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ORIGINAL ARTICLE

What is the hardware removal rate after anteroinferior plating of the clavicle? A retrospective cohort study

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Background: Plate position in the operative treatment of displaced midshaft clavicle fractures or nonunions is most often on the superior side. However, superior clavicular plating often results in complaints of plate prominence and local soft tissue irritation, necessitating hardware removal. We have used anteroinferior placement of the plate in the hope of increasing biomechanical stability and fixation and also of lowering complaints of plate prominence and soft tissue irritation. In this report, we set out to study the percentage of hardware removal in our group of patients treated with anteroinferior plating of the clavicle after long-term follow-up.

Methods: In this retrospective review, we evaluated all patients who were surgically treated with anteroinferior plating for midshaft clavicle fracture, delayed union, or nonunion by the senior author between February 2003 and July 2015. Patients required a minimum age of 16 years at time of surgery and a follow-up of >12 months. Patients with malunion, plating on the superior aspect, or double plating were excluded.

Results: The medical records of 53 patients (54 fractures) were reviewed after a mean follow-up duration of 6.4 years (range, 1.1-13.1). The mean age at follow-up was 47.8 years (range, 20.4-80.7). All fractures and nonunions healed. In only 3 cases (5.6%), hardware removal was requested by the patient because of plate prominence.

Conclusions: Anteroinferior plating of midshaft clavicle fractures, delayed unions, and nonunions resulted in low hardware removal rates in our cohort.

Level of evidence: Level IV; Case Series; Treatment Study

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Keywords: Clavicle; midshaft; plate fixation; anteroinferior plating; hardware removal; irritation

Clavicle fractures are among the most common injuries of the upper limb.¹⁸ Mechanism of injury is most frequently

a fall on the shoulder as a result of athletic activities (eg, cycling).²⁸ The incidence of clavicle fractures in adults ranges from 29 to 64 per 100,000 persons annually.^{26,27} Most involve the midshaft (81%) and heal without operative treatment.³⁰

There is a recent trend toward surgical treatment for acute (displaced) midshaft fractures as during the past decade, research has challenged the nonunion rates reported historically by Neer²⁶ and Rowe.³⁵ Approximately 0% to 12% of

Institutional Review Board or Ethical Committee approval was not required because of the retrospective design of this study.

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surgically treated fractures and 0.1% to 5.9% of conservatively treated fractures are affected by nonunion.^{45,47}

Various surgical clavicle plating techniques have been described.^{22,46} Good results have been reported after plate fixation on the superior aspect of the clavicle.^{6,8,9,17} However, plating on the superior aspect of the clavicle is associated with prominence and soft tissue irritation, often necessitating hardware removal. Therefore, based on an original idea of Jeffrey Mast, Helfet and colleagues introduced anteroinferior plating.²⁰ The proposed benefits of this technique include decreased prominence, longer screw purchase, lower risk of neurovascular injury, increased biomechanical strength, and beneficial residual hole orientation.^{15,21} Others have since reported on anteroinferior plating of the clavicle.^{4,19,42} More recently, plate size has decreased from 3.5 mm to 2.7 mm for superior as well as for anteroinferior plating.

Hardware removal rates of up to 60.1% to 62.7% for superior plating and 36% for anteroinferior plating have been reported.^{13,37,44} However, in our experience, plate removal after anteroinferior plating is rare. To provide a more realistic hardware removal rate after anteroinferior plating, additional long-term outcome data are essential. The purpose of this study was therefore to describe the long-term hardware removal rate after anteroinferior plating of the clavicle.

Materials and methods

We performed a retrospective review of a consecutive series of patients who underwent anteroinferior clavicle plating for a dis-

placed midshaft clavicle fracture or a midshaft clavicle delayed union or nonunion. Between February 2003 and July 2015, 90 patients with clavicle fractures, delayed unions, or nonunions were surgically treated at the Academic Medical Center by the senior author (P.K.). Of these patients, 53 met our inclusion criteria (Fig. 1). At follow-up, the medical records of included patients were reviewed for complications and reoperations.

Inclusion criteria

Patients were eligible for this retrospective cohort study if surgery was indicated for a midshaft clavicle fracture or delayed union or nonunion of the midshaft clavicle. Only patients at least 16 years of age at time of surgery were included. In addition, patients required a minimum follow-up duration of 12 months. Patients with malunion or with plating on the superior aspect or double plating were excluded. The fracture healing classification of the clavicle was based on the U.S. Food and Drug Administration definition and Perkins timetable.^{1,25} A delayed union was defined as a fracture that had not healed within 4 months of injury. A nonunion was defined as a fracture that had not completely healed within 9 months of injury and that failed to show progression toward healing during 3 consecutive months on serial radiographs. Prior to surgery, a conventional radiographic projection was obtained to confirm the diagnosis. In case of inconclusive radiographic images, a computed tomography scan was performed.

Surgical technique

All fractures were treated with anteroinferior plate fixation by a fellowship-trained orthopedic trauma surgeon. General anesthesia

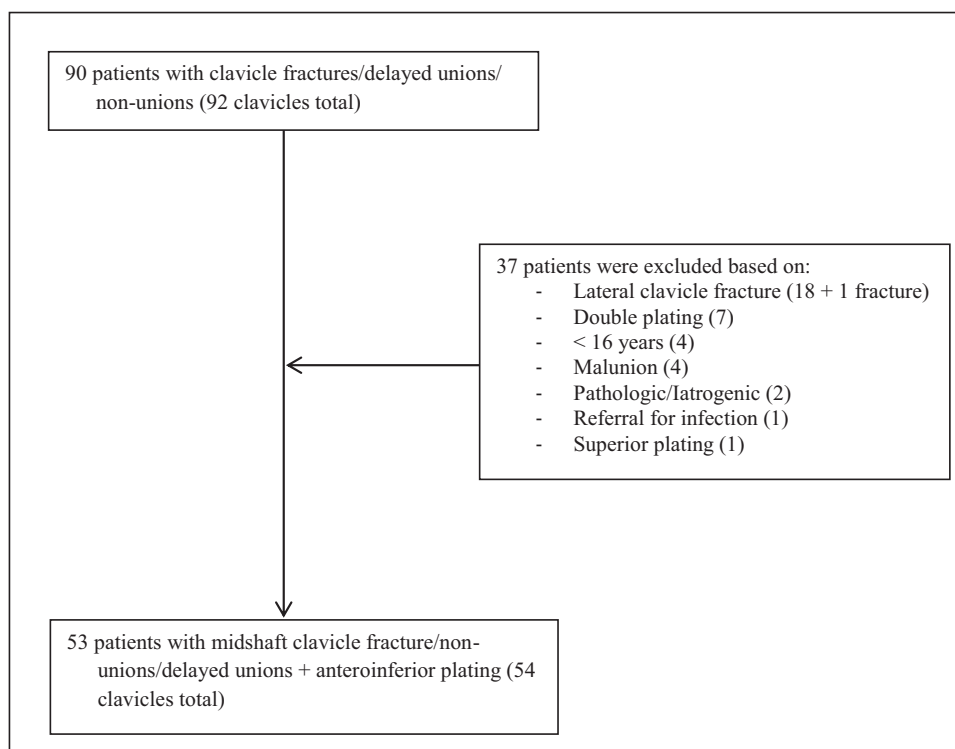


Figure 1 Selection of patients.

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