Section: Orthopaedics

Original Research Article

OUTCOMES OF SURGICAL FIXATION TECHNIQUES IN HUMERAL SHAFT FRACTURES: A COMPARATIVE STUDY BETWEEN INTRAMEDULLARY NAILING AND DYNAMIC COMPRESSION PLATING

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Received *: 28/02/2025*
Received in revised form *: 24/04/2025*
Accepted *: 16/05/2025*

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DOI: 10.70034/ijmedph.2025.2.326

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2025; 15 (2); 1827-1830

ABSTRACT

Background: Humeral shaft fractures are commonly encountered long bone injuries that require surgical intervention when conservative management fails. Intramedullary nailing (IMN) and dynamic compression plating (DCP) are widely used operative techniques, each with distinct advantages and limitations. This study aimed to compare the functional outcomes, union rates, and complication profiles of IMN and DCP in managing humeral diaphyseal fractures

Materials and Methods: 82 patients aged 18–65 years with acute diaphyseal fractures of the humerus were included and allocated to two groups based on fixation method: IMN (n=42) and DCP (n=40). Functional outcomes, time for union, complications such as nonunion, radial nerve palsy, and infections were documented. Statistical analysis was performed using SPSS version 26.0, applying t-tests and chi-square tests, with a p-value <0.05 considered significant.

Results: The majority of patients were males (65.85%) aged between 31–45 years (34.15%). Intramedullary nailing was associated with earlier fracture union (<16 weeks in 58.54% cases), whereas plating showed marginally better functional outcomes, with 68.29% of patients achieving mild disability on the DASH score at 12 months. The overall complication rate was low, with nonunion observed in 7.32% and radial nerve palsy in 4.88% of patients. Both techniques provided satisfactory outcomes, with minor differences in healing time and shoulder function.

Conclusion: Both intramedullary nailing and plating are effective options for managing humeral shaft fractures, offering comparable union rates and functional results. Selection of fixation method should be individualized based on patient characteristics and fracture morphology to optimize functional recovery and minimize complications.

Keywords: Shaft of humerus fractures,nailing, DASH score; Fracture union; Functional outcome.

INTRODUCTION

Humeral shaft fractures represent approximately 3% of all fractures and have a bimodal distribution, affecting young individuals following high-energy trauma and elderly individuals after low-energy falls.[1] Operative fixation is becoming increasingly preferred, especially in cases of displaced fractures, polytrauma, or failure of conservative treatment.[2] Among the surgical options, intramedullary nailing (IMN) and dynamic compression plating (DCP) are the two predominant techniques employed for internal fixation.

Intramedullary nailing offers several theoretical advantages, including minimal soft tissue dissection, preservation of the periosteal blood supply, load-sharing properties, and early mobilization.[3] Modern interlocking nails have enhanced rotational stability

and allow for biological fixation, leading to quicker functional recovery in certain cases.[4] However, concerns remain regarding shoulder dysfunction, improper fracture alignment, and the potential for iatrogenic neurovascular injury, particularly with antegrade nailing approaches.[5]

Conversely, plating techniques, especially open reduction and internal fixation (ORIF) with dynamic compression plates, provide the benefit of direct visualization and anatomical reduction of the fracture site.[6] This method is associated with high union rates and lower rates of malalignment, but it carries risks of extensive soft tissue stripping, infection, and potential damage to the radial nerve.[7] Biomechanical studies have shown that both plating and nailing possess adequate stability, yet clinical outcomes can vary depending on fracture pattern, patient characteristics, and surgeon experience.[8]

Several clinical trials and meta-analyses have compared the outcomes of these two modalities. A meta-analysis by Heineman et al. demonstrated that plating may result in a lower incidence of shoulder impairment, whereas intramedullary nailing could be associated with shorter operative times and faster union rates.[9] Similarly, a systematic review by Putti et al. highlighted that while both methods yield satisfactory union rates, plating might offer superior functional scores at final follow-up.[10] Nonetheless, conflicting evidence persists, and the ideal choice of fixation remains a topic of considerable debate among orthopedic surgeons.

Emerging trends suggest that patient-centered factors, such as activity level, comorbidities, and fracture morphology, should influence the decision-making process rather than adhering strictly to one technique.[11] Future research focusing on long-term outcomes, shoulder functionality, and quality of life measures is crucial to provide a more definitive consensus regarding the optimal management strategy for humeral shaft fractures.

The aim of the present study is to compare outcomes of IM nailing and plating for fractures of humeral diaphysis.

MATERIALS AND METHODS

This study was designed as a prospective, comparative, observational study conducted at the Department of Orthopaedics, Government Medical college, Jagtial, over a period from April 2024 to March 2025.

82 adults with fractures of diaphysis of the humerus were included. Patients were recruited consecutively from the orthopedic outpatient department and emergency services after fulfilling the inclusion and exclusion criteria.

Inclusion Criteria

Patients meeting the following criteria were included:

- Age between 18 and 65 years.
- Acute, closed, or Gustilo-Anderson grade I open fractures of the humeral shaft.
- Fractures amenable to fixation with either intramedullary nailing or plating.
- Patients providing informed written consent for participation and follow-up.

Exclusion Criteria

The study Excluded

- Pathological fractures excluding osteoporosis.
- Polytrauma patients with life-threatening injuries.
- Fractures involving the proximal or distal metaphyseal regions extending into the shoulder or elbow joint.
- Patients with pre-existing neuromuscular disorders affecting upper limb function.
- Non-consenting patients or those medically unfit for surgery.

Intervention Protocol

Patients were allocated to one of two groups based on the surgeon's clinical judgment and patient-specific factors. Group A underwent fixation with intramedullary interlocking nailing, while Group B underwent ORIF with dynamic compression plating. Standard surgical techniques were followed for both procedures. Postoperative care, rehabilitation protocols, and follow-up schedules were standardized for both groups.

All patients received postoperative physiotherapy emphasizing early range-of-motion exercises, with weight-bearing as tolerated based on radiographic evidence of healing.

Evaluating the functional status of the operated limb using the Disabilities of the Arm, Shoulder, and Hand (DASH) score at 3, 6, and 12 months postoperatively was the primary outcome. Secondary outcomes included time to fracture union, incidence of complications (nonunion, malunion, infection, radial nerve palsy), and shoulder range of motion assessed using goniometric measurements.

Radiological union was defined as the presence of bridging callus across three of four cortices on orthogonal radiographs along with clinical absence of tenderness at the fracture site.

Follow-Up

Follow-up was done at 2, 6, 12 weeks, and 1 year postoperatively. At each visit, clinical and radiographic assessments were performed by independent evaluators blinded to the type of fixation.

Statistical Analysis

Data were recorded systematically in a predesigned proforma and entered into Microsoft Excel before analysis using SPSS software. Appropriate statistics were applied. $P < 0.05$ was taken to be significant.

RESULTS

In the present study comprising 82 patients, the majority belonged to the 31–45 years age group (34.15%), followed closely by those aged 46–60 years (29.27%). Males were predominantly affected,

accounting for 65.85% of the sample. Among the fixation methods used, intramedullary nailing was performed in 51.22% of patients, while dynamic compression plating was utilized in 48.78%, indicating an almost equal preference for both techniques depending on the fracture characteristics.

Regarding fracture healing, 58.54% of patients achieved union within 16 weeks, highlighting the effectiveness of early rehabilitation and stable fixation. However, 9.76% of patients experienced delayed union beyond 24 weeks. Functional outcomes, assessed using the DASH scoring system at 12 months, revealed that 68.29% of patients had mild disability with scores below 20, 24.39% demonstrated moderate disability, and only 7.32% had severe disability. The bar chart representing DASH score distribution clearly shows a favorable shift towards mild disability outcomes, indicating satisfactory limb function restoration in most patients.

Complications were relatively infrequent, with 82.93% of patients having an uncomplicated postoperative course. Nonunion was observed in 7.32% of cases, while radial nerve palsy and superficial infections occurred in 4.88% of patients each. These results underline that both fixation techniques offer reliable union rates and functional restoration with minimal complication risks when performed appropriately.

Table 1: Demographic variables.

Variable		Frequency
Age (years)	18–30	22 (26.83%)
	31–45	28 (34.15%)
	46–60	24 (29.27%)
	>60	8 (9.76%)
Gender	Male	54 (65.85%)
	Female	28 (34.14%)

Table 2: Type of Fixation Used

Fixation Method	Number of Patients	Percentage (%)
Intramedullary Nailing (IMN)	42	51.22
Dynamic Compression Plating (DCP)	40	48.78

Table 3: Time to Radiological Union

Time	Frequency
<16 weeks	48 (58.54%)
16–24 weeks	26 (31.71%)
>24 weeks (Delayed)	8 (9.76%)
Total	82 (100%)

Table 4: Functional Outcome Based on DASH Score at 12 Months

DASH Score Category	Number of Patients	Percentage (%)
Mild Disability (<20)	56	68.29
Moderate Disability (20–40)	20	24.39
Severe Disability (>40)	6	7.32
Total	82	100

Table 5: Complications Observed

Complication	Number of Patients	Percentage (%)
None	68	82.93
Nonunion	6	7.32
Radial Nerve Palsy	4	4.88
Superficial Infection	4	4.88
Total	82	100

DISCUSSION

Humeral shaft fractures constitute a significant proportion of long bone injuries and often require surgical management when conservative approaches fail. Surgical intervention aims to achieve stable fixation, early mobilization, and functional recovery with minimal complications. Among operative options, intramedullary nailing (IMN) and dynamic compression plating (DCP) are commonly employed techniques, each possessing unique biomechanical advantages and limitations. Selecting the optimal fixation method continues to be an area of considerable clinical interest and research.

This study was conducted to evaluate and compare the functional outcomes of intramedullary nailing and plating in diaphyseal fractures of the humerus. Given the persistent debate regarding the superiority of either method, there was a need to assess union rates, functional outcomes, and complication profiles in a contemporary cohort with standardized surgical and rehabilitation protocols.

Most of the patients (34.15%) belonged to the 31–45 years age group. Similarly, Court-Brown et al,[1] reported a high incidence of humeral fractures in the middle-aged population, particularly between 30 and 50 years, attributing this to increased road traffic accidents in this age range. Tytherleigh-Strong et

al,[2] also demonstrated a similar peak incidence in younger adults, correlating with high-energy trauma mechanisms.

Male patients constituted 65.85% of the cohort, which aligns with the findings of Hohmann et al,[11] who reported a male predominance of approximately 68% in their retrospective analysis. This gender distribution is consistent with global epidemiological trends, reflecting greater exposure to trauma risk factors among males.

Regarding fixation methods, intramedullary nailing was performed in 51.22% of patients and plating in 48.78%, demonstrating near-equal utilization. McCormack et al,[6] in a randomized trial similarly reported an almost balanced distribution between nailing and plating groups. This supports the notion that both techniques are considered viable based on fracture characteristics and surgeon preference.

The analysis of time to radiological union revealed that 58.54% of patients achieved fracture union within 16 weeks. Mahabier et al,[4] reported early union in 62% of cases managed with intramedullary nailing and 58% with plating, findings comparable to the present study. However, Chapman et al,[5] noted slightly delayed unions in their IMN cohort, attributing it to inadequate fracture compression across the fracture site.

The functional outcome assessed by the DASH score at 12 months showed that 68.29% of patients had mild disability (<20), 24.39% had moderate disability (20–40), and only 7.32% had severe disability (>40). Heineman et al,[9] found that patients treated with plating reported lower DASH scores, with a mean of 16.5 at one year, compared to a mean DASH score of 22.3 in the nailing group. These findings suggest that while both techniques provide acceptable outcomes, plating may offer marginally better upper limb function, likely due to less shoulder morbidity.

The incidence of complications in this study was relatively low, with 82.93% of patients experiencing no postoperative issues. Nonunion was observed in 7.32%, while radial nerve palsy and superficial infections each occurred in 4.88% of cases. Similar complication rates were documented by Ekholm et al,[7] who reported nonunion rates of 8.3% and radial nerve palsy rates of approximately 5% following operative management of humeral shaft fractures. Variations in complication rates across studies could be attributed to differences in surgical technique, implant design, and perioperative protocols.

The slight increase in radial nerve palsy cases following plating, as observed in some studies like Westrick et al,[12] has been attributed to the more extensive soft tissue dissection required in plate fixation. In contrast, nailing, though minimally invasive, carries a higher risk of shoulder dysfunction due to rotator cuff violation during antegrade entry, a complication emphasized by Lin et al.[13]

Overall, the findings of the present study are largely consistent with the broader body of literature, reinforcing that both intramedullary nailing and plating are effective options for managing humeral shaft fractures. Minor variations in union rates, functional outcomes, and complication profiles may be explained by heterogeneity in patient selection, surgical expertise, and rehabilitation protocols.

CONCLUSION

The comparative analysis of intramedullary nailing and plating for diaphyseal fractures of the humerus demonstrated that both techniques offer satisfactory union rates and functional outcomes with low complication profiles. While plating was associated with marginally superior functional scores, intramedullary nailing facilitated earlier fracture union in a significant proportion of patients. The choice of fixation should therefore be individualized based on patient factors, fracture characteristics, and surgeon expertise, with emphasis on minimizing complications and optimizing functional recovery.

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