

## Original Research Article

# Prospective study of radiological and functional outcomes of humeral mid-shaft fractures by anterior bridge plating technique

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**Received:** 18 December 2022

**Revised:** 09 January 2023

**Accepted:** 10 January 2023

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## ABSTRACT

**Background:** The humerus can be considered the most versatile bone in the human body. Can be successfully approached by a variety of methods for fracture fixation including functional bracing, plating (posterior, lateral, and anterior), and intramedullary nailing (antegrade and retrograde). Notably, many humeral fractures can be successfully managed conservatively due to the wide range of acceptability for reduction. Anterior bridge plating (ABP) which utilizes the minimally invasive approach popularly known as the minimally invasive percutaneous plate osteosynthesis (MIPPO) technique can be said to be the latest entrant in this list. The present study was undertaken to evaluate the efficacy of ABP.

**Methods:** The study was carried out from July 2020 to July 2022 in DR. D. Y. Patil medical college and hospital, Nerul, Navi Mumbai, involving 32 patients who met the selection criteria and were operated at the tertiary care centre. Informed consent was obtained from all the patients for use of their clinical and imaging data. Ethical committee approval was taken. The assessment of the patients was done based on functional and radiological outcomes periodically.

**Results:** Majority of patients belongs to age group 18-25 years (46.87%). Majority of side of injury were found right side (65.62%). Most of cases of extent of displacement of fractures were 2-5 cm (71.87%).

**Conclusions:** In conclusion ABP is a very good technique in treating mid-shaft humeral fractures with minimal soft tissue dissection, smaller scars, and early return to overhead activities.

**Keywords:** ABP, Mid-shaft humeral fractures, MIPPO

## INTRODUCTION

Humeral shaft fractures compose around 3% of fractures. Mildly displaced humeral shaft fractures can be treated conservatively.<sup>1</sup> Various modalities of treatment have been described in literature each one having some advantages over the other technique right from conservatively by braces to plating and intramedullary nailing.<sup>2</sup> Fractures which are displaced extending into articular surfaces definitely need operative management in form of plating, nailing and external fixator if it is compound in nature. Modalities of surgical treatment include locking plates, intramedullary nailing and external

fixation. Although locking plates provides swift useful recovery by providing sturdy fixation. Intramedullary nailing of humeral shaft fractures also has given excellent results the latest of all the techniques is ABP which has shown very promising results in various studies. In ABP, there are two small incision made one proximally and one distal to the fracture site.<sup>3</sup> ABP which utilizes the minimally invasive approach popularly known as MIPPO is the latest technique in the management of humeral shaft fractures.<sup>4</sup> Conventional plating involved opening of the fracture site and fixation, while in nailing entry through the rotator cuff had issues in performing overhead activities. ABP has definitely advantages over both the techniques as

it is minimally invasive, does not damage rotator cuff and no need to open the fracture site. Also, it needs less operative time,<sup>5</sup> less radiations and minimal blood loss. The present study was undertaken to evaluate the efficacy of ABP.<sup>6</sup>

## METHODS

### *Type of study*

The study of prospective study type.

### *Study duration*

The study carried out from July 2020 to July 2022.

### *Place of study*

The study conducted at DR. D. Y. Patil Medical College and Hospital.

The study was carried out on 32 patients who met selection criteria and were operated at the tertiary care centre.

Informed consent was obtained from all the patients for use of their clinical and imaging data. Ethical committee approval was taken.

### *Selection criteria*

#### *Inclusion criteria*

Patients with mid-shaft humerus fractures, skeletally mature, minimum 2 years follow up at the time of study were included in the study.

#### *Exclusion criteria*

Patients with ipsilateral upper limb trauma which would hamper rehabilitation, vascular injury, paediatric patients, open fractures, co-morbidities were excluded from study.

### *Surgical procedure*

After pre-anaesthetic fitness, patients were operated for mid-shaft fracture humerus. In this technique, assistants play very important role as the limb is to be held in constant traction. Usually, general anaesthesia was given to achieve complete relaxation. Painting and draping was carried out and then with the skin marker, proximally biceps tendon was marked. Distally the incision was planned above the supracondylar region. Arm was abducted to 30-40 degrees, elbow flexed to 90 degrees and forearm was completely supinated. A long locking compression plate 4.5 mm (LCP) usually 14 hole was chosen and kept over the arm and seen under C-arm to get accurate length of the plate. Proximal part of the incision lies between anterior part of the deltoid muscle and the biceps region in which a relatively avascular raphe is

present and then the incision is deepened to the bone. Distal incision lies in the plane between lateral border of biceps and the brachioradialis. Then the incision is deepened and the musculocutaneous nerve is identified and retracted. Then the brachialis muscle is split in the middle dividing into medial and lateral half, the lateral half protects the radial nerve. Retraction is carried out by retractors and there is no use of bone levers to avoid undue traction and nerve injury. The plate is passed from the proximal end slowly with jig-jag movements sub periosteally till the fracture site is reached. Gentle traction and counter traction are given to achieve the alignment and the reduction of both the fragments under image intensifier. The cortical step sign and diameter difference sign described by Krettek et al was used to prevent the malrotation of the fragments. Once the reduction was acceptable, two k-wires were fixed one in proximal and one in distal hole of the plate under c-arm.

First the proximal screw is inserted after drilling and the screw is not tightened completely. Then the distal most screw is inserted under C-arm and the proximal screw is tightened after making fine adjustments to gain acceptable reduction of the fracture site. Then the distal second screw is inserted and the second proximal screw is inserted. Distal most and the proximal most screws usually are non-locking type and the remaining two screws are locking type. Patients were allowed to start elbow and shoulder movements on the second day as per the pain tolerance capacity. Postoperatively, patients were discharged on fifth day with the arm pouch. Shoulder and elbow pendulum exercises were started under the supervision of physiotherapist on fifth day. Active abduction of the shoulder was started in first week and above head abduction was allowed after 3 weeks post-operatively. Patients resumed to their routine manual work after 2 months postoperatively. There was not a single case of non-union in this study.

### *Data collection procedure and assessment of outcomes*

The assessment of the patients was done based on functional and radiological outcomes every month for 3 months, then every 3 months for 2 years after surgery. Radiological examinations were done after 6 weeks, 3 months, 6 months after surgery and every 6 months thereafter for 2 years postoperatively. Functional outcome was assessed using the constant score, Mayo's elbow score and disabilities of the arm, shoulder and hand (DASH) score. Shoulder abduction, external rotation (ER), elbow flexion, internal rotation (IR) with the arm placed adjacent to the chest and elbow flexed to 90°, and forward flexion (FE) was measured.

### *Statistical analysis*

Data was entered in Microsoft excel after data collection. Excel was used to generate tables and graphs. Descriptive statistics such as mean, SD and percentage was used to present the data.

## RESULTS

Majority of patients belongs to age group 18-25 years (46.87%).

**Table 1: Age distribution.**

Age (years)	Number	Percentage (%)
18-25	15	46.87
25-35	10	31.25
35-45	7	21.87

Male patients (71.87%) were dominant in the study.

**Table 2: Sex distribution.**

Sex	Number	Percentage (%)
Male	23	71.87
Female	9	28.12

**Table 3: Distribution of side of injury.**

Side of injury	Number	Percentage (%)
Right	21	65.62
Left	11	34.37

Majority of side of injury were found right side (65.62%).

Most of cases of extent of displacement of fractures were 2-5 cm (71.87%)

**Table 4: Distribution of extent of displacement of fractures.**

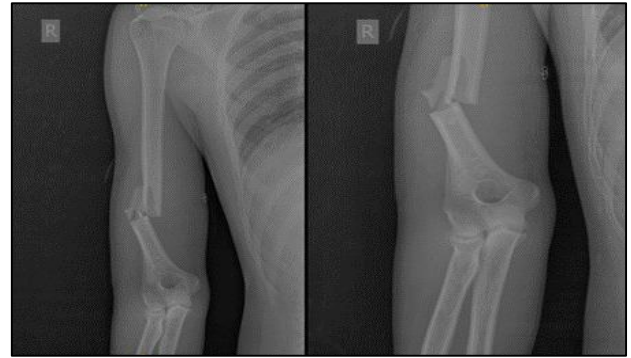
Extent of displacement of fracture (cm)	Number	Percentage (%)
<2	1	3.12
2-5	23	71.87
>5	8	25

The mean time for return to the original activities was 64 days (range, 36 to 182 days). The mean time for confirmed radiographic union was 45 days (range, 34 to 180 days).

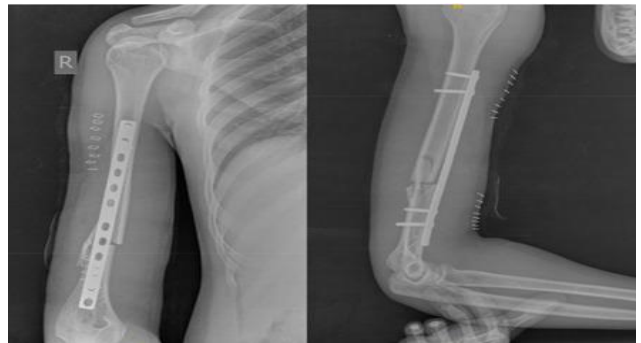
Mean Mayo elbow score was  $95.94 \pm 6.74$  (range, 85 to 100) and mean DASH score  $1.56 \pm 3.15$  (range, 0.0 to 14.0).

**Table 5: Mayo elbow score.**

Score	Achieved ideal score, N (%)	Did not achieve ideal score, N (%)	P value
Mayo elbow performance index	15 (46.87)	17 (53.12)	<0.001
DASH	14 (43.75)	18 (56.25)	0.005



**Figure 1: Pre-op X-ray (Patient 1).**



**Figure 2: Post op X-ray (Patient 1).**



**Figure 3: Pre-op X-ray (Patient 2).**



**Figure 4: Post-op X-ray (Patient 2).**

## DISCUSSION

The most important finding of our study is that ABP can be effective in treating mid-shaft humeral fractures in patients predominantly involved in overhead activities with excellent functional and radiological outcomes. The functional and radiological outcomes achieved in our study is comparable to that in other similar studies on this topic.<sup>7</sup> ABP is very effective in treating mid shaft fracture humerus in patients who are mainly doing the overhead activities. The primary advantage of ABP is the combination of stability with minimal soft tissue and periosteal disruption. Unlike the posterior plating option, it requires a small incision and adheres to the MIPPO principle, which is biologically and cosmetically preferable. In addition, the rotator cuff is spared preventing any major shoulder pathology later on, which is the case in humeral nailing. The ABP follows the principle of relative and elastic stability instead of the absolute rigidity in the open reduction and internal fixation (ORIF) achieved by a posterior approach.<sup>8</sup> In the former, healing takes place by secondary healing and callus formation, which is stronger, whereas in the latter, it is done by primary healing without callus formation. The purpose of using a long plate in ABP is to decrease the stress per unit area as by distributing over a larger surface area. So, this plate, which is placed on the 'anterior tensile surface,' can withstand a larger amount of rotational and bending stresses than the shorter plate.<sup>9</sup>

This technique has a high learning curve, but once mastered is definitely very easy to execute. As it is minimally invasive, the vascularity at the fracture site is well preserved which helps in faster healing of the fractures. Also, it is blind procedure while inserting the plate as the incision is very small, little experience is needed to master the technique and avoid iatrogenic nerve injuries. This technique has minimal soft tissue stripping so less chances of infection is there. Distally more care has to be taken as the split brachialis is retracted very gently to avoid radial nerve injury. There is no role of bone spikes as they are more traumatizing, so plain retractors are used. The forearm has to be supinated continuously and elbow flexed to 90 degrees to provide relaxation of the brachialis muscle.<sup>10</sup>

Two proximal and two distal cortical screws are enough to maintain the reduction and it gives a stable construct. In this study one cortical and one locking screw construct was used to achieve stable construct. In the present, 80% had the right side fracture which was comparable with other study. ABP is also useful in comminuted shaft fractures humerus as it skips the comminuted region and two screws proximally and two screws distally hold the plate in good alignment.

On the downside, the procedure has a steep learning curve and should not be attempted by inexperienced surgeons without supervision. Though increased risk of radial nerve injury is one of the issues with ABP, our study had no such event. As described in multiple cadaveric studies, an

important thing is to keep in mind the course of radial nerve near the distal end of the plate, which usually lies a few centimetres distal to the point where the nerve pierces the lateral intramuscular septum. Sliding of the plate in a wrong fashion, careless drilling for the distal screws, or over-zealous retraction can lead to potentially catastrophic damage.<sup>11</sup> Two cases of forearm tingling in our series were most probably due to neuropraxia caused by one of the above factors.

The most important thing in this technique is to get good reduction with minimal varus/ valgus angulation and also in lateral view which is very important to prevent anterior or posterior angulation.<sup>12</sup>

The screws have to be bicortical as this prevents loosening of the screws. Locking screws are very useful in osteoporotic fractures. Rotational alignment is very important and this is checked by comparing the medullary canal diameter of proximal and distal fragments under image intensifier.<sup>13</sup>

The diameters should be same which indicates that there is no malrotation of the fragments.

## Limitations

Limitations of the study were-non-compliant patients, lost to follow up, steep learning curve and not ideal for compound injuries

## CONCLUSION

In conclusion ABP is a very good alternative technique in treating mid-shaft humeral fractures with minimal soft tissue dissection, smaller scars, and early return to overhead activities.

*Funding: No funding sources*

*Conflict of interest: None declared*

*Ethical approval: The study was approved by the institutional ethics committee*

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**Cite this article as:** Dey JK, Shetty SH, Singh SD, Srivastava A, Agrawal S, Modi RR et al. Prospective study of radiological and functional outcomes of humeral mid-shaft fractures by anterior bridge plating technique. *Int J Res Orthop* 2023;9:245-9.