

A Clinico-Radiological Outcome Assessment of Diaphyseal Humerus Fracture Treated Using Minimal Invasive Plate Osteosynthesis (MIPO)

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Abstract

Aim: To assess the clinico-radiological and functional outcome in management of humerus diaphyseal fracture by MIPO technique.

Methodology: This study was conducted in the Department of Orthopaedics, SB Medical College & Hospital, Hazaribagh, Jharkhand, India in the duration of 1 year. It included 50 diaphyseal fractures of humerus treated with MIPO technique. The cases were followed up for a minimum period of 1 year. 18-65 years patients having closed and Gustilo Anderson grade 1 diaphyseal fracture of humerus were included in this study. The type of fracture was evaluated and reported in accordance with the AO19 classification system after obtaining a ski gram- anteroposterior (AP) and a lateral view of the affected Arm. These radiographs were also used to decide the appropriate length of metal implant and for planning the surgery.

Results: 50 patients of diaphyseal fracture of humerus were included and treated by Anterior Bridge Plating by MIPO technique. Out of 50 patients, 32 (64%) were males and 18 (36%) were females. The mean age of patients was 39.71 ± 13.18 (Range = 18-65) years respectively. The mean surgery time was 99.52 ± 13.50 minutes (Range = 80-120). There was a significant difference in mean UCLA and MEPS between 6 weeks, at 3 months, at 6 months and at 9 months. Callus was reported among significant ($p < 0.005$) cases 34 (64%) at 6 weeks, 42 (84%) at 3 months, at 6 months and at 9 months. Angulation ($>15^\circ$) was reported among 2 (4%) at 6 weeks, 5 (10%) at 3 months and 5 (10%) at 6 months in our study ($p < 0.001$). Screw back out was reported among 2 (4%) at 3 months and 2 (4%) at 6 months due to infection. Roundening of Margins was reported among 4 (10%) at 6 months and sclerosis was reported among 3 (6%) at 6 months in our study. Infection was reported among 2 (4%), Non- Union among 4 (8%) and Radial Nerve Palsy among 7 (14%) cases.

Conclusion: This study demonstrates that the minimally invasive plate osteosynthesis technique (MIPO) for treatment of humeral shaft fractures presents newer, effective, and acceptable modality of treatment for such fractures.

Keywords: Osteosynthesis, humeral shaft, diaphyseal fractures.

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Introduction

The humeral shaft is defined as the expanse between the proximal insertion of the pectoralis major and the distal metaphyseal flare of the humerus [1]. Cylindrical in shape, the shaft inherently provides strength and resistance to both torsional and bending forces. Distally the bone transitions into a triangular geometry with the base posterior which forms a supra-condylar region. This region maintains a narrow anterior-posterior dimension [1]. The blood supply to the humeral shaft is provided predominantly by the nutrient artery, a branch off of the brachial artery that penetrates at the proximal third of the humerus on the medial side of the bone. The periosteum and the surrounding muscle bed also provide vascularity, to a lesser degree. Given the major role the nutrient artery plays in nourishing the humeral shaft, its disruption either through traumatic or iatrogenic means can be detrimental to fracture healing. It should be protected and preserved during surgical dissection.

Diaphyseal fractures of the humerus occur frequently and represent three to five percent of the fractures of the human body [2]. Most of these fractures are caused by direct or indirect trauma [3,4]. Humerus shaft fracture is not an uncommon event, representing 1% to 2% [5, 6] of all fractures happening in the human body and constitutes 14% of all fractures of the humerus [7].

Treatment of diaphyseal humeral fracture has evolved from the conservative cast and brace [8, 9] to internal fixation with plate and screws [10] and intramedullary nailing [10]; each of these techniques has its own complications [10, 11] and there is no definite data that shows the superiority of one over the other.

In seeking minimally invasive techniques, a new therapeutic option has arisen for treating these fractures: Bridge plates [12]. The advantage of MIPO technique over

conventional techniques are its following properties i.e. less soft tissue stripping, less iatrogenic neurovascular injury, less time consuming and cosmetically advanced technique. As a result of technical advancement, the minimally invasive plate osteosynthesis (MIPO) of humerus shaft fracture has shown promising results recently [13-15].

Aim:

To assess the clinico-radiological and functional outcome in management of humerus diaphyseal fracture by MIPO technique.

Materials and Methods

This study was conducted in the Department of Orthopaedics, SB Medical College & Hospital, Hazaribagh, Jharkhand, India in the duration of 1 year. It included 50 diaphyseal fractures of humerus treated with MIPO technique. The cases were followed up for a minimum period of 1 year.

Inclusion criteria:

18-65 years patients having closed and Gustilo Anderson grade 1 diaphyseal fracture of humerus.

Exclusion criteria:

Patients having pathological fracture, pregnancy or any other fracture of the same extremity, radial nerve or brachial plexus injury, and life threatening comorbid conditions were excluded.

The type of fracture was evaluated and reported in accordance with the AO19 classification system after obtaining a ski gram— anteroposterior (AP) and a lateral view of the affected Arm. These radiographs were also used to decide the appropriate length of metal implant and for planning the surgery.

Surgical technique: The patients were positioned supine. All the patients were given general anesthesia. A 2-3 cm incision between the medial border of

deltoid and proximal biceps, 5 cm caudal to the acromion process was made. Distally, a 2-3 cm incision at the lateral border of the biceps, nearly 5 cm proximal to the flexion crease. Retraction of biceps was done to expose the musculocutaneous nerve, overlying the brachialis muscle. The nerve is then retracted and brachialis muscle was split till bone. The lateral half of brachialis muscle then protects radial nerve.

A sub-brachialis, extra-periosteal tunnel was created and a 4.5- mm dynamic compression plate is passed through the incision on the anterior surface of the humerus. Varus/ valgus angulation, length and rotation are restored by traction. Confirmation of the reduction done under image intensifier. Each side of the plate is fixed with three screws in anterior to posterior direction. Tunneling was done carefully in anterior fashion to prevent iatrogenic radial nerve injury. The amount of force required to be used for manual traction for achieving proper reduction was not easy at first, but becomes easy as technique is practiced. Rotational malalignment was checked under image intensifier. The operative time (skin incision to closure) was recorded. Postoperatively, shoulder immobilizer was applied.

Post operatively the operated limb was held in shoulder immobilizer and stitches were removed (i.e. 11th day) and

successively patient were recommended to perform intermittent active gentle Shoulder and Elbow range of motion exercises as their pain control permits. Any complications were noted. Regular follow up was done at 6 weeks, 3 months, 6 months, and 9 months following surgery and all the patients were evaluated clinical, functional and radiological. Functional evaluation was done by using UCLA [16] Shoulder rating score and Mayo elbow performance score (MEPS) [17]. Anteroposterior (AP) and the lateral radiograph were taken at each follow-up for assessing fracture union and position of the implant. The fracture union and any complication were noted. Radiological callus formation at the fracture site, and alleviation of pain on movement with absence of tenderness at the fracture site was adopted as criteria for union.

Results:

50 patients of diaphyseal fracture of humerus were included and treated by Anterior Bridge Plating by MIPO technique. Out of 50 patients, 32 (64%) were males and 18 (36%) were females. The mean age of patients was 39.71 ± 13.18 (Range = 18-65) years respectively. The mean surgery time was 99.52 ± 13.50 minutes (Range = 80-120). Infection was reported among 2 (4%), Non- Union among 4 (8%) and Radial Nerve Palsy among 7 (14%) cases.

Table 1: Demographic details, etiology mean surgery and union time details

Variables		Number	%
Gender	Male	32	64
	Female	18	36
Cause of fracture	Road traffic accident (RTA)	35	70
	Fall	12	24
	Direct trauma	3	6
Mean age (in years)		42.65 ± 15.62	
Mean surgery time (in minutes)		92.38 ± 20.64	
Mean union time (in weeks)		12.63 ± 6.72	
Complications	Radial nerve	7	14

	palsy		
	Non-union	4	8
	Infection	2	4
	None	37	74

The mean UCLA and MEPS was compared at 6 weeks, at 3 months, at 6 months and at 9 months using the repeated measures ANOVA test. There was a

significant difference in mean UCLA and MEPS between 6 weeks, at 3 months, at 6 months and at 9 months.

Table 2: Mean UCLA and MEPS score at different intervals of follow-up

Scores	At 6 weeks	At 3 months	At 6 months	At 9 months
Mean UCLA score	17.92 ± 1.54	22.64 ± 1.95	26.34 ± 1.75	30.04 ± 1.63
Mean MEPS score	30.25 ± 2.93	55.83 ± 7.82	70.05 ± 6.23	79.92 ± 7.01

Table 3: Comparison of Radiological Assessment at 6 weeks, 3 months, 6 months and 9 months (N/A- not available)

Radiological assessment	At 6 weeks	At 3 months	At 6 months	At 9 months
Callus	34 (64%)	42 (84%)	42 (84%)	42 (84%)
Angulation (>15°)	2 (4%)	5 (10%)	5 (10%)	N/A
Displacement (>2 mm)	2 (4%)	4 (8%)	4 (8%)	N/A
Screw back out	N/A	2 (4%)	2 (4%)	N/A
Roundening of margins	N/A	N/A	4 (8%)	N/A
Sclerosis	N/A	N/A	3 (6%)	N/A

Radiological assessment was done by subsequent radiographs on each follow up. In current study, callus was reported among significant ($p < 0.005$) cases 34 (64%) at 6 weeks, 42 (84%) at 3 months, at 6 months and at 9 months. Angulation (>15°) was reported among 2 (4%) at 6 weeks, 5 (10%) at 3 months and 5 (10%) at 6 months in our study ($p < 0.001$). Screw back out was reported among 2 (4%) at 3 months and 2 (4%) at 6 months due to infection. Roundening of Margins was reported among 4 (10%) at 6 months and sclerosis was reported among 3 (6%) at 6 months in our study.

Discussion:

Diaphyseal humerus fractures are common injuries encountered in daily practice resulting in significant burden to society in terms of productivity and wages. Being one of the most versatile bones its fracture

can be managed with a wide variety of treatments. Humerus has a wide functionally acceptable criteria due to mobile shoulder joint, and is highly amenable to conservative treatment. However, the same requires a splint or cast for 4 to 6 weeks and is cumbersome for the patient. Though functional bracing continues to be the gold standard treatment for the diaphyseal fractures of humerus, the trend in near past has moved towards surgical fixation so as to achieve the aim of early rehabilitation and return to activities of daily living.

Deepak S et al [18] in their study discussed that minimally invasive technique for fracture treatment has evolved based on the idea that with the preservation of fracture haematoma and the vascularity around the fracture site, the new bone is laid down in the form of callus.

In our study, the mean age of patients was 39.71 ± 13.18 (Range = 18-65) years respectively. - The mean surgery time was 99.52 ± 13.50 minutes (Range = 80-120). The study by Kulkarni et al [19] reported mean surgical time of 116 ± 17 minutes and while the similar study conducted by Shetty et al [20] has the comparable mean surgical time of 91.5 minutes (range: 70–120 minutes). The mean operating time was 52 (range, 40–82) minutes as recorded by Sanjeevaiah and Reddy [21].

In our study, 76% showed excellent to good outcome, followed by fair results by 10% and poor by 14% subjects. This was quite similar to the studies by Deepak et al [18] where excellent shoulder scores were reported in 26 (86.7%) of the cases and good outcome in four cases This was quite similar to the study by Oh et al [22] where mean UCLA scores of 34.3 was reported. This was lesser than the study by Kulkarni et al [19] where average UCLA score was 18.3 ± 4.0 . Sharma et al [23] assessed functional outcome in eleven cases and found an excellent to good shoulder function in 9 cases (81.8%) and fair in 1 case (9.1%) on the UCLA score.

There were 2 case of infection reported by us in our study which is similar to the complication reported by Oh et al [22] which was due to poor tissue handling. We managed the case by implant removal and U slab application with concurrent antibiotics for a period of time and final fixation with ORIF with locking compression plate was done only after absence of any signs of infection. Concha et al [24] reported six cases of post-operative radial nerve palsy (neuroparaxia) which is similar as reported by our study. Risk of iatrogenic radial nerve injury is low and but still persists if the appropriate surgical technique is not used. The radial nerves were intact and recovered within 12 weeks of injury with post op rehabilitation in form of active/active assisted range of

movement exercises and dynamic cock up splint in our study.[25]

Conclusion:

This study demonstrates that the minimally invasive plate osteosynthesis technique (MIPO) for treatment of humeral shaft fractures presents newer, effective, and acceptable modality of treatment for such fractures.

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