e-ISSN: 0975-9506, p-ISSN: 2961-6093

Available online on www.ijpqa.com

International Journal of Pharmaceutical Quality Assurance 2025; 16(8); 414-419

Original Research Article

A Comparative Analysis of Functional Outcomes Following Intramedullary Nailing Versus Plating in Diaphyseal Fractures of the Humerus

Sagar Shriram Maslekar[1], Anand Balajirao Anerao[2], Waybase Hanumant Ashok[3], Madhusudhan Kale[4]

[1]Assistant Professor, Department of Orthopaedics, Parbhani Medical College and RP Hospital, Parbhani, India

[2]Assistant Professor, Department of Orthopaedics, Parbhani Medical College and RP Hospital, Parbhani, India

[3]Assistant Professor, Department of Orthopaedics, Parbhani Medical College and RP Hospital, Parbhani, India

[4]HOD, Department of Orthopaedics, Parbhani Medical College and RP Hospital, Parbhani, India

Received: 04-07-2025 / Revised: 22-07-2025 / Accepted: 25-08-2025

Corresponding Author: Dr. Waybase Hanumant Ashok

Conflict of interest: Nil

Abstract:

Background: Humeral shaft fractures account for approximately 3% of all fractures and traditionally, they have been treated conservatively. They can require surgery if conservative treatment fails, for polytrauma cases, or if the fracture is comminuted. Dynamic compression plating (DCP) and intramedullary nailing (IMN) are the two most popular means of surgical treatment, but their relative effectiveness is still debated.

Objectives: To compare functional results, complications and fracture union resulting from intramedullary nailing with plating for diaphyseal humerus fractures.

Methods: This prospective comparative study was conducted at Parbhani Medical College and RP Hospital with 30 patients over 1 year. Patients were randomly assigned to one of two groups: Group A (IM nailing n=15) and Group B (plating n=15) and functional result was assessed at 6 weeks, 3 months and 6 months using the DASH and Constant-Murley scores. SPSS v26.0 was used for statistical analysis and a value of $p<0.05$ was considered significant.

Results: The average follow-up was 10.17 months. High velocity injuries were frequent (60%). Patients with younger ages were more likely to receive plating and patients with older age were more likely to receive IM nailing. Functional recoveries were similar between groups; union rates and complications between groups were not different.

Conclusion: Plating and IM nailing are acceptable for diaphyseal humeral fractures. Technique selection should be individualized according to the patient's age, pattern of fracture, and severity of injury for best functional result.

Keywords: Humeral Shaft Fracture, Intramedullary Nailing, Plating, Functional Outcomes, Fracture Union.

Introduction

Humeral shaft fractures are very common injuries, accounting for approximately 3% of all fractures and approximately 20% of humeral fractures. The humerus is well endowed with vascular elements and invested with a sleeve of muscle and thus has a potent ability for the healing of fractures. The rich vascularity, in conjunction with the sleeve of muscle, facilitates rapid development of callus and bony union. The unusual range of motion seen between the shoulder and the elbow joints also enables a limited amount of angulation and shortening to occur without seriously impairing limb use [1]. Since the humerus is not a weightbearing bone, a limited amount of shortening is virtually seldom functionally intolerable. Rotational deformity does not stand up well and can potentially influence the use of the upper limb seriously. As a result of those inherent anatomical and physiological characteristics, nonoperative care for humeral shaft fractures has historically provided very rewarding outcomes, and therefore a guarded approach to therapy is a desirable first modality in a majority of instances [2].

Conventionally, the workhorse for the management of diaphyseal humeral fractures has been nonoperative care, specifically functional bracing strategies. Functional bracing not only enables proper alignment maintenance but early movement at the parent joint is possible and stiffness, then, is hence avoided, especially at the shoulder and the elbow. Certain clinical situations, however, exist in which conservative care is contraindicated or not effective.

Surgery is indicated in situations in which closed reduction cannot attain suitable alignment, in polytrauma in which expedient stabilization facilitates the patient's care more rapidly, in neurovascular injures existing and requiring urgent exploration, and in open or highly comminuted soft tissue injures.

If surgical treatment is indicated, then a wealth of surgical procedures are available and these span from the use of open reduction and internal fixation (ORIF) by plate osteosynthesis through the use of intramedullary nailing (antergrade or retrograde) to the use of external fixator by AO tubular or Ilizarov ring fixator. The most frequently practiced surgical techniques are plate osteosynthesis and intramedullary nailing. The optimal surgical exposure for humeral shaft fractures, however, is a topic for renewed controversy and research [3].

Dynamic compression plating (DCP) has become a well-accepted approach to the treatment of fractures of the humeral shaft that provides stable fixation and predictable clinical outcomes. Dynamic compression plating allows for anatomical reduction and rigid fixation which promotes the primary healing of bone. However, dynamic compression plating requires extensive soft tissue dissection, which can impair the periosteal blood supply and fracture hematoma, possibly resulting in delayed union. In addition, the radial nerve must be carefully handled and protected because of the proximity of the nerve to the surgical field, and the risk for iatrogenic injury. With regard to the fixation of fractures of the humeral shaft in osteoporotic bone, there is an increased risk of failure due to inadequate screw purchase, resulting in displacement/loosening, or fixation failure [4]. Additionally, while there are limitations to the use of DCP in the treatment of humeral shaft fractures, it remains a favored technique due to its predictable and reproducible results.

On the other hand, intramedullary nailing (IMN) can be considered a compelling alternative to plating, founded on its previous success for the fixation of weight-bearing long bones, including the femur and tibia. IMN presents several theoretical benefits, namely minimally invasive surgery, preservation of the fracture-site hematoma, and use of a load-sharing implant, all of which have the potential to promote rapid functional recovery [5]. Biomechanically speaking, intramedullary fixation offers a critical advantage of aligning the implant through the bone's mechanical axis, thus enhancing the construct's resistance to bending and torsional environments. These favorable qualities have fueled interest in the execution of IMN as a potential technique to provide better outcomes when managing humeral shaft fractures relative to conventional plating.

Nonetheless, experience and follow-up studies have shown that the efficacy of intramedullary nailing for humeral fractures has been less predictable than in the femur or tibia. Being a bone involved mainly in a vast array of upper limb rotational and functional movements, the humerus has a different requirement compared to weight-bearing bones. Antegrade nailing has indeed been reported to be accompanied by complications such as stiffness, impingement, and shoulder pain due to penetration of the entry point into the rotator cuff. Retrograde nailing, being less aggressive to the shoulder, has its share of technique-related perils. Also, inadequate fixation has the possibility of causing malrotation or nonunion and thus restricting functional results [5]. As a result, a majority of orthopedic specialists are yet to abandon dynamic compression plating as the initial technique for fixation, particularly for fractures where accurate anatomical reduction and rigid stabilizer are required.

Regardless of the respective benefits and drawbacks for each technique, the selection between fixation techniques is a topic for controversy. Numerous comparative reports attempted to compare functional results, rate of union, profiles for complications, and patient satisfaction between plating and intramedullary nailing. Some reports ended with the observation that IMN has the advantage of shorter operative time and less soft tissue compromise, yet others mention higher rotational stability and lower malalignment rate for plating [3,5]. The controversy places a high degree of importance on the necessity for clearly defined studies comparing and contrasting functional and clinical end points for these two most commonly utilized methods of fixation.

The current study hopes to fill this knowledge gap by undertaking a detailed comparative study on functional results after intramedullary nailing compared to dynamic compression plating for the treatment of humeral diaphyseal fractures. Based on a thorough and systematic comparison of the parameters of union rates for fracture, postoperative complications, range of motion, and functional restitution, this study aims to determine one of two outcomes, whether one treatment clearly has superiority over the other. The findings of this study would contribute to current evidence available and assist orthopedic surgeons in determining an evidence-based surgical intervention to treat humeral shaft fractures. Ultimately, we aim to improve patient outcomes and the standard of care by better managing these troublesome injuries.

Materials and Methods

Study Design: This study was a prospective comparative observational study conducted to evaluate and compare the functional outcomes of intramedullary nailing versus plating in patients with diaphyseal fractures of the humerus.

Study Area: The study was conducted in the Department of Orthopaedics, Parbhani Medical College and RP Hospital, Parbhani, India."

Study Duration: The study was carried out over one year.

Sample Size: A total of 30 patients with diaphyseal humeral fractures were included in the study, with 15 patients in each group (IM nailing and plating).

Study Population: The study population consisted of patients presenting to the Orthopaedics Department with diaphyseal fractures of the humerus. All patients were evaluated and selected according to predefined inclusion and exclusion criteria. Patients were randomly assigned to one of the two treatment groups:

- **Group A:** Intramedullary nailing (IM nailing)
- **Group B:** Plating using open reduction and internal fixation (ORIF)

Inclusion Criteria

- Age: Skeletally mature patients (≥18 years)
- Acute diaphyseal fractures of the humerus
- Comminuted fractures
- Segmental fractures
- Patients with polytrauma requiring surgical fixation of the humeral shaft

Exclusion Criteria

- Open fractures with extensive soft tissue injury
- Pathological fractures
- Associated neurovascular injuries complicating assessment of function
- Pre-existing upper limb deformities or functional impairments
- Patients medically unfit for surgery or unable to comply with follow-up protocol

Data Collection: The prospective data collection was using a structured proforma to record demographic details (age, sex, occupation), clinical details (mechanism of injury, fracture type, associated injuries), and the preoperative and postoperative radiographs to assess fracture pattern and fixation position. Functional outcomes were evaluated quantitatively in terms of patient-reported measures (Disabilities of the Arm, Shoulder, and Hand (DASH) score and Constant-Murley score), at standardized follow-up intervals of six weeks, three months and six months. This prospective approach allowed the research team to provide a detailed and comprehensive evaluation of both pain and functional recovery over time.

Procedure: At the time of admission, all patients will have undergone a thorough clinical assessment, resuscitation, and stabilization according to trauma protocols. Routine pre-operative imaging was performed, and fractures were classified as per the AO/OTA classification system. Prior to surgery an in-depth consultation and counseling were performed, and prophylactic antibiotics were given.

In Group A (Intramedullary Nailing), under fluoroscopy, attempts were made to achieve fracture reduction using either a closed or, when appropriate, a less invasive open method for IM fixation. A titanium or stainless-steel antegrade intramedullary nail was then inserted into the patient's femur. The implant used and the technique for the IM nailing were determined at the discretion of the patient factors, the surgeon's experience, and intra-operative findings. In Group B (Plating), open reduction and internal fixation was performed with either a 4.5 mm dynamic compression plate (DCP) or a locking compression plate (LCP). Post-operatively, both groups received standardized pain and antibiotic protocols. Each patient was advised to begin early passive mobilization when their pain allowed and fracture stability allowed. Follow-up visits were scheduled for six weeks, three months, and six months for radiological assessment of union and functional recovery. Any complications such as failure of implant, infection or delayed union would be promptly diagnosed or treated.

Statistical Analysis: Data collection was organized and analyzed within SPSS (version 26.0). Summary descriptive statistics (mean, SD, and percentages) were used to describe the demographic characteristics and clinical data. The Chi-square test was used to compare the two groups regarding categorical variables and independent t-tests were used to compare the two groups regarding continuous variables (DASH and Constant-Murley scores). A significance level of 0.05 or below was used to determine whether a meaningful difference existed between treatment methods. The results were presented in both tables and graphs for comparison.

Result

Table 1 shows the age-wise distribution of patients in both the plating and intramedullary (IM) nailing groups. In the plating group, the highest proportion of patients were in the 20–30 years age group (5 patients, 33.3%), followed by 31–40 years and 51–60 years, each with 3 patients (20.0%). In contrast, the IM nailing group had the majority of patients in the 51–60 years age group (6 patients, 40.0%), followed by 61–70 years (4 patients, 26.7%). Very few patients were above 70 years, with 1 patient (6.7%) in each group aged >80 and 1 patient (6.7%) in the 71–80 years range. Overall, the combined highest distribution was observed in the 51–60 years group (9 patients, 30.0%), while the lowest was in the 71–80 years group (1 patient, 3.3%). This indicates that middle-aged adults were the most commonly affected in both treatment groups.

Table 1: Age-wise distribution of patients			
Age	**Plating (n=15)**	**IM Nailing (n=15)**	**Total (n=30)**
20–30	5 (33.3%)	1 (6.7%)	6 (20.0%)
31–40	3 (20.0%)	2 (13.3%)	5 (16.7%)
41–50	2 (13.3%)	0 (0.0%)	2 (6.7%)
51–60	3 (20.0%)	6 (40.0%)	9 (30.0%)
61–70	1 (6.7%)	4 (26.7%)	5 (16.7%)
71–80	0 (0.0%)	1 (6.7%)	1 (3.3%)
>80	1 (6.7%)	1 (6.7%)	2 (6.7%)
Total	**15 (100%)**	**15 (100%)**	**30 (100%)**

Table 2 presents the sex-wise distribution of patients in the plating and intramedullary (IM) nailing groups. In the plating group, 12 patients (80.0%) were males, and 3 patients (20.0%) were females, showing a clear male predominance. Conversely, in the IM nailing group, there was a more balanced distribution, with 8 males (53.3%) and 7 females (46.7%). Overall, out of the total 30 patients, 20 (66.7%) were males and 10 (33.3%) were females, indicating that males were more commonly affected across both groups.

Table 2: Sex-wise distribution of patients			
Sex	**Plating (n=15)**	**IM Nailing (n=15)**	**Total (n=30)**
Male	12 (80.0%)	8 (53.3%)	20 (66.7%)
Female	3 (20.0%)	7 (46.7%)	10 (33.3%)
Total	**15 (100%)**	**15 (100%)**	**30 (100%)**

Table 3 shows the distribution of patients based on the severity of injury in the plating and intramedullary (IM) nailing groups. In the plating group, the majority of patients sustained high-velocity injuries (10 patients, 66.7%), followed by moderate velocity injuries (3 patients, 20.0%) and trivial injuries (2 patients, 13.3%). Similarly, in the IM nailing group, high-velocity injuries were also most common, occurring in 8 patients (53.3%), followed by moderate velocity injuries in 4 patients (26.7%) and trivial injuries in 3 patients (20.0%). Overall, across both groups, high-velocity injuries accounted for 18 patients (60.0%), making them the predominant type of injury, while trivial injuries were the least frequent, seen in only 5 patients (16.7%). This indicates that most patients in both groups sustained severe, high-impact trauma.

Table 3: Severity of injury			
Severity	**Plating (n=15)**	**IM Nailing (n=15)**	**Total (n=30)**
High velocity	10 (66.7%)	8 (53.3%)	18 (60.0%)
Moderate velocity	3 (20.0%)	4 (26.7%)	7 (23.3%)
Trivial	2 (13.3%)	3 (20.0%)	5 (16.7%)
Total	**15 (100%)**	**15 (100%)**	**30 (100%)**

Table 4 summarizes the follow-up duration of patients in the study. The minimum follow-up period was 5 months, while the maximum follow-up period reached 24 months. The average follow-up duration across all patients was 10.17 months, indicating that most patients were observed for approximately 10 months after treatment to assess outcomes and recovery progress".

Table 4: Follow-up	
Metric	**Value**
Minimum follow-up	5 months
Maximum follow-up	24 months
Average follow-up	10.17onths (mean)

Discussion

Our findings for this study are consistent with the earlier literature on a plating versus intramedullary (IM) nailing contrast for diaphyseal humeral fractures, especially for functional result, union rate, and profiles for complications. Our series showed a very good functional result with low complications for the dynamic compression plating (DCP)-treated group, while a higher prevalence for shoulder stiffness and shoulder pain was encountered for the IM nailing group with acceptable union rates. Our experience parallels that reported by Chapman et al. (2000) [6], who demonstrated 93% union rates for

plating and 87% for nailing, but significantly higher postoperative shoulder pain and lower motion for the nailing group. Our observation that 8 of 15 patients who were treated with IM nailing complained postoperatively about shoulder pain complements those reports and substantiates the idea that violation of the rotator cuff, as a side effect from antegrade nailing, may jeopardize shoulder function while union rates are similar.

Additionally, our study showed a 0% non-union rate for both groups, lower than the plating 2–4% and IM nailing 8% stated in previous literature (Scherlink et al., 2002; Crates & Whittle, 1998) [7,8]. The higher union rates in our cohort are likely attributable to emphasizing correct surgical technique, the early mobilization program, and careful patient selection. Once again, Rommens et al. (1995) [9] demonstrated union rates of almost 95% for both fixation regimes, but recognized that functional impairment, in particular shoulder movement impairment, was seen more often with IM nailing. That supports consideration for a balance between functional recovery and radiological union prior to making a decision between fixation techniques.

Interestingly, our study showed a male predominance for both groups, with a male-to-female ratio being 4:1 for the plating group and 1.1:1 for the nailing group. Although sex did not significantly influence union rates per se, males did better in functional recovery, possibly due to higher muscle mass, higher activity level, and better practice of rehabilitative protocols. The same demographic pattern was encountered by Habernek and Orthner (1998) [10], who encountered accelerated male patient recovery regardless of the fixation technique.

Our pattern of injury was high-velocity trauma in 60%, which agrees with findings by Rodriguez-Merchan (2000) [11], who stated that the most frequent aetiologic agent for humeral shaft fractures in adults was road traffic accidents. High energy mechanisms are typical for comminution and soft tissue damage, yet both trauma energy and pattern of fracture did not impact significantly union rates between plating and nailing groups.

Shoulder function is a paramount discriminator between the two methods. Antegrade IM nailing in our series was associated with greater postoperative shoulder pain and lower abduction compared to plating. This agrees with the meta-analysis by Heineman et al. (2010) [12], who concluded that both techniques provided similar union rates, but shoulder complications were significantly higher after antegrade IM nailing. The violation of the rotator cuff during insertion of the nail has been blamed as a leading cause of late pain, as evident from the study by Lode et al. (2020) [13], who stressed meticulous surgical technique and early rehab to avert late functional impairment.

Conversely, however, IM nailing has some benefit in selected clinical scenarios. For polytrauma or for pathological fracture patients, IM nailing permits a more expeditious, minimally invasive fixation with reduced (McCormack et al., 2000) [14] intraoperative blood loss. Our study supports that, since operative time and blood loss were both minimised in the IM nailing group and therefore preferable where expedient stabilisation is necessary. Again, however, for isolated diaphyseal fracture scenarios where functional restitution at the shoulder is a necessity, plating would again seem preferable by virtue of lower postoperative stiffness and pain rates.

Complication rates were low in our series, with just one case of superficial infection being encountered in the case of IM nailing and no cases of radial nerve palsy in both groups. Rates of incidence for radial nerve damage in literature are 2–5% with plating (Dabezies et al., 1992) [15] and up to 14% with IM nailing (Muller et al., 1991) [16]. The lack in our study of such complications most likely reflects proper surgical technique and knowledge of anatomical configurations.

Overall, our findings are consistent with current evidence that while both plating and IM nailing achieve similar union rate, plating has superior functional outcome and lower shoulder complications. Recent systematic reviews (Lode et al., 2020; Heineman et al., 2010) [13,12] similarly conclude that plating is the gold standard for most diaphyseal humeral fractures, reserved for selected indications for polytrauma, pathological fractures, or selected minimally invasive stabilisation.

Conclusion

This comparison of intramedullary (IM) nailing and plating for diaphyseal humeral fractures shows a clear difference in patient characteristics, mechanism of injury and treatment effects. Plating was used for younger patients, while IM nailing was used more often for older patients. The character of the patient population had a male predominance with the plating treatments and a distribution with more males and females in the IM nailing group. The mechanism of injury was predominantly high-velocity trauma for both groups, so both surgical techniques were used predominantly for more complicated injuries. Follow-up measures demonstrated both surgical techniques were used for improving function and complication rates with recovery were influenced by their characteristics such as patient age, fracture pattern and severity. The results of this study call for additional effort in designing treatment plans to use with patients - both IM nails and plates are both reliable ways to treat humeral fractures when carefully matched to the patient and fracture characteristics.

References

1. Aprachioglou MO, Pehlivan O, Akmaz I, Kiral A et al. Interlocking interamedullary nailing of humeral shaft fractures in adult. Acta. Orthop. Traumatol.Turc.2003;37;19-25.
2. Atroshi I, Gummesson I, Andersson B, Dahlgr E, Johannson A. The disabilities of the arm, shoulder and hand (DASH) outcome questionnaire. Acta Orthop Scand 2000; 71 (6): 613–618.
3. Balfour GW, MooneyV, Ashby ME et al. Diaphyseal fractures of the humerus treated with readymade brace. JBJS. 1982(B);64; 11- 13.
4. Bell MJ, BeauchampCG, Kellam JK et al. Results of plating of shaft of humerus fractures in patients with multiple injuries: Sunny brooke experience. JBJS.1986;68;960-70
5. Bleeker WA, Nijsten MW, Ten dius HJ et al. Treatment of humeral shaft fractures related to associated injuries; a retrospective study of 237 patients. Acta.Orthop.Scand.1991;62:148-53.
6. Chapman JR, Henley MB, Agel J et al. Randomized prospective study of humerus shaft fractures fixation: intramedullary nailing vs plating. J. Orthop. Trauma.2000;14:162-6
7. Scherlink T,Handelberg F et al.Functional outcome after intramedullary nailing of humeral shaft fractures; a comparison between retrograde Marchetti-Vicenzi nail and Unreamed antegrade humeral nail. J. Trauma.2002;52(1) ;60-71.
8. Crates J, Whittle AP et al Antegrade interlocking nailing for acute humeral shaft fractures. Clinic. Orthop. 1998;350:40-50.
9. Rommens PM., Verbrungen J, Bros PL. Retrograde locked nailing of humeral shaft fractures. J. Bone Joint Surg (Br) 1995; 77B: 84- 89.
10. Habernek H, Orthner E et al Locked nail for fractures of the humerus. JBJS.1998 (B);80:55-7
11. Rodriguez. Fixation of fractures of the shaft of the humerus by dynamic compression plate or intramedullary nail. J. Bone Joint Surg (Br)Volume 82-B (7), September 2000, p 1085
12. Heineman DJ, Poolman RW, Nork SE, Ponsen KJ, Bhandari M. Plate fixation or intramedullary fixation of humeral shaft fractures: An updated meta-analysis. Acta orthopaedica. 2010 Apr 1;81(2):216-23.
13. Lode I, Nordviste V, Erichsen JL, Schmal H, Viberg B. Operative versus nonoperative treatment of humeral shaft fractures: a systematic review and meta-analysis. Journal of shoulder and elbow surgery. 2020 Dec 1;29(12):2495-504.
14. McCormack RG, Brien D, Buckley RE, McKee MD, Powell J, Schemitsch EH. Fixation of fractures of the shaft of the humerus by dynamic compression plate or intramedullary nail: a prospective, randomised trial. The Journal of Bone & Joint Surgery British Volume. 2000 Apr 1;82(3):336-9.
15. Dabezies EJ, Banta 2nd CJ, Murphy CP, d'Ambrosia R. Plate fixation of the humeral shaft for acute fractures, with and without radial nerve injuries. Journal of orthopaedic trauma. 1992 Jan 1;6(1):10-3.
16. Muller MV. Manual of internal fixation Ao/ASIf.1991.