

Functional Outcome of Comminuted Fracture Shaft of Humerus Operated by Minimally Invasive Anterior Plate Osteosynthesis – A Prospective Study

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Abstract

Introduction: Minimally invasive plate osteosynthesis (MIPO) has been advocated as a safe approach to humeral shaft fracture management.

Aim: This study aims to analyze and evaluate the functional outcome of surgical management of comminuted shaft of humerus by minimally invasive anterior plate osteosynthesis.

Materials and Methods: In this prospective study, patients with humeral shaft fractures were included in the study. All the patients with a comminuted diaphyseal fracture of humerus underwent MIPO technique. Constant–Murley score for shoulder and Mayo Elbow Performance Score (MEPS) for elbow were assessed postoperatively at 3 months, 6 months, and 2 years follow-up and score calculated at each visit.

Results: In 15 patients, the mean Constant score was 87 on the affected side and 90.67 on the unaffected side. The mean MEPS was 97.33 ranging from 85 to 100. The mean surgical time with MIPO was 69 min (range: 60–90 min). The average blood loss with MIPO was 109 ml (range: 75–150 min).

Conclusion: MIPO of the humerus gives good functional and cosmetic results and should be considered one of the management options in the treatment of humeral diaphyseal fractures.

Key words: Diaphyseal fracture, Humerus, Minimally invasive plate osteosynthesis

INTRODUCTION

Humeral shaft fractures make up approximately 1% of all fractures. Typically, they are the result of direct trauma but also occur in sports where rotational forces are greater, for example, baseball or arm wrestling. Fractures of the middle or distal third of the shaft put the radial nerve at risk. In a small percentage of cases, humeral shaft fractures

are associated with a vascular injury. Open fractures are uncommon but can represent serious injuries, particularly if associated with crushing in industrial injuries.^[1]

Non-operative treatment of diaphyseal humeral fractures can be accomplished with various techniques such as Velpeau bandage, a sling and body bandage, abduction cast or splint, coaptation splint or u-slab, hanging arm cast, and functional bracing. Functional bracing, as described by Sarmiento *et al.*, is widely used by orthopedic practitioners for the management of acute diaphyseal humeral fractures. Sarmiento *et al.* have also presented the largest series of 620 patients treated with functional bracing with adequate follow-up.^[2]

By 1996, the previous list was enriched with segmental fractures, pathological fractures, bilateral fractures, floating

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elbow, polytrauma cases, neurologic loss after penetrating injury, associated vascular injury, and intra-articular fracture extension while some of the previous indications, such as open fractures or fractures associated with radial nerve palsy, were reassessed.^[1]

Over the past 10–20 years, surgeons have paid attention to the details and secondary characteristics of fracture patterns and although the basic list of indications for operative treatment has not changed, more “relative” indications have been added.

Plating enables the surgeon to reduce and hold the critical articular or periarticular fragments. Although plating can be technically demanding, the results are predictable. Associated shoulder or elbow stiffness is infrequent, unless there is a periarticular or intra-articular extension of the fracture planes. Plating is also best for holding corrected malunion cases following osteotomy and remains the treatment of choice for non-union of the humerus.^[3]

Another option for managing humeral fractures is intramedullary nailing. Recent designs include nails with smaller diameters, which are more flexible, have multiple locking options, and can compress the fracture. Humeral nails can be inserted either antegrade or retrograde in a reamed or unreamed manner.^[4]

Minimally invasive approaches should be considered to plate a multifragmentary humeral shaft fracture and are usually performed with a pair of incisions, one distal and one proximal. Minimally invasive plate osteosynthesis (MIPO) techniques are challenging and have the benefit of reducing soft tissue damage but are not without their risks.^[5]

Aim

This study aims to analyze and evaluate the functional outcome of surgical management of comminuted shaft of humerus by minimally invasive anterior plate osteosynthesis.

MATERIALS AND METHODS

Patients attending the Department of Orthopaedics in Government Rajaji Hospital and Madurai Medical College from November 2016 to October 2018 who are diagnosed with comminuted shaft of humerus fracture and willing for surgery.

Inclusion Criteria

The following criteria were included in the study:

1. Fractures of the shaft of humerus
2. Age of more than 18 years

3. Simple injury
4. Mid-third comminuted fracture
5. Spiral fractures
6. Osteoporotic fractures.

Exclusion Criteria

The following criteria were excluded from the study:

1. Patients who not fit for surgery
2. Patients below 18 years of age
3. Compound fractures
4. Vascular injury.

At the time of admission, fractures were classified according to the Orthopaedic Trauma Association classification. Nature of the injury was also noted. All the patients with comminuted diaphyseal fracture of humerus underwent MIPO technique. In the post-operative radiographs, humerus malalignment was measured. The degree of the angulation (varus or valgus), anteroposterior, rotational, and shortening were evaluated radiologically and clinically.

Constant–Murley score for shoulder and Mayo Elbow Performance Score (MEPS) for elbow were assessed postoperatively at 3 months, 6 months, and 2 years follow-up and score calculated at each visit.

RESULTS

Among the 15 patients studied, the highest number of patients was seen in 40–60 years (53.3%) age group. Among the 15 cases, there were 9 male and 6 female patients with predominant male distribution. Among the patients studied, most of the patients had affected left side compared with right. Most cases were due to road traffic accidents (73.3%). The other mechanisms are accidental fall (26.6%). Among the 15 cases, 6 cases had no angulation and 5 cases did have minimum angulation of <10° of varus or valgus angulation. Three cases had varus angulation (>10°) which showed no significant functional impairment and no cases had valgus angulation. One case had reported posterior angulation due to excessive plate contouring. None of the patients had any amount of rotational malalignment or shortening [Figures 1 and 2]. The mean union time is 11.9 weeks, ranging from 8 to 20 weeks. With respect to shoulder range of motion, among the 15 patients; 9 patients (60%) had excellent results, 4 patients (26.7%) had good result, 2 (13.3%) had fair result, and no poor result. With respect to elbow range of motion, among the 15 patients; 12 patients (80%) had excellent results, 3 patients (20%) had good result, no fair result, and no poor result [Table 1]. Shoulder function is assessed by Constant–Murley score. The mean

Constant score was 87 on the affected side and 90.67 on the unaffected side. Shoulder function was assessed by Constant–Murley score. Among the 15 patients, 14 patients had excellent results and 1 patient had good result [Table 2]. The mean MEPS was 97.33 ranging from 85 to 100. Elbow function score was assessed by MEPS. Among the 15 patients, all patients had excellent elbow

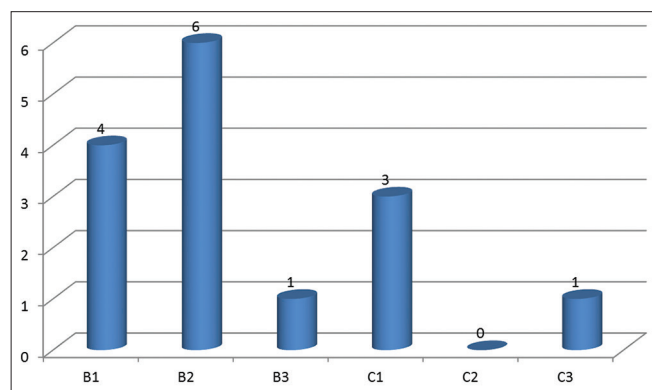


Figure 1: OTA classification

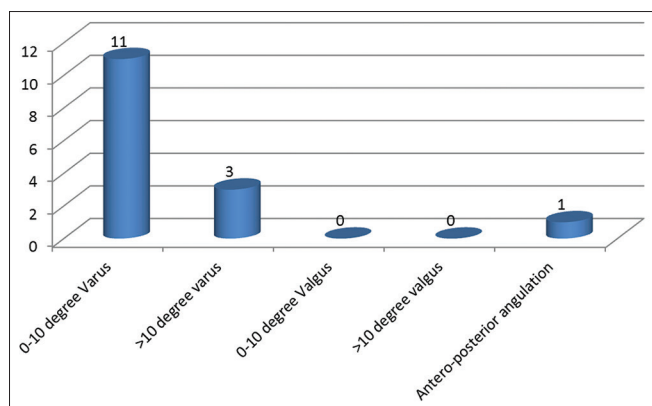


Figure 2: Radiological valgus/varus angulation

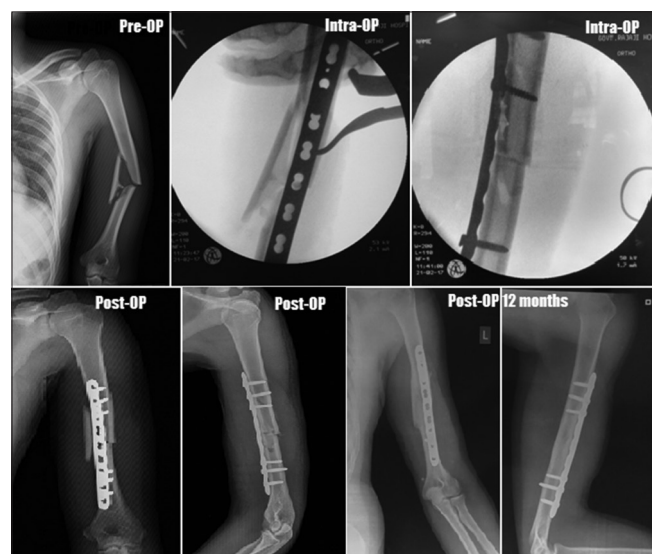


Figure 3: Simple #shaft of humerus left mid-third comminuted

function score. The mean surgical time with MIPO was 69 min (range: 60–90 min). The average blood loss with MIPO was 109 ml (range: 75–150 min). Two of 15 had radial nerve palsy postoperatively. Postoperatively, these cases are given with cock-up splints, preferably dynamic cock-up splints. Nerve conduction study was done in these two cases by 6 weeks. Recovery was assessed at every follow-up by sensory and motor examination. One case had full recovery by the end of 6 months and the other case showed no recovery by the end of 1 year for which tendon transfer planned. One case showed delayed union by 20 weeks. The fracture was fixed in distraction [Figure 3].

DISCUSSION

Minimally invasive surgical treatment of skeletal injuries aims to preserve the biology of soft tissue and bone. The rationale for performing mechanical stabilization through fracture fixation is the obvious need to restore anatomy and mechanical function of the bone. Optimal bone healing requires a balance between mechanics and biology and is aided by modern osteosynthesis. In open reduction internal fixation (ORIF), the problem was that, all too often, precise reduction and absolute stable fixation were achieved at the expense of extensive soft tissue trauma caused by the surgery.

MIPO scores over open reduction and plate fixation of humerus fractures by decreasing the surgical trauma to the soft tissue and maintaining the periosteal circulation. Application of the plate on the bone by an open technique interferes with the local vascularization, leading to osteonecrosis beneath the implant, which can cause delayed healing or non-healing (the reported rate of non-union being 5.8%). The primary bone healing without callus formation is not very strong and there exists a real risk

Table 1: Shoulder/elbow range of motion

Range of motion	Shoulder	Elbow
Excellent (100%)	9	12
Good (75–100%)	4	3
Fair (50–75%)	2	-
Poor (<50%)	-	-
Total	15	15

Table 2: Functional outcome

Outcome	Constant score	MEPS
Excellent	14	15
Good	1	0
Fair	0	0
Poor	0	0

MEPS: Mayo Elbow Performance Score

for refracture after removal of the implant in the open technique. MIPO is that it is devoid of the entry point problems of intramedullary nailing such as rotator cuff impingement.^[6]

The average union time for fractures in our study was 11.9 weeks (range: 8–20 weeks) and the union rate was 93.7%. One case showed delayed union by 20 weeks. The fracture was fixed in distraction at fracture site due to excessive traction after initial proximal screw placement. The results were good compared to Concha *et al.* study where union rate was 91.5% (32/35) at an average of 12 weeks. All the cases showed union without primary or secondary bone grafting.^[7]

ORIF for comminuted fractures draws the need for lag screw fixation or bone grafting which prolongs the surgery time, blood loss, and post-operative morbidity. Nevertheless, the risk of non-union rate is higher than MIPO due to extensive soft tissue stripping according to literature around 5.8%. MIPO gains advantage over ORIF in these issues.

Esmailiejah *et al.* found better results with MIPO when compared to open reduction and plating as regard to the time of surgery and iatrogenic radial nerve injury (3% vs. 12%) and the rate of infection (0% vs. 6%), patients managed with the MIPO technique had also shorter time for union and earlier return to their previous level of activities.^[8]

Of the 15 cases, 4 cases had more than 10° angulation which does not show any functional impairment. Hence, near-normal biological reduction in MIPO does not compromise on functional outcome of the patient.

The mean surgical time with MIPO was 69 min (range: 60–90 min) which was less compared to Shetty *et al.* study which was 91.5.^[6]

Shoulder function was assessed by Constant–Murley score which was 87 on affected side and 90.67 on healthy side and better compared to Apivatthakakul *et al.* study which reported 85.8 on affected side and 90.6 on the healthy side.^[9]

The mean MEPS for the elbow is 97.66 which was comparable to other studies.

No cases reported infection postoperatively which was better compared to Concha *et al.* study which reported two cases of infection.^[7]

Post-operative iatrogenic radial nerve palsy was reported in two cases which were higher compared to Deepak *et*

al.^[10] study and Hadhoud *et al.*;^[11] one case recovered by 6 months follow-up and one case did not show recovery at 1 year for which tendon transfer planned subsequently. These nerve injuries occurred earlier in the study probably due to plate offset and unicortical drilling with chance of drill bit slippage into the neural structures posteriorly. Hence, plate position should be visualized digitally and radiologically before drilling. Take care to be in the proper intermuscular plain and the plate advanced gently in close contact to bone over the anterior surface in a proximal to distal direction to protect deltoid insertion. The forearm must be positioned in supination; pronation brings the radial nerve closer to plate according to Apivatthakakul *et al.*^[9] study. The scar was cosmetically acceptable when compared to ORIF. The average blood loss was less compared to ORIF and all the patients showed early return of activities due to decreased post-operative morbidity.

CONCLUSION

MIPO offers excellent functional outcome for the comminuted shaft of humerus with better union rate and decreased risk of non-union compared to ORIF. Near-normal biological reduction in MIPO offers equally good functional outcome with better union rate compared to anatomical reduction in ORIF, more so for comminuted fractures. There is decreased post-operative morbidity with early return to function. The operating time and blood loss are less compared to ORIF. The chance of infection is negligible due to decreased surgical exposure. Risk of radial nerve palsy is there to start with, but with experience can be neglected.

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