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Research Article

Comparison of Dynamic Compression Plating vs. Flexible Intramedullary Nailing in Diaphyseal Humerus Fractures: A Study of 50 Cases

Jeevan Kishor A.[1], Ruchit Vyas[2], Mukesh S. Dwivedi[3], Tarun V. Desai[4], Bharat Soni[2], Shantanu Vijay[1], Fenil Shah[1], Prashant Alwani[5], Ammar Rampurwala[2], Chirag V. Thakkar[3,*]

[1] Junior Resident, Department of Orthopedics, GMERS Medical College Gotri, Vadodara, India
[2] Senior Resident, Department of Orthopedics, GMERS Medical College Gotri, Vadodara, India
[3] Professor, Department of Orthopedics, GMERS Medical College Gotri, Vadodara, India
[4] Associate Professor, Department of Orthopedics, GMERS Medical College Gotri, Vadodara, India
[5] Assistant Professor, Department of Orthopedics, GMERS Medical College Gotri, Vadodara, India

[*]Corresponding author: Chirag V. Thakkar; Department of Orthopedics, GMERS Medical College Gotri, Vadodara, India. Tel: +91-9898265691; Email: cvtortho@gmail.com

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Abstract

Background: Diaphyseal humerus fractures are frequent orthopaedic injuries requiring effective management for optimal recovery. This study aims to evaluate and compare the outcomes of open reduction with dynamic compression plating (DCP) and closed reduction with flexible intramedullary nailing (IMN) for treating humeral shaft fractures.
Methods: This prospective, randomized study included 50 patients with diaphyseal humeral fractures, randomized to either DCP (group P) or IMN (group N). Primary outcomes assessed were radiological union, functional recovery through Disabilities of the Arm, Shoulder, and Hand (DASH) scores, and range of motion (ROM). Secondary outcomes included surgical duration, exposure to radiation, and postoperative complications.
Results: The union rate was comparable between the two groups, with 100% in group P and 96% in group N (P = 0.99). Similarly, the DASH scores showed no significant difference (group P: 21.80 ± 6.98, group N: 24.56 ± 9.48, P = 0.24). Group P required longer surgical time and showed higher chances of surgical site infection (SSI), while group N experienced higher exposure to radiation and increased implant-related complications.
Conclusion: Both DCP and flexible IMN are viable options for diaphyseal humerus fractures, with no significant difference in functional outcomes. The choice between these methods should consider patient-specific needs and fracture characteristics.

Keywords: Fracture Fixation; Intramedullary Nailing; Humeral Fractures; Prospective Studies

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Background

In western world, humeral shaft fractures represent approximately 1-3 percent of all fractures. Achieving a stable union and restoring function are primary therapeutic goals, necessitating interventions that balance stability with minimal complications (1, 2). Traditional treatment options include conservative approaches like functional bracing, though surgical methods such as dynamic compression plating (DCP) and intramedullary nailing (IMN) have gained traction due to early mobilization and reduced complications related to immobilization (3). While DCP and IMN are widely used, their relative benefits are debated, particularly concerning infection rates, surgical invasiveness, functional outcomes, and complications. This study compares these two methods by evaluating rate of union, functional recovery [Disabilities of the Arm, Shoulder, and Hand (DASH) score] (4), range of motion (ROM), and complications in patients with humeral shaft fractures.

Methods

This prospective, randomized comparative study was conducted at GMERS Medical College and General Hospital, Vadodara, India, over two years (from 2022 to 2024), following approval from the institutional ethics committee.

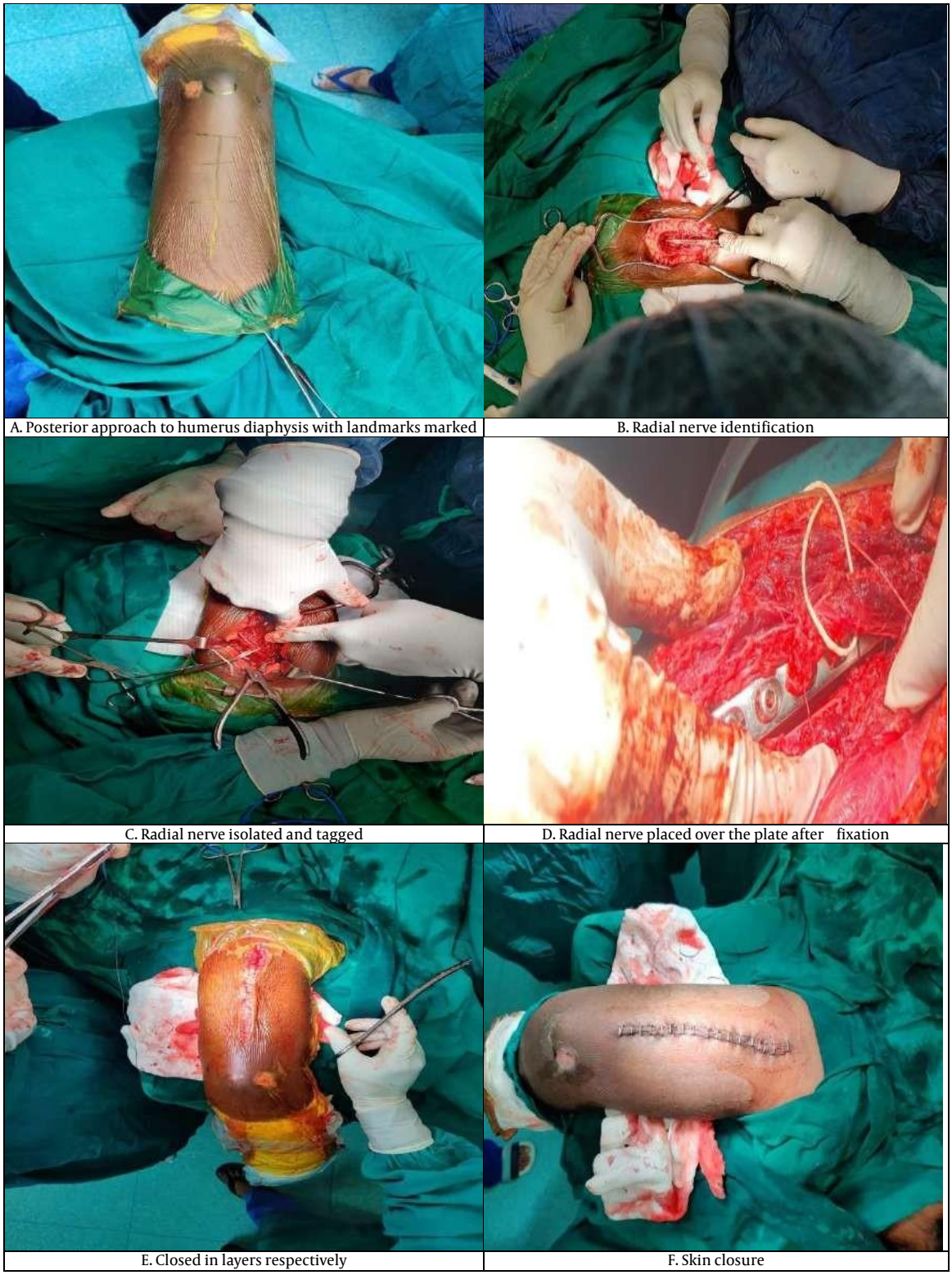
The study involved 50 patients with diaphyseal humeral fractures, equally divided into two groups: 25 patients in the DCP group (group P) and 25 in the IMN group (group N). Inclusion criteria comprised patients aged 18 to 65 years with closed fractures and no associated skeletal injuries. Exclusion criteria included open fractures, neurovascular deficits, or any contraindications to surgical intervention.

Plain radiographs were obtained in anteroposterior (AP) and lateral views of the affected arm, including the shoulder and elbow joints. The radiographs were carefully analyzed to plan the technical aspects of the surgical intervention. A U-slab was applied for temporary immobilization, and a collar-and-cuff sling was used. Analgesics were administered for pain relief.

Preoperative blood tests [complete blood count (CBC), blood urea, serum creatinine, blood sugar, human immunodeficiency virus (HIV), hepatitis B surface antigen (HBsAg), hepatitis C virus (HCV)], electrocardiography (ECG), and chest radiograph were performed. A pre-anesthetic evaluation was conducted before all surgical procedures.

After explaining the details of the operative procedure, informed written consent was obtained from all the patients regarding the choice of implants. All cases were managed either by closed reduction and flexible IMN or open reduction with DCP after randomization; odd numbered patients were included in group P and even numbered in group N.

Group P (DCP): Patients underwent open reduction with DCP. Posterior approach was used with a longitudinal incision, radial nerve identification and isolation followed by fixation with a 4.5 mm narrow DCP (Figure 1).



A. Posterior approach to humerus diaphysis with landmarks marked | B. Radial nerve identification

C. Radial nerve isolated and tagged | D. Radial nerve placed over the plate after fixation

E. Closed in layers respectively | F. Skin closure

Figure 1. Humerus shaft plating (operative procedure)

Group N (IMN): Patients underwent closed reduction with flexible IMN, using Ender nails inserted through proximal and distal lateral entry points (Figure 2).

Post-operatively, patients received intravenous (IV) analgesics and antibiotics for two days and were discharged after first dressing. Group N patients were immobilized in posterior above elbow slab for two weeks and group P patients were given a shoulder arm pouch without any rigid immobilization.

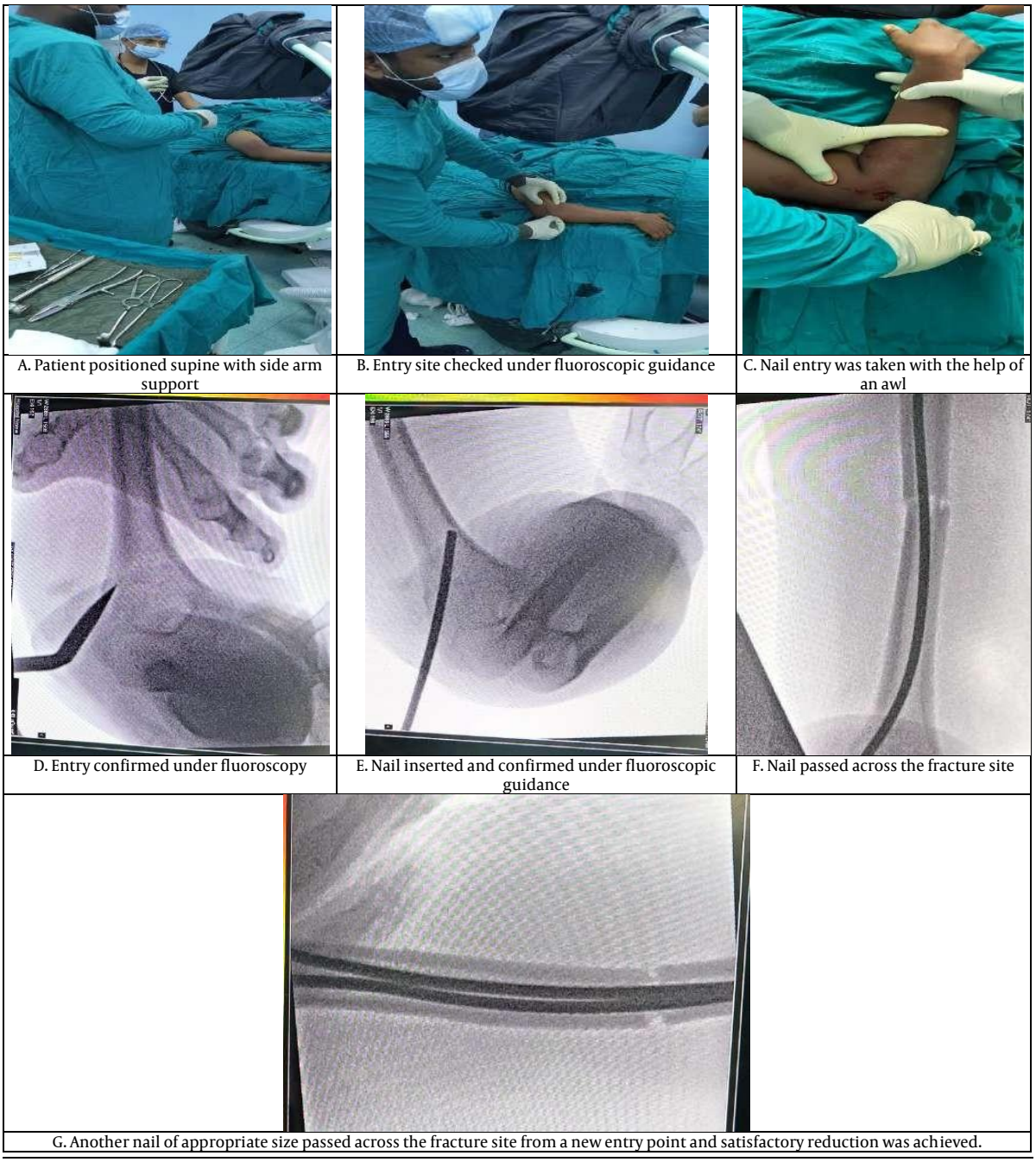


Figure 2. Ender's nailing procedure

During follow-up visits, dressings were done on weekly bases and sutures were removed by two weeks. Gradual ROM exercises under supervision were started the next day as per pain tolerance in group P patients. Similarly, guarded gradual mobilization was started in group N patients after removal of slab support at two weeks. Radiological union was assessed by AP and lateral radiographs (Figures 3, 4) and functional assessment was assessed with DASH score. Surgical duration, exposure to radiation, and complications during and after surgical procedures were compared.

Data were analyzed using paired t-tests for continuous variables and statistical significance was set at P-value < 0.05.

Results

Demographic Data of the Study (Table 1): In this study, mean age was 39.20 ± 13.02 years in group P and 40.56 ± 14.21 years in group N (P = 0.72). Gender distribution and hand dominance were similar across groups, with the majority being right-sided fractures and involving the dominant hand.

In this study, the fracture-pattern of shaft of humerus was classified into: transverse, oblique, spiral, and comminuted types.

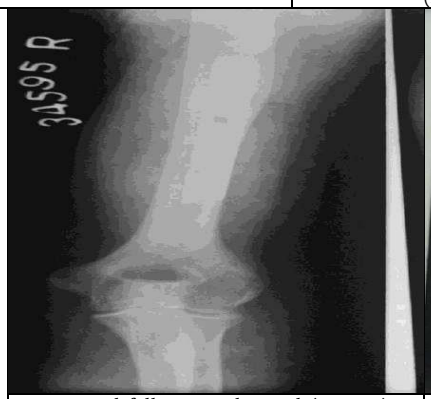
We found no significant variations in these patterns across both groups. In our study, more subjects were found to be injured with the accidental fall compared to road traffic accidents (RTAs).

A. Pre-operative images of fracture of diaphyseal of humerus

B. Immediate post-operative radiograph

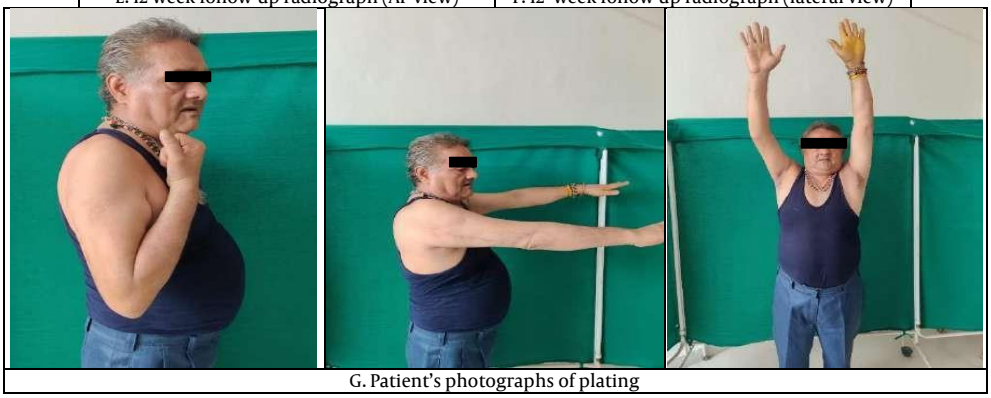
C. 6 week follow-up radiograph (lateral view)

D. 6 Week follow-up radiograph (AP view)



E. 12 week follow-up radiograph (AP view)

F. 12- week follow-up radiograph (lateral view)



G. Patient's photographs of plating

Figure 3. X-ray pictures of before and after treatment and follow-up of plating (50-year-old man) and clinical photos showing range of motion (ROM)

A. Diaphyseal humerus fracture | B. Pre-operative image | C. Ender's nailing – post-operative day 1

D. Two-month follow-up | E. Three-month follow-up | F. Four-month follow-up

G. Six-month follow-up | H. Implant removal –six months

I. Patient's photographs of nailing

Figure 4. X-ray pictures of before and after treatment and follow-up of nailing (60-year-old woman) and clinical photos showing range of motion (ROM)

Table 1. Demographic data of study participants

Parameters		Group P (n = 25)	Group N (n = 25)	P-value
Age (year)		39.20 ± 13.02	40.56 ± 14.21	0.72
Gender	Men	19	18	0.74
	Women	6	7	
Dominancy of hand	Dominant	16	17	0.77
	Non-dominant	9	8	
Side	Right	19	18	0.74
	Left	6	7	
Pattern of fracture	Transverse	4	5	0.53
	Oblique	10	11	
	Spiral	10	7	
	Comminuted	1	2	
AO classification	12-A1	10	7	0.53
	12-A2	10	11	
	12-A3	4	5	
	12-B1	0	0	
	12-B2	1	2	
	12-B3	0	0	
	12-C1	0	0	
	12-C2	0	0	
	12-C3	0	0	
Mode of injury	Accidental fall	16	15	0.77
	RTA	9	10	

Data are presented as mean ± standard deviation (SD) or number
RTA: Road traffic accidents

Primary Outcomes (Table 2)

Rate of Union: Radiological union was assessed at 6, 12, and 24 weeks, respectively.

A fracture was considered united once we observed continuity of at least three cortices across the fracture in AP and lateral radiographs. Group P and group N showed 100% and 96% radiological union, respectively, at the end of 12 weeks postoperatively.

Further, clinical union was assessed at follow-up visits by checking for tenderness at fracture site and noting any frank mobility.

DASH Scores: The subjective questionnaire provided with DASH scoring system (more score suggests more disability) showed no difference in functional outcomes between group P and group N (group P: 21.80 ± 6.98, group N: 24.56 ± 9.48, P = 0.24).

Patients in both groups achieved similar ROM at shoulder and elbow without any statistical difference.

Table 2. Comparison of radiological and clinical sign of union in both groups

Parameters	Group P (n = 25)	Group N (n = 25)	P-value
DASH score	21.80 ± 6.98	24.56 ± 9.48	0.24
Union time (week)	11.30 ± 2.64	12.35 ± 1.77	0.10
Shoulder abduction (ROM: 0-170 degrees)	154.64 ± 10.95	157.40 ± 6.60	0.28
Elbow flexion (ROM: 0-140 degrees)	131.28 ± 4.84	134.52 ± 6.80	0.11

Data are presented as mean ± standard deviation (SD)
DASH: Disabilities of the Arm, Shoulder, and Hand; ROM: Range of motion

Secondary Outcomes (Table 3)

Surgical Duration: Duration of surgery was longer in group P as compared to group N (128.56 ± 15.60 minutes vs. 118.36 ± 18.17 minutes).

Exposure to Radiation: The exposure to radiation was assessed on the basis of duration of exposures intra-operatively. It was significantly higher in group N as compared to group P (134.52 ± 30.73 seconds vs. 2.96 ± 0.93 seconds, respectively, P < 0.0001).

Complications: Complications like delayed union, non-union, surgical site infection (SSI), implant failure, or neurovascular injury were recorded for each group. Group P demonstrated two cases of radial nerve injury with partial wrist drop and four cases of SSI. Both nerve injuries recovered in eight and ten weeks post-surgery. Group N had one case of SSI and one case of nail backing out from proximal insertion site.

All infections were superficial and were treated with oral antibiotics and regular dressing of wounds, and resolved with time. One case of implant back-out in group N was taken for impinging-nail removal at six months post initial surgery. None of the cases in our study had delayed union (more than 14 weeks) or non-union.

Table 3. Comparison of clinical outcome parameters between the study groups

Parameters	Group P (n = 25)	Group N (n = 25)	P-value
Radial nerve involvement			0.5500
Yes	2	0	
No	23	25	
Length of incision	15.21 ± 1.70	8.37 ± 1.51	< 0.0001
Blood loss	346.12 ± 142.18	92.60 ± 21.89	< 0.0001
Surgical time (minute)	128.56 ± 15.60	118.36 ± 18.17	0.0300
Radiation exposure (second)	2.96 ± 0.93	134.52 ± 30.73	< 0.0001

Data are presented as mean ± standard deviation (SD) or number

Discussion

This study found comparable outcomes for DCP and IMN in terms of union rates, DASH scores, ROM, and complications, indicating that both methods are effective treatment for humeral shaft fractures.

The average age in the plating group was 39.20 ± 13.02 years, while in the nailing group, it was 40.56 ± 14.21 years. These data highlight a significant prevalence of diaphyseal fractures among younger individuals. A similar age-distribution was observed in the study by Ingale and Faisal (5) in which they had a study population with mean age of 41.5 years.

The DASH score, which evaluates functional outcome, was 21.80 ± 6.98 for group P and 24.56 ± 9.48 for group N, with P-value of 0.24, indicating no significant difference between the two groups. Similarly, the time to union was 12.35 ± 1.77 weeks for group P and 11.30 ± 2.64 weeks for group N, with a P-value of 0.10, again showing no significant difference. Likewise, in the study by Zhang et al. (6), the mean DASH score was 23.76 ± 16.78 in the nailing group and 22.37 ± 15.18 in the plating group (P = 0.609).

ROM assessments revealed that shoulder abduction was 154.64 ± 10.95 degrees for group P and 157.40 ± 6.60 degrees for group N, with a P-value of 0.28, and elbow flexion was 131.28 ± 4.84 degrees for group P versus 134.52 ± 6.80 degrees for group N, with a P-value of 0.11. These values also did not show significant differences.

Similar studies by Zhang et al. (6) and Ingale and Faisal (5) reported no significant differences in functional outcomes between DCP and IMN, supporting our findings. Our study reinforces that both techniques yield satisfactory functional recovery.

In our study, the average operating time was 128.56 ± 15.60 minutes for group P and 118.36 ± 18.17 minutes for group N. This duration was longer for the plating group compared to the nailing group although the difference was not statistically significant. Ingale and Faisal (5) reported similar results, where the average operating time for the plating group (group A) was 74.65 ± 5.80 minutes, significantly longer than the 58.50 ± 5.11 minutes recorded for the nailing group (group B). These findings indicate that plating is associated with a longer operating time compared to nailing, highlighting the relative invasiveness of the plating procedure.

We observed two cases of radial nerve injury in our study which resolved eventually. Similarly, Walla et al. (7) and Bernard de Dompsure et al. (8) observed 8.7% and 4.7% cases of radial nerve injuries, respectively. SSI was noted in four patients in group P (16%) and one in group N (4%) with a P-value of 0.345. These values also did not show a significant difference. They were treated with oral antibiotics and surgical-site care and recovered fully.

Moreover, Gandhi et al. (9) and Ingale and Faisal (5) observed 3.84% and 5% incidence of infection in plating group, respectively. In our study, backing out of nail was observed in one patient while no patient in plating group had implant failure. In contrast to our study, Ingale and Faisal found one implant failure in plating group.

DCP allows better anatomical reduction but it requires a longer surgical time, predisposes to SSI, and results in greater blood loss (5). In contrast, IMN minimizes soft tissue disruption but increases exposure to radiation and implant-related complications.

Limitations: Limitations include the small sample size and the single-center study design. Further multi-center studies with larger sample sizes are needed to generalize findings.

Clinical Implications

Clinicians should consider both fracture characteristics and patient-related factors while choosing between DCP and flexible IMN, balancing the invasiveness of the procedure with anticipated recovery and potential complications.

Conclusion

Both DCP and IMN are effective surgical options for diaphyseal humerus fractures, providing comparable functional outcomes. While DCP may offer improved fracture stabilization, IMN is less invasive with faster recovery times. Treatment decisions should be individualized, considering patient needs and specific fracture characteristics.

Conflict of Interest

The authors declare no conflict of interest in this study.

Acknowledgements

We acknowledge the patients for their cooperation during the study and informed consent was taken from the patients to participate in the study.

We obtained approval from the institutional review board under the study number IHEC/22/OUT/SRPG026.

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