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Research Article

Intramedullary Interlocking Nailing Versus Dynamic Compression Plating in Diaphyseal Humeral Fractures in Adults-A Comparative Study

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ABSTRACT

Introduction: The diaphyseal fractures of humerus account for 3% of all fractures. The management of diaphyseal humeral fractures remains controversial. The various studies proved the conservative management of these fractures were the gold standard which outweighs the risk-benefits associated with the operative procedures. To improve the functional quality of life, early return to sports and to avoid complications, the surgical management of these fractures are of prime importance.

Objectives: To study the functional outcome of humerus diaphyseal fractures operated with intramedullary nailing and dynamic compression plating.

Materials and Methods: From September 2015 to August 2018, a total of 107 patients were operated for diaphyseal humeral fractures in the department of Orthopedics, JJM Medical College, Davangere, Karnataka, India. These 107 patients were divided into two groups namely group N (n=59) were the patients who received intramedullary interlocking nailing for humeral diaphyseal fractures and group P (n=48) were the patients who received dynamic compression plating for humeral diaphyseal fractures. All the patients were functionally analyzed with DASH scores.

Results: In our study, in group N (n=59), the range of movements according to DASH scores were excellent in 39 patients (66.10%), good in 15 patients (25.42%) and poor in 5 patients (8.47%) and in group P (n=48), the range of movements according to DASH scores were excellent in 23 patients (47.91%), good in 16 patients (33.33%) and poor in 9 patients (18.75%). In our study, group N patients experienced less complication than group P patients, as group P patients developed post-operative nerve palsy which seems to be grievous injury out of surgery. The correlation analysis with Spearman's Rank correlation coefficient (rho ρ) was 0.79 for group N and 0.63 for group P between implants used and the union of humeral diaphyseal fractures. There is a statistically significant difference between union rate and complications between two groups with $p<0.03$.

Conclusion: No specific implant is superior to treat shaft of humerus fractures. Due to improved technical advances, closed reduction and internal fixation with intramedullary interlocking nailing of shaft of humerus fractures serve the better implant of choice in terms of post-op complications and blood loss.

Keywords: DASH scores; Diaphyseal; Dynamic compression plate; IMIL nailing

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INTRODUCTION

Humerus diaphyseal fractures account for 3% of all fractures, and 20% of all humerus fractures [1-3]. The incidence of diaphyseal humeral fractures are 11.5 per 1,00,000 people annually, or 0.011% [4]. Humerus shaft fractures were previously treated conservatively by using hanging cast and functional cast bracing. In recent times, for early mobilization and preventing long term complications of immobilization. Internal fixation with various modality options for the fixation including dynamic compression plate, limited contact DCP, locking compression plate, external fixation, intramedullary interlocking nailing, TENS flexible nailing system, it has not been possible to get any conclusive evidence for the same [5-7].

With the advent of rigid intramedullary nailing with transverse locking screws, the surgeons are now trying to couple the advantages of conservative management with the advantages of operative treatment [8]. Closed interlocking nailing involves minimal surgical intervention, biological fixation, no periosteal stripping with rotational and torsional stability, anatomical reduction, and early mobilization preservation of hematoma. This method can be easily controlled with the image intensifier control this method has become extremely easy. However, it has a disadvantage of rotator cuff impingement and restricted elbow movements [9].

The plate osteosynthesis has proven the higher rates of fracture union with anatomical reduction and good compression across fracture site, with no damage to the rotator cuff and the elbow joint, but has the disadvantage of periosteal stripping, extensive incision, and increased chances of infection or nerve damage, less secured fracture of osteopenic bone [10].

OBJECTIVES

To study the functional outcome of humerus diaphyseal fractures operated with intramedullary nailing and dynamic compression plating.

MATERIALS AND METHODS

Patient's recruitment

With level IV evidence, a prospective cohort study was performed from September 2015 to August 2018 in the department of Orthopaedics, Bapuji hospital and Chigateri Government General Hospital, JJM Medical College, Davangere, Karnataka, India. The patients for this study were recruited by convenient sampling technique. Among 119 clinically and radiologically confirmed humeral diaphyseal fracture patients, a total of 12 patients (9 patients of open fractures and 3 patients of neurological deficit) were excluded and remaining 107 patients divided into two groups namely group N (n=59) were the patients who received intramedullary interlocking nailing for humeral diaphyseal fractures and group P (n=48) were the patients who received dynamic compression plating for humeral diaphyseal fractures.

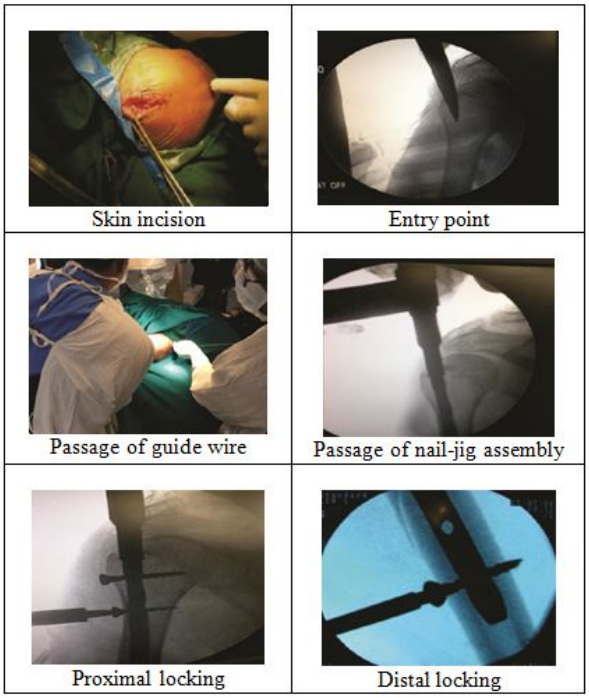

Figure 1: Surgical procedure for humeral IMIL nailing.

Inclusion criteria

The patients between the age of 18-70 years, patients with closed humeral diaphyseal fractures, patients with fractures less than 2 weeks old and patients who are willing to undergo surgical management according to our protocol were included in the study.

Exclusion criteria

The patients aged less than 18 years or more than 70 years, patients with open fractures according to Gustilo Anderson classification, patients with fractures more than 2 weeks old, patients with neurological deficits, patients with pathological fractures and patients who are not willing and unfit for surgical management according to our protocol were excluded from the study.

Surgical procedure for humeral IMIL nailing

A small skin incision from the anterolateral edge of the acromion distally towards the deltoid insertion was made. Split and retract deltoid muscle, and split the supraspinatus tendon insertion and expose the superior humerus articular cartilage. The ideal entry exposure is just posterior to the long head of the biceps' tendon. Insert a guidewire through the correct entry point and confirm proper placement by image intensification. And proximal humerus is opened by using a cannulated reamer or bone awl. Ream up sequentially to an appropriate size for the desired nail. Mount the nail to jig and pass it over the guidewire and through the fracture site till just above the olecranon fossa. The proximal end of the nail should be buried under the bony surface to prevent post-operative impingement under the acromion process. To lock the nail in the correct rotation, swivel

the aiming arm approximately 25° anteriorly. Due to the physiological retroversion of the humeral head. The proximal locking is done with the jig and distal locking is done by freehand technique, then the jig removed and wound closed in layers after repair of the supraspinatus tendon (Figure 1).

Surgical procedure for humeral DCP plating

The skin incision follows the line extending between biceps and mobile wad distally and between the deltoid and lateral edge of the biceps proximally. Retract biceps medially and mobile wad laterally to expose the brachialis muscle, dissect brachialis in interval supplied between the radial and musculocutaneous nerve. Look for the radial nerve and musculocutaneous nerve in the distal humerus and trace it proximally along with the dissection and expose the humerus. The anterolateral plate (4.5 mm narrow DCP) is best suited for diaphyseal humeral fractures. With reduction clamp and manual traction on the distal fragment alignment and proper rotation achieved. With eccentric drilling over the sufficient DCP plate, the compression is achieved at the fracture site and anatomic reduction is possible. The minimum of 3 screws on either side of fracture supplemented with interfragmentary screws at the fracture site, the satisfactory reduction was possible. Thorough wash was given and wound closed in layers and skin sutured (Figure 2).

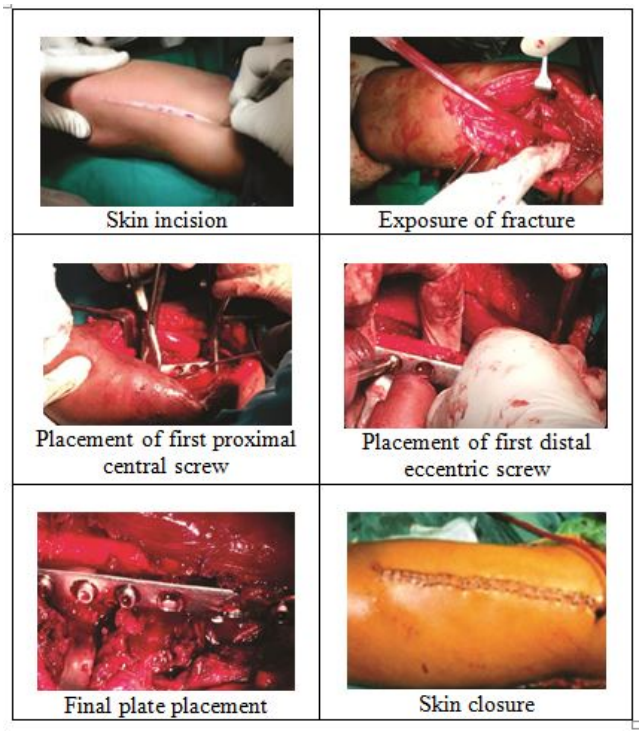

Figure 2: Surgical procedure for humeral DCP nailing.

Post-operative protocol

Immediately following surgery, the limb was supported in arm pouch and gradually active shoulder and elbow exercises were carried out. The drain was removed after 48 hours for DCP patients. The sutures were removed after 12th POD. The patients were trained for home-based shoulder strengthening exercises.

Follow up

The functional outcome of humeral diaphyseal fractures was assessed by DASH scoring. The follow up of patients were done with regular clinical and radiological analysis at the immediate post-op period and at the end of 1, 3, 6 and 12 months. All the patients were offered implant removal at an average of 24 months post-surgical procedure that showed clinical and radiological fracture union.

RESULTS

A total of 107 patients, who underwent surgical management as per the study protocol, were taken into consideration for statistical analysis. The group N patients (n=59) received intramedullary interlocking (IMIL) nailing and group P patients (n=48) received Dynamic Compression Plating (DCP) for humeral diaphyseal fractures. The descriptive-analytical statistics were evaluated statistically with IBM SPSS Statistics for Windows, Version 20.0, IBM Corp, Chicago, IL (Table 1).

Among 107 patients in this study, 65 patients (60.74%) were males and 42 patients (39.25%) were females. All the patients belong to age between 23 to 67 years of age. The average age of the study population was 42.12 ± 6.27 years. The sex difference among both the groups was statistically insignificant (p=1.923).

Table 1: Patient's demography according to the study groups.

Age group	Group N (n=59)		Group P (n=48)	
	No of males	No of females	No of males	No of females
21-30	6	4	2	3
31-40	12	7	11	8
41-50	9	5	7	4
51-60	6	5	5	3
61-70	3	2	4	1
Total	36 (61.01%)	23 (38.98%)	29 (60.41%)	19 (39.58%)

Table 2: Type of fracture patterns among the study groups.

Pattern of fracture	Group N (n=59)	Group P (n=48)	Total (n=107)
Transverse	12 (20.33%)	9 (18.75%)	21 (19.62%)
Spiral	17 (28.81%)	18 (37.50%)	35 (32.71%)
Oblique	25 (42.37%)	14 (21.66%)	39 (36.44%)
Comminuted	5 (8.47%)	7 (14.58%)	12 (11.21%)

All the patients were operated with an average of 2.52 ± 0.47 days ranging from 2.18-3.63 days of admission. All patients were

treated with IV antibiotics for 5 days followed by one week of oral antibiotics. All patients were advised to start the active range of shoulder and elbow exercises to prevent rotator cuff arthropathy and elbow stiffness and contractures. The sutures were removed at the end of the 12th post-op day. No intraoperative complications were noted during the surgical procedures (Table 2).

All the patients were followed up serially as per our protocol with serial clinical and radiographical examinations. The mean radiological union of humeral fractures by IMIL nailing (n=59) were 21.17 ± 4.26 weeks and by DCP (n=48) were 22.90 ± 3.05 weeks. A total of 2 patients (3.38%) in group N and 4 patients (8.33%) in group P showed signs of established non-union after 9 months of post-procedure (Figure 3).

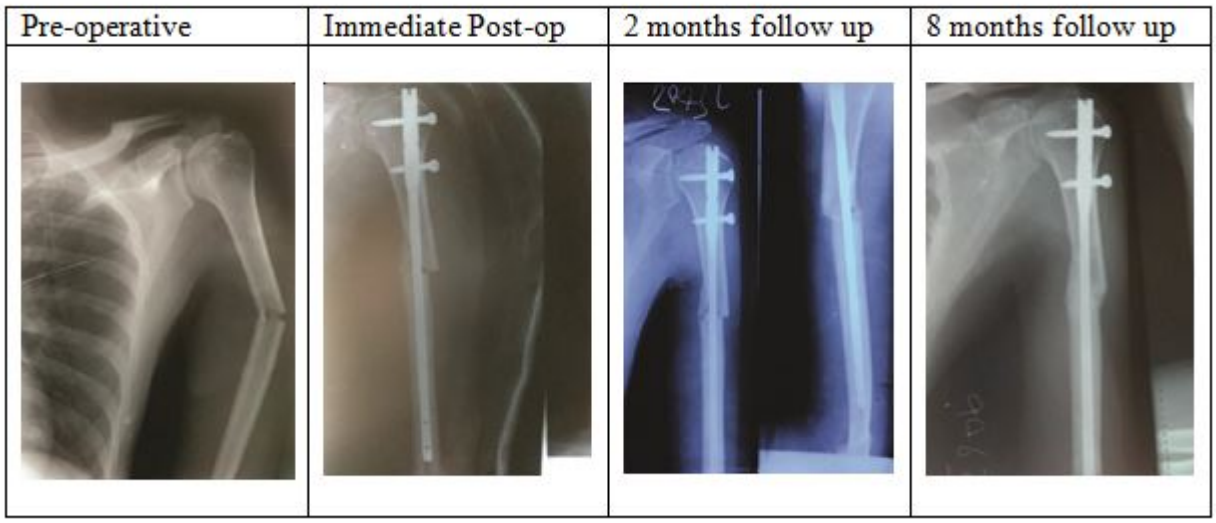

Figure 3: Radiographs of IMIL nailing for diaphyseal humeral fractures.

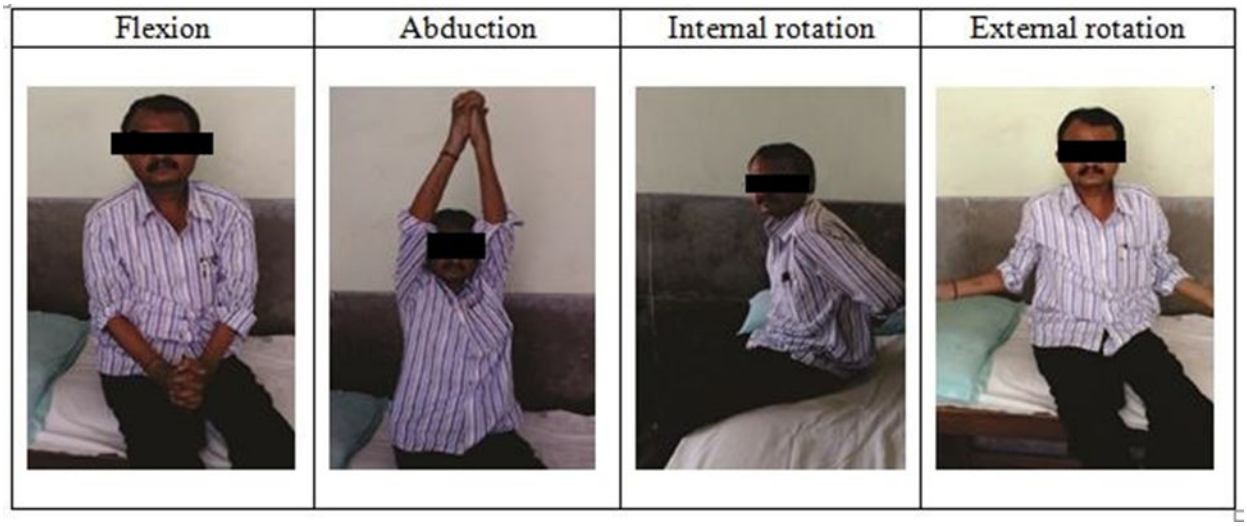

Figure 4: Clinical outcome of IMIL nailing for diaphyseal humeral fractures.

The functional assessments were made with DASH scores. In group N (n=59), the range of movements according to DASH scores was excellent in 39 patients (66.10%), good in 15 patients (25.42%) and poor in 5 patients (8.47%). The poor range of movements (n=5) was due to non-union 2 patients, breakage of nail 2 patients and shoulder impingement 1 patient (Figure 4).

In group P (n=48), the range of movements according to DASH scores was excellent in 23 patients (47.91%), good in 16 patients (33.33%) and poor in 9 patients (18.75%). The poor range of movements (n=9) was due to deep infection 2 patients, non-union 4 patients, wrist drop 3 patients (Figure 5).

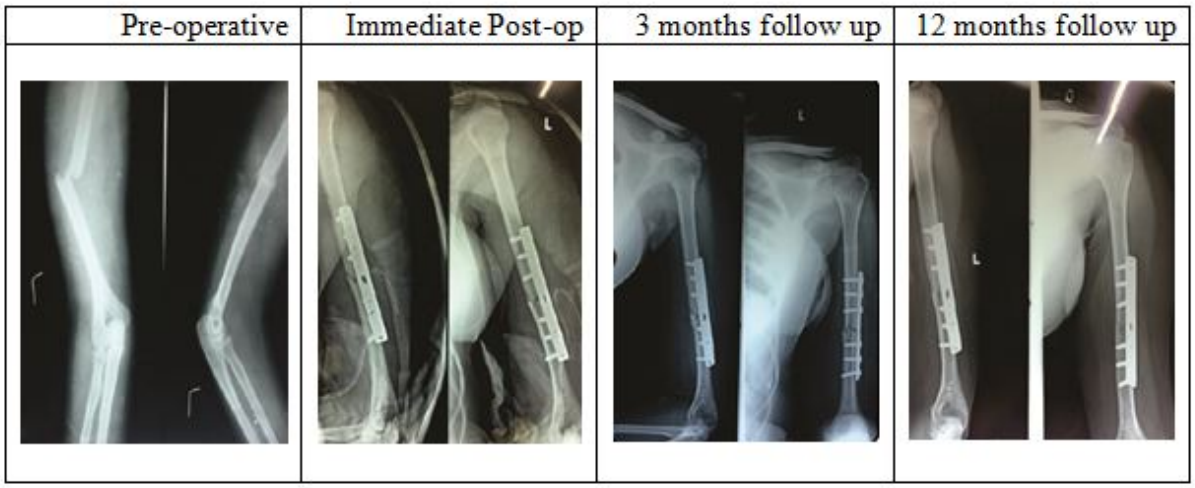

Figure 5: Radiographs of DCP plating for diaphyseal humeral fractures.

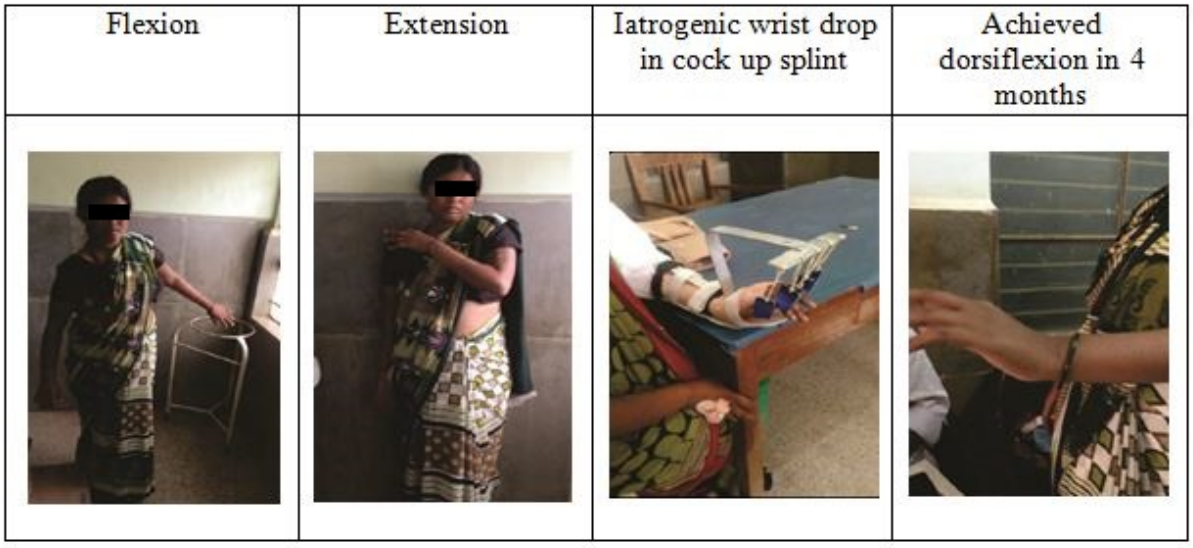

Figure 6: Clinical outcome of DCP plating for diaphyseal humeral fractures.

Table 3: Complications.

Complications	Group N (n=59)	Group P (n=48)	Total (n=107)
No complication	37 (62.71%)	23 (47.91%)	60 (56.07%)
Infection	0 (0.00%)	2 (4.16%)	2 (1.86%)
Shoulder impingement due to nail migration	1 (1.69%)	0 (0.00%)	1 (0.93%)
Shoulder stiffness	7 (11.86%)	4 (8.33%)	11 (10.28%)
Open reduction of fracture	2 (3.38%)	0 (0.00%)	2 (1.86%)
Stiff elbow	0 (0.00%)	2 (4.16%)	2 (1.86%)
Wrist drop	0 (0.00%)	3 (6.25%)	3 (2.80%)
Implant breakage	2 (3.38%)	0 (0.00%)	2 (1.86%)
Non union	2 (3.38%)	4 (8.33%)	6 (5.60%)

The superficial and deep infection patients in group P were treated with culture-sensitive IV antibiotics for 2 weeks followed by oral antibiotics for 4 weeks with serial radiographic analysis. The non-union of fracture in both the groups were counseled for the second surgical procedure with opening and freshening the fracture site and dynamic compression plating. The shoulder impingement due to nail migration patients were tracked

regularly with the advice of nail removal once when clinical and radiological signs of fracture union were observed. The nail breakage case went into non-union of fracture and later implant removal followed by dynamic compression plating along with bone grafting were done (Figure 6).

For the wrist drop patients in group P, nerve conduction studies were performed after 3 weeks of surgical procedure. The results turned out to be neuropraxia of the radial nerve. So those patients were managed with a dynamic cock-up splint for 16-20 weeks and were regularly followed up for clinical and functional recovery of the nerve (Table 3).

The correlation analysis with Spearman's Rank correlation coefficient (rho ρ) was 0.79 which show a highly positive correlation between the union of humeral diaphyseal fracture and intramedullary interlocking nailing and (rho ρ) was 0.63 which show a moderately positive correlation between the union of humeral diaphyseal fracture and dynamic compression plating. There is a statistically significant difference between union rate and complications between two groups with $p<0.03$.

DISCUSSION

The management of diaphyseal humeral fractures have always posed a problem to the Orthopaedic surgeon, as they were very frequently associated with the complications of fragment rotation, nerve injury, infection, delayed- and non-union, non-union. The various research analysis showed the decreased morbidity and the improved functional outcome of diaphyseal humeral fractures by conservative management through hanging U cast method for a considerable period of immobilization. The objective of surgical management of diaphyseal humeral fractures is to maintain the proper length, de-rotation of fragments and the alignment of humeral diaphysis, satisfactory fracture union, earlier immobilization and early return to work [11,12]. The gold standard surgical methods to manage humeral diaphyseal fractures are Dynamic Compression Plating (DCP) or intramedullary interlocking nailing (IMIL) [13].

An acceptable functional result can be achieved in shaft humerus fractures even if 3cm of shortening, 30 degrees of rotation and 20 degrees of angulation exists after fracture union, making many of these fractures amenable to conservative treatment [9].

The intramedullary interlocking nailing (IMIL) for diaphyseal humeral fractures are a less invasive procedure with load sharing feature of the implant. The diaphyseal humeral fractures managed with IMIL nailing improve the biomechanics, faster union as reaming serves as an autograft with minimal periosteal stripping. The nail serves the better stabilization than plates in extreme degree of osteoporosis. Nailing is associated with postoperative shoulder impingement syndrome, violation of rotator cuff and glenohumeral joint [7,8].

The usage of the dynamic compression plate provides the anatomical reduction at fracture site without violation of rotator cuff muscles and impingement syndromes. On the outweigh, plating requires extensive soft tissue dissection, mechanical failure in osteopenic bone, tracing of the radial nerve and prolonged immobilization [7,8].

Ouyang et al. worked out an extensive meta-analysis to compare the results of intramedullary nailing and plating techniques in the treatment of diaphyseal humeral fractures. They concluded that no significant difference present between intramedullary nailing and plating except for an increased incidence of shoulder related complications in the nailing group [14].

Venkatesh Gupta et al. concluded that CRIF with IMIL nailing offers better result than ORIF with DCP in view of fewer chances of infection and early union of fracture [15]. Elango et al. reported that none of the implants is superior to others, in terms of fracture union and functional outcome. The choice of the implant solely relies on the discretion of the operating surgeon [16]. Mamood et al. concluded that no single treatment option is superior in treating humeral shaft fractures. They pointed out that each case has to be individualized as per the choice of implant for a particular fracture. Plating has been shown to have better results compare to interlocking nails in the treatment of closed humeral shaft fractures in terms of the union of fractures [17].

Ashwin Kasturi et al. showed that treatment of fracture shaft of the humerus with IMIL nailing was superior to DCP as it was a minimally invasive procedure with lesser blood loss and a lower rate of infection [18]. Angad Jolly et al. concluded that ORIF with LCP is a better surgical option for managing humerus shaft fractures as compared to CRIF with IMIL nails due to a better functional outcome and a lesser chance of implant failure, despite there being a larger volume of intra-op blood loss and longer duration of surgery [19].

Mir GR et al. concluded IMIL nailing for shaft humerus fractures is an effective surgical option though there are high chances of shoulder related complications [20]. Intramedullary interlocking nailing was also associated with significantly decreased blood loss than plating as stated by Chao et al. [21]. Flinkilla et al. in an analysis of shoulder from different studies reported similar shoulder scores in both nailing and plating groups, with plating having better abduction and flexion [22]. Bhandari et al. did not show higher risks of infection or radial nerve palsy with plating [23].

In our study, in group N (n=59), the range of movements according to DASH scores were excellent in 39 patients (66.10%), good in 15 patients (25.42%) and poor in 5 patients (8.47%) and in group P (n=48), the range of movements according to DASH scores were excellent in 23 patients (47.91%), good in 16 patients (33.33%) and poor in 9 patients (18.75%). In our study, group N patients experienced less complication than group P patients, as group P patients developed post-operative nerve palsy which seems to be grievous injury out of surgery.

CONCLUSION

Although in literature, it is mentioned that no specific implant is superior to treat shaft of humerus fractures. Due to improved technical advances, closed reduction and internal fixation with intramedullary interlocking nailing of shaft of humerus fractures serve the better implant of choice in terms of post-op complications and blood loss. As a surgeon, we suggest the

implant of choice is to be individualized as per the mechanism of injury, pattern of fracture and quality of bone.

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