Anteromedial plating for mid-shaft humeral fractures

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Received: 24 September 2019
Revised: 5 October 2019
Accepted: 14 October 2019
Published: 29 April 2021

The Egyptian Orthopaedic Journal 2019, 54:268–271

Background
Operative treatment of humeral shaft fractures includes plate osteosynthesis, intramedullary nailing, or external fixation. The present study aimed to evaluate functional and radiological results of fixation of mid-shaft humeral fractures through anteromedial plating.
Patients and methods
This prospective study was conducted on 21 patients with middle third humeral fractures treated through anteromedial plating. Patients were followed up monthly up to 9 months after surgery. Follow-up included radiograph imaging, pain during rest, the ability to perform ordinary activities, range of movement of elbow joint, and functional assessment using Murphy scoring system.
Results
The operative functional outcome was excellent in 14 (66.7%) patients, good in four (19.1%) patients, and fair in three (14.2%) patients. All patients returned to preoperative activity levels and achieved full range of movement. Eighteen (85.8%) fractures united 3 months postoperatively, whereas the remainder three patients achieved union within 6 months. Comparison between patients with various clinical outcomes revealed significant association between better outcome and younger age.
Conclusion
Anteromedial plating is an effective and safe option for humeral shaft fractures. Younger age is associated with better outcome.

Keywords:
anteromedial plating, humeral shaft fractures, humerus

Egypt Orthop J 54:268–271

1110-1148

Introduction

Humeral shaft fractures represent ~1–5% of all fractures. Conservative management continues to be the mainstay of treatment for isolated humeral shaft fractures with overall good results. However, nonsurgical management is associated with some morbidity and complications included nonunion, as high as 20% in some studies, malunion, and persistent radial nerve deficits [1,2].

Operative treatment is indicated in specific circumstances including open fractures, associated neurovascular injury, proximal and distal articular extension, patients with multiple injuries or polytrauma, floating elbow, progressive radial nerve deficits, significant soft tissue injury (unable to brace), pathologic fractures, and failed nonoperative management. Surgical management includes plate osteosynthesis, intramedullary nailing, or external fixation. Anterolateral plating and posterior plating are the gold standard for operative fixation of humeral shaft fractures. However, anterolateral approach has many shortcomings. These include difficult fixation particularly in wedge-shaped fractures, improper plate fixation due to lack of anatomical fitting with the curved and irregular lateral humeral surface, and importantly, the risk of radial nerve entrapment. In the posterior approach, the main disadvantage is the increased risk of radial nerve injury [3,4].

So, it was suggested that anteromedial plating with anterolateral approach for humeral shaft fractures can provide better radial nerve exploration, less chances of radial nerve injury, stable medial plate fixation due to less irregularities, and good union rates, with fewer complications. The present study aimed to evaluate functional and radiological results of fixation of mid-shaft humeral fractures through anteromedial plating.

Patients and methods

This prospective study was conducted between August 2017 and October 2018 at Tanta University Hospitals. The study protocol was approved by the local ethical committee in line with the recommendations of Helsinki declaration on clinical research involving

human participants. Informed consent was obtained from all patients before enrollment.

This study included 21 patients with middle third humeral fractures. Inclusion criteria were age more than 18 years old, recent fracture (within 2 weeks after trauma), closed or open fractures grade I, and floating elbow. Patients were excluded if they had preoperative radial nerve palsy, ununited fracture, open fractures grades II and III, and pathological fracture.

Preoperative management

On admission, all patients were subjected to history taking, clinical examination, and routine laboratory investigations. Plain radiograph (anteroposterior and lateral views) of the arm was done to detect level of fracture, type of fracture, extent of displacement, and angulation.

Operative technique

Patients were placed in the supine position on an operating table with the arm in abduction on arm board after induction of general anesthesia and the entire limb was prepared exposing both shoulder and elbow (Fig. 1). The humerus was approached by the standard Henry's approach. The incision was made along the lateral border of biceps with sufficient length to allow insertion of the plate. The space between biceps and brachialis was identified, and the musculocutaneous nerve was visualized and protected. The biceps was retracted medially, and the brachialis muscle was splitted longitudinally to expose the humerus. The arm was externally rotated to facilitate the visualization of the anteromedial surface of the humerus. Then, reduction of the fracture and plate fixation on the anteromedial surface were achieved. Final steps included wound hemostasis, wound closure, and drain insertion. Postoperatively, immediate radiograph was taken.

Postoperative care and follow-up

A pouch arm sling was used, and 2 days postoperatively, the suction was removed. The wound was inspected and sterile dressing was applied. Guarded active movements were encouraged from the third day to avoid elbow and shoulder stiffness keeping in mind the probable damage to soft tissue, either as result of trauma or owing to surgery and the security of fixation. Stitches were removed 2 weeks postoperatively.

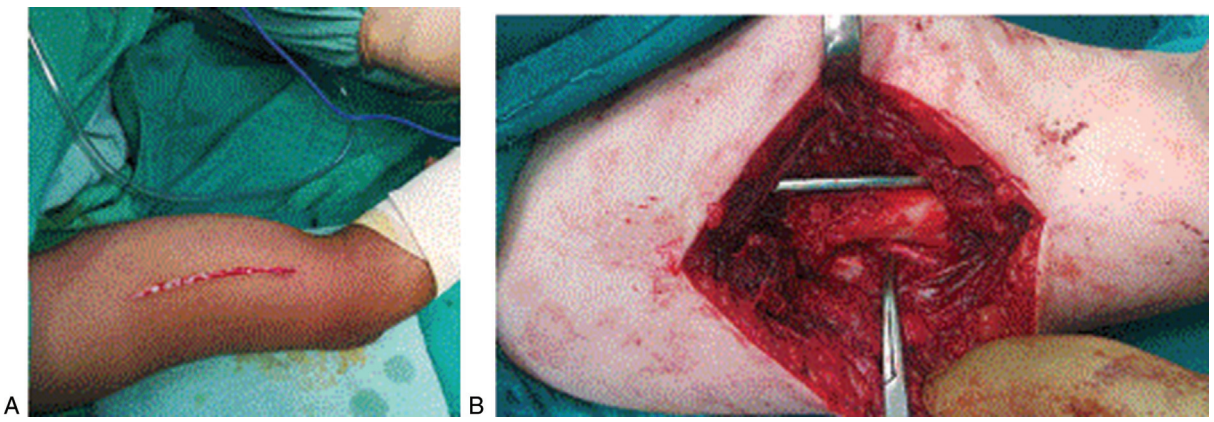
Patients were followed up monthly at least for 6 months after surgery. Follow-up included radiograph imaging, pain during rest, the ability to perform ordinary activities, range of movement of elbow joint, and functional assessment using Murphy scoring system [5]. Fracture union was graded as union, if occurred within 12–16 weeks; delayed union, if union occurred after 16 weeks; and nonunion, if union occurred after 24 weeks.

The obtained data were statistically analyzed using SPSS, version 20 (IBM, Chicago, Illinois, USA). Numerical data were expressed as mean±SD, whereas categorical data were expressed numbers and percent. Comparative statistics were achieved using Fisher exact test, χ^2 test, or t test as appropriate. P value less than 0.05 was considered statistically significant.

Results

The present study included 21 patients. They had an age of 35.0±12.4 years and comprised 16 (76.2%) males and five (23.8%) females. Other clinical data are shown

Figure 1



(a): Skin incision. (b) Exposure medial surface of the humerus and apply the palate which is fitted to the bone.

Table 1 Clinical data of the studied patients (*N*=21)

Age (years) mean±SD	35.0±12.4
Sex [*n* (%)]	
Male	16 (76.2)
Female	5 (23.8)
Affected side [*n* (%)]	
Right	11 (52.4)
Left	10 (47.6)
Associated morbidities [*n* (%)]	
Smoking	3 (14.2)
Obesity	3 (14.2)
DM	1 (4.7)
Work demand	
Low demanding	3 (14.2)
High demanding	18 (85.8)
Mechanism of injury [*n* (%)]	
MVA	6 (28.6)
FOOSH	6 (28.6)
Direct trauma	6 (28.6)
FFH	3 (14.2)
Fracture shape [*n* (%)]	
Transverse	8 (38.1)
Oblique	6 (28.6)
Spiral	6 (28.6)
Comminuted	1 (4.7)

DM, diabetes mellitus; FFH, fall from height; FOOSH, fall onto an outstretched hand; MVA, motor vehicle accident.

in Table 1. The operative functional outcome was excellent in 14 (66.7%) patients, good in four (19.1%) patients, and fair in three (14.2%) patients. All patients returned to preoperative activity levels and achieved full range of movement. Eighteen (85.8%) fractures united 3 months postoperatively, whereas the remainder three patients achieved union within 6 months (Table 2).

Comparison between patients with various clinical outcomes revealed significant association between better outcome and younger age (Table 3).

Discussion

This study included 21 patients with humeral shaft fractures operated with anterolateral approach and anteromedial plating. In this approach, there is guarantee of avoiding radial nerve injury with minimal soft tissue injury together with decreased risk of infection and early return to normal daily activities. Clinical results were graded as excellent in 14 (66.6%) patients, good in four (19%) patients and fair in three (14.3%) patients. Almost all (20) patients had no pain, and all patients developed full range elbow mobility and returned early to their normal daily activities. Fractures were united within 3 months in 18 (85.7%) patients and within 6 months fracture in three (14.3%) patients.

Table 2 Treatment outcome in the studied patients (*N*=21)

Murphy functional clinical score [n (%)]	
Excellent	14 (66.7)
Good	4 (19.1)
Fair	3 (14.2)
Poor	–
Postoperative pain [*n* (%)]	
No pain	20 (95.2)
Very mild pain with no medications needed	1 (4.8)
Full range of motion	21 (100.0)
Return to previous activity	21 (100.0)
Postoperative radiological assessment [*n* (%)]	
United fracture (3 months)	18 (85.8)
United fracture (6 months)	3 (14.2)

In line with these conclusions, Liskutin *et al.* [6] reported using this technique that an anatomic reduction and satisfactory clinical outcome were achieved. They concluded that anterolateral approach to the humerus offers excellent exposure to some humeral shaft fractures, particularly those that lie more proximally. Likewise, Kirin *et al.* [7] noted that an anteromedial plating of humeral shaft fractures through anterolateral approach was a simple, safe, effective, and also fast surgical treatment, and they highly recommended it as operative technique for treating humeral shaft fractures.

Moreover, Zheng *et al.* [8] in their study comparing the mechanical properties of anteromedial, anterolateral, and posterior plating for humeral shaft fractures, found that anteromedial plating was superior to anterolateral or posterior plating in almost all mechanical tests. In accordance with these results, Jawa *et al.* [9] concluded that using posterior approach was associated with high rate of persistent postoperative radial nerve palsy.

In support of our results, ElBassiouny and Elgohary *et al.* [10] concluded that lateral approach for the humerus is an excellent way for radial nerve exploration and for cases where lateral, anterior, and posterior surfaces of the humerus needed to be approached simultaneously. This approach allows supine positioning of the multiply injured patients and proper visualization of the radial nerve without muscle splitting; however, it does not allow exploration of the radial nerve in the proximal third of the humerus.

Moreover, Lu *et al.* [11] concluded that medial plating for the humerus had equivalent outcomes to anterolateral fixation. It is an available choice for humeral mid-shaft fracture fixation in cases where there is no need to expose the radial nerve. The medial plating does not require a prebent plate and creates a large operative exposure. A well-hidden

Table 3 Relation between treatment outcome and the clinical data

	Excellent (*N*=14)	Good (*N*=4)	Fair (*N*=3)	*P* value
Age (mean±SD)	28.6±9.3	44.3±5.9	52.7±1.2	< 0.001
Sex [*n* (%)]				
Male	11 (78.6)	3 (75.0)	2 (66.7)	0.91
Female	3 (21.4)	1 (25.0)	1 (33.3)	
Affected side [*n* (%)]				
Right	7 (50.0)	3 (75.0)	1 (33.3)	0.53
Left	7 (50.0)	1 (25.0)	2 (66.7)	
Associated morbidities [*n* (%)]				
Smoking	–	1 (25.0)	2 (66.7)	0.009
Obesity	1 (7.1)	1 (25.0)	1 (33.3)	0.4
Other	–	–	1 (33.3)	0.043
Work demand [*n* (%)]				
Low demanding	2 (14.3)	–	1 (33.3)	0.46
High demanding	12 (85.7)	4 (100.0)	2 (66.7)	
Mechanism of injury [*n* (%)]				
MVA	4 (28.6)	1 (25.0)	1 (33.3)	0.44
FOOSH	2 (14.3)	2 (50.0)	2 (66.7)	
Direct	5 (35.7)	1 (25.0)	–	
FFH	3 (21.4)	–	–	
Fracture shape [*n* (%)]				
Transverse	5 (35.7)	1 (25.0)	2 (66.7)	0.15
Oblique	4 (28.6)	2 (50.0)	–	
Spiral	5 (35.7)	1 (25.0)	–	
Comminuted	–	–	1 (33.3)	

FFH, fall from height; FOOSH, fall onto an outstretched hand; MVA, motor vehicle accident.

incision can also be designed, improving cosmetic outcomes.

Conclusion

Anteromedial plating is an effective and safe option for humeral shaft fractures. Younger age is associated with better outcome.

Financial support and sponsorship

Nil.

Conflicts of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. ICMJE forms for all authors are available online..

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