



## MINIMALLY INVASIVE ANTERIOR BRIDGE PLATING FOR MANAGEMENT OF DIAPHYSEAL HUMERUS FRACTURES IN ADULTS

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**ABSTRACT** **Introduction**-In terms of post-operative pain and union time, diaphyseal fractures of the humerus treated with bridge plating with minimum invasive technique produce superior results. In our study, we looked at the clinical, radiological, and functional outcomes of such fractures in 30 patients, all of whom were treated with a dynamic compression plate over a 12 month period on average. Though the open reduction and plating technique of humerus shaft fracture is the gold standard, but in terms of result, this technique produces good results.

**Materials and methods** -This study included 30 patients with humerus shaft fractures who were treated with anterior bridge plating using the minimally invasive osteosynthesis technique between June 2019 and December 2021. Using the MIPO technique, all cases were managed with closed reduction and 4.5mm dynamic compression plate fixation over the anterior aspect in bridging mode. The dominant side, gender ratio, surgery time, fracture union time, and complications were all recorded. The UCLA shoulder and Mayo elbow scores were used to evaluate shoulder and elbow function.

**Results**-Out of the thirty patients in the study, nineteen were males and eleven were females. The mean age was 39.7 years (range 19 to 61 years). Twelve out of thirty patients (40%) had the dominant side fractured. Mean surgical time in minutes was 67.4 min (range: 60-80 minutes). The mean blood loss is about 108 ml (range :60-200 ml ).The mean fracture union time was 10.86 weeks (range: 6-16 weeks). With respect to shoulder Range of Motion, Among the 30 patients; 15 patients (50%) had excellent results, 13 patients (43.33%) had good result, 2 (6.66%) had fair result and no poor result. With respect to Elbow Range of Motion, Among the 30 patients; 22 patients (73.33%) had excellent results, 8 patients (26.66%) had good result, no fair result and no poor result.

**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. Near normal biological reduction in MIPO offers equally good functional outcome with better union rate compared to Anatomical reduction in ORIF, more so for comminuted fractures. 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. All cases reported good to excellent functional outcome according to CONSTANT MURLEY & MEPS score. but It requires good experience and skill.

**KEYWORDS :** Anterior bridge plate, Diaphysis humerus fracture, minimally invasive plate osteosynthesis.

### INTRODUCTION-

Diaphyseal humeral fractures account for 3% to 5% of all humeral fractures. They are caused by direct trauma, but they can also happen in activities with high rotating forces, like as baseball or arm wrestling. Biological fixation of fractures with soft tissue preservation and near acceptable reduction is becoming more acceptable nowadays, but it is still a point of contention. Healing in the desired time is not the only requirement for a satisfactory outcome; an early and acceptable functional result of the limb is the goal. As a result, the concept of biological fixation was developed over a stable mechanical fixation. This is the advancement and improvement of biological fracture fixation and stabilisation techniques.

From cast and braces to interlocking nailing or plating for internal fixation<sup>2,3</sup>. Research is still being conducted to demonstrate one's superiority over another. Recently, a minimally invasive technique for humerus shaft fracture has yielded promising results. We evaluated the clinical, radiological, and functional outcomes of the minimally invasive technique for humerus fracture over a minimum of 12 months in our study.

### MATERIAL AND METHODS:

This study included 30 patients with humerus shaft fractures who were treated with anterior bridge plating using the minimally invasive osteosynthesis technique between June 2019 and December 2021 at our centre. The cases were followed for a maximum period 12 months. All patients who had fracture at diaphyseal level were selected. These fractures were reduced and fixed with 4.5mm narrow Dynamic compression plate (DCP). All surgeries were

done by the same surgeon. Institutional Ethical Committee approved the study. The inclusion criterion included all those diaphyseal fracture of humerus between 19 and 61 years and who consented to participate. The operative procedure was performed within 4 days of the injury. Exclusion criteria included Patients who not fit for surgery, Patients below 18 years of age, Compound fractures, Vascular injury, patient who does not gave consent.

A preoperative clinical examination of the affected arm was performed in all aspects such as abrasions, swelling, contusion, puckering, and neurovascular deficit (chiefly Radial nerve status)<sup>4</sup>. Antero posterior (AP) and lateral (Lat) radiographs of the patient's humerus were evaluated. These radiographs were also used to plan the reduction mannuare and to find out proper length of implant. Functional outcome where analyzed by UCLA shoulder score and Mayo elbow score<sup>5,6</sup> (table no 1&2).

**Table 1: UCLA Shoulder Rating Scale**

Measure	Finding	Points
Pain	no pain	10
	occasional and slight pain	8
	pain with heavy or particular activities only; uses salicylates occasionally	5
	none or little at rest; occurs with light activities; salicylates frequently	4
	constant but bearable; strong medications occasionally	2
	constant, unbearable; strong medications frequently	1

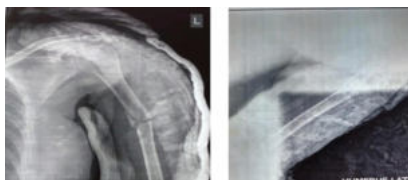
Function	normal activities	10
	slight reduction in function; able to work above shoulder level	8
	most housework, washing hair, putting on brassiere, shopping, driving	5
	light housework or most daily living activities (ADL)	4
	very light activities only	2
	unable to use arm	1
muscle power and motion	normal muscle power; motion near normal	10
	muscle power good or normal; elevation 140°; external rotation 20°	8
	muscle power fair to good; elevation 90°; internal rotation 90°	5
	muscle power poor to fair; elevation less than 60°; internal rotation < 45°	4
	ankylosis with good functional position	2
	ankylosis with deformity	1
Score for Each Measure	Interpretation	
10 (> 8)	Excellent	
8 (> 6)	Good	
4 or 5 (> 4)	Fair	
1 or 2 (< 3)	Poor	

**Table 2:** Mayo elbow performance score (MEPS)

1	Pain	0-45(no pain –sever pain)
2	Stability	0-10(grossly unstable-stable)
3	Morbidity	0-20(<500,1000)
4	Daily functional activity	0-25(none possible-normal function for 5 different)
	Excellent	>90
	Good	75-89
	Fair	60-74
	Poor	<60

**Surgical technique-**

The patients were positioned supine and operated in either brachial block or general anesthesia. Tourniquet was not applied for this procedure. After preparing the arm, arm was kept in 90 abduction and supination. A 3 cm incision between the proximal biceps and the medial border of deltoid, 6 cm distal to the acromion process was made. Dissection was carried to the humerus. Distally, 3 cm incision was made along the lateral border of biceps, approximately 5 cm proximal from the flexion crease. Retraction of biceps was done to expose the musculocutaneous nerve, overlying the brachialis muscle. The nerve is then retracted and brachialis muscle was split till bone. The lateral half of brachialis muscle then protects radial nerve. A sub brachialis, extraperiosteal tunnel was created with long stripper. Then 4.5-mm dynamic compression plate is passed through the incision on the anterior surface of the humerus from distal incision<sup>7</sup>. Length, rotation and angulations are restored by traction under fluoroscopic guidance. Then two/three proximal and two /three distal screws were placed antero-posteriorly. Care was taken to pass the tunneling instrument anteriorly and anteromedially to avoid the chances of injury to radial nerve. Good assistant with proper knowledge of fracture anatomy makes the surgery easy. The operative time (Skin incision to closure) and duration of radiation exposure (In seconds) was recorded. Postoperatively, shoulder immobilizer was applied. Suture removal on 14 th post op day.Regular follow up taken at 1,6,12 months.<sup>8-9</sup>



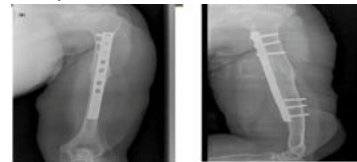
**PREOPX RAYS**



**Intraoperative images**



**Post operative x rays**



**Follow up x ray after 12month**



**Range of movements during follow up RESULTS-**

**Follow up** - Arm was immobilized in a neck wrist sling or broad arm pouch for pain control in the first 5 days if necessary, mainly at night while sleeping. Stitches were removed on 14th postoperative day. The patients were advised to perform passive gentle limb range of motion exercises as their pain control permits<sup>10</sup>. Immobilizer was removed after stitch removal. However they were informed to take out the limb and perform informed exercise for 8 to 10 times a day. Post-operative xray and 6 weeks x-ray and 3 month x-ray were taken in follow up. After 6 weeks they were allowed active gentle exercises and light work as per radiological signs of healing. The aim was to gain full mobility, muscular strengthening soon as possible. The final goal is to restore pain free functional to full range of motion and strength. The union time and complications were noted. Follow ups were done after 6 weeks, 3months, 6 months and 12 months. The patients shoulder and elbow function were analyzed using the UCLA shoulder score and the Mayo elbow performance score (MEPS). The UCLA shoulder score was graded into excellent to good (>27 points), fair to poor (< 5° of varus/ valgus angulation intra operatively and on following these patients up , 3 out of 30 had Radial nerve palsy post operatively. Postoperatively, these cases are given with cockup splints, preferably dynamic cockup splints. Nerve conduction study was done in these 2 cases by 6 weeks. Recovery was assessed at every followup by sensory and motor examination. 1 case had full recovery by the end of 6 months and the other case showed no recovery by the end of 1 year for which tendon transfer to be planned. On determining the functional outcome of other cases, 28 cases had excellent , two with good outcome by Sarmiento et al<sup>11</sup>

**RESULTS :**

- 30 patients who had diaphyseal humerus fractures who were treated in **Department Of Orthopaedics , Govt.medical college and hospital, AURANGABAD** were followed up in the study.
- The longest follow up was One year; The shortest duration being THREE months. The mean duration was found to be 9.43 months.
- Age incidence** ranged from 19 to 61 years with average age being 39.7 years
- Side of the fracture** :The left side was more commonly involved [18 in number] than the right side [12 in number].
- Nature of the injury**:Most cases were due to road traffic accidents (73.3%). The Other mechanism being accidental fall (26.6%).
- Assessment of radiological valgus/varus angulation**:Among the 30 cases, 14 cases had no angulation & 10 cases did have Minimum angulation of less than 10° of varus or valgus angulation were accepted which remodeled to correct alignment over due course of time. 4 cases had varus angulation (>10 degree) which showed no significant functional impairment and no cases had valgus angulation.
- Antero-Posterior Malalignment**:1 case had reported posterior angulation because of excessive plate contouring.
- Rotational malalignment and Shortening** :None of the patients

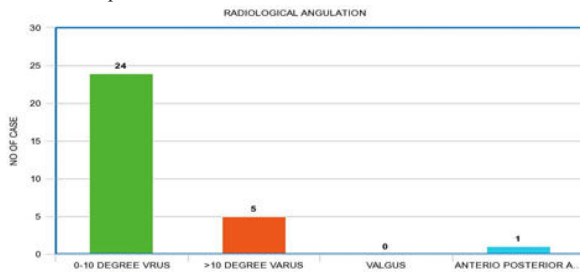
had any amount of rotational malalignment or shortening.

9. **Time of union** :The Mean union time is 10.86 weeks, ranging from 6-16 weeks.
10. **Range of movements at the shoulder & elbow [expressed as percentage]** - With respect to shoulder Range of Motion, Among the 30patients ; 15 patients(50%) had excellent results,13 patients(43.33%) had good result, 2(6.66%) had fair result and no poor result.
  - With respect to Elbow Range of Motion, Among the 30 patients ; 22 patients(73.33%) had excellent results,8 patients(26.66%) had good result, no fair result and no poor result.
11. **SHOULDER/ELBOW FUNCTIONAL SCORE:**  
Among the 30 patients, 28 patients had excellent results and 2 patient had good result.
12. **ELBOW FUNCTION is assessed by MAYO ELBOW**  
Among the 30 patients, All patients had excellent elbow function score.
13. **The mean surgical time** with MIPO was 67.4 minutes (range: 60–80 minutes). The average blood loss with MIPO was 108ml(range : 60-200 mL)

**14. Complications:**

□ 3 out of 30 had Radial nerve palsy post operatively. Postoperatively, these cases are given with cockup splints, preferably dynamic cockup splints.

Nerve conduction study was done in these 2 cases by 6 weeks. Recovery was assessed at every followup by sensory and motor examination. 1 case had full recovery by the end of 6 months and the other case showed no recovery by the end of 1 year for which tendon transfer to be planned



**RADIOLOGICAL ANGLULATION**

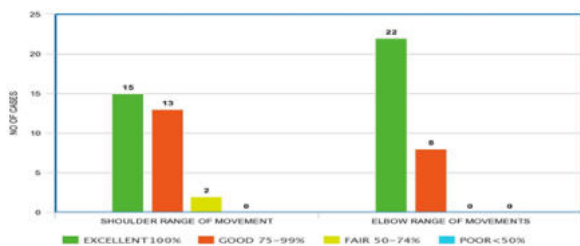
	FREQUENCY	PERCENTAGES
NO ANGLULATION	14	46.66
0- 10 Degree varus angulation	10	33.33
>10valgus angulation	5	0.16
Valgus	0	0
anterior posterior angulation	1	0.03
Total	30	100

**SHOULDER RANGE OF MOTION**

RANGE OF MOTION	FREQUENCY	PERCENTAGE%
EXCELLENT (100%)	15	50
GOOD (75-99%)	13	43.33
FAIR(50-74%)	2	6.66
POOR(<50)	0	0
TOTAL	30	100

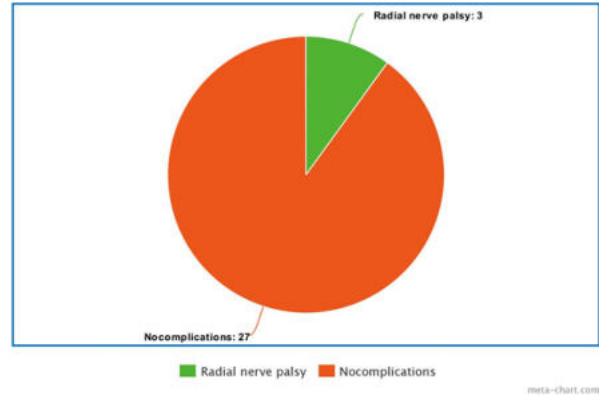
**Table-elbow Range Of Movement**

RANGE OF MOTION	FREQUENCY	PERCENTAGE%
EXCELLENT (100%)	22	73,33
GOOD (75-99%)	08	26.6
FAIR(50-74%)	0	0
POOR(<50)	0	0
TOTAL	30	100



**COMPLICATIONS**

COMPLICATIONS	FREQUENCY	PERCENTAGE %
RADIAL NERVE PALSY	3	10
INFECTION	0	0
DELAYED AND NON UNION	0	0
NO ANY COMPLICATIONS	27	90
TOTAL	30	100



**CONCLUSION**

the humerus bone has a wide range of acceptability criteria in its reduction and is highly amenable to conservative management or closed reduction as done in our study by MIPO technique. Despite the requirement of high surgical expertise and time taken for adaptation of the procedure, the MIPO technique seems to be reproducible and applicable in almost all types of shaft humeral fractures. Lower rates of iatrogenic nerve injury with minimal bone vascularity disruption, and soft tissue dissection are all the advantages over conventional plate technique<sup>12</sup>. Although the reduction and plating were difficult procedure initially. Whole construct becomes elastic and allows micro motion at fracture site, which favors union. Excellent to good results have been achieved with interior bridge plating with no major soft tissue problems and with functional results as per other methods . Open technique of plating compromises with the local vascularity because of periosteal stripping, leading to osteonecrosis underneath the plate, which may cause delayed healing to non-healing. Other fixation modalities have many drawbacks associated with the technique of fixation and the implant itself. The potential for rotator cuff damage during conventional antegrade nailing makes it an unattractive option for patients with higher work demands<sup>13-14</sup>. The posterior plating involves greater soft tissue stripping and larger incisional scars<sup>15</sup>. Union fractures in this study presents good results with fixation through indirect reduction aims at maintaining bone alignment through small incisions and replacing absolute stability by relative stability. The MIPO technique causes less tissue dissection and periosteal stripping which makes a promising modality of treatment. In conclusion, this minimally invasive technique presents newer, effective, minimal post-operative scarring) and acceptable modality of treatment for close diaphyseal humerus fractures. While this technique requires good surgical skills with good assistant. The learning curve of MIPO is long. However more studies have to be done to standardize the protocol. To conclude, MIPO is definitely a newer and acceptable modality of treatment<sup>16</sup>

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