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A comparative study of plating versus interlocking nail in fracture shaft humerus

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ABSTRACT

This study is to compare the outcomes of each method of fixation i.e. plating and interlocking nailing for the patients with fracture shaft of humerus and to analysis statistically significant difference in the results of these two methods conducted during October 2020 to September 2022 among 20 patients who satisfied the inclusion criteria and exclusion criteria, follow up was done up to 9 months. The study of 20 patients of humerus shaft fracture fixed either with plate or interlocking nail showed postoperatively in the plating group there were 2 complications and in the interlocking group there were 6 cases with complications, healing rate is found to be good in the plating maximum time taken is ≤17 weeks and while interlocking more than half cases took ≥17 weeks, the average disabilities of the arm, shoulder and hand (DASH) score in the plating group was 19.8 and in the interlocking group it was 44.6, among the 20 patients 5 had excellent results, 8 had good results, 5 had fair results, 2 had poor results. We conclude that both the modalities of treatment i.e., plating and interlocking nailing are good as far as union of the fracture is concerned, but considering the functional outcome and rate of complications, we are of the opinion that plating offers better result than interlocking nailing with respect to pain and function of the shoulder joint.

Keywords: Humerus shaft fractures, Plating, Interlocking nail

INTRODUCTION

Humeral shaft fractures are frequent, making up 3% of all fractures (20% of all humerus fractures) and were once considered to be benign, with a high percentage of primary healing rate when treated conservatively with a functional brace or a hanging arm cast.[1] However, loss of reduction in the plaster cast invariably leads to malunion. In the past, surgical therapy for humerus fractures has typically been saved for patients with neurovascular problems, polytrauma, nonunion, and forearm fractures. Early mobilization is an advantage of operative management. However, technical errors and postoperative consequences, such as nerve damage and infections, are risks associated with operative care. The majority of studies have used fracture union as the primary determinant of the outcome and few studies have looked at the functions at the elbow and shoulder joints, and there is ongoing discussion on the best technique for fixing humeral shaft fractures.[2-10] Plate osteosynthesis and intramedullary nailing are two methods being studied.

Although plating yields satisfactory results, it necessitates meticulous radial nerve protection and extensive dissection. Intramedullary nailing was thought to be a better option than plating for humeral shaft fractures due to the dynamic success of intramedullary treatment of femur and tibia fractures. Less invasive surgery, an undisturbed fracture hematoma, and the utilization of a load-sharing device support were among the potential benefits of intramedullary nailing. But in the humerus, interlocking nailing does not exhibit the same remarkable success as it does in long bones like the femur and tibia. Recent studies have shown that plate osteosynthesis is the

preferred technique for fixing humeral fractures and the aim of this study is to evaluate the results of the two fixation techniques (plating and interlocking nailing) and examine any statistically significant variations between the two techniques.[2,3,6,7,10]

CASE SERIES

This prospective comparative study includes twenty patients of shaft of humerus fracture was conducted in the Department of Orthopaedics Surgery and Traumatology, Mamata Medical College and General Hospital, Khammam. Each patient who met the inclusion criteria i.e. patients of age 18 years and above, all fractures of diaphysis of humerus indicated for treatment were included in the study after taking informed consent.

A thorough history and clinical examination was done. The status of radial nerve injury was recorded. Roentgenogram of the arm with shoulder and elbow was taken in both antero-posterior and lateral views. The humeral shaft fracture was temporarily immobilized with a U-slab and arm pouch. Preoperative planning consists of whether to do plating or nailing, determine the approach depending open type of fracture and level of fracture, length of the plate and nail and diameter of nail determined on the basis of X-rays.

Posterior approach used mostly in distal third fractures and patient is put in lateral or prone position with the arm resting on a support, incision is made a line joining a point eight centimeters below the acromion to the olecranon. The plane of dissection is between the long and the lateral heads of the triceps. The radial nerve is then identified and retracted, separated from the bone by the medial head of the triceps and then split it in the midline exposing the bone.[1,11]

Anterolateral approach used for upper and middle third and with the patient in supine position an incision is made along the lateral border of the biceps, till about ten centimeters proximal to the flexion crease of the elbow.[1] The lateral border of the biceps is identified and retracted medially. The interval between the Brachialis and the brachioradialis is identified proximal to the elbow and separated. The brachialis and the biceps are retracted medially and the brachioradialis laterally. The advantage of splitting the brachialis is that, the lateral part covers the radial nerve and the medial part covers the musculocutaneous nerve. The radial nerve is identified and traced proximally through the intermuscular septum and protected throughout the procedure. The periosteum is incised longitudinally at the lateral border of the brachialis muscle and humerus subperiosteally dissected.

Plating is the gold standard for fixation of humeral shaft fractures and associated with high union rate, low complications rate and rapid return to function.[1] It is applied on the tension side of the bone in accordance with the tension band principle. In humerus the most commonly used plates are the dynamic compression plate (DCP).

In transverse fractures the plate is applied in compression mode whereas in other fractures it is applied in neutral mode with a lag screw whenever feasible.[1] A minimum of 6 cortices (preferably eight) should be engaged on either side of the fracture when fixing a humeral shaft fracture.[1] Static compression between two fragments is maintained over several weeks and does not enhance bone resorption or necrosis. Fracture fragment interdigitation and compression reduces interfragmentary motion to nearly zero and allows for direct bony remodeling of the fracture (primary bone healing without callus). Compression must sufficiently neutralize all forces (bending, tension, shear, and rotation) along the whole cross section of a fracture to achieve absolute stability.

Approach in nailing is a longitudinal skin incision is made from the most lateral point of the acromion and extended distally and centered over the tip of the greater tuberosity.[1] Fascia over the deltoid is incised and the greater tuberosity is palpated. Point of insertion of the nail is medial to the tip of the greater tuberosity, approximately 0.5 cm posterior to the bicipital grove (to minimize damage to the rotator cuff), and should be template to be buried in the bone proximally, to minimize sub acromial impingement.

Small curved awl is used to establish the entry portal just medial to the tip of the greater tuberosity, is confirmed with the help of image intensifier. It should be centered on the anteroposterior and lateral views to ensure that the nail will be in the mid plane of the humerus.

The basic principle of intramedullary nailing is “dynamic osteosynthesis”. Intrinsic characteristics that affect nail biomechanics include its material properties, cross-sectional shape, anterior bow, and diameter. Extrinsic factors, such as reaming of the medullary canal, fracture stability (comminution), and the use and location of locking bolts also affect fixation biomechanics.

Although reaming and the insertion of intramedullary nails can have early deleterious effects on endosteal and cortical blood flow, canal reaming appears to have several positive effects on the fracture site, such as increasing extra osseous circulation, which is important for bone healing.

Interlocking produces positive fixation with both proximal and distal locking produces fixation of comminuted, segmental more proximal and distal humeral fractures. Statically locked nail does not allow gliding of the nail within the bone and controls both axial shortening and rotation. Dynamic locking refers to nails with either proximal or distal locking screws.

Post operatively arm sling pouch is given for 3 days and active range of motion started 4-7 days.

Follow up was done at 4 weeks for 1st 3 months and then every 6-weekly for the next 9 months, clinical examination was done to assess status of the surgical wound, pain, tenderness, range of motion of shoulder and elbow, stability of the fracture and clinical union. Roentgenograms were taken in AP and lateral views to look for signs of radiological union.

If there are no clinical and radiological signs of union by 16-17 weeks, the fracture was categorized as delayed union and if absence of fracture union after 32 weeks after injury was categorized as non-union. Return of 5/5 power was regarded as complete recovery in radial nerve palsy.

The functional outcome was measured by the "disabilities of arm, shoulder and hand" (DASH) questionnaire at nine months or at full recovery which ever was earlier, developed by the American Academy of Orthopaedics Surgeons (AAOS) and has been validated by various studies.[12]

The DASH questionnaire has thirty questions the answers of which are graded from one to five points.

The functional score is calculated by the formula.

$$DASH\ disability/symptom\ score = \{[Sum\ of\ N\ responses) - 1\} \times 25$$

Where 'N' is the number of 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 follows: excellent - 0 to 20 points, good - 21 to 40 points, fair - 41 to 60 points, and poor - greater than 60 points.

The time taken for radiological union and the functional outcome in both groups were then compared.

There were 20 fracture shaft of humerus in adults, maximum number of people had encountered fracture due to road traffic accident distribution being 10 in plating, 10 in interlocking group. The age of the plating group ranged from 22 to 60 years with mean 37.3 years, in the interlocking group ranged from 23 to 70 years with a mean age of 36.1 years. The student 't' test value was 0.2383 with "p value" of 0.8143 ($p>0.05$). Table 1 shows that there was no statistically significant difference in the age distribution of the two groups. Complications were more in the interlocking group, with 't' test 3.1623 and statistically significant with p value 0.0054 (Table 4).

Healing rate is found to be good in the plating maximum time taken is ≤17 weeks and while interlocking more than half cases took ≥17 weeks, with statistical significance p value 0.011 (Table 5). The average DASH score of the whole series was 30.2 (lower the DASH score better the function), in plating group was 19.8 and in interlocking group it was 44.6 i.e.; statistically significant with p value of 0.0006 (Table 6). Among the 20 patients 5 had excellent results, 8 had good results, 5 had fair results, 2 had poor results.

Table 1: Mean age distribution.

Group	N	Mean	Std. deviation	Sig.
Interlocking nail	10	36.1	11.3300	T=0.2383
Plating	10	37.3	11.1900	P=0.8143[NS]

NS: not significant

Table 2: Mode of injury.

Mode of injury	Group (%)		Total (%)
	Interlocking nail	Plating	
Domestic	1 (10)	1 (10)	2 (10)
Fall	2 (20)	2 (20)	4 (20)
RTA	7 (70)	6 (60)	13 (65)
Other	0 (0)	1 (10)	1 (5)
Total	10 (100)	10 (100)	20 (100)

Table 3: Showing level of injury.

Site	Group (%)		Total (%)
	Interlocking nail	Plating	
L/3	3 (30)	2 (20)	5 (25)
M/3	5 (50)	5 (50)	10 (50)
M/3 L/3	1 (10)	1 (10)	2 (10)
U/3	1 (10)	1 (10)	2 (10)
U/3 L/3	0 (0)	0 (0)	0 (0)
U/3 M/3	0 (0)	1 (10)	1 (5)
Total	10 (100)	10 (100)	20 (100)

L/3-lower third, M/3-middle third, U/3-upper third

Table 4: Post-operative complication.

Complications	Group (%)		Total (%)
	Interlocking nail	Plating	
Impingement	3 (50)	0 (0)	3 (37.5)
Implant failure	0 (0)	0 (0)	0 (0)
Radial nerve injury	0 (0)	1 (50)	1 (12.5)
Non union	0 (0)	0 (0)	0 (0)
Shoulder pain	1 (16.7)	1 (50)	2 (25)
Shoulder stiffness	2 (33.3)	0 (0)	2 (25)
Superficial	0 (0)	0 (0)	0 (0)
Total	6 (100)	2 (100)	8 (100)

Table 5: Rate of healing.

No. of weeks	Group (%)		P value
	Interlocking nail	Plating	
10-11	0 (0)	2 (20)	0.011, statistically significant
12-13	1 (10)	2 (20)	
14-15	2 (20)	2 (20)	
16-17	1 (10)	4 (40)	
18-19	3 (30)	0 (0)	
20-21	2 (20)	0 (0)	
22-23	1 (10)	0 (0)	
Total	10 (100)	10 (100)	
Mean±SD	17.5±3.74	13.5±2.5819	

Table 6: Statistical analysis of DASH scores.

Variables	N	Minimum	Maximum	Mean	Std. deviation	P value
Interlocking nail	10	0.00	92.00	44.6	14.13647	0.0006
Plating	10	0.00	65.00	19.8	12.2947	
Total	20	0.00	92.00	30.2	13.21558	

DISCUSSION

Our study is compared to similar studies which were done earlier. This study is having a follow up of minimum of 6 months and maximum of 22 months and therefore discussion is essentially a preliminary assessment.

Approximately 14% of all humeral fractures and 1% to 3% of all fractures in the human body are humeral shaft fractures. It becomes essential to create a customized treatment plan for each patient due to the wide range of potential treatment techniques. Placing and intramedullary fixation13 are options for surgical fixation when appropriate.

Most surgeons agree that intramedullary nailing is the best internal fixation for femoral and tibial shaft fractures, but there is no 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.[14]

In our study, average age is 37.3 years in plate osteosynthesis group and 36.1 years in nailing group. The maximum number of patients are in 2nd and 3rd decades which was similar to the observation of McCormack et al, Gongol et al and there was no statistically significant difference in the age distribution among two groups.[15,16]

Raju et al who reported that out of total 38 patients treated surgically, mean age was 37.27 years in plating and 35.05 years in nailing group.[3]

The most common mode of injury is due to road traffic accident (RTA) around 60-70% in both groups. RTA was the most common mechanism of injury with 29 (67.5%) cases in Pansey et al study, 34 (85%) patients in Janakbhai et al and in our study.[2,4]

Majority of the fractures in our study were in the middle third i.e., 10 (50%) patients which is in accordance with other studies except for Bell et al and Klenerman et al.[18] Most of the fractures in our series were transverse or short oblique, 10 (51%) patients, is similar to more recent studies, but not with older studies like Klenerman.[18]

Incidence of non- union in our study was found to be 0% in both the nailing and plating group which was different from that of previous studies, which reports the incidence of non-union after plating has ranged from 2% to 4% and retrospective studies of locked intramedullary nail fixation quote incidences of non-union ranging from 0% to 8%.[19,20] The study conducted by Kesemenli et al in 2003 in 60 patients with fractures of the shaft of humerus, 33 fixed with interlock nailing and 27 with dynamic compression plating, showed that healing did not differ in both the groups, but non-union rate was higher with interlock nailing.[5]

Our study is almost similar to the study conducted by Desai et al which showed no non-union cases in plating group and 1 delayed union in interlocking group.[7]

The incidence of radial nerve palsy with fracture shaft humerus varies from 6% to 15%.[21] In our series the incidence was 0% in nailing. In plating group, the incidence of post-operative radial nerve palsy is 2% to 5%, but there were 1 (5%) case in our study which recovered completely.[19,22] The incidence was 6.66% and recovered completely according to Desai et al.[7]

In our study mean healing time of 17.5 weeks in nailing group and 13.5 weeks in plating group. Mean time taken

for fracture healing in plating is shorter period than nailing which is similar to the study conducted by Putti et al were he reported a mean time of healing of 16 weeks in patients with DCP plating and 18 weeks in patients treated with nailing.[6]

Functional results of our study were comparable to the study by Singisetti and Ambedkar.[10] In 2010 in a prospective, comparative study of management of acute humeral shaft fractures treated by antegrade interlocking nailing and DCP plating over a period of 3 years. A higher rate of excellent and good results and a tendency for earlier union was seen with the plating group in their series. A study carried out by Desai et al has achieved a mean healing time of 18.05 in patients treated with humerus nailing and 17.4 weeks in patients treated with DCP plating.[7]

Pansey et al observed radiological union was seen at 13±4.8 weeks and 15±3.9 weeks in the nailing and plating group respectively.[2] In Janakbhai et al study fracture union in plating group was seen at 15.30 weeks and in nailing group 14.45 weeks.[4] Healing rate was relatively faster in nailing group compared to plating group but it is statically not significant.

Raju et al showed similar findings in their study. Facture union in plating group was seen at 16 weeks and in IMN group 14 weeks.[3] Average time taken for radiological union was 15 weeks. In plating group, average time taken for fracture union was 16.06 weeks, and in IMN group, average was 14.05 weeks. Healing rate was relatively faster in IMN group compared to plating group.

Table 7: Comparing duration of union of our study with other study.

Study	ILN (weeks)	Plating (weeks)
Putti et al[6]	18	16
Desai et al[7]	18.05	17.4
Pansey et al[2]	13±4.8	15±3.9
Raju[3]	14	16
Janakbhai[4]	14.45	15.30
Our study	17.5	13.5

3 patients had developed shoulder pain or stiffness and 6 of our 10 patients in the interlocking nailing group reported some or the other shoulder pain in our study confirming that antegrade insertion of nail can lead to problems with shoulder function and range of movement (ROM) probably because of damage to the rotator cuff. Our results were similar to the studies conducted by Habemek and Orthner, Hems and Bhullar, and Desai et al.[7,8,19] Reported individually, Habemek and Orthner in 1991 reported good results with Seidel's interlocking nail but later withdrew their support in 1998, as they had not assessed the shoulder functions of their patients properly.[8] The cause of pain could be disruption of the rotator cuff in its avascular zone within 1 cm of its insertion to the greater tuberosity that may lead to poor healing.[8]

Hems and Bhullar suggest that nailing adversely affects healing by distracting the fracture and the soft tissues, 5 cases of impingement occurred in nailing, confirms that IM nail insertion can lead to problems with shoulder function and ROM, probably because of damage to the rotator cuff.[9,19] Desai et al study confirms that antegrade insertion of nail can lead to problems with shoulder function and ROM probably because of damage to the rotator cuff.[7] Pansey et al study reported 3 (13.6%) cases in the nailing group had post-operative shoulder stiffness.[2]

Saini et al study reported 4 (20%) cases of shoulder pain in nailing group which was main complication, one case with delayed union in nailing.[4] In plating group 19 (95%) patients recovered completely and 1 (5%) had superficial infection that was treated with regular dressing and oral antibiotics.

Table 8: Comparing shoulder function of our study with other study.

Study	ILN	Plating
Our study	Shoulder pain and stiffness	Nil
Hems and Bhullar[19]	Decreased shoulder function	Nil
Desai et al[7]	Decreased shoulder function	Nil
Saini et al[4]	Shoulder pain	Nil
Pansey et al[2]	Shoulder pain	Nil

DASH scoring

Saini et al studied 26 (65%) patients who had DASH score as excellent, followed by 8 (20%) as good and 5 (12.50%) as fair score.[4] Only in 1 (2.50%) patient DASH score was categorized as poor. In our study among the 20 patients 5 had excellent results, 8 had good results, 5 had fair results, 2 had poor results in our study. Our study is not in accordance with the Saini et al.[4]

The union rates are comparable in both the groups with the results in excellent and good category are similar. The complications were more in the interlocking nailing group with most of them pertaining to poor shoulder function or pain and statistically significant. The functional outcome was good in plating than in nailing. Our study is in accordance with Puri et al suggest that open reduction and internal fixation with a DCP remains a better treatment option for fractures of the shaft humerus.[23] McCormack et al performed a prospective randomized study of 44 patients with fracture shaft humerus fixed with dynamic compression plate and intramedullary interlock nailing.[15] They concluded that open reduction and internal fixation with a DCP remains the best treatment for unstable fractures of shaft of the humerus. Our results were

comparable with this study, found plating was better than nailing for fracture shaft humerus.

CONCLUSION

Fractures of the shaft humerus are one of the common fractures affecting present generation and treatment modality has to be decided carefully. Both the modalities of treatment i.e. dynamic compression plating and interlocking nailing are good as far as union of the fracture is concerned, but considering the functional outcome and rate of complications, we are of the opinion that dynamic compression plating offers better result than interlocking nailing with respect to pain and function of the shoulder joint.

In conclusion, no single treatment option is superior in all circumstances for particular fracture and each case has to be individualized. Plating has been shown to have better overall results compared to interlocking nails in treatment of closed humeral shaft fractures. A tendency for earlier union is seen with the plating group in our study.

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