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Original Research Article

# A Clinical Study of Humeral Shaft Fractures Treated with Minimally Invasive Plate Osteosynthesis (MIPO) Technique

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**Abstract**

**Background:** The population is growing rapidly, and the number of vehicles on the road are increasing accordingly. As a result, the incidence of road traffic accidents and humerus fractures has also risen. Humeral shaft fractures are a frequent occurrence, representing approximately 1 to 3% of all fractures. There are various surgical methods available to treat humeral shaft fractures, including plate fixation, intramedullary nailing, and tens nailing. Biological union occurring at the fracture site is not interfered with by the recently discovered MIPO approach for treating humerus fractures.

**Methods:** Successive cases of shaft of humerus fractures reported to our hospital were included. In all the cases the treatment of fractures was within 3 weeks of the injury. The fractures were classified based on the AO/ASIF (Arbeitsgemeinschaft fuer Osteosynthesefragen/ association for the study of internal fixation) classification system. All operations were performed by the same surgeon using the Standard technique for MIPO plating.

**Results:** In this study, we found 72% of cases were with Good functional outcomes as evaluated by UCLA scores. The range of UCLA scores was from 29 to 35 and the mean scores were 33.2 ± 1.5 (table 3). Similarly, the MEPS scores were evaluated in this study we found all the cases were in Excellent/Good groups by MEPS scores and the range of scores were 80 – 100 and the mean score was 84.5 ± 2.5. In this study, we found the meantime for fracture healing was 14.55 ± 2.5 weeks the range of time was from 12.5 weeks to 16.0 weeks. The range of motion in degrees obtained in the cases of the study was from 115.0 ± 15.0 degrees and the mean range of motion was 123.5 degrees.

**Conclusion:** Compared to the conventional methods of open reduction and internal fixation, the use of humerus MIPO plating yields favorable outcomes and leads to a faster recovery after surgery and minimal post-operative complications. Hence this method must be considered with priority in cases of fracture of the shaft of the humerus whenever feasible.

**Keywords:** Humeral shaft fractures, Minimally Invasive Plate Osteosynthesis (MIPO), UCLA Score, MEPS score.

## Introduction

Road traffic accidents have increased proportionately as a result of the rapidly expanding population and its correspondingly growing number of automobiles. Humeral shaft fractures make up around 2–4% of all fractures. [1] The humerus, a single long bone similar to the femur in the lower limb, makes up the upper arm. It articulates with ulna and radius bones to from the elbow joint, which is relatively stable, and in the shoulder joint it articulates with the glenoid via the glenohumeral (GH) joint which is an intrinsically unstable joint. The most common reason for humerus shaft fractures is direct trauma, which results in transverse, comminuted, or oblique fractures. Twisting injuries result in spiral fractures. There is currently no proven gold standard for their care. [2, 3] While nonoperative therapy is an option for the majority of humeral shaft fractures, surgical intervention promotes earlier functional exercise and greater fracture reduction. [4] The risk of fracture non-union, incision infection, and iatrogenic nerve damage, however, might increase due to the dissection of soft tissue during open reduction because it can influence the blood supply to the fracture. Nonetheless, the preferred method for fixing humeral shaft fractures continues to be plate osteosynthesis. [5] Due to the preservation of the biological medium at the fracture site, minimally invasive plate osteosynthesis (MIPO) approaches recently demonstrated positive outcomes when compared to open traditional techniques. [6, 7] The prevalence of distal incision iatrogenic radial nerve palsy was shown to be substantial by certain writers employing the anterolateral minimally invasive method. [7] The radial nerve's unique anatomical position and locus are associated with iatrogenic damage [1]. Our study's goal was to share our expertise in using an anteromedial approach to MIPO to treat middle and distal humerus fractures. [8] Nonetheless, questions have been raised concerning the suitability of MIPO procedures in this area because of the proximity of neurovascular systems to the humeral bone. To prevent neurovascular damage, some surgeons advise using an anterior approach to the humeral surface. The objective of the current study was to evaluate the functional and clinical results of MIPO vs conventional open reduction and internal fixation (ORIF) for the treatment of two-thirds of distal humeral shaft fractures.

## Material and Methods

The present study was carried out in the Department of Orthopedics, Rajiv Gandhi Institute of Medical Sciences (RIMS), Adilabad, Institutional Ethical approval was obtained for the study. Written consent was obtained from all the participants of the study after explaining the nature of the study in the vernacular language.

### Inclusion Criteria

1. Age above 18 years
2. Male and Female patients
3. Closed fractures. Fractures with unacceptable displacement after attempting closed reduction.
4. Diaphyseal transverse fracture
5. Shaft Fractures that required operative intervention.
6. Intact vascularity

### Exclusion Criteria

1. Skeletally immature patients
2. Patients were not fit for surgery.
3. Patients are managed conservatively.
4. Pathological fractures

In all the cases the treatment of fractures was within 3 weeks of the injury. The fractures were classified based on the AO/ASIF (Arbeitsgemeinschaft fuer Osteosynthesefragen/ association for the study of internal fixation) classification system. All operations were performed by the same surgeon. In the MIPO approach,

the patient was positioned in a supine or breech position, the limb was elevated with a pad under the scapula, and the arm was draped loosely to provide access to the shoulder and elbow. A 3 to 4 cm incision was made along the anterior border of the deltoid muscle and the lateral border of the biceps brachii, 5 cm distal to the acromion, with the limb supported on an arm board, the forearm in supination, and the elbow bent 70°. On the front of the arm, 5 cm proximal to the flexion crease, a 3 to 4-cm long incision was made distally along the lateral border of the biceps. The musculocutaneous nerve was then exposed by retracting the biceps muscle medially, which was situated between the biceps and the brachialis muscle. The brachialis was separated longitudinally from the bone in the depth of the incision, with the medial half being retracted medially to protect the musculocutaneous nerve and the lateral half being retracted laterally to preserve the radial nerve. After that, a sub-brachialis tunnel was made from each incision to the fracture site, deep to the brachialis muscle, and over the periosteum. Care was made to pass the periosteal elevator anteriorly or anteromedially, avoid utilizing lever retractors, and utilize moderate traction and manipulation for the reduction to reduce the possibility of iatrogenic radial nerve damage. Depending on the extent of the fracture, a 4.5-mm narrow dynamic compression plate (DCP) with 9 to 14 holes was carefully placed via the submuscular tunnel from a proximal or distal incision (based on the location of the fracture). A screw was then placed in the distal fragment after the fracture had been reduced using light traction and abduction, and the reduction's quality had been assessed using an image intensifier. The proximal piece was screwed with a second screw if the reduction was satisfactory. The fixation was strengthened by adding one or two extra screws, one to each side of the fracture. The antibiotics are given according to the routine guidelines.

Post-Operative Protocol: The neurovascular status of each case was checked post-operatively. The operated limb is in a broad arm sling. The Wound inspection was done on the second day. Passive motion exercises 2 days postoperatively up to 45 degrees. One week post-op passive flexion up to 60 degrees. Suture removal was done after 12 days postoperatively. One month post-op passive flexion up to 90 degrees was advised. A 6-week post-operative active mobilization began in the cases. Weightlifting, as tolerated, was prescribed for each case. Follow-up check x-rays are taken at monthly intervals to check for the union.

Statistical analysis: The data was collected and uploaded on an MS Excel spreadsheet and analyzed by SPSS version 22 (Chicago, IL, USA). Quantitative variables were expressed on mean and standard deviations and qualitative variables were expressed in proportions and percentages.

## Results

Out of n=25 cases included in the study based on the inclusion and exclusion criteria we found most of the cases belonged to the younger age group 18 – 30 collectively with 36% of all the cases. The age range of the study group was from 18 years to 70 years with a mean age of 42. 5 years (table 1). Out of the n=25 cases n=20(80%) were males and n=5(20%) were females. The male-to-female ratio was 4:1. The follow-up ranged from 16 to 42 weeks with a mean duration of follow-up duration of 30.8 weeks.

**Table 1: Showing the age-wise distribution of cases in the study.**

| Age | Frequency | Percentage |
|---|---|---|
| 18 – 20 | 3 | 12.00 |
| 21 – 30 | 6 | 24.00 |
| 31 – 40 | 3 | 12.00 |
| 41 – 50 | 5 | 20.00 |
| 51 – 60 | 4 | 16.00 |
| > 60 | 4 | 16.00 |
| Total | 25 | 100.00 |

Mechanism of Injury: The majority of fractures resulted from high-velocity incidents, with 68% of cases being caused by Road Traffic Accidents, while low-velocity falls accounted for 20% of cases and sports-related injuries made up 12% of cases.

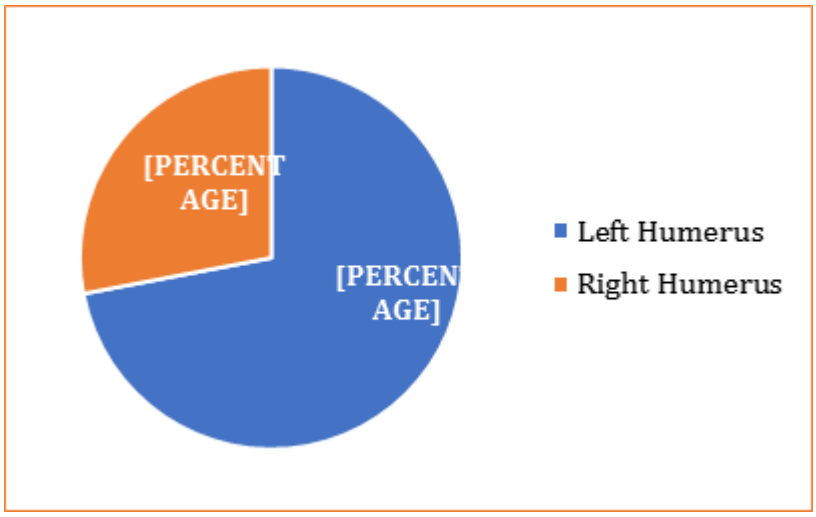


**Figure 1: Laterality of involvement of the humerus fractures**

In most of the cases, 72% in the study saw the involvement of left humerus fractures, and 28% of cases involved right humerus fractures given in Figure 1.

**Table 2: AO Classification of fracture of humerus in cases of the study**

| AO Classification | Frequency | Percent |
|---|---|---|
| A-1 | 2 | 08.00 |
| A-2 | 2 | 08.00 |
| A-3 | 8 | 32.00 |
| B-1 | 3 | 12.00 |
| B-2 | 10 | 40.00 |
| Total | 15 | 100.0 |

In this study, most of the cases of fractures of the humerus were classified based on AO classification and it was found that B2 fractures were in 40% of cases followed by fracture A3 in 32% of cases and 12% were cases of B1 fractures and 8% fractures were A1 and A2 respectively details depicted in table 2.

The time interval between fractures and presentation to the hospital were varying from 1 day to 16 days and the mean time interval between fractures and presentation was 7.5 ± 2.2 days details depicted in Figure 2.

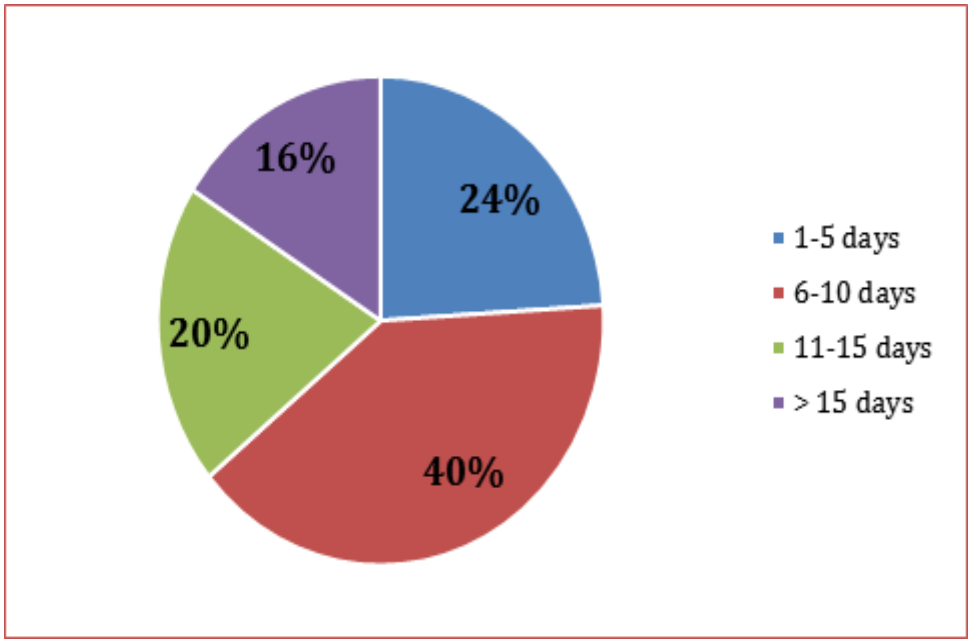


**Figure 2**: **Time interval between the injury and presentation to the hospital**

The overall time of surgery in MIPO in the cases of the study ranged from 60 minutes to 120 minutes and the mean time was 95.0 ± 15.0 minutes. The overall blood loss in the procedure was from 90 ml to 150 ml. The mean blood loss was 115.0 ± 25.0 ml.

**Table 3: Functional Evaluation by UCLA Scores**

| UCLA Score | Frequency | Percentage |
|---|---|---|
| Excellent | 5 | 20.00 |
| Good | 18 | 72.00 |
| Fair | 2 | 08.00 |
| Poor | 0 | 00.00 |
| Total | 25 | 100.0 |

In this study, we found 72% of cases were with Good functional outcomes as evaluated by UCLA scores. The range of UCLA scores was from 29 to 35 and the mean scores were 33.2 ± 1.5 (table 3). Similarly, the MEPS scores were evaluated in this study we found all the cases were in Excellent/Good groups by MEPS scores and the range of scores were 80 – 100 and the mean score was 84.5 ± 2.5. In this study, we found the meantime for fracture healing was 14.55 ± 2.5 weeks the range of time was from 12.5 weeks to 16.0 weeks. The range of motion in degrees obtained in the cases of the study was from 115.0 ± 15.0 degrees and the mean range of motion was 123.5 degrees. The rate of complications was 12% which included n=2 cases of superficial infections which were managed adequately with antibiotics and one case of elbow stiffness which was managed by extended physiotherapy.

**Table 4: Complications reported in the cases of the study.**

| Complications | Frequency | Percentage |
|---|---|---|
| Superficial infection | 2 | 8.00 |
| Deep infection | 0 | 0.00 |
| Non-Union | 0 | 0.00 |
| Shoulder stiffness | 1 | 4.00 |

## Discussion

The term "minimally invasive" does not refer to the length of the incision, but rather to a procedure in which the fracture is reduced and soft tissue is dissected away from the fracture site. Indirect reduction is accomplished by inserting the tools and implants via the little soft tissue window that was formed. This avoids the requirement for extensive soft tissue incision required for open reduction and internal fixation and retains the soft tissue and bone biology. In addition, indirect reduction preserves the fracture hematoma. When a plate is placed on the bone with complete stability, primary bone healing occurs instead of secondary bone healing, which requires callus development. It is believed that callus development promotes bone mending significantly more effectively than primary repair. With the open reduction and internal fixation, the plate also contributes to osteonecrosis beneath it, which results in refracture when the plate is removed. [9] In most of the cases by MIPO an LCP is used which does not need to be contoured to the bone surface [10, 11] the use of locking screws reduces the pressure of the plate on the bone and protects the periosteal blood supply and is conducive to fracture healing. The most significant result of the current study was that the MIPO technique's union time was less, and these patients were quicker to resume their prior level of daily living activities. In the current study, we found the range of time for fracture healing was 12.5 weeks to 16.0 weeks, with a mean of 14.55 2.5 weeks. The degrees of motion obtained in the study's cases ranged from 115.0 to 15.0, and the mean degree of motion was 123.5. An Z et al. evaluated the outcomes of treating 33 patients' mid-distal humeral shaft fractures using ORIF and MIPO. In the MIPO group, the mean union time was 15.29 weeks, whereas, in the ORIF groups, it was 21.25 weeks; the difference was not statistically significant. Functioning results were good and comparable across the two groups. An Z et al., [7] concluded that the MIPO approach is preferable to ORIF in treating humeral shaft fractures because of the decreased incidence of iatrogenic nerve damage, quicker union, and equivalent functional results. In recent prospective research, Oh et al., [12] found that the functional results and primary union rate were identical (95.6% in the MIPO group and 90% in the ORIF group). The MIPO group's mean operation time was greatly reduced (110 minutes versus 169 minutes). Only one patient in the MIPO group and five individuals in the ORIF group needed bone grafting. Although humeral shaft fractures often heal well with conservative therapy, [13, 14] there are some situations where surgical treatment is unavoidable. [15] According to research by Sarmiento et al., [16] functional bracing for the treatment of closed humeral diaphysis fractures produced a high rate of the union as a result of the soft tissues' hydraulic effects. Functional bracing has been documented to cause significant restrictions in shoulder and elbow movement as well as a few lingering angular abnormalities, which makes it challenging to resume normal daily activities. [17, 18]

The acknowledged standard method for treating humeral shaft fractures is humeral plating. [7, 19] The procedure has certain benefits, including a high union rate, anatomical reduction, and a reduced risk of shoulder and elbow morbidities. [20, 21] Nevertheless, because of certain drawbacks of humeral plating, including a large incision, higher risk of infection, aesthetic issues, a high incidence of iatrogenic radial nerve damage, disruption of the periosteal blood supply, and breach of the fracture site hematoma, surgeons frequently choose MIPO. [22-24] In this study we found 72% of cases were with Good functional outcomes as evaluated by UCLA scores. The range of UCLA scores was from 29 to 35 and the mean scores were 33.2 ± 1.5 (table 3). Similarly, the MEPS scores were evaluated in this study we found all the

cases were in Excellent/Good groups by MEPS scores and the range of scores were 80 – 100 and the mean score was 84.5 ± 2.5. In a prospective trial, Malhan et al., [25] examined the effects of MIPO in 42 patients using a locking compression plate (LCP), and they discovered that after a year, the disability of arm, shoulder, and hand score (DASH score) had greatly improved. In the coronal and sagittal planes, the mean angulation was 4° and 7°. All fractures joined after 14 weeks, except for two cases of delayed union, and one incidence of iatrogenic radial nerve palsy occurred. Moreover, Shin et al., [26] presented a modified MIPO approach for humeral shaft fractures with satisfactory clinical and functional results and no iatrogenic radial nerve damage. They concluded that, despite the MIPO technique's technical difficulty and shoulder function.

## Conclusion

Our study revealed that fracture healing time ranged from 12.5 to 16.0 weeks, with an average of 14.55 weeks. The degree of motion achieved varied between 15.0 and 115.0, with an average of 123.5. The functional outcome using UCLA scores found that 72% of cases resulted in good outcomes. The range of UCLA scores observed was between 29 and 35, with a mean score of 33.2 ± 1.5. Compared to the conventional methods of open reduction and internal fixation, the use of humerus MIPO plating yields favorable outcomes and leads to a faster recovery after surgery and minimal post-operative complications. Hence this method must be considered with priority in cases of fracture of the shaft of the humerus whenever feasible.

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