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Functional outcome of minimal invasive anterior bridge plating for humerus shaft fractures

Dr. Priyank R Pancholi
Assistant Professor, Department of Orthopaedics, Parul Institute of Medical Sciences & Research, Parul Sevashram Hospital, Waghodia, Vadodara, Gujarat, India

Dr. Niravkumar Prabhudas Moradiya*
Assistant Professor, Department of Orthopaedics, SMIMER Hospital and Medical College, Surat, Gujarat India, Contact no: 9825998949
*Corresponding author email: moradiyanirav@gmail.com

Dr. Khatri Chaitanya Nileshkumar
Senior resident, Department of Orthopaedics, Pacific institute of medical sciences, Umarda, Udaipur, Rajasthan, India

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Functional outcome of minimal invasive anterior bridge plating for humerus shaft fractures

***Abstract*---**Objectives: To study clinical & functional outcomes and complications in patients with humeral shaft fractures treated using anterior bridge plating. Materials and Methods: 25 patients with fractures of middle third humerus were treated with Minimum invasive Anterior Bridge plating in a case study at tertiary care hospital Surat. Both male and female patients above 20 years of age with closed and OG type I & II diaphyseal fractures of Humerus were included. Pathologic fracture, OG III fractures, Fractures in skeletally immature patients, Old neglected fractures, Those who Refused to provide informed consent and Fractures with neuromuscular disorders / neurovascular insufficiency were excluded. Functional outcome where analyzed by constant murley shoulder outcome score &Mayo elbow performance index. Results: The totals of twenty-five patients were included in the study. Out of total twenty-five patients 17 were males and 8 were females with the average age of 39 years. Right side fracture was found in 20 patients out of total 25. The average time for the surgery for the entire patient was 68 minutes. The average mean union time was found to be two months (10 weeks)

for initial union of surgery. On the basis of the Constant Murley score the excellent to good score were found in 20 cases, fair to poor results in rest 5 patients. With regard to elbow function, 22 cases had excellent outcome and 3 patients had good outcome. One of our patients had superficial infection, one patient had musculocutaneous nerve injury and one patient had radial nerve palsy. Both palsies recovered within 6 months. Conclusions: minimally invasive plate osteosynthesis (MIPO) is definitely a newer and acceptable modality of treatment with regards to bone healing and functional capacity.

***Keywords*---**Anterior bridge plating, Diaphyseal fractures, Shaft humerus, Minimally invasive plating.

Introduction

Diaphyseal fractures of the humerus occur frequently and represent three to five percent of the fractures of the human body.[15]Stable mechanical fixation requires precise reduction and opening of the fracture site. It heals by primary intention which is biologically inferior to healing by secondary intention with the preservation of fracture haematoma causing minimal soft tissue injury. Acceptable reduction and less rigid yet stable fixation has advantage ascompare to absolute anatomical reduction with compromising soft tissue and vascularity[2].Biological fixation of fractures with soft tissue preservation and near acceptable reduction isbecoming a more acceptable entity. However it is to be evaluated. For satisfactorily outcome only union is not the requirement but early and acceptable functional range of motion of joints and usage of the limb is necessary. Therefore idea of biological fixation came into picture over a stable or rigid mechanical fixation[1]. This has evolved the techniques of minimally invasive stabilization systems[3,4] From conservative cast and braces[5,6,7] tointernal fixation with intramedullary interlocking nailing[8], MIPO with plate and screw.The humerus can be considered the most versatile bone in the human body as it can be successfully approached by a various methods for fracture fixation including functional bracing; plating or interlock nailing.[16, 17]Treatment of humeral fracture has evolved a lot with their complications. Studies are stillgoing on to prove superiority of one over another[8-9].

Anterior bridge plating which utilizes the minimally invasive approach popularly known as the minimally invasive percutaneous plate osteosynthesis technique can be said to be the latest entrant in this list.[18, 19]This technique brings together the ease of handling of plates and the relative stability principle of nails. Minimally invasive technique for humerus shaft fracture has shown good results recently[12-13]. This study has evaluated the clinical, radiological, and functional outcomes of this minimally invasive technique for humerus fracture over a minimum follow-up of 16 months.

Intramedullary interlock nailing is minimally invasive, but it has the main disadvantage of damaging the rotator cuff and causing shoulder impingement.

Aims and Objectives

- To study the functional outcome of Anterior Bridge Plating for humeral shaft fractures in adults
- To study the duration of union
- To study the complications of Anterior Bridge Plating for humeral shaft fractures

Materials and Methods

Prospective observational study was carried out at tertiary care hospital of Surat, Gujarat. 25 patients with fractures of middle third humerus were treated with Minimum invasive AnteriorBridge plating in a case study at tertiary care hospital Surat.

Inclusion Criteria:

- Both male and female patients above 20 years of age with closed and OG type I & II diaphyseal (upper, middle and lower third) fractures of Humerus
- Consent for the surgery and to participate in the study

Exclusion Criteria:

- pathologic fracture
- OG III fractures
- multiple trauma patients
- Fractures in skeletally immature patients
- Old neglected fractures
- Refusal to provide informed consent

Fractures with neuromuscular disorders / neurovascular insufficiency

Average follow up period was 16 months. These fractures were reduced and fixed with 4.5mm dynamic compression plate (DCP). Prior approval was taken from Scientific research Committee (SRC). A preoperative detailed clinical work-up was conducted for swelling, contusion, abrasions and neurovascular deficit (Radial nerve). Standard Antero posterior (AP) andlateral (Lat) radiographs of the humerus of the patient were evaluated. Fractures were classified according to AO classification system into 12A, 12B & 12C categories. These radiographs were used todecide the appropriate length of plate and planning the surgery.

Functional outcome where analyzed by constant murley shoulder outcome score &Mayo elbow performance index.

Surgical Technique:

Position: supine with the shoulder was abducted to 30°–60°, the elbow was flexedto about 90°, and the forearm was supinated throughout the procedure.

Anaesthesia: brachial block / GA

Incision: Proximal incision was about 2–3 cm long between the deltoid and biceps and as proximal as possible in this intermuscular plane on anterolateral surface, whereas the distal incision of a similar length was made as distal as possible while ensuring that the plate ending proximal to the supracondylar notch, and the brachialis muscle was split to reach the anterior surface of the humerus. The biceps and underlying neurovascular structures were retracted medially while the lateral part of the brachialis muscle protected the radial nerve. Undue forceful retraction was avoided for fear of neuropraxia. Indirect reduction maneuvers were used when needed for optimal fracture reduction including temporary retrograde ender's nail.

The plate was inserted from proximal incision and fixed temporarily with k-wires. After achieving satisfactory reduction under IITV guidance, 2 proximal and 2 distal cortical screws were used to fix the plate. Non-locking cortex screws were used in young patients while locking screws were used in old patients.

Post operative & Rehabilitation Protocol: Postoperatively, all patients were given above elbow plaster slab. Clean dressing was done with spirit only and changed once every 3 days. Pendulum exercises and elbow, wrist, and hand range of motion (ROM) exercises were started immediately postoperatively as tolerated by the patient. Passive and active assisted shoulder ROM exercises were started under supervision of a physiotherapist after surgery as tolerated. Active abduction beyond 90° and active rotation were not allowed upto 3–4 weeks after surgery. The patient was allowed to gradually resume preoperative activities with muscle strengthening and return to full spectrum of activities at 9–12 weeks after surgery. Patients with no signs of radiographic/clinical union at more than 270 days or 9 months after surgery were subsequently treated for nonunion.

Assessment of Outcomes: Patients were assessed for functional and radiological outcome sat 6, 8, 12, 24 weeks in outpatient department. Radiographic assessments included union, fracture alignment, angulations, deformity, delayed union, and nonunion. The functional outcome was assessed using theConstant murley score& Mayo's elbow score. The ROM of the affected limb was evaluated for forward flexion, abduction, external rotation(ER) in 90° of abduction and elbow flexion, internal rotation (IR) with the arm placed adjacent to the chest and elbow flexed to 90°. The strengths of the shoulder muscles were assessed.

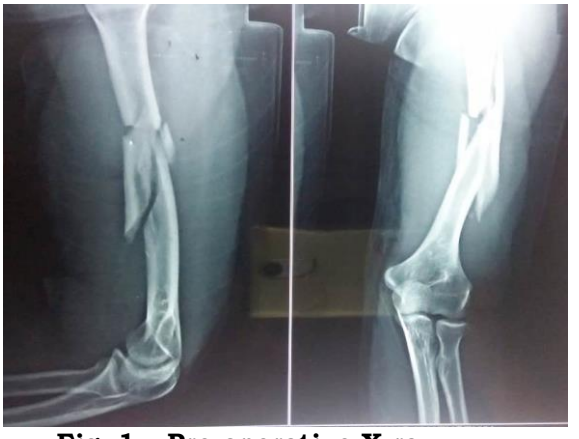

Fig. 1 – Pre-operative X-ray

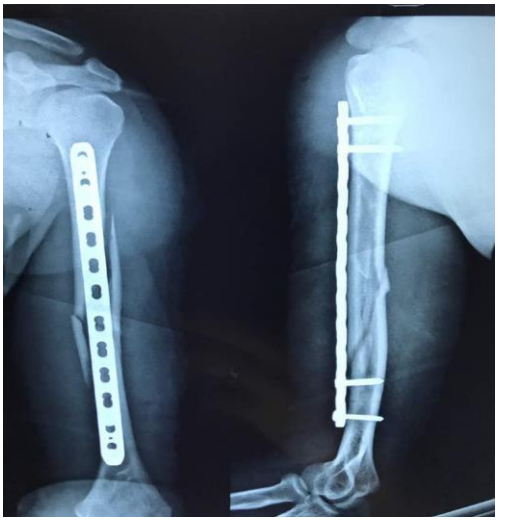

Fig. 2 – Post-operative X-ray

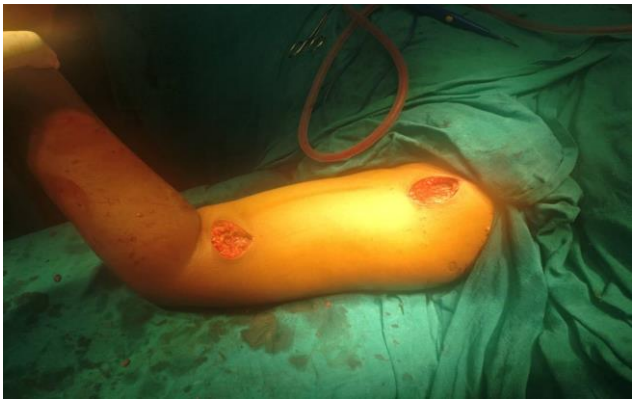

Fig. 3 – Intra-operative photograph of Minimally invasive wounds

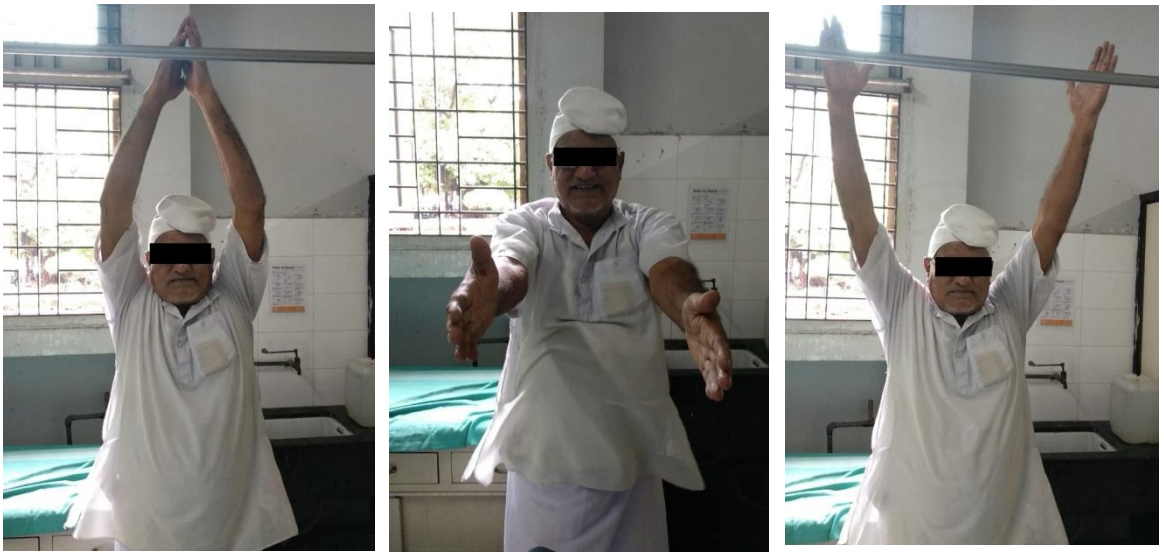

Fig.4 – Post-operative clinical photographs of patient

Statistical Analysis

The data on categorical variables are presented as the number of patients (%) and the data on continuous variables are presented as mean & standard deviation (SD).The statistical significance of pair-wise difference of the mean of continuous variables was tested using Wilcoxon signed rank test and that of one-sample distribution was tested using one-sample chi-square test for majority. A *p*-value less than 0.05 was considered statistically significant. All the hypotheses were formulated using two tailed alternatives against each null hypothesis (hypothesis ofno difference). The entire data were statistically analyzed using SPSS software.

Results

Table 1: Demographic details of patients (25 patients)	
Age	**Number**
<20	1
21-30	5
31-40	7
41-50	5
51-60	4
61-70	2

70	1
Gender	
Male	17
Female	8
Side involvement	
Right	20
Left	5
Mode of Injury	
RTA	13
Fall	10
Direct injury	3
Fracture Type	
12A	16
12B	6
12C	3
Occupation	
Labourer	18
Other	7

Table 2: Outcome Scores (number of patients)			
Score	**Excellent & Good**	**Average & Poor**	**P value**
Constant Murley	20	5	0.882
Mayo elbow	19	6	<0.003

The totals of twenty-five patients were included in the study. Out of total twenty-five patients 17 were males and 8 were females with the average age of 39 years.

(Table 1) Right side fracture was found in 20 patients out of total 25. The average time for the surgery for the entire patient was 68 minutes. The average mean union time was found to be two months (10 weeks) for initial union of surgery. On the basis of the Constant Murley score the excellent to good score were found in 20 cases, fair to poor results in rest 5 patients. With regard to elbow function, 22 cases had excellent outcome and3patients had good outcome. (Table 2)

Superficial wound infection was seen in 1 patient; wound was meticulously debrided and managed then conservatively. Road traffic accident (RTA) was the most common mode of injury, found in 13 cases. The mean follow-up of our cases were 22 months (range: 18–28 months). We had accepted <5° of varus/ valgus angulation intra operatively. We had one case with post-operative sensory deficit over the lateral part of the forearm due to musculocutaneous nerve injury, which recovered within 6 months of surgery without any intervention. We had one patient of post operative radial nerve palsy which recovered within 6 months.

Discussion

The acceptability criteria for humerus bone are wide and are highly amenable to conservative management. Minimally invasive technique is evolved and it seems to be 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.In addition, the rotator cuff is spared preventing any major shoulder pathology later on, which is the case in humeral nailing. It works on principle of relative stability and hence it promotes micromotion at the fracture site. 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.

The posterior plating involves greater soft tissue striping and larger incisional scars. The ABP is the ‘logical middle’ in this case. On the downside, the procedure has a steep learning curve and should not be attempted by inexperienced surgeons without supervision. Although we did not carry out a formal study, the amount of intraoperative fluoroscopy exposure required was greater than posterior plating or intramedullary nailing. It is good to place nail (rush or ender’s) before Plate for provisional reduction of humeral shaft. Open technique of plating interferes with the local vascularity, underneath the plate, which might cause delayed healing. The present technique through its less tissue dissection and periosteal stripping makes a promising modality of treatment.

Another matter of controversy with ABP is whether to use locking or simple cortical screws. We first used cortex non-locking screw proximally and distally to fix the plate flush to bone followed by locking screws proximally and distally. The distal non-locking screw was half tightened followed by full tightening of proximal screw and than full tightening of distal screw was done; so both non-locking and locking screws were there on either side of the fracture. According to Apivatthakakul *et al.*[11] when a plate is placed on the anterior side of the humeral shaft, the mean distance from the closest part of the plate to the radial nerve is 3.2 mm. Apivatthakakul *et al.*[11] also pointed out that when the forearm was

pronated, the radial nerve was noted to move medially closer to the distal end of the plate and was at risk of iatrogenic injury. For this reason, the supination position of the forearm should be maintained during the operation.The functional outcome achieved in our study is comparable to that published studies on this topic.[7-10,13-15,21,22].

Our study has certain limitations. Firstly, there was no control group to compare our results with, which might have introduced a bias in the study. However, the main aim of our study was to assess the utility of ABP in a selected patient population and not to compare this procedure with any other modes of treatment. Secondly, the malrotation of the humerus after union could not be accurately calculated as no parameter was included to calculate malrotation in criteria. Besides, there was no case of severe rotational restriction in our patients; implying that any major rotational malalignment was unlikely. Thirdly, limitation of this study was the inhomogeneous patient population. However, the lack of a homogeneous populationdoes not influences the results. There were a large age range with different types of nonunion, and some patients with osteoporotic bones.

MIPPO techniques have an increased risk of secondary shoulder arthritis due to malrotation inadvertently caused during surgery. To know the exact incidence of this, a much longer follow-up would be needed and this could be an area of future study.

Conclusion

In conclusion, ABP for mid-shaft humerus fractures is a safe, newer, acceptable modality and effective treatment modality yielding high rates of union, excellent functional recovery, minimal biological disruption, better cosmesis, and superior patient satisfaction. Therefore, we would recommend considering this procedure as routine for any shaft humeres fractures. Though the technique is complex, requiring a relatively long learning time the results are good and reproducible. However a larger multicentric metanalytical study with control groups will help us toarrive at a standardize protocol.

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