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Original Research Article

Functional and Radiological Outcome of Fracture Shaft Humerus Managed by Minimally Invasive Percutaneous Plateosteosynthes is Technique

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Abstract:

Background: Fractures of the shaft of the humerus constitute nearly 3-5% of all long bone fractures. While conservative management remains an option for many diaphyseal humeral fractures, operative fixation is increasingly preferred in fractures with unacceptable alignment, polytrauma, segmental injuries, and pathological fractures. Minimally Invasive Percutaneous Plate Osteosynthesis (MIPO) has emerged as a biologically favourable alternative to conventional open plating, aiming to preserve the fracture haematoma and periosteal blood supply while achieving stable fixation.

Aims and Objectives: To evaluate the functional and radiological outcome of fracture shaft humerus treated with MIPO technique and to assess the rate of union, time to union, and associated complications.

Materials and Methods: This prospective observational study was conducted in the Department of Orthopaedics, JLNMCH, Bhagalpur, over a period of 9 months. Thirty patients with closed extra-articular fractures of the humeral shaft (AO type 12-A, 12-B and 12-C) meeting the inclusion criteria were managed with MIPO using a locking compression plate. Patients were followed up at 6 weeks, 12 weeks, 6 months and final follow-up. Functional outcome was assessed using the Constant-Murley Shoulder Score, and radiological union was assessed using standard anteroposterior and lateral radiographs.

Results: The mean age of the study population was 39.5 ± 10.9 years, with a male preponderance (66.7%). Road traffic accident was the commonest mode of injury (60%). The mean operative time was 79.7 ± 11.2 minutes and the mean time to radiological union was 14.6 ± 2.2 weeks. At final follow-up, functional outcome was excellent in 14 patients (46.7%), good in 10 patients (33.3%) and fair in 6 patients (20%), with no poor results. Complications were recorded in 5 patients (16.7%), including transient radial nerve neuropraxia (2), delayed union (2) and superficial infection (1); no patient required secondary intervention beyond conservative management of the complication.

Conclusion: MIPO is a safe and effective technique for the management of extra-articular fracture shaft humerus, providing satisfactory functional and radiological outcomes with a low rate of major complications, and should be considered as a preferred modality in appropriately selected patients.

Keywords: Humeral shaft fracture, Minimally Invasive Percutaneous Plate Osteosynthesis, MIPO, Locking compression plate, Constant-Murley score, Functional outcome.

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Introduction

Fractures of the shaft of the humerus account for approximately 3-5% of all fractures and about 20% of fractures involving the humerus. They occur in a bimodal age distribution, with a peak in young males following high-energy trauma such as road traffic accidents, and a second peak in elderly females following low-energy falls associated with osteoporosis [25].

The humerus is unique among long bones in that a significant degree of angulation and shortening can be accepted without major functional compromise, owing to the compensatory mobility of the shoulder and elbow joints. For this reason, closed conservative treatment with a functional brace, as popularised by Sarmiento, has traditionally been the mainstay of management and continues to yield

union rates exceeding 90% in appropriately selected patients [1,9].

However, operative intervention is indicated in fractures with segmental or comminuted patterns, associated vascular injury, open fractures, polytrauma, floating elbow, pathological fractures, and in fractures where closed reduction fails to achieve acceptable alignment [14,15]. Conventional open reduction and internal fixation (ORIF) through an anterolateral or posterior approach provides excellent stability but is associated with extensive soft tissue dissection, devascularisation of the fracture fragments, higher infection rates and, notably, a reported radial nerve palsy rate of up to 10-18% due to direct nerve handling [24].

Minimally Invasive Percutaneous Plate Osteosynthesis (MIPO) was developed to combine the mechanical stability of internal fixation with the biological advantages of closed methods [2,3]. The technique relies on indirect fracture reduction and submuscular plate passage through limited proximal and distal incisions, thereby preserving the periosteal and endosteal blood supply, the fracture haematoma, and minimising the risk of iatrogenic radial nerve injury [3,28]. Locking compression plates (LCP), functioning as internal fixators, are particularly suited to this technique as they do not require intimate plate-bone contact for stability [2,7].

Given the increasing adoption of MIPO for humeral shaft fractures [4,16] and the relative paucity of prospective data from this region, the present study was undertaken to evaluate the functional and radiological outcomes of patients with fracture shaft humerus managed by the MIPO technique at a tertiary care teaching institute.

Aims and Objectives

1. To study the functional outcome of fracture shaft humerus managed by Minimally Invasive Percutaneous Plate Osteosynthesis (MIPO) using the Constant-Murley Shoulder Score.
2. To study the radiological outcome, including rate and time to union, in patients managed by MIPO technique.
3. To evaluate the intra-operative and post-operative complications associated with the MIPO technique.

Materials and Methods

Study Design: Hospital-based prospective observational study.

Study Place: Department of Orthopaedics, Jawaharlal Nehru Medical College and Hospital (JLNMCH), Bhagalpur.

Study Duration: 9 months.

Sample Size: 30 patients, selected by purposive/consecutive sampling from among patients presenting to the emergency and outpatient department with fracture shaft humerus fulfilling the inclusion criteria.

Inclusion Criteria

1. Patients aged 18-65 years.
2. Closed, extra-articular fractures of the humeral diaphysis (AO type 12-A, 12-B and 12-C).
3. Patients willing to give written informed consent and available for regular follow-up.

Exclusion Criteria

1. Open fractures (Gustilo-Anderson type II and above).
2. Pathological fractures other than osteoporotic fractures.
3. Fractures with pre-existing radial nerve palsy or associated vascular injury requiring exploration.
4. Intra-articular extension of fracture and periprosthetic fractures.
5. Patients unfit for surgery or not willing to participate in the study.

Surgical Technique: All patients were operated under general or regional (brachial plexus block) anaesthesia in the supine position with the affected limb on a radiolucent arm table, or in the lateral position depending upon fracture location. Closed reduction was achieved under image intensifier guidance by longitudinal traction, and a locking compression plate of appropriate length was inserted submuscularly through limited proximal and distal incisions, bridging the fracture site without direct exposure of the fracture fragments. Proximal and distal locking screws were placed percutaneously through stab incisions, with careful attention to the course of the radial nerve during distal screw placement. Intra-operative fluoroscopy was used to confirm reduction, plate position, and screw length in both anteroposterior and lateral planes.

Post-operative Protocol and Follow-up: Post-operatively, the limb was supported in an arm pouch and shoulder-elbow mobilisation exercises were initiated as pain permitted from the first post-operative day. Patients were followed up at 2 weeks (suture removal), 6 weeks, 12 weeks, 6 months, and at final follow-up, with clinical and radiological assessment at each visit. Radiological union was defined as bridging callus at three of four cortices on orthogonal radiographic views with absence of tenderness at the fracture site on clinical examination. Functional outcome at final follow-up was graded using the Constant-Murley Shoulder Score (excellent: 90-100, good: 75-89, fair: 60-74, poor: <60).

Statistical Analysis: Data were entered in Microsoft Excel and analysed using SPSS software (version 25.0). Continuous variables were expressed as mean ± standard deviation, and categorical variables were expressed as frequency and percentage. A p-value of <0.05was considered statistically significant.

Results

A total of 30 patients with fracture shaft humerus managed by the MIPO technique were included in this study and followed up for a minimum period of 6 months. The results are summarised below.

Table 1: Age and Gender Distribution of Study Population (n=30)

Age Group (years)	Male	Female	Total	Percentage (%)
18-30	6	2	8	26.7
31-40	7	2	9	30.0
41-50	5	2	7	23.3
51-60	2	3	5	16.7
61-70	0	1	1	3.3
Total	20	10	30	100.0

Mean age of the study population was 39.5 ± 10.9 years (range 22-63 years), with a male to female ratio of 2:1.

Table 2: Distribution According to Side Involved and Mode of Injury

Parameter	Category	No. of Patients	Percentage (%)
Side Involved	Right	16	53.3
	Left	14	46.7
Mode of Injury	Road Traffic Accident	18	60.0
	Fall from Height	6	20.0
	Sports Injury	4	13.3
	Assault	2	6.7

Table 3: AO Classification of Fracture Pattern

AO Type	Description	No. of Patients	Percentage (%)
12-A	Simple fracture (spiral/oblique/transverse)	15	50.0
12-B	Wedge fracture	10	33.3
12-C	Complex/comminuted fracture	5	16.7
Total		30	100.0

Table 4: Operative and Post-operative Parameters

Parameter	Mean ± SD	Range
Operative time (minutes)	79.7 ± 11.2	65 - 102
Intra-operative blood loss (ml)	68.3 ± 15.4	40 - 110
Parameter	**Mean ± SD**	**Range**
Hospital stay (days)	5.8 ± 1.6	3 - 9
Time to radiological union (weeks)	14.6 ± 2.2	12 - 20
Duration of follow-up (months)	7.4 ± 1.1	6 - 9

Table 5: Functional Outcome According to Constant-Murley Shoulder Score at Final Follow-up (n=30)

Grade	Score Range	No. of Patients	Percentage (%)
Excellent	90 - 100	14	46.7
Good	75 - 89	10	33.3
Fair	60 - 74	6	20.0
Poor	< 60	0	0.0
Total		30	100.0

Satisfactory outcome (excellent + good) was achieved in 24 patients (80%), while fair outcome was observed in 6 patients (20%), predominantly those with AO type 12-C fractures and those who developed post-operative complications.

Table 6: Distribution According to Fracture Union

Union Status	No. of Patients	Percentage (%)
Union within 16 weeks	24	80.0
Delayed union (>16 weeks)	4	13.3
Union with radial nerve neuropraxia recovery	2	6.7
Non-union	0	0.0
Total	30	100.0

Table 7: Complications Observed in the Study Group

Complication	No. of Patients	Percentage (%)
Transient radial nerve neuropraxia	2	6.7
Delayed union	2	6.7
Superficial surgical site infection	1	3.3
Deep infection	0	0.0
Implant failure	0	0.0
Non-union	0	0.0
No complication	25	83.3

All cases of transient radial nerve neuropraxia recovered completely with conservative management (wrist splint and physiotherapy) by 12 weeks. Delayed union was managed conservatively with continued immobilisation and was not associated with implant-related complications; both fractures eventually united without further surgical intervention. The single case of superficial infection resolved with oral antibiotics and regular wound care.

Discussion

The present prospective study evaluated 30 patients with fracture shaft humerus managed by the MIPO technique over a period of 9 months at a tertiary care teaching institute. The demographic profile of our study, with a mean age of 39.5 years and a male preponderance (66.7%), is consistent with previously published series, reflecting the predominance of high-energy trauma such as road traffic accidents in the relatively younger, economically active male population [25,10].

The mean operative time in our study (79.7 ± 11.2 minutes) and mean time to radiological union (14.6 ± 2.2 weeks) are comparable to those reported in other MIPO series, which have generally documented union times between 12 and 18 weeks [2,6,7,11]. This is attributable to the biological fixation principle underlying MIPO, wherein the fracture haematoma and periosteal blood supply are preserved by avoiding direct exposure of the fracture site, thereby promoting earlier callus formation compared with conventional open plating [3,28].

In terms of functional outcome, 80% of patients in our study achieved an excellent or good Constant-Murley score at final follow-up, which is in keeping with the satisfactory-to-good functional outcomes of 75-90% reported across various MIPO series for humeral shaft fractures [5,8,12,19,20,30]. Patients with comminuted (AO type 12-C) fracture patterns tended to have relatively lower functional scores, likely related to a combination of higher energy of injury, longer time to union, and a greater incidence of associated complications in this subgroup [16].

The overall complication rate of 16.7% in our study, with transient radial nerve neuropraxia in 6.7% of patients, is favourable when compared with the reported radial nerve palsy rates of 10-18% following conventional open reduction and internal fixation [24,14]. Importantly, all nerve-related complications in our series were transient and resolved completely with conservative management, underscoring the relative safety of percutaneous distal screw placement when performed with careful attention to the course of the radial nerve and, where necessary, a limited direct visualisation of the nerve at the distal incision [3,20].

The absence of non-union or deep infection in our series, despite a modest sample size, further supports the biological advantage of the MIPO technique [6,9]. These findings collectively suggest that MIPO offers a reliable balance between mechanical stability and soft-tissue preservation, translating into predictable union and satisfactory functional recovery in patients with extra-articular humeral shaft fractures [16,30].

Limitations of the study

1. The sample size of 30patients and follow-up duration of 9months are relatively modest, limiting the generalisability of the findings and precluding subgroup analysis with adequate statistical power.
2. This was a single-centre study without a comparator arm (e.g., conventional ORIF or conservative bracing), which limits the ability to draw comparative conclusions regarding superiority of the MIPO technique.

3. Longer-term follow-up would be required to comment on late complications such as implant-related shoulder impingement or stiffness.

Conclusion

Minimally Invasive Percutaneous Plate Osteosynthesis is a safe, reliable and biologically sound technique for the management of extra-articular fracture shaft humerus. In this study, it was associated with a high rate of union, satisfactory functional outcome in the majority of patients, and a low incidence of major complications, particularly iatrogenic radial nerve injury. MIPO may therefore be considered a preferred surgical option in appropriately selected patients with humeral shaft fractures requiring operative fixation, though larger, multi-centric, randomised studies with longer follow-up are recommended to further validate these findings.

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