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Outcome of Treatment of Fracture of Middle One Third Shaft Humerus by Anterior Plating with Mipo Technique in Adults

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Authors' contributions

This work was carried out in collaboration among all authors. Author JS designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author PSV managed the analyses of the study. Authors PSB and MS managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Introduction: Fractures of the humeral shaft account for roughly 3% to 5% of all fractures. Generally, these fractures are the results of direct trauma. The treatment of these fractures has always been a debated topic, as both the conservative and the surgical treatment have their own advantages and disadvantages. The internal fixation of fractures has evolved in recent years with a change of emphasis from mechanical to biological priorities that is MIPO/MIO (Minimally Invasive Percutaneous Plate Osteosynthesis). MIPO/MIO has been widely used to treat long bone shaft fractures in recent years because of its technical and biological advantages

Materials and Method: It was a two year prospective study. Thirty patients were scheduled to undergo anterior plating by MIPO technique for fracture shaft humerus middle one third.The fractures were classified based on the AO/ASIF classification system.

Results: In our study constant score was used for assessing shoulder function. It was observed

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that 18 patients had excellent score, 10 had good score and 2 had fair score. In our study, Mayo score was used for assessing the elbow function. It was found that 17 patients had excellent score, 11 had good score and 2 had fair score.

Conclusion: MIPO/MIO of closed fracture of humerus, is a complex technique, requiring a relatively long learning curve. However, the results were good and reproductive and there were few risks.

Keywords: MIPO; humerus; fracture; internal fixation.

1. INTRODUCTION

Fractures of the humeral shaft account for roughly 3% to 5% of all fracture [1], generally these fractures are the result of direct trauma. The treatment of these fractures have always been a much debated topic, as both the conservative and the surgical treatment have there own advantages and disadvantages. In fact, most of humeral shaft fractures can be successfully managed by conservative methods and good to excellent results have been reported with conservative treatment [2,3,4]. Malunion with anterior angulation of upto 20 degree or a varus of upto 30 degree are usually well tolerated both functionally and esthetically, hence most studies on conservative treatment have reported good to excellent results [5,6]. Charnley stated that it was perhaps the easiest of the major long bones to treat by conservative methods. The range of motion afforded by the shoulder and elbow joints coupled with a tolerance for small amounts of shortening compensate for radiographic imperfections of humeral shaft fractures thus causing minimal functional deficit. Historically, methods of conservative treatment have included skeletal traction, abduction casting and splinting, Velpeau dressing, and hanging arm cast. Functional cast bracing has essentially replaced all other conservative methods and has become the gold standard non operative treatment because of its ease of application, adjustability, allowance of shoulder and elbow motion and relatively low cost and in addition, it has reproducible results [2,3]. The goal of operative treatment of humerus fractures is to reestablish length, alignment, and rotation with stable fixation that allows early motion and return of function on the fractured extremity. Various methods of treating middle and distal humeral shaft fractures have continued to evolve from closed methods, external fixation, antegrade and retrograde intramedullary nailing, and conventional plating to minimally invasive plate osteosynthesis. External fixation is generally reserved for high-energy gunshot wounds, fractures with severe soft tissue injuries, and fractures with massive contamination [7]. Plate osteosynthesis remains the gold standard for operative fixation for humeral shaft fractures. Plate osteosynthesis can be used for fractures with proximal and distal extension and for open fractures [8]. The internal fixation of fractures has evolved in recent years with a change in emphasis from mechanical to biological priorities that is MIPO/MIO (Minimally Invasive Percutaneous Plate Osteosynthesis). MIPO/MIO has been widely used to treat long bone shaft fractures in recent years because of its technical and biological advantages. This technique uses the anterior approach to humeral shaft as demonstrated by T. Apivatthakakul et al. [9]. In a cadaveric study. Clinical results have been equally encouraging as depicted by Zhiquan An et al. [10] and Sang-Jin Shin et al. [11]. Looking at the good results of new biological method ,we decided to conduct a study.

2. MATERIALS AND METHOD

It was a two year case series study. 30 patients were scheduled to undergo anterior plating by MIPO technique for middle one third fracture shaft humerus.

2.1 Inclusion Criteria

1. Closed fracture of middle one third shaft humerus.
2. Patients >18 years of age.

2.2 Exclusion Criteria

1. Open fractures.
2. Neurovascular injury.
3. Pathologic fractures

Detailed demographic and clinical data of all the patients was obtained. The fractures were classified based on the AO/ASIF (Arbeitsgemeinschaft fuer Osteosynthesefragen / Association for the study of internal fixation) classification system.

Preoperatively, POP back splint was applied to temporary stabilized the fracture.

Technique: In the MIPO technique, after positioning the patient in the supine position under appropriate anaesthesia, a sand bag was placed beneath the scapula to elevate the limb and the arm was draped free to facilitate access to the shoulder and elbow while the limb was abducted to 90 degree and put on side trolley, the forearm was positioned in supination and the elbow flexed 70°, a 3 - 4 cm incision was made 5 cm distal to the acromion along the anterior border of the deltoid muscle and palpable lateral border of the biceps brachii. Distally a 3 - 4cm incision was made on the anterior surface of the arm along the lateral border of the biceps, extending to within 5 cm proximal to the flexion crease. Then, the biceps muscle was retracted medially to expose the musculocutaneous nerve, between the biceps and the brachialis muscle. In the depth of the incision, the brachialis was exposed and split longitudinally to the bone, the medial half was retracted medially accompanying the musculocutaneous nerve and the lateral half was retracted laterally to protect the radial nerve. Then a sub-brachialis tunnel was created from each incision to the fracture site under the periosteum deep to the brachialis muscle. To minimize the risk of iatrogenic radial nerve injury, care was taken to pass the periosteal elevator anteriorly or anteromedially to avoid injury to the brachial artery using lever retractors and to use gentle traction and manipulation for reduction. A 4.5-mm narrow locking compression plate (LCP) with 8 - 12 holes (depending on the length of the fracture) was inserted through the submuscular tunnel from proximal or distal incision (based on the location of the fracture). After reducing the fracture in all the 4 planes by applying gentle traction and manipulation and reduction was checked under c-arm and a screw was inserted in the distal fragment in compression mode, the quality of reduction was evaluated using an image intensifier. If the reduction was acceptable, a locking screw was inserted in the proximal fragment. Then, one or two more locking screws were inserted on each side of the fracture to make the fixation more secure.

After surgery, the arm was supported in a sling for 1 week. The patient was instructed to start elbow and active shoulder exercises at the second postoperative day. Monthly clinical evaluations were performed on follow-up upto 6 months in the form of check X-rays and movement of proximal and distal joint. Shoulder function and elbow function of the operated side were evaluated and compared with the normal side as per Constant score (for shoulder) and Mayo score (for elbow) respectively. Constant Score Constant [12] system consists of four variables that are used to assess the function of the shoulder. The right and left shoulders were assessed separately. The subjective variables were pain and Activity of daily living, which give a total of 35 points. The objective variables were range of motion and strength, which give a total of 65 points. Hence, total of 100 points.

Rodriguez-Merchan criteria (1995)

Chart 1. Criteria for evaluating functional results

Rating	Elbow range of movement	Shoulder range of movement	Pain	Disability
Excellent	Extension 5 Flexion 130	Full range of movement	None	None
Good	Extension 15 Flexion 120	<10% loss of full range of movement	Occasional	Minimum
Fair	Extension 30 Flexion 130	10-30% loss of full range of movement	With activity	Moderate
Poor	Extension 40 Flexion 90	>30% loss of full range of movement	Variable	Severe

Constant Score (Constant 1991)

This scoring system consists of four variables that are used to assess the function of the shoulder. The right and left shoulders are assessed separately.

The subjective variables are pain and Activity of daily living, which give a total of 35 points. The objective variables are range of motion and strength, which give a total of 65 points. Hence, total of 100 points.

1) Pain Score (Max 15 points)

None	15
Mild	10
Moderate	5
Severe	0

2) Activity of daily living (Max 20 points)

a) Activity level (10 points)

Full work	4
Full recreation/sport	4
Unaffected sleep	2

b) Positioning (10 points)

Upto waist	2
Upto Xiphoid	4
Upto Neck	6
Upto top of head	8
Above head	10

3) Range of motion (Max 40 points)
(The number of degrees at which the pain starts determines the range of motion)

a) Forward flexion (Max 10 points)

0-30°	0
31-60°	2
61-90°	4
91-120°	6
121-150°	8
151-180°	10

b) Abduction (Max 10 points)

0-30°	0
31-60°	2
61-90°	4
91-120°	6
121-150°	8
151-180°	10

c) External rotation (Max 10 points) (hand is not allowed to touch the head)

Not reaching the head	0
Hand behind head with elbow forward	2
Hand behind head with elbow back	2
Hand on top of head with elbow forward	2
Hand on top of head with elbow back	2
Full elevation from top of head	2

d) Internal rotation (Max 10 points)

End of the thumb to lateral thigh	0
End of the thumb to buttock	2
End of the thumb to lumbosacral junction	4
End of the thumb to L3 (waist)	6
End of the thumb to T 12	8
End of the thumb to T 7(interscapular)	10

4)	Strength of abduction (Max 25 points)	1 point/ lb
	Mayo Elbow Performance Score	
1)	Pain (Max 45 points)	
	None	45 points
	Mild	30 points
	Moderate	15 points
	Severe	0 point
2)	Mean Range of motion (Max 20 points)	
	Arc > 100 degrees	20 points
	Arc 50 to 100 degrees	15 points
	Arc < 50 degrees	5 points
3)	Mean Stability (Max 10 points)	
	Stable	10 points
	Moderately stable	5 points
	Grossly unstable	0 points
4)	Mean Function (Max. 25 points)	
	Able to comb own hairs	5 points
	Able to feed self	5 points
	Able to perform personal hygiene tasks	5 points
	Able to put on shirt	5 points
	Able to put on shoes	5 points
	Total (max) - 100 points.	

Results of constant score and mayo elbow score will be graded as:

Excellent	>90 points
Good	>75 – 89 points
Fair	>60 – 74 points
Poor	<60 points

Complications grading:

Minor complications:

a) Superficial infection.
b) Excellent to fair shoulder and elbow score.
c) Iatrogenic fracture not affecting union.
d) Malunion

Major complications:

a) Deep infection.
b) Iatrogenic fracture affecting union and requiring second procedure.
c) Iatrogenic radial nerve palsy.
d) Delayed / Non union.
e) Early or late implant failure.
f) Compartment syndrome
g) Poor shoulder and elbow score.

Inference:

Overall inference will be assessed as:

Excellent - Excellent shoulder score with excellent elbow score and healing of fracture within 3 months without complications.

Good - Good shoulder score with Good elbow score and healing of fracture within 3 months with minor complications

Satisfactory - Fair shoulder score or fair elbow score and healing of fracture in three to four months with minor problems.

Poor - Poor shoulder score / poor elbow score / nonunion / any major complications / Any case requiring second surgical procedure.

3. RESULTS

It was observed that more than half of fractures of shaft humerus occurred in middle aged population in fourth and fifth decade of life. The age group of 31-50 years is the most productive period of life financially, socially and also on the personal front. Out of 30 patients analyzed, 25 were male and 5 were female. Out of 30 patients included in study, more than half of the fractures (16) involved dominant side. In this study, most of our patients (80%) sustained injury due to road traffic accident and other (20%) were due to fall.

All 30 humeral shaft fractures analysed in the study were graded in accordance to the AO/OTA classification [13]. It was observed that 6 out of 30 fractures were A1 (20%), 2 fractures were A2 (6.7%), 4 fractures were A3 (13.33%) 2 were B1 (6.7%), 12 fractures were B2 (40%) and 4 fractures were C2 (13.33%). It was observed that more than half of the fracture were comminuted. In our study, 13 patients had isolated mid humeral shaft fracture, 11 patients presented with associated fractures, 3 had head injury, 2 had soft tissue injury foot and 1 had chest trauma. Majority of patients in our study had multiple injuries. Majority of the patients (26) were operated within 1 day of admission, 3 cases were operated on 3rd day and 1 was operated on the 4th day. The delay was due to head injury or chest trauma. Most of the patients (23) were operated under brachial block and 7 patients were operated under general anaesthesia. Physiotherapy in bed was started on second post operative day in most of the patients (23) and in remaining 7 patients it started on 3rd post operative day. The radiological healing occurred after 12 weeks (Table 1) (Figs 1-4). In our study constant score was used for assessing shoulder function. It was observed that 18 patients had excellent score, 10 had good score and 2 had fair score(Table 2). In our study Mayo score was used for assessing the elbow function (Fig. 5). It was found that 17 patient had excellent score, 11 had good score and 2 had fair score.(Table 3) After assessing shoulder and elbow function, RM criteria was used which was based on Constant and Mayo score. It was found that 18 patients had excellent RM Criteria, 10 had good and 2 had fair RM Criteria. In our study more than half of patients (66.66%) had no post operative complications, 7 patients were having pain and 3 patients had neuropraxia. Neuropraxia was recovered in all 3 patients on follow up.

Table 1. Radiological healing

Radiological healing (weeks)	No. of cases	Percentage
12-13	7	23.3
13-14	13	43.3
14-15	9	30.0
>15	1	3.3
Total	30	100.0

Among our patients in this study time taken for radiological healing was found to be 13 weeks in 7 patients, 14 weeks in 13 patients, 15 weeks in 9 patients and in 1 patient time taken for radiological healing was more than 15 weeks.

Table 2. Final constant score

Final Constant score	No. of cases	Percentage
Excellent	18	60%
Good	10	33.33%
Fair	2	6.66%
Total	30	100.0

In our study constant score was used for assessing shoulder function. It was observed that 18 patients had excellent score, 10 had good score and 2 had fair score.

Table 3. Final mayo score

Final Mayo score	No. of cases	%age
Excellent	17	56.66%
Good	11	36.66%
Fair	2	6.66%
Total	30	100.0

In our study Mayo score was used for assessing the elbow function. It was found that 17 patient had excellent score, 11 had good score and 2 had fair score.

Fig. 1. Pre operative x-ray

Fig. 2. Post operative x-ray

Fig. 3. Post operative xray 3 weeks

Fig. 4. Post operative xray 24 weeks

(a) extension at elbow

(b) flexion at elbow

(c) flexion at shoulder

(d) extension at shoulder

(e) abduction at shoulder

Fig. 5. Movements at shoulder and elbow

4. DISCUSSION

We observed in our series, majority of patients were in the fourth and fifth decade of life. This is in correlation in with other series [14,15]. However, sex ratio in our study was more towards male pre-ponderance as compared to the literature. This could be attributed to males being more prone to injury especially due to motor vehicular accidents as the use of two wheelers is more prevalent in this part of the world. This trend is also reflected in high 56.66% of patients having associated injuries in our series. In this study, most of our patients (80%), suffered from road side accident and in remaining patients (20%) mode of injury was fall. Concha et al analysed 35 patients with a fracture of the humeral diaphysis were treated using the MIPO technique and observed that the main cause of these 52 fractures are motor vehicular accidents, he pointed that there injuries can also be sustained by minor to moderate trauma in old people due to osteoporosis, their series also had injuries due to gunshot injuries. Shetty et al in

their series of observed Road traffic accident as the most common mode of injury followed by the fall on the outstretched hand [14,16]. The series corelates with literature as most of our patients had road side accident as mode of injury and some of our patient had fall as mode of injury. In this study more than half of the fractures were comminuted. Shetty et al in their series also reported comminution of approximately 75% of the fractures. Concha et al also in their study reported more than half of the fractures (51.42%) were communited [14,16]. The high number of comminuted humeral shaft fractures observed in our series is in correlation with literature and is attributed to high velocity motor vehicle accidents. Only 13 patients had isolated humeral shaft fracture, 11had associated fracture. There were 3 patients with associated head injury, 1 had blunt trauma chest and 2 patients had soft tissue injury foot. High incidence of associated injuries in our series is due to the fact that all our patients were cases of road traffic accident so associated injuries are common in road traffic accident. In this study, we observed union in all our patient with mean healing time of 14.13 weeks. There was no case of non union or delayed union in our study. Pospula et al reported union of all the fractures with mean healing time of 16.2 weeks [17]. There was no non union. Concha et al in their series with average follow up of 12 months union of 91% of fractures with mean healing time of 12 weeks [18]. The union rate in our series corroborates with the literature. All the fractures in our study were closed fractures. We didn't observe any deep or superficial infection. No incidence of infection in our study can be attributed to nature of injury (all closed fractures), strict aseptic conditions maintained in operating room, use of perioperative antibiotics and corroborate with literature.

In our study, functional outcome was analysed by studying shoulder and elbow function. 18 (60%) patients had excellent shoulder function, 10 (33.33%) had good shoulder function and 2 (6.66%) patients fair shoulder function. 17(56.66%) patients had excellent elbow function, 11(36.66%) patients had good elbow function, 2(6.66%) patients had fair elbow function. Shetty et al in their study reported 27 cases (84.3%) had excellent outcome and 5 cases (15.6%) had good shoulder function. With regard to elbow function, 26 cases (81.2%) had excellent outcome, 5 cases (15.6%) had good outcome, and 1 case (3.1%) (who also had an associated olecranon fracture that was fixed with tension band wiring) had fair outcome. Pospula et al in their study reported excellent results in 7 cases (53.8%) and good results in 5(41.6%) cases. twelve patients had excellent results of the elbow function. The results of this study corroborates with the contemporary literature relevant to humeral shaft fractures managed with minimally invasive percutaneous plate osteosynthesis, therefore MIPO/MIO is safe and more biological technique to treat humeral shaft fractures.

The study had limitation as it neither had randomization nor had a control group for comparison. Our Cohort is small in size. A large, randomized, controlled multi-centre study shall be necessary to make a meaningful conclusion.

5. CONCLUSION

MIPO/MIO of closed fracture of humerus gives good functional and cosmetic results and should be considered one of the management option in the treatment of humeral diaphyseal fracture. However,this is a complex technique, requiring a relatively long learning curve. However, the results are good and reproductive and there are few risks, The plate placement and indirect reduction requires experience.

ETHICAL APPROVAL AND CONSENT

Ethical clearance was obtained from institutional ethical committee and written consent was obtained from all the patients after explaining in detail the entire research protocol.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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