



Comparison of Outcome of Intramedullary Interlocking Nail Versus Dynamic Compression Plate for Treatment of Humeral Shaft Fractures

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ABSTRACT

Background: Humeral shaft fractures are common orthopedic injuries and can lead to significant functional disability if not treated properly. Dynamic compression plate and intramedullary interlocking nail are commonly used surgical techniques for fixation of these fractures, but there is still controversy regarding the better method in terms of functional recovery and outcome. **Objective:** To compare the frequency of excellent functional outcome with dynamic compression plate and intramedullary interlocking nail for treatment of humeral shaft fractures. **Study Design:** Randomized controlled trial. **Duration and Place of Study:** The study was conducted from 16th February 2025 to 16th June 2025 at the Orthopedic A Unit, Khyber Teaching Hospital, Peshawar. **Methodology:** A total of sixty patients aged between eighteen and sixty years with closed humeral shaft fractures classified under type A1 to A3 of the AO/OTA system were enrolled and randomly divided into two equal groups. Group A underwent open reduction and internal fixation with dynamic compression plate, and Group B received fixation by intramedullary interlocking nail through antegrade or retrograde approach. Patients were followed to evaluate bone healing and functional recovery using the Disabilities of the Arm, Shoulder and Hand scoring system. An excellent outcome was defined as a score below twenty-four. **Results:** The mean age of participants was 42.48 ± 9.42 years. Excellent functional outcome was achieved in twenty-six patients (86.7%) treated with dynamic compression plate and twelve patients (40.0%) treated with intramedullary interlocking nail, showing a statistically significant difference ($p < 0.001$). **Conclusion:** Dynamic compression plate fixation provides superior functional outcomes compared with intramedullary interlocking nail for the treatment of humeral shaft fractures.

INTRODUCTION

Humeral shaft fractures are one of the common long bone injuries which affect the diaphyseal part of humerus bone mostly caused by direct trauma, road traffic accident, or fall from height.¹ These fractures are seen in adult population more often and usually associated with radial nerve injury in some cases.² The management of these fractures depend on pattern of fracture, age of patient, and functional demand of limb.³ Conservative treatment sometimes used when fracture is minimally displaced but in most of cases surgical management is required for early mobilization and union.⁴ The goal of surgical treatment is to achieve stable fixation, anatomical alignment and early movement of shoulder and elbow joint.⁵ There are many surgical options available but the two main methods that have been most commonly used are intramedullary interlocking nail and dynamic compression plate which both have their own benefits and complications.

Intramedullary interlocking nail fixation is a procedure where a metal rod is inserted inside the medullary canal of humerus which provide internal support and stability to the fractured bone.⁶ This technique is done through minimal incision either antegrade or retrograde route. It offers many advantages such as small exposure, less soft tissue damage, preservation of periosteal blood supply and early rehabilitation.⁶ The nail shares the load along the mechanical axis of bone so it provides good biomechanical advantage. However, it also has some drawbacks like shoulder pain and restricted motion in antegrade method, risk of rotator cuff injury, and sometimes difficulty in achieving perfect reduction in comminuted or spiral fractures.⁷ Despite that, interlocking nailing is preferred in multifragmentary and segmental fractures because it gives axial and rotational stability and also allows early weight bearing and quick return of function.⁶ Dynamic compression plate fixation is another standard

method used for humeral shaft fracture management in which the fracture site is exposed and plate is fixed to bone with screws by open reduction technique.⁸ This method allows the surgeon to achieve direct visualization and anatomical reduction of fracture fragments which help in proper alignment and faster bone healing.⁹ It provides rigid fixation and is more suitable in transverse or short oblique fractures where compression can be applied effectively.⁹ The main advantage of DCP is low incidence of shoulder complications and easier management of associated radial nerve injury because of open exposure.¹⁰ But disadvantages include larger incision, extensive soft tissue stripping, more blood loss and risk of infection or delayed union due to periosteal damage.¹¹ The choice between interlocking nail and DCP mainly depend on surgeon experience, type of fracture, and patient requirement but both methods aim for same goal which is stable fixation and early functional recovery of upper limb. A study by Hussain B et al. demonstrated that the proportion of excellent functional outcomes was 80% using dynamic compression plates, compared to 33.33% using intramedullary interlocking nails for the management of humeral shaft fractures.¹²

Also, there was a need to conduct this study at Peshawar due to the regular involvement of humeral shaft fractures at that location because of a higher incidence of road traffic accidents, falls, and workplace injuries. Although there exist a number of surgical procedures for humeral shaft fracture repair, there was a lack of evidence at that location that documented a comparison of the results of treatment using intramedullary inter-locking nail fixation and dynamic compression plate fixation at that location. Also at Peshawar, healing times and patient recovery may differ due to varying patient characteristics and healthcare facility differences.

METHODOLOGY

This randomized controlled study was conducted at the Orthopedic A Unit of Khyber Teaching Hospital, Peshawar, from 16th February 2025 to 16th June 2025. These cases were grouped according to the AO/OTA system under type A1 to A3 pattern. Approval for this study was taken from the ethical and review committee (No: 90/DME/KMC dated 23-01-2025) of the hospital as well as from CPSP before enrolling the patients. Sample size was calculated using the WHO software, keeping 80% test power and 95% confidence level. Expected rate of very good arm recovery was taken as 80% in plate group and 33.33% in nail group.¹² A total of sixty subjects were finally included and equally divided into two groups, thirty each. Those who were between 18 and 60 years of age, both male and female, and diagnosed with closed humeral shaft fracture under A1 to A3 type were accepted. Only those classified under ASA physical status class I or II were fit for the operation and included. Patients having open wounds, fracture near joint, fracture with vessel or nerve injury, infection, or chronic joint disorder like rheumatoid or osteoarthritis were excluded.

Before surgery starting every patient was clearly informed about the study and its purpose, and written consent was

taken. Detailed history was taken about duration of fracture, pain level, and any previous bone problem. Physical examination included inspection for swelling, tenderness, and limb position. Radiographs were used to confirm the type of fracture and alignment. After that, the patients were divided randomly into two groups using blocked randomization method. Group A received fixation through dynamic compression plate by standard anterolateral exposure. Bone fragments were reduced and plate with screws was placed under fluoroscopic control. Group B was treated by intramedullary interlocking nail either through antegrade or retrograde route, depending on the fracture pattern, and placement of nail and screws was checked under fluoroscopy. After surgery, all patients were given pain relief medicines and regional anesthesia where required. They were encouraged to start gentle arm and shoulder movements when their condition was stable. Lifting weight was restricted as per surgeon advice. X-rays were taken in each visit to check healing, which was considered complete when clear bone union line appeared and no movement or tenderness was present. Function of arm was assessed through DASH scoring system, which is a questionnaire that gives score from 0 to 100; a score below 24 was taken as excellent recovery of function.

All collected data was analyzed by SPSS version 26. Continuous data were expressed as mean with standard deviation while non-continuous variables were shown as frequencies and percentages. The comparison between both treatment groups was made using Chi-square or Fisher's exact test. The difference was counted significant if $p\text{-value} \leq 0.05$. Stratification was also applied on variables like age, sex, BMI, occupation, and other demographic features to see their influence on functional recovery, and post-stratification analysis was done by the same statistical tests.

RESULTS

In Group A, the mean age was 40.30 ± 9.03 years while in Group B it was 44.67 ± 9.51 years, and the duration of fracture before treatment was 9.03 ± 2.16 days in Group A compared to 11.83 ± 2.97 days in Group B, with mean BMI being 25.03 ± 1.66 kg/m² and 25.66 ± 1.52 kg/m² respectively (as shown in Table I). Regarding gender distribution, males comprised 25 patients (83.3%) in Group A and 23 patients (76.7%) in Group B, while females were 5 (16.7%) and 7 (23.3%) respectively. For socioeconomic status, poor patients were 9 (30.0%) in Group A versus 17 (56.7%) in Group B, middle class were 17 (56.7%) versus 11 (36.7%), and rich were 4 (13.3%) versus 2 (6.7%). Educational level showed uneducated patients as 4 (13.3%) in Group A and 13 (43.3%) in Group B, primary education 11 (36.7%) and 12 (40.0%), secondary education 9 (30.0%) and 1 (3.3%), and higher education 6 (20.0%) and 4 (13.3%) respectively. Rural residents were 18 (60.0%) in Group A and 13 (43.3%) in Group B, while urban residents were 12 (40.0%) and 17 (56.7%). ASA Class I patients were 21 (70.0%) in Group A and 18 (60.0%) in Group B, while Class II were 9 (30.0%) and 12 (40.0%) respectively (as shown in Table 1).

Table 1
Patient Demographics in Both Groups

Variables	Dynamic Compression Plate (Group A) n=30	Intramedullary Interlocking Nail (Group B) n=30
	Mean ± SD	Mean ± SD
Age (years)	40.30 ± 9.03	44.67 ± 9.51
Duration of Fracture (days)	9.03 ± 2.16	11.83 ± 2.97
BMI (kg/m ²)	25.03 ± 1.66	25.66 ± 1.52
Gender	n (%)	n (%)
Male	25 (83.3%)	23 (76.7%)
Female	5 (16.7%)	7 (23.3%)
Socioeconomic Status		
Poor	9 (30.0%)	17 (56.7%)
Middle	17 (56.7%)	11 (36.7%)
Rich	4 (13.3%)	2 (6.7%)
Educational Level		
Uneducated	4 (13.3%)	13 (43.3%)
Primary	11 (36.7%)	12 (40.0%)
Secondary	9 (30.0%)	1 (3.3%)
Higher	6 (20.0%)	4 (13.3%)
Residential Status		
Rural	18 (60.0%)	13 (43.3%)
Urban	12 (40.0%)	17 (56.7%)
ASA Class		
I	21 (70.0%)	18 (60.0%)
II	9 (30.0%)	12 (40.0%)

The comparison of excellent functional outcome between both groups revealed that 26 patients (86.7%) in Group A achieved excellent outcome compared to only 12 patients (40.0%) in Group B, while 4 patients (13.3%) in Group A and 18 patients (60.0%) in Group B did not achieve excellent outcome, with this difference being statistically significant ($p < 0.001$) using Fischer Exact Test (as shown in Table 2).

Table 2
Comparison of Excellent Functional Outcome Between the Two Groups

Excellent Functional Outcome	Group A (Dynamic Compression Plate) n=30 n (%)	Group B (Intramedullary Interlocking Nail) n=30 n (%)	P value
Yes	26 (86.7%)	12 (40.0%)	
No	4 (13.3%)	18 (60.0%)	<0.001*
Total	30 (100%)	30 (100%)	

*Fischer Exact Test

When stratified by demographic variables, for age group

Table 3
Association of Excellent Functional Outcome with Demographic Variables

Demographic Variable	Category	Group A Yes n(%)	Group A No n(%)	Group B Yes n(%)	Group B No n(%)	p-value*
Age Group (years)	≤ 40	10 (71.4)	4 (28.6)	2 (18.2)	9 (81.8)	0.015
	> 40	16 (100.0)	0 (0.0)	10 (52.6)	9 (47.4)	0.001
Gender	Male	21 (84.0)	4 (16.0)	9 (39.1)	14 (60.9)	0.002
	Female	5 (100.0)	0 (0.0)	3 (42.9)	4 (57.1)	0.081
Duration of Fracture (days)	≤ 10	18 (81.8)	4 (18.2)	4 (36.4)	7 (63.6)	0.017
	> 10	8 (100.0)	0 (0.0)	8 (42.1)	11 (57.9)	0.008
Socio-economic Status	Poor	8 (88.9)	1 (11.1)	5 (29.4)	12 (70.6)	0.011
	Middle	15 (88.2)	2 (11.8)	7 (63.6)	4 (36.4)	0.174
	Rich	3 (75.0)	1 (25.0)	0 (0.0)	2 (100.0)	0.400
Educational Level	Uneducated	4 (100.0)	0 (0.0)	1 (7.7)	12 (92.3)	0.002
	Primary	9 (81.8)	2 (18.2)	9 (75.0)	3 (25.0)	1.000
	Secondary	8 (88.9)	1 (11.1)	0 (0.0)	1 (100.0)	0.200
	Higher	5 (83.3)	1 (16.7)	2 (50.0)	2 (50.0)	0.500
Residential Status	Rural	15 (83.3)	3 (16.7)	6 (46.2)	7 (53.8)	0.052
	Urban	11 (91.7)	1 (8.3)	6 (35.3)	11 (64.7)	0.003
ASA Class	I	17 (81.0)	4 (19.0)	7 (38.9)	11 (61.1)	0.010
	II	9 (100.0)	0 (0.0)	5 (41.7)	7 (58.3)	0.007

*Fischer Exact Test

≤40 years, excellent outcome was achieved in 10 (71.4%) versus 4 (28.6%) in Group A and 2 (18.2%) versus 9 (81.8%) in Group B with $p=0.025$, while for age >40 years it was 16 (100.0%) versus 0 (0.0%) in Group A and 10 (52.6%) versus 9 (47.4%) in Group B with $p=0.001$. For males, excellent outcome was 21 (84.0%) versus 4 (16.0%) in Group A and 9 (39.1%) versus 14 (60.9%) in Group B ($p=0.004$), while for females it was 5 (100.0%) versus 0 (0.0%) in Group A and 3 (42.9%) versus 4 (57.1%) in Group B ($p=0.081$). Regarding duration of fracture ≤10 days, excellent outcome was 18 (81.8%) versus 4 (18.2%) in Group A and 4 (36.4%) versus 7 (63.6%) in Group B ($p=0.017$), while for >10 days it was 8 (100.0%) versus 0 (0.0%) in Group A and 8 (42.1%) versus 11 (57.9%) in Group B ($p=0.008$). For poor socioeconomic status, excellent outcome was 8 (88.9%) versus 1 (11.1%) in Group A and 5 (29.4%) versus 12 (70.6%) in Group B ($p=0.011$), for middle class it was 15 (88.2%) versus 2 (11.8%) in Group A and 7 (63.6%) versus 4 (36.4%) in Group B ($p=0.174$), and for rich it was 3 (75.0%) versus 1 (25.0%) in Group A and 0 (0.0%) versus 2 (100.0%) in Group B ($p=0.400$). Educational level stratification showed for uneducated patients, excellent outcome was 4 (100.0%) versus 0 (0.0%) in Group A and 1 (7.7%) versus 12 (92.3%) in Group B ($p=0.002$), for primary education it was 9 (81.8%) versus 2 (18.2%) in Group A and 9 (75.0%) versus 3 (25.0%) in Group B ($p=1.000$), for secondary education it was 8 (88.9%) versus 1 (11.1%) in Group A and 0 (0.0%) versus 1 (100.0%) in Group B ($p=0.200$), and for higher education it was 5 (83.3%) versus 1 (16.7%) in Group A and 2 (50.0%) versus 2 (50.0%) in Group B ($p=0.500$). For rural residents, excellent outcome was 15 (83.3%) versus 3 (16.7%) in Group A and 6 (46.2%) versus 7 (53.8%) in Group B ($p=0.052$), while for urban residents it was 11 (91.7%) versus 1 (8.3%) in Group A and 6 (35.3%) versus 11 (64.7%) in Group B ($p=0.003$). Finally, for ASA Class I patients, excellent outcome was 17 (81.0%) versus 4 (19.0%) in Group A and 7 (38.9%) versus 11 (61.1%) in Group B ($p=0.018$), while for Class II it was 9 (100.0%) versus 0 (0.0%) in Group A and 5 (41.7%) versus 7 (58.3%) in Group B ($p=0.007$), all analyzed using Fischer Exact Test (as shown in Table 3).

DISCUSSION

The present study was conducted to compare the outcome of dynamic compression plate versus intramedullary interlocking nail for treatment of humeral shaft fractures, and the results demonstrated that dynamic compression plate (Group A) achieved significantly superior excellent functional outcome (86.7%) compared to intramedullary interlocking nail (40.0%) with $p < 0.001$. This finding can be explained by the fact that dynamic compression plate provides more anatomical reduction and stable fixation which allows better bone-to-bone contact and promotes primary bone healing, whereas intramedullary nailing may cause rotational instability and difficulty in achieving proper alignment especially in cases where fracture geometry is complex. The biomechanical advantage of compression plating lies in its ability to neutralize all deforming forces including rotation, angulation and translation through direct visualization and fixation of fracture fragments, while intramedullary nail relies on interlocking screws which may not always provide adequate control of fracture fragments particularly in middle third humeral shaft fractures. Another important factor contributing to better outcome in plate fixation is that it allows direct reduction under vision which ensures proper restoration of humeral anatomy and length, whereas closed nailing technique depends on indirect reduction which may result in malunion or nonunion due to interposition of soft tissues or inadequate fracture reduction. The stratification analysis revealed that patients with age >40 years in Group A achieved 100% excellent outcome compared to 52.6% in Group B ($p = 0.001$), this can be attributed to the fact that older patients have better tolerance for open surgical approach and the rigid fixation provided by plate is more suitable for osteoporotic bone which is common in this age group. The findings of present study demonstrated that dynamic compression plate achieved significantly superior excellent functional outcome (86.7%) compared to intramedullary interlocking nail (40.0%) with $p < 0.001$, which is consistent with several previous studies that reported better outcomes with plating technique. Hussain B, et al.¹² in their randomized controlled trial of 60 patients found that DCP resulted in excellent outcomes in 80% cases compared to only 33.3% in ILN group ($p < 0.05$), which closely matches our findings and supports the superiority of compression plating for humeral shaft fractures. Similarly, Ansari HR et al.¹³ found that the DCP group showed 76.7% excellent outcome whereas the nail group showed 43.3%, which further supports the strong trend of achieving better functional outcome with plating. One of the reasons for this similar trend can be attributed to the fact that dynamic compression plate offers greater rigidity with better anatomical reduction that can only be achieved with the help of DCP and not with the help of intramedullary nails since IMN may not always guarantee adequate rotational stability of the fracture unit, particularly for transversely fractured fragments. Reddy CV, et al.¹⁴ also concluded that DCP resulted in superior range of motion and fewer complications compared to IM nailing with significant intergroup difference ($p < 0.05$), which further validates our results and suggests that plating technique offers biomechanical advantages that

translate into better clinical outcomes. However, some studies have shown contrasting results where intramedullary nailing demonstrated certain advantages over plating technique. Wang Y, et al.¹⁵ found that IMN had significantly reduced operative time, hospital stay, and union time with lower overall complications (10%) compared to plating group (20%), which differs from our findings where DCP showed better outcomes. This difference in results could be explained by the variations in surgical expertise, patient selection criteria, and fracture patterns included in different studies, as Wang's study might have included more simple fracture patterns that are better suited for closed nailing technique. Kumar LLS¹⁶ reported that union within 10 weeks occurred in 48.8% of IMIL cases compared to 41.8% in DCP cases, and IM nailing led to faster recovery with less blood loss, which contradicts our findings of superior outcomes with plating. The possible explanation for this discrepancy is that Kumar's study focused more on union time and surgical morbidity rather than functional outcome, and also the minimally invasive nature of intramedullary nailing reduces soft tissue damage which can contribute to faster initial recovery despite potentially inferior functional results in long term. The meta-analysis by Nadeem A, et al.¹⁷ synthesizing 26 studies with 1,674 patients showed that IMN significantly reduced union time by 1.06 weeks and had lower risk of radial nerve palsy and infection, but authors concluded that ORIF ensures anatomical alignment and remains preferred option for complex fractures, which partially supports our findings as it acknowledges the superiority of plating for achieving better anatomical reduction. McCormack RG, et al.¹⁸ found no significant differences in shoulder or elbow function between groups, but complications were higher in IMN (13 cases) than DCP (3 cases) with secondary surgeries needed in 7 IMN patients versus only 1 DCP case ($p = 0.016$), which aligns with our results showing better outcomes with plating and can be explained by the fact that complications such as implant failure, shoulder impingement, and rotational malalignment are more common with intramedullary fixation. Chandan RK, et al.¹⁹ reported mean union time of 7.83 weeks for ILN and 8.64 weeks for DCP with statistically similar functional results, but DCP group showed less shoulder pain and better joint function, which is consistent with our finding of superior functional outcome with plating and suggests that even when union times are comparable, the quality of reduction and preservation of joint function is better with compression plating. Akalin Y, et al.²⁰ found that both methods yielded similar radiologic and functional results, but DCP showed superior shoulder mobility with better UCLA shoulder scores ($p = 0.034$), which supports our results and indicates that plating preserves shoulder function better than nailing possibly due to avoidance of proximal screw impingement and better restoration of humeral anatomy. The stratification analysis in our study showed that age >40 years had 100% excellent outcome with DCP compared to 52.6% with nail ($p = 0.001$), and male patients achieved 84.0% excellent outcome with DCP versus 39.1% with nail ($p = 0.004$), these demographic associations have not been extensively reported in previous literature but can be explained by the fact that

older patients and males often have higher functional demands and more complex fracture patterns which benefit more from anatomical reduction provided by compression plating.

The present study has several limitations that should be acknowledged which may affect the generalizability of findings. First, this was single center study conducted at one institution which limits the external validity and applicability of results to other populations and healthcare settings with different patient demographics and surgical expertise. Second, the sample size was relatively small with only 30 patients in each group which may not provide adequate statistical power to detect all clinically significant differences between two treatment modalities. Third, the follow-up duration was not mentioned which is important limitation as long-term functional outcomes and complications may differ from short-term results.

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CONCLUSION

Our study has concluded that dynamic compression plate is superior treatment modality compared to intramedullary interlocking nail for management of humeral shaft fractures as it provides significantly better excellent functional outcomes. The stratification analysis revealed that compression plating demonstrates consistent superiority across various demographic variables including age, gender, duration of fracture, socioeconomic status, educational level, residential status and ASA class.

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