

# The effect of plate position on results of surgery in mid-shaft clavicular fractures in adults

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**The Egyptian Orthopedic Journal; 2019 supplement (2), December, 54: 12-16**

## Abstract

### Introduction

Mid-shaft clavicular fractures account for approximately 70-80% of all clavicular fractures. Despite the world wide acceptance of plating for displaced clavicular fracture, optimal plate position is still debated. This study is a prospective study to discuss the effect of plate position on the final end results of mid-shaft clavicular fractures in adults.

### Patients and Methods

Thirty patients with displaced mid-shaft clavicular fracture operated by open reduction and internal fixation with plate and screws during the period from January 2015 to January 2018. In 16 patients, the plate was applied in the antero-superior surface of the clavicle (group A) while in 14 patients the plate was applied in the antero-inferior surface (group B). The follow up period ranged from 9 to 24 months with a mean of 16.4 months.

### Results

Fifteen patients in group B had satisfactory final results. However, five patients in group A had unsatisfactory final results. The average final shoulder score for the antero-inferior plating was 88.0625 while the final score for antero-superior plating was 77.2857. The difference between the two groups was found to be statistically significant. Three patients complained of hardware prominence in the group A that one of them required removal after two years of surgery. This complication in the antero-inferior plate group.

### Conclusion

Antero-inferior plating of the displaced diaphyseal clavicular fracture is a reliable and safe method of fixation with few complications and high patient satisfaction.

### Key words

clavicular fractures, middle third, adults, fixation, anterosuperior and anteroinferior plating.

## Introduction

Clavicular fractures represent 3-5 % of all fractures of the body [1]. Mid-shaft clavicular fractures account for approximately 70-80% of all clavicular fractures. Distal clavicular fractures are the next most common, accounting for 15-20% of clavicular fractures, and medial third fractures are the least common, making up 5-10% of injury [2,3]. The first reporters on treatment of clavicular fractures were the Ancient Egyptians[4]. Although most middle-third clavicular fractures unit with conservative treatment, many require surgical intervention. Indications for surgery include: more than 2 cm of clavicular shortening, severe displacement, and severe comminution [5,6]. A number of authors have reported good results after plate fixation of clavicular fractures with the optimal restoration of shoulder stability and function of the patient and decreased rate of malunion and non-union [7-9].

Despite the world wide acceptance of plating for dis-

placed clavicular fracture, optimal plate position is still debated. Jupiter [10] and Belaji et al [11] suggested that superior plating was biomechanically better than antero-inferior plating because the superior aspect of the clavicle was the load-bearing side. On the other hand, Kloen et al [12] and Glide AK [13] recommended plating on the anterior-inferior side because it functions as an inferior buttress, especially under the lateral osteopenic bone, allowing the better medial fixation to support the construct without the risk of screw pull-out of the lateral fragment.

This study was a prospective study to discuss the effect of plate position on the final end results of mid-shaft clavicular fractures in adults.

## Patients and methods

The material of this study includes 30 patients with displaced mid-shaft clavicular fracture operated by

open reduction and internal fixation with plate and screws during the period from January 2015 to January 2018 at Kafr El-Shiekh University Hospital, Egypt. There were 12 females and 18 males. Their age ranged from 18 years to 55 years with a mean of 34 years. The dominant side was affected in 16 patients.

The fracture type was determined according to Neer

modification of Allman classification [14] into 22 fractures of diaphyseal non comminuted type, 6 fractures of diaphyseal wedge type and 2 fractures of diaphyseal segmental type. In 21 patients the fracture was isolated while in 9 patients the fracture was present in polytrauma patient. **Table (1)** shows the distribution of the preoperative data and follow up period in the antero-superior plate group (group A) and in the antero-inferior plate group (group B).

**Table 1:** Shows the preoperative data and follow up period. Group A: antero-superior group  
Group B: antero-inferior group

Preoperative data	Group A	Group B
<b>Mean age</b>	36 (range 18-54)	35 (range 20-55)
<b>Sex</b>		
<i>Males</i>		9
<i>Females</i>	9	7
	5	
<b>Side affected</b>		
<i>Right side</i>		10
<i>Left side</i>	6	6
	8	
<b>Mechanism of injury</b>		13
<i>Motor vehicle accident</i>	11	3
<i>Others</i>	3	
<b>Fracture type</b>		
<i>Diaphyseal noncom.</i>		12
<i>Diaphyseal wedge</i>	10	3
<i>Diaphyseal segmental</i>	3	1
	1	
<b>Mean follow up period (months)</b>	17 ms. (range 10-24)	16 ms. (range 9-24)

The indications for open reduction and internal fixation of mid-shaft clavicular fracture in this study include shortening of more than 20 mm, impending skin disruption with displaced fracture, and polytrauma patient. The surgical interference was performed between 5 to 10 days after the injury. Seventeen patients were operated within 5 days from the injury while 13 patients were operated after 5 days from the injury. The delay in the interference was related mostly to the associated life threatening non-orthopedic injuries.

General anesthesia was given in all patients. The patients were positioned in supine or beach chair position. The skin incision is made over the clavicle and centered over the fracture after identification of the proximal and distal ends of the clavicle. Open reduction followed by plate fixation were performed with the application of the plate in antero-superior position in 14 patients (group A) and in antero-inferior position in 16 patients (group B). A well contoured reconstruction plate was used. The plates used are 6 to 8 holes with at least three screws or more on each side

of the fracture. (**Fig 1,2**)



**Figure 1: Anterosuperior plating** Right Mid clavicular fracture clavicle surgically fixed with anterosuperior reconstruction 3.5 plate



**Figure 2: Anteroinferior plating** Left Mid-clavicular fracture clavicle surgically fixed with anteroinferior reconstruction 3.5 plate

The follow-up period ranged from 12 to 24 months with a mean of 16.4 months. All patients were followed up clinically and radiologically. Patients were discharged with their arm immobilized in a sling or shoulder immobilizer. After 2 weeks the sutures were removed and motion of the elbow with gradual shoulder motion were encouraged to improve function and to restore patient independence. The results were assessed clinically according to Constant and Murley Scoring (CMS) [15]. This scoring system combine subjective and objective items in the assessment of shoulder function.

The data of this study were statistically analyzed using Arithmetic mean or average (X), Standard deviation (S.D) and T Test with significant value when  $P < 0.05$ .

## Results

The overall result at end of follow up period, according to Constant and Murley Shoulder score in both groups was 83.367 (SD = 10.0155) ranging from 56 to 96. There were 9 patients with excellent results, 15 patients with good results, three patients with fair results, and three patients with poor results.

Patients operated within 5 days after injury gave more satisfactory results (15 out of 17) than patients operated after 5 days (9 out of 13) however the difference was found to be statistically insignificant ( $P = 0.15472$ ). The mean hospital stay for group B was 4 days (ranged from one to 7 days) while the average hospital stay for group A was 5 days (ranged from 2 to 7 days). The difference was found to be statistically insignificant ( $P = 0.13529$ ).

In group A, Superior plates were used in 14 patients

while in group B, antero-inferior plates were used in 16 patients. Fifteen patients in group B had satisfactory excellent or good final results and one patient had poor final result while five patients in group B had unsatisfactory results. The average final shoulder score for the patients in group B was 88.0625 while the final score for the patients in group A was 77.2857. The difference between the two groups was found to be statistically significant ( $P = 0.00479$ ). Table (2) shows the distribution of clinical results, union and postoperative data in the two groups.

**Table 2:** Shows the clinical results, union and postoperative data. Group A: antero-superior group Group B: antero-inferior group

Clinical results	Group A	Group B	P Value
<b>Mean Shoulder score</b>	77	88	0.004
<b>Shoulder score No (%)</b>			
> 90 (excellent)	4 (28.6%)	5 (31.25%)	
70-90	5 (35.7%)	10 (62.5%)	
>70	5 (35.7%)	1 (6.25%)	
<b>Mean union time (w.)</b>	16.6 weeks	15 weeks	0.127
<b>Mean surgical time</b>	65 minutes	50 minutes	0.15
<b>Mean hospital stay</b>	5 days	4 days	0.135
<b>Complications (total)</b>	4	1	
Superficial infection	1	1	
Hardware prominence	3	0	

Union occurred in all patients who had attended the final follow up. The time of union ranged from 12 weeks to 20 weeks with an average of 15.7 weeks  $\pm$  2.8 weeks. The mean union time in group A was 16.6 weeks, while the mean union time in group B was 15 weeks. The difference was found to be statistically insignificant ( $P = 0.12774$ ).

The operative time for group A was between 40 to 60 minutes with a mean of 50 minutes, while the surgical time for group B was between 45 to 75 minutes with a mean of 65 minutes. The difference was found to be statistically insignificant ( $P = 0.15056$ ).

The complications met within this study were three patients complained of hardware prominence of antero-superior plates that one of them required removal two years after surgery.

## Discussion

Good results with excellent union and low complication rates were seen in numerous studies done on primary fixation of clavicle fractures opposing the disbelief that surrounded previous studies where a poor understanding of soft tissue manipulation, selection of patients and inadequate implants combined to produce inferior results [16,17].

Displaced fractures of the middle third of the clavicle cannot be treated the same way as un-displaced fractures because the deforming pull of muscles is too great and that the deformity recurs shortly after use of figure of eight bandage [18-21].

A number of authors have reported good results after plate fixation of mid-shaft clavicular fractures [4-9]. Plate fixation provides immediate stabilization of the fracture, pain relief, allows early mobilization and early return to previous activities. A multicenter trial conducted by Canadian Orthopedic Trauma Society on 111 patients showed good overall shoulder function, rapid decrease in pain with lower non-union and malunion rates, and a shorter overall time to union in clavicle fractures treated with plating [17].

Liu et al [22] concluded that operative treatment is better than non-operative treatment, but decisions should be made in accordance with specific conditions for clinical application. Thompson [23] reviewed 100 mid third clavicular non-unions and found that 90% of the original fractures had displacement >100%, over riding >1 cm or had severe comminution, thus necessitating surgical stabilization.

Modern plate fixation techniques provide reliable healing rates. However, optimal plate position, size, and type remain controversial.

Jupiter [10] and Bellaji [11] suggested that superior plating was biomechanically better than antero-inferior plating because the superior aspect of the clavicle was the load-bearing side (loaded in tension), and the fracture fragments are usually compressed. Also, Celestre et al [24]; in their biomechanical study; found that treating a midshaft clavicle fracture with a superior plate was more favorable compared to anterior-inferior plating in terms of both load to failure and bending failure stiffness.

However, on the other hand biomechanical studies by Paratal et al [25] and Drosdowech DS et al [26] showed that no significant difference was found in axial or torsional stiffness between the two plate positions but when the plate was placed antero-inferiorly, bending rigidity was significantly higher ( $P < 0.001$ ) than in the superior position. They also concluded that placing the plate antero-inferiorly on the clavicle provides a more stable construct in terms of bending rigidity with no detriment in axial and torsional stiffness compared with placing the plate superiorly.

Kloen et al [12] found that antero-inferior plating is a reliable and safe technique that leads to high rates of bony union in midshaft clavicular nonunion. Also, Collinge et al [27] found that anterior-inferior plating

of acute middle-third fractures of the clavicle and clavicular nonunion using a plate and lag screws typically results in early healing, few complications and an excellent return of function. The other advantages of antero-inferior clavicular plate are avoidance of neurovascular compromise, the use of longer screws, and decreased hardware prominence [20].

In the present study; the antero-inferior plating clavicular plating (group B) give better final clinical results (fifteen out of sixteen patients) than antero-superior clavicular plating (group A) (nine out of fourteen patients). The average final shoulder score for the antero-inferior plating was 88.0625 while the final score for antero-superior plating was 77.2857. The difference was found to be statistically significant ( $p = 0.004789$ ).

Union occurred in all patients with the mean union time in antero-superior plate group of 16.6 weeks, while the mean union time in antero-inferior plate group was 15 months. The mean surgical time with the antero-inferior plate position was more than that of antero-superior position however the difference was statistically insignificant ( $p = 0.150563$ ).

While there is increased interest in treating clavicle fractures operatively, it is imperative to remember that most fractures can be treated non-operatively and the pattern of clavicle fracture management should be individualized to the patient. Operative treatment is beneficial to a subset of patients where surgery rapidly restores anatomy and provides stable fixation facilitating early mobilization.

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## Conclusion

Antero-inferior plating of the displaced diaphyseal clavicular fracture is a reliable and safe method of fixation with few complications and high patient satisfaction.

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