

Outcome of Humeral Shaft Fracture Treated with Anteromedial Plating through an Anterolateral Approach

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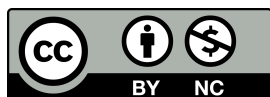
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ABSTRACT

Introduction: Humerus shaft fracture is a common injury representing 1.2-3% of all fractures. It can be managed both conservatively and operatively with various modalities. Among operative, plate osteosynthesis is the most widely accepted method of treatment when conservative treatment is not adequate to achieve union with good functional outcome. Anteromedial plating through anterolateral approach is a safe and reliable approach in plate osteosynthesis.

Methods: A prospective study was conducted in the Department of orthopaedics, Nepal APF hospital, Kathmandu from 2015 February to 2020 February. Forty-four patients who underwent anteromedial plating for humeral shaft fracture were included in the study. Patients were evaluated for functional recovery and progress of fracture healing. Rodriguez-Merchan criteria was used to grade the functional outcome.

Results: A total of 44 patients were included in the study with mean age of 36. There were 31 males and 13 females. The majority of patients 31 (70.45%) sustained injury due to road traffic accident followed by fall from height 11 (25%) and direct injury 2(4.55%). The most common fracture pattern was AO /OTA Type A. The mean duration of surgery was 60±15min. Fracture union occurred in less than 4 months in 36 patients (81.81%). Rodriguez Merchan criteria showed majority of the patients had excellent 23(52.27%) and good 15 (34.1%) functional outcomes.

Conclusion: Anteromedial plating provides a safe form of fixation of humeral shaft fracture. It has benefit of supine positioning of the patient during operation with good union rate, less fixation time, lesser complications leading to better functional outcome.

Keywords: Anteromedial; Humerus; Nailing; Plate Osteosynthesis.

INTRODUCTION

Humeral shaft fracture is a common orthopaedic trauma accounting for 1.2-3% of all cases of fractures.¹⁻³ The aim of treatment is to achieve union and to bring the patient to pre-injury status.^{4,5} Humeral shaft fracture can be managed conservatively and operatively with external fixation, nailing and plating.⁵⁻⁷ Among them, the plate osteosynthesis has been established as the gold standard.^{6,8-10} Humeral shaft is cylindrical shape extending from pectoralis major insertion proximally to supracondylar ridges distally with origin and insertion of several muscles consisting of anteromedial, anterolateral and posterior surfaces.^{6,7} Posterior plating offers biomechanical advantages as the plate is applied on the tensile side of the bone.^{11,12} In posterior approach radial nerve lies directly above the plate with chances of nerve

getting irritated or damaged and also the patient can not be kept in a supine position.^{7,13,14} Anterolateral plating allows supine positioning but still, the radial nerve lies closer to humeral shaft as the nerve traverses from posterior to anterior and is always in danger of being entrapped in the distal aspect of plate and anterolateral surface being curved and irregular, requires pre-bending of the plate to have adequate plate bone contact.^{12,13,15} Butterfly fragment usually on lateral surface makes reduction even more difficult in anterolateral plating.^{7,13,16} Anteromedial surface is relatively smooth where stable plate fixation can be done without pre-bending of the plate with good union rates and lesser complications through anterolateral approach.^{3,17} It has benefit of both supine positioning and radial nerve exploration if required.

METHODS

A prospective study was conducted in the Department of orthopaedics, Nepal APF hospital, Kathmandu from 2015 February to 2020 February. Forty-four patients who underwent antero-medial plating through anterolateral approach for humeral shaft fracture in the age group of 18 to 70 years were included in the study. Fracture shaft of humerus associated with ipsilateral injury in the same limb, patient with Gustilo Type B and Type C open fractures and those refusing to give consent were excluded from the study. After proper evaluation of the patient clinically and radiologically, patient were operated under general anaesthesia or regional anaesthesia i.e Brachial Plexus Block. Preoperative antibiotic was given 30 minutes before incision. Anterolateral approach was used in all cases.

After reaching the bone, the arm was externally rotated to have easy access to anteromedial surface for plate application. Post-operative radiographs were checked to know the adequacy of reduction and any iatrogenic complication. Post-operatively the limb was placed in an arm sling and elbow movements were allowed on the second post-operative day. Radiological union was defined as the presence of bridging callus in two planes (AP and Lateral). Union was defined as fracture healing within 4 months, delayed union as signs of union within 4–6 months of injury and nonunion as no signs of union after 6 months.¹⁸ Rodriguez–Merchan criteria was used to assess the final functional results.¹⁹

Patients were discharged after 1st dressing and follow ups were done on 2 weeks, 1 month, 4 months, 6 months and 1 year. Patients were evaluated for functional recovery and progress of fracture healing radiologically. Rodriguez–Merchan criteria was used to grade the functional outcome. Statistical analysis was done using SPSS version 17.0.

RESULTS

A total of 44 patients were included in the study, the majority of them were from age group 31-50 years with mean age of 36 (Table 1). There were 31 males and 13 females in the study. The majority of patient sustained injury due to road traffic accidents i.e 31 (70.45%) followed by fall from height i.e 11 (25%) and direct injury i.e 2 (4.55%). The most common fracture pattern was AO/OTA Type A (Table 2). The mean duration of surgery was 60±15min (Table 3). Fracture union occurred in less than 4 months in most of the cases (Table 4). Union is defined as presence of bridging callus in two

planes and no tenderness at the fracture site (Fig 1, Fig 2). Six patients showed delayed union and 2 patients had nonunion which required autologous iliac crest bone grafting. Six patients had radial nerve palsy preoperatively which recovered within 12 weeks postoperatively. Rodriguez Merchan criteria showed majority of patient had excellent, n=23 (52.27%) and good, n=15 (34.1%) functional outcome (Table 5).

Table 1: Age wise distribution

Age group (Years)	No of patients	Percentage (%)
18-30	13	29.55
31-50	25	56.81
50-70	6	13.64

Table 2: Type of fracture

OTA classification	Number	Percentage (%)
Type A		
A1	10	22.73
A2	10	22.73
A3	7	15.90
Type B		
B1	2	4.54
B2	8	18.18
B3	5	11.36
Type C		
C1	1	2.27
C2	1	2.27
C3	-	-
Total	44	

Table 3: Duration of Surgery

Duration of Surgery	No of patients	Percentage (%)
Less than 60 mins	26	59.09
More than 60 mins	18	40.91

Table 4: Time for Radiological Union

Time taken for union	No of patients	Percentage (%)
Less than 4 month	36	81.81
4-6 Months	6	13.64
Nonunion	2	4.55

Table 5: Rodriguez-Merchan Criteria

Rating	Number of Patients	Percentage (%)	Elbow range of movement	Shoulder range of movement	Pain	Disability
Excellent	23	52.27	Extension 5 degree Flexion 130 degree	Full range of movement	None	None
Good	15	34.1	Extension 15 Flexion 120	<10% loss of total range of movement	Occasional	Minimum
Fair	5	11.36	Extension 30 Flexion 110	10-30% loss of total range of movement	With activity	Moderate
Poor	1	2.27	Extension 40 Flexion 90	>30% loss of total range of movements	Variable	Severe

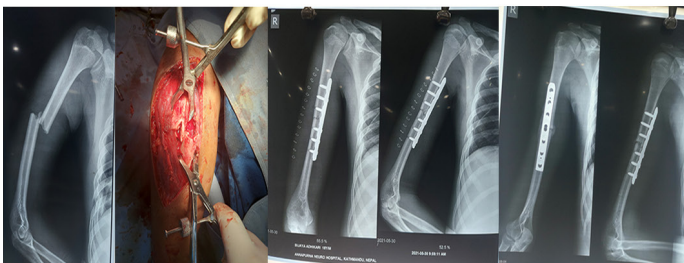


Figure 1: Fracture shaft of humerus(proximal half) and progress of union in anteromedial plating

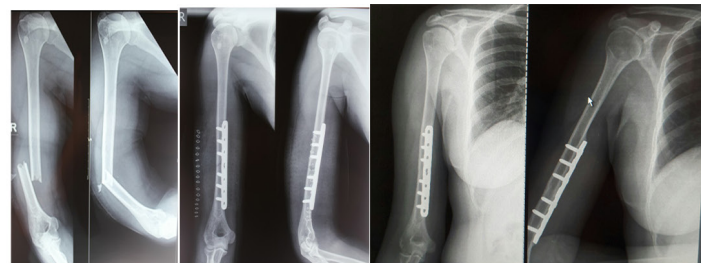


Figure 2: Fracture shaft of humerus (distal half) and progress of union in anteromedial plating

DISCUSSION

There are various modalities in treatment of shaft of humerus fractures, among which the well accepted surgical options are plating and intramedullary nailing.^{17,20} Denies et al. in his study compared plating with intramedullary nailing in ninety-one patients showed lower complication rate in plating and suggested plate osteosynthesis as primary treatment.²¹ The ideal treatment for humeral shaft fractures associated with radial nerve injury is still controversial.²² Approaching posteriorly, radial nerve has to be isolated and is always at risk of either direct or indirect injury. Anterolateral approach is widely accepted and is comfortable both for anaesthetist and in polytrauma patients and offers safe exposure as the radial nerve is not directly exposed.²³

Operating through anterolateral approach, the plate can be applied both anterolaterally and anteromedially with its own merits and demerits. Anterolateral plating can sometimes cause irritation to radial nerve distally as the nerve courses from posterior to anterior and also the anterolateral surface being rough, plate cannot be applied with adequate plate bone contact without prebending and also there can be medial distraction of fracture causing delayed union. Prebending hampers the locking property if locking compression plate is used and

there will be loose fixation strength.^{12,13,15} In anteromedial plating, radial nerve can be explored if required; as the medial surface is smooth, there will be more plate bone contact and locking compression plate can be applied without prebending. Most of the time communiton is also in the lateral side.^{3,7} Anteromedial surface has relatively less muscle attachments, with benefit of limited soft tissue dissection or stripping compared to anterolateral plating. Akan et al. found that anteromedial plating can markedly reduce the occurrence of iatrogenic radial nerve injury without increasing the incidence of the median nerve, brachial vein or ulnar nerve injury.²⁴ Ivan Kirin et al performed anterolateral and anteromedial plating through anterolateral approach and found no nerve injury and mean operative time was comparatively less in anteromedial plating. In our study also there was no iatrogenic nerve injury and the mean surgical time was comparable to Ivan Kirin et. al study.⁴ The plate should ideally be placed on tensile side either the anterolateral or posterior surface of the humerus but unlike the femur and tibia, whose primary stresses are weight-bearing, the non-weight bearing humerus is exposed to only low tensile stress, and usually the major stresses are rotational forces, therefore plate can be placed on the anteromedial aspect of the humerus.^{3,17,25} Mean duration of surgery in our study was 60±15 minutes, which was similar to study reported by Ivan et. al where

they did both anteromedial and anterolateral plate osteosynthesis by anterolateral approach and the mean operative time for anterolateral plating was 74.61 ± 10.74 min. and for anteromedial plating 55.45 ± 10.56 min, signifying that anteromedial humeral plating is less time consuming.⁴ Union was achieved in 36 cases in less than 4 months, 6 cases in 4 to 6 months and non union occurred in 2 cases for which bone grafting was done. The time needed for union was comparable to other studies, using anteromedial, anterolateral and posterior plating.^{5,17} A prospective randomized trial, published by Matsunaga et al. in 2017, provided level one evidence comparing functional bracing and bridge plating for humeral shaft fractures and showed that conservative treatment was associated with a significantly higher rate of nonunion and angular displacement than bridge plating.²⁶

Biomechanical and clinical studies have reported better results for anteromedial plating with regard to bone union and iatrogenic neurovascular injury.^{3,24} One retrospective study of 96 humeral fractures treated with anteromedial plating presented a union rate of 97%, even though 20% of the fractures included were open fractures.¹⁵ In contrast, Papasoulis et al. reviewed the literature in 2010 and stated that the union rate ranged from 77 to 100% after the conservative treatment of humeral shaft fractures with good functional results.²⁷

Six patients were having radial nerve palsy preoperatively which recovered on its own during post operative period. No post operative radial nerve palsy occurred in any patient. Most radial nerve injuries in humeral fractures are neuropraxia and much fewer are axonotmesis or neurotmesis.²⁸ Pre-operative radial nerve palsy in large proportion of cases shows spontaneous recovery, which signifies anterolateral approach with anteromedial plating is better alternative to posterior approach. Functional outcome with Rodriguez Merchan criteria in our study was excellent in 23 cases (52.27%), good in 15 cases (34.1%), fair in 5 cases (11.36%) and poor in 1 case (2.27%). The higher rate of excellent and good results in Rodriguez Merchan criteria with anteromedial plating was also reported in other studies.^{5,7} Patient who required bone grafting for union showed fair and poor rating in Rodriguez Criteria.

CONCLUSION

Anteromedial plate osteosynthesis using anterolateral approach provides a safe form of fixation of humeral shaft fracture. It allows supine positioning of the patient during operation with good union rate, less fixation time, lesser

complications and also protects the muscular insertions and the vascularity of the wedge fragment, leading to better functional outcomes.

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