



E-ISSN: 2395-1958  
P-ISSN: 2706-6630  
IJOS 2020; 6(2): 208-211  
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[www.orthopaper.com](http://www.orthopaper.com)  
Received: 02-01-2020  
Accepted: 05-02-2020

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## Radiological and clinical outcome of minimally invasive percutaneous plate osteosynthesis for diaphyseal fractures of humerus

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**DOI:** <https://doi.org/10.22271/ortho.2020.v6.i2d.2039>

### Abstract

**Introduction:** Nowadays minimally invasive plate osteosynthesis (MIPO) is gaining preference with respect to other treatment modalities for diaphyseal fracture of humerus because biological fixation of fractures with soft tissue and fracture haematoma preservation and near acceptable reduction is becoming a more acceptable entity. MIPO technique shows high rate of union, less risk of infection, reduced risk of iatrogenic radial nerve palsy and decreased blood loss. We have evaluated the radiological and clinical outcomes of fracture shaft of humerus treated with the MIPO technique over a minimum follow up of 1 year.

**Materials and Methods:** A hospital based prospective study was conducted in the Department of Orthopaedics, Silchar Medical College and Hospital, Assam. 12 adult patients with diaphyseal fracture of humerus admitted in Silchar Medical College and hospital treated with Minimally Invasive Percutaneous Osteosynthesis (MIPO) technique between June 2017 and May 2018 were included in the study. In all cases 4.5mm locking compression plate was applied using MIPO technique and follow up was done monthly with 1<sup>st</sup> follow up on completion of 2 weeks and thorough clinical and radiological evaluation was done.

**Results:** Out of 12 patients, the maximum numbers of patients were observed between 31–40 years, with a mean age of 39.17 years. There was male preponderance (66.67%) in the study group with maximum of the cases due to road traffic accident (66.67%). Left side was most commonly affected (54.16%) with maximum of them being Type A fractures (50%) as per AO/OTA classification.

The average time interval between the trauma and surgery was 7.08 days. The minimum operative time was 62 minutes and maximum was 115 minutes with a mean of 98.5 minutes. The mean amount of blood loss was 85.42 ml. Overall, average hospital stay of the studied group was 8.75 days.

The mean forward flexion & abduction of the shoulder joint was 155.83° & 119.17° respectively. The mean range of motion of elbow was (2.5° - 126.25°). The mean UCLA shoulder score at last follow up was 33.42 considered as Good/Excellent. The mean MEPS score at last follow up was 92.25 (Excellent). The mean VAS score was 4.67 at last follow up. The mean time for union was at 12.5 weeks.

In the study group, 25% (3 cases) had complications. 2 (16.67%) had varus malunion and the remaining 1 (8.33%) had infection.

**Conclusion:** The fracture of diaphysis of humerus mostly occurs in adults; road traffic accidents and fall are the two most common modes of injury. The primary goal in treatment of this injury is to provide good reduction and immediate stability to achieve early fracture union, allow the quick return of function, and to avoid complications which is achieved by minimally invasive percutaneous plate osteosynthesis (MIPO).

**Keywords:** Minimally invasive percutaneous plate osteosynthesis, humerus

### Introduction

Fracture of shaft of humerus is a common orthopaedic trauma<sup>[1]</sup>, which comprises 1 to 3% of all fractures<sup>[2]</sup> and 14% of all fractures of the humerus<sup>[3]</sup>. A bimodal distribution is seen in occurrence of fracture of diaphysis of humerus<sup>[4]</sup>. In young individuals the fracture of mid shaft of humerus is commonly due to high velocity trauma and in elderly age group the main cause is fall on outstretched hand<sup>[5]</sup>.

Due to close anatomical proximity of radial nerve with diaphysis of humerus, any fracture involving it might also cause Radial nerve injury<sup>[2]</sup>.

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In 90% of cases, good outcome has been reported for humeral diaphyseal fractures treated conservatively [6]. But in cases of bilateral humerus fractures, polytrauma, open fractures of humerus, floating elbow, obese patients who may develop varus angulation, unacceptable reduction of fractures, associated radial nerve palsy and vascular lesion operative treatment is indicated [7].

Association of varus deformity and restriction of shoulder and elbow motion due to prolonged immobilization with conservative treatment is drawing more orthopaedic surgeons to prefer operative treatment [8].

In present scenario, open reduction and plate fixation is the standard surgical option for treatment of diaphyseal fracture of humerus [9].

The widely acceptable technique of open reduction and internal fixation with compression plate for diaphyseal fracture of humerus provides high rate of union because of its anatomical reduction and lesser restriction to function of elbow and shoulder joint [10, 11].

But some limitations are associated with this technique, such as requirement of excessive soft tissue stripping which further increases the possibility of non-union, deep infection and iatrogenic radial nerve palsy [12]. Moreover, in it primary fracture healing occurs which is considered inferior to secondary healing biologically [13, 14].

Nowadays preservation of soft tissues, fracture hematoma along with near acceptable alignment is considered better than stable mechanical fixation [15].

So based on this recently a new technique of minimally invasive percutaneous plate osteosynthesis (MIPO) for Humerus, which is producing encouraging results has been developed [13, 14]. It shows high rate of union, less risk of infection, reduced risk of iatrogenic radial nerve palsy and decreased blood loss [14].

So we have undertaken this study to evaluate radiological and clinical outcome of minimally invasive percutaneous plate osteosynthesis (MIPO) in diaphyseal fracture of humerus in adults.

**Materials and Methods:** A hospital based prospective study was conducted in the Department of Orthopaedics, Silchar Medical College and Hospital, Assam from 01-06-2017 to 31-05-2018.

**Data Collection:** 12 patients with diaphyseal fractures of the Humerus attending the OPD and emergency of Department of Orthopaedics, Silchar Medical College and Hospital who met the inclusion criteria outlined below were recruited in the study. Inclusion criteria included patients in the age group of 18-65 years. Fractures within 14 days of injury. Closed fracture of diaphysis of humerus (a fracture located at least 5cm distal to surgical neck of humerus and 5cm proximal to olecranon fossa). Medically stable patients who could undergo post-operative rehabilitation. Exclusion criteria included open fractures of diaphysis of humerus, Polytrauma involving the same limb, patients medically unfit for surgery, fracture of diaphysis of humerus during pregnancy, associated neurovascular injury, pathological fractures of diaphysis of humerus, Drug addict patients (alcohol & others) and those participating in other clinical trial.

The cases were followed up for a period of 1 year. Standard antero-posterior and lateral view of the affected humerus was taken. The fractures were classified as per AO-ASIF trauma classification, these fractures were fixed with 4.5 mm narrow locking compression plate.

**Consent:** An informed written consent was obtained from each patient prior to participation in the study.

**Ethical clearance:** Ethical clearance for this study was taken from the Ethical Committee of Silchar Medical College and Hospital, Assam.

### Operative procedure

Surgery was performed with the patient in supine position on the operating table, with the arm in 90° abduction on a radiolucent arm board and elbow flexed to approximately 70° and forearm is kept in full supination. As in supination the radial nerve moves away from the anteriorly placed plate.

First the interval between the lateral border of the proximal part of the biceps and the medial border of the deltoid muscle was palpated. A 3 cm proximal incision was then made approximately 6cm distal to the anterior part of the acromion process. The biceps brachii muscle is retracted medially and deltoid and cephalic vein are retracted laterally. Distally, a 3 cm incision was made along the lateral border of the biceps muscle approximately 5cm proximal to flexion crease of the elbow. The interval between the biceps brachii and the brachialis was identified. The biceps was retracted medially to expose the musculocutaneous nerve lying over the brachialis. The brachialis is split longitudinally along its midline to reach the periosteum or anterior cortex of distal humerus. The musculocutaneous nerve is retracted along the medial half of the split brachialis, while the lateral half is retracted along with the radial nerve laterally. From the distal to the proximal direction a tunnel was made sub-muscularly by a tunneling instrument. In our case a 4.5 mm locking plate attached to locking sleeve/periosteum elevator was used as a tunneling instrument. To avoid injury to radial nerve at the lateral aspect of the distal humerus, the tunneling instrument is passed along the anterior or anteromedial aspect. A 4.5mm locking compression plate/dynamic compression plate of appropriate holes (9-14 holes) is passed close to the bone through the tunnel from distal to proximal direction. Under the image intensifier the plate is positioned on the anterior surface of the bone. Assistant applies slight traction throughout the procedure and arm is abducted to 90° to correct varus deformity. A total of 2 or 3 locking head screws per fragment were inserted thus making the construct not too rigid. Initially, one screw is inserted in the distal fragment and it is kept relatively loosened and it is tightened after securing another screw in proximal fragment. The wound was closed in layers. Postoperative sterile dressing was done and arm was kept in arm sling pouch for 6 weeks.



**Fig 1:** Proximal and Distal Incision



**Fig 2:** Preoperative X-Rays: Anteroposterior & Lateral Views



**Fig 3:** Postoperative X-Rays: Anteroposterior & Lateral Views



**Fig 4:** Range of Movement at Last Follow Up



**Fig 5:** Postoperative Infection

### Post-operative care and rehabilitation

After surgery in the either operative procedures, the involved arm was kept in arm sling pouch.

- Elbow and shoulder movement was initiated immediately from the 3<sup>rd</sup> post operative day to avoid any stiffness, edema and to promote circulation. Arm sling pouch was continued till 6 weeks from the operative procedure, which was put off during the time of shoulder and elbow exercises.

**Follow up:** The follow-up of the patients done at an interval of 2 weeks, 6weeks, 3months and 6 months with suture removal at 2 weeks following the surgery.

The patients were assessed subjectively for pain at the fracture site and clinically for any stiffness, tenderness or any signs of infection.

The fracture union was clinically assessed by the absence of tenderness and presence of three bridging cortices on images in two orthogonal planes. For this, antero-posterior and lateral views were obtained at 6weeks, 3 months and 6 months in all followed up cases.

The functional outcomes of shoulder and elbow were analysed using the UCLA Shoulder and MEPS scoring system respectively at 3months, 6 months and at final follow up.

### Observations and results

All the 12 patients were followed up for 12 months with no lost to follow up. The age ranges from 22 to 59 years in our study with a mean age of 39.17 years. Maximum incidence of humerus fractures was found in 31 to 40 years. Of the 12 patients, 8 (66.67%) patients were males and 4 (33.3%) patients were females in our study. Out of the 12, 8 (66.6%) were due to road traffic accidents, 3 (25%) were due to self fall and 1 (8.33%) was due to physical assault. Left side of the diaphysis of humerus was most commonly affected (54.16%) with maximum of them being Type A fractures (50%) as per AO/OTA classification.

The average time interval between the trauma and surgery was 7.08 days. The minimum operative time was 62 minutes and maximum was 115 minutes with a mean of 98.5 minutes. The mean amount of blood loss was 85.42 ml (range: 60-110 ml). Overall, average hospital stay of the studied group was 8.75 days (range: 5-14 days).

The mean forward flexion & abduction of the shoulder joint was 155.83° (range: 170°-100°) & 119.17° (range: 150°-100°) respectively. The mean range of motion of elbow was (2.5° - 126.25°). The mean UCLA shoulder score at last follow up was 33.42, which is considered as Good/Excellent. The mean MEPS score at last follow up was 92.25 (Excellent). The mean VAS score was 4.67 at last follow up. The mean time for union was at 12.5 weeks (range: 10-16 weeks).

In the study group, 25% (3 cases) had complications. 2 (16.67%) had varus malunion and 1 (8.33%) had infection.

### Discussion

Excellent results has been reported in MIPO technique for humeral shaft fractures [13] in literatures earlier, In our study, the mean time required during surgery was 98.50 minutes which is similar to the time reported by Oh CW *et al.* [16] and Esmailiejah AA *et al.* [17] Blood loss during the surgery is minimal and it is almost equivalent to blood loss reported by Malhan S *et al.* [18] Due to less soft tissue dissection MIPO provides good functional ability to the patient. The mean forward flexion and abduction of shoulder joint at the final follow up in the study group was 155.83° (range: 170°-100°) & 119.17° (range: 150°-100°) respectively it is similar to the



results shown by Sharma J *et al.* [19]. At the last follow up the mean range of motion of elbow joint was (2.5° - 126.25°) and it is comparable to the data reported by.

Shetty MS *et al.* [20] UCLA shoulder score and MEPS score at final follow up in our study is similar to results reported by An Z *et al.* [21] Fracture union time in our study was 12.5 weeks which is less but comparable to data reported by An Z *et al.* [21] 1 case (8.33%) got infected in our study group, the infection didn't subsided after debridement so the plate was removed after the bone healed radiologically and clinically. Similar results were shown by Sharma J *et al.* [19] where 1 case (9.09 %) got infected, there was no postoperative radial nerve palsy and 2 (16.67%) patients had varus malunion. Malreduction is probably due to inability to reduce the fracture anatomically but it didn't compromise the functional outcome. Shetty MS *et al.* [20] reported 7 cases (21.87 %) with varus malalignment in their study on MIPPO for fracture of diaphysis of humerus.

### Conclusion

The primary goal in treatment of this injury is to provide good reduction and immediate stability to achieve early fracture union, allow the quick return of function, and to avoid complications. From the above results it can be concluded that the MIPO technique can be used to treat humerus shaft fractures with many advantages such as short operative time, minimal intraoperative bleeding, and decreased incidence of postoperative infection, rate of nonunion, delayed union, and postoperative radial nerve palsy. The radial nerve is not at risk as long as the forearm is kept in supination during the procedure, and no screws are inserted into that part of the humeral shaft where the radial nerve runs along the spiral groove.

Performing the procedure slowly and carefully, attending to every detail, and being aware of the possible complications should enable the surgeon to fix the fracture and achieve a satisfactory result.

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