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## Functional outcome of midshaft humerus fracture treated with minimally invasive anterior plate osteosynthesis

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### Abstract

**Introduction:** Humeral shaft fractures make up approximately 1% of all fractures. Typically, they are the result of direct trauma. Though open reduction and plating technique of humerus shaft fracture is prevailing, Minimally invasive plate osteosynthesis technique also gives favorable outcome. This techniques are challenging and have the benefit of reducing soft-tissue damage.

**Materials and Methods:** Twenty two patients with humerus shaft fractures were managed by anterior bridge plating using MIPO technique between March 2017 to November 2019 were included in this series. All cases were treated with locking compression plate fixation in bridging mode using the MIPO technique. The dominant side, gender ratio, surgery time, radiation exposure, and fracture union time were noted. The constant Murley score for shoulder and Mayo elbow performance score for elbow were used for assessing the shoulder and elbow function.

**Results:** Of the twenty two patients in the study, 54.4% were males and 45.5% were females. The mean age was 45.8 years (range 21 to 85 years). 59.1% patients had the left side fractured. RTA was most common mode of injury. Mean surgical time in minutes was 71.36 mins. The mean fracture union time was 12.82 weeks. At the end of 1-year follow-up, mean constant score was 87.9 and mean Mayo score was 97. 20 patients had no post-op complications and 2 had delayed union.

**Conclusion:** This study confirmed a high overall rate of union and excellent functional outcomes. Mini incision anterior bridge technique should be considered as an effective, cosmetically advanced surgical option. It is a safe and less time consuming method for simple types of humeral shaft fracture.

**Keywords:** Midshaft Humerus fracture, anterior bridge plate, minimally invasive plate Osteosynthesis (MIPO)

### 1. 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. Fractures of the middle or distal third of the shaft put the radial nerve at risk. Open fractures are uncommon but can represent serious injuries particularly if associated with crushing in industrial injuries. Nonoperative treatment of diaphyseal humeral fractures can be accomplished with various techniques. Functional bracing, as described by Sarmiento is widely used for the management of acute diaphyseal humeral fractures. Indications for operative reduction and fixation include diaphyseal fractures in an unacceptable position, open fractures, transverse fractures, comminuted fractures with radial nerve palsy and pseudoarthrosis. Inability to maintain satisfactory reduction by closed means is one of the main indications for surgical treatment. Plating enables the surgeon to reduce and hold the critical articular or periarticular fragments. Although plating can be technically demanding, the results are predictable. Another option for managing humeral fractures is intramedullary nailing. 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 techniques are challenging but has shown promising results recently<sup>[1-4]</sup>. We have evaluated the clinical, radiological and functional outcomes of this mini invasive technique for humerus fractures over a minimum follow-up of 01 year.

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## 2. Materials and Methods

It is a prospective study. Twenty two patients with fractures of humerus shaft were treated with anterior bridge plating using minimal invasive technique between March 2017 to November 2019 at our centre. Out of twenty two patients 54.5% are male, 45.5% female, 40.9% right 59.1% left. According to AO 18.2% A, 54.5% B, 27.3% C types of fractures. All patients who had fracture at mishaft level were selected. These fractures were reduced and fixed with locking compression plate. All surgeries were done by the same surgeon. Institutional ethical committee approved the study. The inclusion criteria included all those mid shaft humerus fracture above 18 years and who consented to participate. Anteroposterior and lateral X-ray of the affected arm including one joint above and one joint below were used to template the exact length of implant. The operative procedure was performed within 07 to 18 days of the injury.

### 2.1 Surgical approach

With the arm and forearm fully supinated and supported on a surgical table, two small windows must be made on the anterior surface of the arm. The most proximal window is made between lateral border of the proximal part of the biceps and medial border of the deltoid. Distal window is made between the biceps brachii and the brachialis 03 cm proximal to the flexion crease of the elbow. The brachialis is then split longitudinally along its midline to reach the periosteum of the anterior cortex of the distal humerus.

### 2.2 Plate introduction

The critical steps to take before introducing the plate are to prepare adequate space for the tunnel through the tight musculotendinous section between the brachialis and the deltoid muscles. Before insertion of the plate the fracture must be initially reduced to achieve correct alignment and rotation. The plate can be introduced directly from the proximal window to the distal window manually, until it reaches the distal window. During this procedure the elbow must be kept in traction and aligned by an assistant. The LCP can be introduced using two drill sleeves attached to one end to act like a handle. Another technique to introduce the plate uses a tunneling instrument introduced deep to the brachialis from the distal to the proximal incision. To avoid injury to the radial nerve at the lateral aspect of the distal humerus, the tunneling instrument should be passed along the anterior, or slightly anteromedial aspect of the humerus.

### 2.3 Reduction and fixation

LCP drill sleeve attached to each end of the plate is helpful to manipulate the plate into the correct position. After positioning the plate over the center of the anterior surface of the distal humerus, it is fixed with one cortex screw distally which is not completely tightened. Reduction of the fracture is usually achieved by traction to restore length, abduction, and correct varus. The intercondylar axis is kept perpendicular to the long head of the biceps to correct rotational deformities. In the proximal window the plate is maintained in place using the drill guide and the drill hole is made. The screw is inserted proximally and both screws are tightened. The alignment is verified with image intensification. It is preferable to fix the screws in a divergent direction to catch more of the cortex.

### 2.4 Post op protocol

All patients are immobilized with arm sling. At the end of 48 hrs – pendular exercise and elbow ROM were started. When pain reduces – active assisted shoulder and elbow ROM exercises were started. Patients were followed up Clinically and Radiologically at 6weeks, 3 months, 6 months and 1 year. Clinical assessment was done using constant Murley score for shoulder and Mayo elbow performance score for elbow. Radiological assessment was done with degree of angulation, rotation and evidence of union at the fracture site. Union was assessed by absence of pain & tenderness at fracture site and presence of bridging callus in 3 out of 4 cortices.

### 2.5 Clinical Photos and X-rays

#### Case 1



Pre op X rays



Post op X rays



Intra Op



Post op X rays

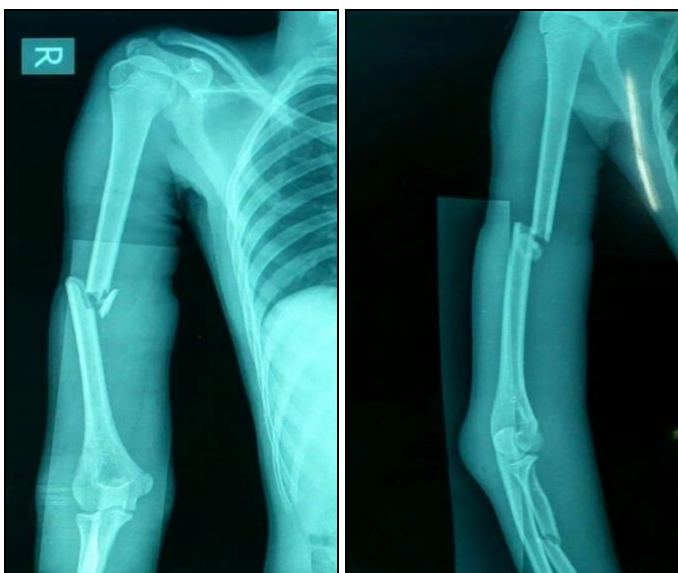


1 year follow up X-rays



Intra Op

**Case 2**



Pre op X rays







1 year follow up X-rays

### 3. Results

The longest follow up was 1 year; the shortest duration being six months. The mean duration of follow up was found to be 9.4 months. Age incidence ranged from 21 to 85 years with average age being 45.8 years. The left side was more commonly involved. Most cases were due to road traffic accidents (72.7%). The other mechanism being accidental fall (27.3%). The mean duration of surgery was 71.36 mins.

Of 22 cases studied, 8 did not have malalignment, 12 had 0 – 10 degree varus malalignment and 2 had more than 10 degree varus malalignment in the study group. None of the patients had any amount of rotational malalignment or shortening. The mean time of union in the study group was 12.82 weeks. At the end of 1-year follow-up, mean constant score was 87.9, ranging from 67-99 and mean Mayo score was 97, ranging from 85-100. 20 patients had no post-op complications and 2 had delayed union.

**Table 1:** Distribution of radiological malalignment among the cases studied.

Malalignment	No. of cases	% Cases
Nil	8	36.4
0 – 10 Degree Varus	12	54.5
>10 Degree Varus	2	9.1
Total	22	100.0

**Table 2:** Descriptive statistics of Constant score and Mayo score at the end of 1-year follow-up among the cases studied.

Score	Mean	SD	Median	Minimum	Maximum
Constant Score	87.91	10.39	92.00	67.00	99.00
Mayo Score	97.50	4.56	100.00	85.00	100.00

### 4. 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. Minimally invasive surgery is not determined by the length of the incisions but more by the reduction technique and soft-tissue handling. Mean surgical time was less compared to. Shantharam Shetty M *et al.* [5] study. 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. MIPO gains advantage over ORIF in these issues. Shoulder function was assessed by constant Murley score which

was comparable to Apivatthakakul T *et al.* [1] study.

Union of the humeral shaft fractures in this series presents good results with fixation through indirect reduction aims at maintaining bone alignment through mini incision and replacing absolute stability by relative stability. Union rates are comparable with Tijoriwala P *et al.* [6] study. Near normal biological reduction in MIPO does not compromise on functional outcome of the patient. Open technique of plating interferes with the local vascularity, leading to osteonecrosis underneath the plate, which may cause delayed healing to non healing (published rate of nonunion being 5.8%) [7].

This anterior bridge- plate technique can be used even for the treatment of humeral shaft nonunion (both atrophic and hypertrophic nonunion) [8]. We agree with Sharma J *et al.* [9] study, the anterior minimally invasive bridge-plate technique for treatment of humeral shaft fractures effective, cosmetically advanced (minimal operative site scar) and acceptable modality of treatment for such fractures. The present technique makes a promising modality of treatment through its less tissue dissection and periosteal stripping.

### 5. Conclusion

Minimal invasive plate osteosynthesis offers excellent functional outcome for shaft of humerus with better union rate and decreased risk of non union compared to ORIF. There is decreased postoperative 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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