33%) had AO Type 12A fracture. There were 3 (7%) cases of AO Type 12B fracture and no cases of AO Type 12C fracture. The mean operative time in Group A was 48.87 min with SD of 5.29 min and in Group B was 36.93 min with SD of 4.68 min, which is significantly shorter.

The mean hospital stay in Group A was 9.92 days with SD of 3.34 which is longer than Group B, 7.60 days with SD of 2.75. The P value between the two groups was statistically significant ($P < 0.05$).

The mean union time in Group A was 12.84 weeks with SD of 3.20 and in Group B was 13.71 weeks with SD of 4.36. The P value was not statistically significant between the two groups ($P > 0.5$).

Majority of cases in Groups A and B had $<5^\circ$ of extension lag and more than 130° of flexion and Group B. In Group A, number of patients who had least loss of range of motion at elbow joint were comparatively lower. Majority of cases in Groups A and B had none or $<10\%$ restriction of movement at shoulder joint. In Group B, number of patients with more than 10% restriction of movements at shoulder joint were comparatively higher. In our study, no statistically significant difference was present in terms of pain between the two groups.

Both the groups had 1 case (6.66%) of superficial infection at the surgical site. In both groups, superficial infection gradually improved with antibiotic therapy and daily dressings. There was one case (6.66%) in Group A which developed a deep infection at surgical site post-operatively which healed after second surgery. There was one case (6.66%) in Group A and three cases (20%) in Group B

Table 1: Rodriguez–Merchan criteria

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

Table 2: ASES score

Parameters	Group A	Group B
ASES score	Number of cases (%)	Number of cases (%)
<40	1 (6.66)	2 (13.33)
41–43	1 (6.66)	1 (6.66)
44–46	9 (60)	10 (66.66)
>46	4 (26.66)	2 (13.33)
Total	15 (100)	15 (100)

ASES: American Shoulder and Elbow Surgeons

Table 3: Complications

Parameters	Group A	Group B
Complications	Number of cases (%)	Number of cases (%)
Superficial infection	1 (6.66)	1 (6.66)
Deep infection	1 (6.66)	0 (0)
Shoulder stiffness	1 (6.66)	3 (20)
Elbow stiffness	1 (6.66)	1 (6.66)
Implant failure	1 (6.66)	0 (0)
Radial nerve palsy	1 (6.66)	0 (0)
Delayed union	1 (6.66)	2 (13.33)
Non-union	1 (6.66)	1 (6.66)

who developed shoulder stiffness post-operatively. The *P* value was statistically significant ($P < 0.05$). There was one case (6.66%) each in both groups which developed elbow stiffness. There was one case (6.66%) of implant failure in Group A where post-operatively at 6th week due to back out of screw patients plating failed. The patient was posted for surgery again, and dynamic compression plating was done, the fracture united after the second surgery. There was one case (6.66%) of radial nerve palsy in Group A which was present pre-operatively. There was one case in Groups A and 2 cases in Group B who had delayed union. There was one case each in both the groups who had non-union of fracture. These patients were posted for a second surgery where bone grafting was done at fracture site post which both the fractures united.

The mean ASES score in Group A was 45.07 with SD of 2.28 which is better than Group B, 44 with SD of 2.54. *P* value was not statistically significant ($P > 0.05$). According to Rodriguez–Merchan criteria, patients in Group A had

higher number of cases in good–to-excellent category than Group B, but this difference was statistically not significant.

DISCUSSION

The management of diaphyseal fractures of the humerus is always a challenging problem to orthopedic surgeon, as they are very frequently associated with multiple injuries, leading to complications such as shortening, malunion, infection, delayed union, and non-union etc.

The aim of treatment in these fractures is to achieve length and alignment and produce favorable environment for bone and soft tissue healing. Acceptable fracture alignment, which is the guide to continued conservative management, includes 20° of anterior bowing, 30° of varus angulation, 15° of malrotation, and 3 cm of shortening or bayonet apposition.^[5]

Conservative treatment has its demerits such as prolonged limb immobilization, the need for constant cooperation, and repeated hospital visits. Second, it cannot be recommended in every case like unstable fractures.

While there are several methods of operative intervention for diaphyseal fractures of the humerus, the internal fixation methods can be broadly grouped as plating or intramedullary nailing techniques. Interlocking nailing is preferable in comminuted, segmental, and pathological fractures, while plating may be the preferred option where radial nerve exploration is contemplated. Infection, non-union, and radial nerve palsy are general concerns suggested in the plating group.

In our study, we found that the maximum numbers of cases 15 (50%) were in the age group of 18–38 years. There were 11 cases (36.66%) in 38–58 years interval and 4 cases (13.33%) who were above 58 years. The mean age of patients was 37.2 years with SD of 16.95. Mulier *et al.* studied on 55 patients and found that the age of patients ranging between 30 and 40 years was the most common.^[6] McCormack *et al.* in their study of 44 patients

found that such fractures were common in the age group of 35–45 years.^[2]

In our study, we have found that mode of injury by RTA was the major cause of diaphyseal fracture of humerus 24 cases (80%) followed by fall on ground 5 cases (17%), and 1 case (3%) OUP B, 2 cases (13.33%). There was a single case of assault in Group B, 1 case (3.3%). Mulier *et al.* recorded that the most common cause to diaphyseal humerus fracture is high- energy trauma such as due to RTA.^[6]

In our study, we have found that 12 cases (33.33%) were operated in the interval of 3–4 days, 10 cases (20%) were operated in <2 days, 5 cases (26.66%) were operated in 5–6 days interval, and 3 cases (20%) were operated after 7 days interval. The mean between trauma and surgery in our study was 8.63 days with SD of 3.04. In a comparative study done by Mir *et al.*, the mean interval between admissions to surgery was 6.12 days (SD 3.67) in the interlock nailing group and 11.88 days (SD 3.29) in the dynamic compression plating group, and the values were statistically significant ($P > 0.05$).^[7] In our study, majority of the cases were operated in <7 days which is comparable to other study.

In our study, fluoroscopy was done in Group B only, and in majority of patients, 13 cases (86.66%) exposure time for fluoroscopy was between 3 and 6 min. Mean fluoroscopic exposure time was 4.3 min with SD of 1.35 min. In a study done by Mir *et al.* on 50 patients, the mean fluoroscopy time in the interlocking group was 4.6 min, while fluoroscopy was not used in the plating group.^[7] These findings are comparable to our study.

In our study, we found that in most of the cases, union time in weeks was 12 weeks, 13 cases (92.86%) in Group A and 12 cases (85.71%) in Group B. There was 1 case (7.14%) of delayed union (union at 24 weeks) in Group A and 2 cases (14.28%) in Group B. The mean union time in Group A was 12.84 weeks with SD of 3.20 and in Group B was 13.71 weeks with SD of 4.36. The p value was not statistically significant between the two groups ($P > 0.5$). A comparative study done by Mulier *et al.* in their study found the mean time of union to be 16 weeks with a range from 8 weeks to 65 weeks. They found that union time was less in case of plate fixation than nail fixation.^[6]

In our study, we found that both groups had one case (6.66%) that had superficial infection at the surgical site. In both groups, superficial infection gradually improved with antibiotic therapy and daily dressings. There was one case (6.66%) in Group A which developed deep infection at surgical site post-operatively. The surgical site was opened again in the OT, and dead and infected tissue was debrided; wound was thoroughly washed with saline and closed over

drains. Infection was controlled and the fracture healed normally. There was one case (6.66%) in Group A and three cases (20%) in Group B who developed shoulder stiffness post-operatively. The P value was statistically significant ($P < 0.05$). There was one case (6.66%) each in both groups which developed elbow stiffness. There was one case (6.66%) of implant failure in Group A, where at 6th week follow-up, there was a failure of plating due to screw back out. The patient was posted for surgery again and dynamic compression plating was done, the fracture united after the second surgery. There was one case (6.66%) of radial nerve palsy in Group A which was present pre-operatively, and the patient recovered completely during the follow-up. There was one case (6.66%) in Group A and two cases (13.33%) in Group B who had delayed union, both fractures united at 24 weeks. There was one case (6.66%) each in both the groups who had non-union of the fracture. These patients were posted for a second surgery where bone grafting was done at fracture site post which both the fractures united.

In our study, we found that ASES functional score at final follow-up was more than 46 in 4 cases (26.66%) of Group A and 2 cases (13.33%) in Group B. This value was statistically significant ($P < 0.05$). There were 9 cases (60%) in Group A and 10 cases (66.66%) in Group B whose ASES score was in interval between 44 and 46. There was one case (6.66%) in both groups who had their ASES score in the interval between 41 and 43. There was one case (6.66%) in Group A and two cases (13.33%) in Group B who had their ASES score below 40. The mean ASES score in Group A was 45.07 with SD of 2.28 and in Group B was 44 with SD of 2.54. The P value was not statistically significant ($P > 0.05$). A study done by Changulani *et al.* found that mean ASES score in patients treated with nailing was 44 and that of patients treated with plate fixation was 45.^[8]

In our study, we found that according to Rodriguez–Merchan criteria, five cases (33.33%) in Group A and four cases (26.66%) in Group B had excellent rating at final follow-up. There were eight cases (53.33%) each in both the groups who had good rating. There was one case in Group A and two cases in Group B who had fair rating. Mir *et al.* in their study reported excellent results in 7 (28%), good in 13 (52%), fair in 3 (12%), and poor in 2 patients of interlock group. Results were similar in the Digital Cinema Package with excellent result in 8 (32%), good in 13 (52%), fair in 2, and poor in 2 patients. The final outcome in this series did not show any significant advantage of one method over the other.^[7]

CONCLUSION

Patients in the interlock nailing group had shorter operative time and hospital stay, and there was no statistically significant

difference in terms of time of union of fractures or the functional score between the two. Interlock nailing provides rigid secure fixation along with maintenance of biology which makes it effective alternative to dynamic compression plate. No single treatment is superior in all circumstances for a particular fracture, and each case has to be individualized.

The shortcoming of this study was that there were less number of cases. We recommend more number of randomized studies consisting of larger number of cases in future to be done so that a clear-cut consensus can be reached.

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