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## Anterior bridge plating by minimally invasive plate osteosynthesis in humerus shaft fractures

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### Abstract

**Introduction:** Shaft humerus fractures constitute 1-3% and 20% of all fractures of the humerus. For shaft humerus fractures, fixation with absolute stability using Dynamic Compression Plate by open technique is today's gold standard. MIPO was developed to attain a more stable fixation, which might improve the union rate and cut back complications related to open plating together with infection and induced radial nerve palsy.

**Materials & Methods:** 25 cases of fracture of shaft humerus fractures were studied. During the period from August 2015 to July 2017. Case selection was done in the criteria of history, clinical examination and radiological (X-ray) examination. Result was noted according to UCLA score & MEP score and filled up.

**Results:** 100% union seen in our cases. Union was achieved in 12-14 weeks in 13(52%) of patients, 14-16 weeks in 9 (36%) of the patients and more than 16 weeks in the remaining 3(12%) patients with average time to union being 14.24 weeks. It was observed that the majority of the cases had excellent 17(68%), Good 5(20%) UCLA and 3(12%) had fair UCLA. Only 2 cases had less than an excellent MEP score, while the rest had excellent scores.

**Conclusion:** Anterior Bridge plating by Minimally Invasive Plate Osteosynthesis in shaft humerus fractures showed promising results. They provide relative stability to the fracture site and fracture hematoma is not disturbed. MIPO preserves the vascularity and hence decreases the risk of infection and wound breakdown.

**Keywords:** ABP, MIPO, shaft humerus fractures

### Introduction

Out of all the Fractures in adults, Shaft humerus fractures constitute 1-3%<sup>[1, 2]</sup> and 20% of all fractures of the humerus<sup>[3]</sup>. Conservative management remains the standard cure for Shaft fractures of humerus<sup>[4, 5]</sup>, though this technique gives disappointing sequel, like shoulder impairment and non-union<sup>[6,7]</sup>. Of all the patients treated this way, 14% had a limited range of movements and unification was seen in 12.6%, with angulation of more than<sup>[10]</sup> degrees 8.

Surgical procedures comprises Interlocking Nail, internal fixation with compression plate and Plate Osteosynthesis by minimally invasive technique.

Intramedullary nailing presents with pain in shoulder and movements restriction in comparison to rigid fixation with plate<sup>[9]</sup>.

For Shaft humerus fractures fixation with absolute stability using Dynamic Compression Plate<sup>[10-12]</sup> by open technique through posterior approach is today's gold standard.

However, precise reduction and absolute stable fixation has its biological price<sup>[13]</sup>. There has been evidence to show the superiority of biological fixation over a stable mechanical fixation<sup>[14]</sup>

This led to the development and improvement in the techniques of biological fixation for fractures and also the development of stabilization systems that help in achieving a biological fixation<sup>[15, 16]</sup>.

MIPO is developed to attain a stable fixation, which might improve the union rate and cut back complications related to open plating together with infection and induced radial nerve palsy<sup>[17-20]</sup>. MIPO may also be advantageous compared to IM nailing procedures in terms of shoulder function and intraoperative fracture.

This study was conducted to evaluate Shaft Humerus fractures treated by MIPO and to study the clinical outcome with respect to elbow and shoulder functions associated with complications.

### Materials & Methods

Twenty Five patients with shaft humerus fractures were prospectively enrolled for the study between August 2015 and July 2017. 18 patients were male and 7 were female. The mean age of patients was 37.7 years (range 18-80 years). In 10 patients, the fracture involved the dominant hand.

Patients above 18 years of age, with closed fracture AO type 12A,12B,12C giving consent for surgery were included in this study. Pathological fractures, Compound fractures and fractures associated with Distal Neurovascular injury were excluded. Out of the 25 patients enrolled for the study, none of them were lost to follow-up.

The mode of trauma was a simple fall on the outstretched hand in 6 patients, RTA in 18 patients and one patient with a history of assault. All were closed fractures. Fractures were classified according to the AO classification, using the preoperative anteroposterior and lateral roentgenogram.

### Operative Procedure

Patient positioned supine, with the arm resting on the side table extension and the elbow flexed to approx 70°. Forearm and the elbow were kept in this position by an assistant who applied slight traction during the whole procedure. This position facilitates access for plate introduction reducing the risk of vital structure injury. Two incisions, each approximately [2, 3] cm vertical, were made on the anterior arm surface. Proximal Incision was 5cm inferior to the coracoid process of scapula on the anterior aspect of the arm. Humerus was approached by retracting the biceps muscle medially and Deltoid laterally. Distal Incision nearly 5cm proximal to the flexion crease on the anterior surface of the arm and the Biceps Brachii muscle retracted medially. Retraction of biceps is done to expose the Musculocutaneous nerve, overlying brachialis muscle. The nerve is then retracted and Brachialis muscle is split till bone. Brachialis function was not compromised due to its double innervations. The lateral half of brachialis muscle then protects the radial nerve. Under no circumstances the lever retractors were used for humeral exposure. Instead, Farabeuf type retractors were applied in order to avoid radial nerve lesions from compression or stretching. A sub-brachialis, extra-periosteal tunnel was created using a 4.5mm Dynamic Compression plate through the incision on anterior surface of the humerus. Implant placement - The 4.5 mm narrow DCP was introduced in a proximal to distal direction, sliding on the anterior surface of the humerus. The plate should not reach the coronoid fossa. After the plate was introduced, the first screw was placed in the distal fragment and left relatively loose to allow the final fracture reduction. The varus deformity was corrected by arm abduction at 90° and

rotational deviations were avoided by aligning the bicondylar axis on an orthogonal plane to the biceps brachii tendon. After these maneuvers the second screw was placed in the proximal fragment and the distal one was tightened, securing the plate to the bone. Reduction quality was clinically and radiographically assessed before the remaining proximal and distal screws were placed. In good quality bone only two screws inclined and well-spaced needed to be inserted into each bone segment. The utilization of wide plates was avoided, as this may increase assembly rigidity and lead to retardation of fracture healing. For the same reason, locked plates should use only two locked screws in each fragment so that the assembly does not become excessively rigid.

Post-operatively, the limb was kept in a universal shoulder immobilizer. Elbow flexion extension and Shoulder Pendulum exercises were started from post operative day 1. Patient was evaluated at 1.5months, 3 months and 6 months postoperatively with anteroposterior & lateral x rays and UCLA shoulder score and Mayo Elbow Performance Score.



Results

Master Chart

Sr.No.	Age	Gender	Mechanism of Injury	Side affected	Pattern of fracture AO based	Pre Op Radial Nerve Injury	Associated Fractures	Time Interval between Injury & Surgery	Postoperative Complications	Appearance of Callus	Time of Union	UCLA Score	MEP Score	Radial Nerve Recovery	Varus/Valgus angulation	IITV Exposure
1	19	M	Fall	L	12-A3	Intact	Nil	2	Nil	1 month	3 months	35	100	-	-	121
2	55	F	RTA	L	12-B1	Intact	Nil	5	Superficial infection	2month	4 months	35	100	-	-	100
3	43	F	RTA	L	12-A3	Intact	Nil	1	Nil	1.5 month	3 months	25	95	-	-	132
4	55	M	RTA	L	12-A2	Intact	Nil	3	Nil	2 months	3.5 months	35	100	-	-	98
5	40	F	Assault	R	12-A2	Intact	Proximal humerus fracture same side	8	Nil	2 month	5 months	27	85	-	-	132
6	80	M	Fall	R	12-A3	Intact	Nil	14	Nil	2.5 month	4.5 months	34	100	-	10 degree varus	145
7	25	M	RTA	L	12-C2	Intact	Nil	4	Nil	1.5 months	3 months	29	100	-	3 degrees valgus	134
8	30	M	RTA	L	12-B3	Intact	Nil	1	Nil	1month	3 months	35	100	-	2 degree valgus	111
9	35	M	RTA	R	12-B1	Intact	Nil	1	Nil	2months	4 months	32	100	-	3 degrees valgus	121
10	30	F	RTA	R	12-A2	Intact	Nil	3	Nil	1.5 months	3 months	35	100	-	5 degrees varus	136
11	30	F	RTA	R	12-C3	Intact	Nil	1	Nil	1.5 months	3.5 months	35	90	-	3 degrees varus	165
12	34	M	RTA	L	12-A2	Radial Nerve injury present	Nil	6	Nil	1.5month	3 months	35	100	3 months	5 degrees varus	110
13	52	M	RTA	R	12-B2	Radial Nerve injury present	Capitulum # same hand	19	Nil	3 months	5 months	29	100	3 months	10 degree varus	134
14	32	M	RTA	L	12-A2	Intact	Nil	2	Nil	2 months	3 months	33	100	-	8 degree varus	122
15	40	M	RTA	L	12-A3	Radial Nerve injury present	Nil	7	Nil	1.5months	3 months	35	100	3 months	-	101
16	18	M	Fall	L	12-A3	Intact	Nil	1	Wrist drop present	1.5months	3 months	35	100	2 months	-	109
17	19	F	Fall	L	12-A2	Intact	Nil	1	Nil	1.5month	3 months	35	90	-	12 degrees varus	132
18	66	M	RTA	R	12-A3	Intact	Nil	2	Proximal screws blackout	2months	4 months	27	95	-	13 degrees varus	100
19	50	M	Fall	L	12-A3	Intact	Nil	2	Nil	2 month	4 months	35	100	-	-	134
20	25	M	RTA	R	12-A3	Radial Nerve injury present	Radius ulna shaft # same hand	11	Nil	1.5 months	4 months	35	100	3 months	-	143
21	45	M	RTA	L	12-A2	Intact	Nil	1	Nil	2months	4 months	35	95	-	8 degrees varus	123
22	40	F	RTA	L	12-A3	Intact	Nil	3	Nil	2months	4 months	35	95	-	5 degrees varus	133
23	25	M	RTA	L	12-A2	Intact	DER# same hand	5	Nil	1.5month	3 months	35	100	-	12 degrees varus	122
24	27	M	RTA	R	12-A3	Intact	DER# same hand	7	Nil	1.5months	3 months	35	95	-	3 degrees varus	143
25	28	M	Fall	R	12-C1	Intact	Nil	4	Nil	1.5 months	3 months	35	100	-	-	128

Master Chart

All 25 patients were evaluated. According to AO Classification 8 patients (32%) were A2 type, 10 patients (40%) were A3 type and the rest were in B1-B3, C1-C3 groups. 4 patients (16%) had associated Radial nerve injuries which recovered with radial nerve splint. 2 patients (8%) had associated distal end radius fracture and 1 patient (4%) had radius ulna shaft fracture. 21 patients (84%) were operated within 1 week of admission and 4 patients (16%) underwent surgery in 2nd week of admission. Average duration between trauma and surgery was 4.6 days. Radiological exposure varied from case to case, Mean was 125.16 seconds with minimum of 98 shoots (=seconds) and maximum of 165 shoots per case. We have one case of superficial infection, 1 Case of Proximal screw Blackout and 1 case of intraoperative radial nerve injury which was treated conservatively with radial splint and the patient recovered within 2 months. Thus the complication rate was 12% (3/25). 2(8%) cases callus was visible in less than 4 weeks, 12(48%) patients had callus visibility between 6-8 weeks and 11(44%) patients had callus visibility in more than 8 weeks. It was observed that union time was less than 12-14 weeks for 13(52%) and 14-16 weeks

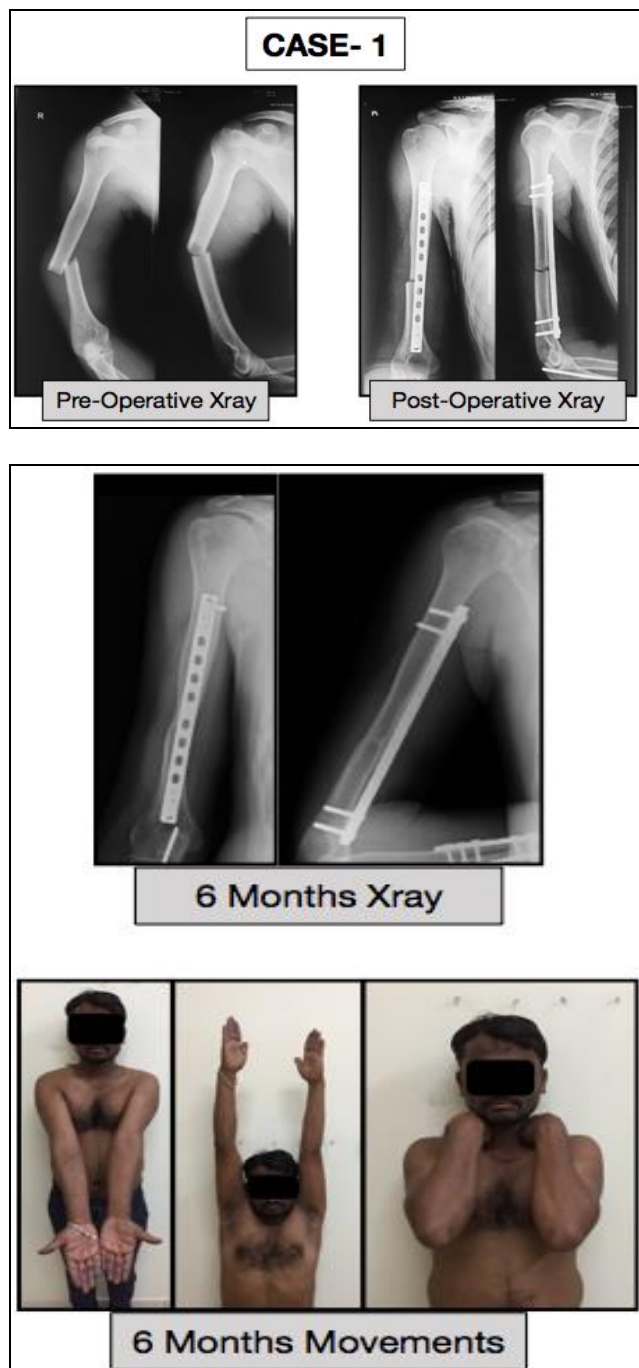
for 9 (36%) cases as shown in figure. It was further noted that union was reported in all the 25 cases, union rate was 100%. It was observed that the majority of the cases had excellent 17(68%), Good 5(20%) UCLA and 3(12%) had fair UCLA. In the present study it was noted that 12(48%) cases had varus angulation which was less than 10 degrees and valgus angulation of less than 5 degrees in 3(12%) of the patients.

Table 1: Association of Deformity with MEP Score

MEP Score	Deformity			Total
	Varus Angulation	Valgus Angulation	None	
Excellent (>/=90)	11	3	9	23
Excellent (>/=90)	48%	13%	39%	92%
Good (75-89)	1	0	1	2
Good (75-89)	50%	0%	50%	8%
Fair (60-74)	0	0	0	0
Fair (60-74)	0%	0%	0%	0%
Poor (<60)	0	0	0	0
Poor (<60)	0%	0%	0%	0%
Total	12	3	10	25

Table 2: Association of Deformity with UCLA Score

UCLA Score	Deformity			Total
	Varus Angulation	Valgus Angulation	None	
Excellent (34-35)	9	1	7	17
Excellent (34-35)	53%	6%	41%	68%
Good (29-33)	2	2	1	5
Good (29-33)	40%	40%	20%	20%
Fair (21-28)	1	0	2	3
Fair (21-28)	33%	0%	67%	12%
Poor (0-20)	0	0	0	0
Poor (0-20)	0%	0%	0%	0%
Total	12	3	10	25



### Discussion

Based on the outcome of our study it can be concluded that MIPO should be considered as the choice of surgery for closed diaphyseal humerus fractures. As this technique does not disturb the fracture site hematoma thus favors early callus formation and natural healing process of the fracture. Large numbers of exposure to radiation is another point of concern while doing MIPO for shaft humerus and it can be curtailed by expertising the technique. Holding onto an accurate reduction is difficult in MIPO of the shaft humerus and thus leads to varus and valgus angulation at the fracture site. Cosmetically MIPO has an edge over conventional posterior plating due to small suture scar and over Interlock Nailing as rotator cuff injury can be prevented. Patients can be mobilized within 24 hours post-surgery and normal activities can be started within a week's time. Our study has proved that regardless of fracture pattern, diaphyseal humerus fractures can be treated with excellent clinical outcome by Minimally Invasive Plate Osteosynthesis by Anterior Bridge Plating. In cases such as Osteoporosis, locking plates have an edge over

DCP as complications like Screw backout can be prevented.

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