Surgical treatment of acute displaced midshaft clavicular fractures with plates

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Received 01 January 2013
Accepted 02 February 2013

Egyptian Orthopedic Journal 2015, 50:144–147

Background
Plate fixation of acute displaced midshaft clavicular fractures has been shown to decrease nonunion, symptomatic malunion, and residual shoulder disability compared with nonoperative treatment.

Materials and methods
Our study included 16 patients with acute displaced midshaft clavicular fractures who were treated with open reduction, and internal fixation with 3.5 mm reconstruction plates in 14 patients and small dynamic compression plates (DCP) in two patients.

Results
Our series included 16 patients, all the fractures achieved union with no complications.

Conclusion
Plate fixation of displaced clavicle fractures is a safe procedure resulting in excellent functional outcomes, with an early return to the normal activities.

Keywords:
clavicular shaft fracture, plate fixation, internal fixation

Egypt Orthop J 50:144–147

1110-1148

Introduction

Clavicle fractures are common injuries and account for ~2.6–5% of all the fractures in adults [1,2]. Middle-third fractures are the most common type (80%). The latter are displaced in 48% of the cases and comminuted in 19% [1,2]. The most common mechanism for a clavicular fracture is a fall onto the ipsilateral shoulder, making athletes particularly prone to this injury [3]. Traditionally, nonsurgical management has been favored as the treatment for most clavicular fractures [4,5]. However, recent evidence has emerged indicating that operative fixation presents lower nonunion rates, better functional outcomes, improved cosmesis, and greater patient satisfaction compared with closed treatment. Several recent prospective randomized clinical trials that compared nonoperative treatment with open reduction and internal fixation with plate fixation showed that operative treatment improved functional outcomes and significantly decreased the incidence of long-term complications such as nonunion and symptomatic malunion [6–9]. Consequently, there has been a trend in the past few years to increase operative treatment. As this injury usually affects young, active patients, the objective of the treatment is to obtain early union and subsequently a rapid return to prior function. Favourable results with surgical treatment for middle-third clavicular fractures have been reported [7,9,10].

Functional outcome of midshaft clavicle fractures is not only related to its union but also to its length [11]. Clavicle acts as a 'strut' that keeps the upper limb away from torso for efficient shoulder and upper limb function, while also transmitting forces from upper limb to the trunk. Thus, displaced or comminuted fractures carry risk of symptomatic malunion, nonunion, and poor functional outcome with cosmetic deformity [12,13]. The recent trend is shifting towards internal fixation of these displaced midshaft clavicle fractures.

Materials and methods

Sixteen unilateral acute displaced midshaft clavicular fractures, operated between August 2010 and December 2013, included in this study were treated primarily by plate and screw. Adults (age between 18 and 50 years) had post-traumatic middle shaft clavicular fractures. There were 13 men (81.25%) and three women (18.75%); there were nine (56.25%) right side fractures and seven (43.75%) left side fractures. In regard to the mechanism of injuries, there were six cases (37.5%) of sport injuries, four (25%) cases of motorcycle accidents, one case (6.25%) of car accident, and five cases (31.25%) of falling. According to AO/OTA classification there were 10 B1 type (62.5%) and six B2 bending wedge fractures with a

third fragment (37.5%); 14 cases (87.5%) were treated by reconstruction plate and two cases (12.5%) by small DCP (Table 1). This study approved by the Ethical committee of Al-Azhar University, Damietta, Egypt.

Our exclusion criteria: open fractures, pathological fractures, fractures more than 7 days, and fractures associated with neurovascular injury. Radiographic examination was performed. Radiography of the chest was routinely done to detect fractures of ribs or pneumothorax.

Operative procedures

For surgical interventions patients were placed in the beach-chair 'semi-sitting' position. Involved shoulders were prepared and draped free. Before surgery, 1 g of cefazolin sodium was given as antibiotic prophylaxis. Incision was made transversally just under the fracture site. Supra clavicular nerve were identified and spared wherever possible; soft tissue was kept to a minimum. After reduction with bone-fixation clamps, the reduction was checked in two separate planes with fluoroscopy and fixed with a plate. Bone grafting was not performed. During drilling, the soft tissue around the clavicle was displaced and a blunt elevator was placed under the clavicle periosteum from the medial and lateral window to prevent neurovascular damage. After reduction of fractures, the plate was fixed on the anterosuperior surface of the bone, starting medially using biocortical screw. The fascia and the skin were closed in layers.

Postoperative rehabilitation protocol consisted of arm sling during the first 2 postoperative weeks, with sling removal four times a day to perform pendulum exercises. Patients were not allowed to elevate the surgical arm above 90° in any plane during the first 3 weeks and were told to avoid lifting heavy weights for the first 6 weeks. After week 8, full shoulder active range of motion in all planes was allowed, with increase in intensity of strength and functional training for gradual return to activities and sports.

Table 1 Demographic and fracture-related characteristics

Variables	
Total number (*n*)	16
Sex [*n* (%)]	
Male	13 (81.25)
Female	3 (18.75)
Involved side [*n* (%)]	
Right	9 (56.25)
Left	7 (43.75)
Mechanism of injuries [*n* (%)]	
Sports	6 (37.5)
Motorcycle	4 (25)
Car accident	1 (6.25)
Fall	5 (31.25)
AO/OTA classification [*n* (%)]	
B1	10 (62.5)
B2	6 (37.5)
Type of plate [*n* (%)]	
Reconstruction plate	14 (87.5)
Small DCP	2 (12.5)

Results

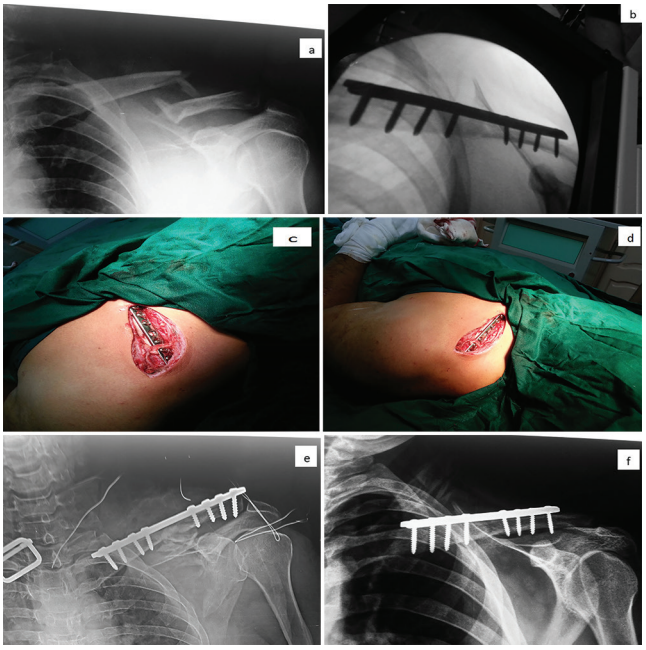
Clinical and radiological union was observed in all patients after an average of 14 (range 9–21) weeks. No implant failures, or deep infections or iatrogenic neurovascular damage were observed in any patient. After bone healing, all patients had a normal range of motion. Clinical and radiological evaluation was performed during follow-up in the first month weekly and then monthly until fracture consolidation was reached. Radiological evaluation consisted of frontal clavicle radiograph and a 45° up-tilted anteroposterior radiograph. Fracture consolidation was evaluated through clinical examination and through radiological analysis (looking for at least three consolidated corticals in two incidences).

Functional outcome was evaluated using the Constant score [14] and the short version of the Disabilities of the Arm, Shoulder, and Hand (quick DASH) score [15]. DASH scoring system measures the clinical outcome using a 30-item questionnaire: seven items on symptoms (pain, tingling), two items on social impact and 21 items on impact on daily functions; 0 (best function) to 100 (worst). A low score indicated a low degree of disability. The patient had to fill in 27/30 of the questions. Thirteen patients showed excellent results (0–15) and three patients showed good results (15–30). The main duration follow-up ranged from 5 to 17 months (mean 11 months).

Discussion

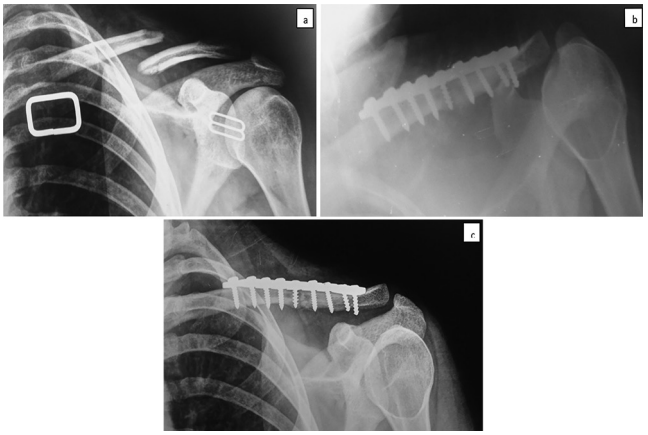
Traditional mid-diaphyseal clavicle fractures are treated using conservative methods. Neer [16] and Rowe [17] reported nonunion rates with conservative treatment of as low as 0.13 and 0.8%, respectively. However, both studies were limited due to the lack of functional outcomes and the pediatric age of the majority of patients. Previous studies have reported nonunion rates ranging between 5.9 and 15% in adult patients with mid-diaphyseal clavicle fractures treated by conservative methods [18]. All prospective comparative studies that compared surgical and conservative treatment in displaced mid-diaphyseal clavicle fractures have reported high functional

Figure 1



(a) Preoperative radiograph of a midshaft fracture of the left clavicle. (b) Radiographic image intensfier after fixation. (c, d) Intraoperative photo after fixation with preserved supraclavicular nerve. (e) Postoperative radiograph. (f) Last follow-up radiograph.

Figure 2

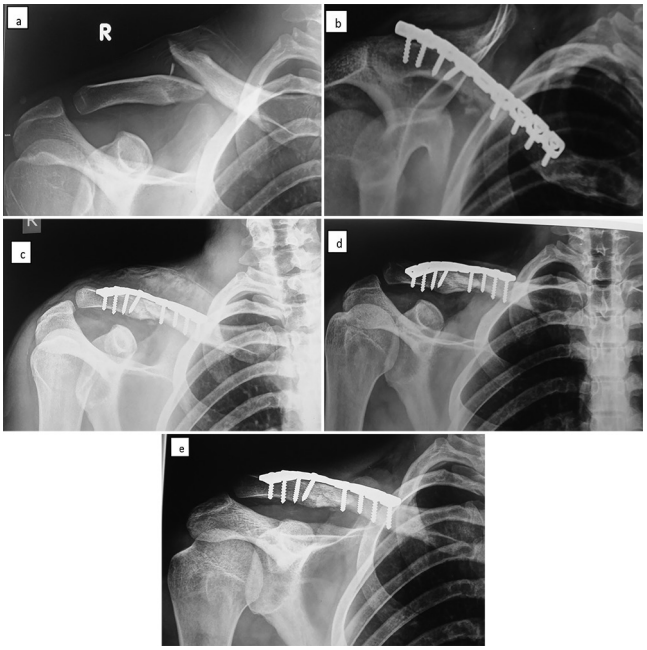


(a) Preoperative radiograph of displaced left midshaft clavicular fracture. (b) 3 months postoperative radiograph. (c) 6 months postoperative radiograph with achieved union.

outcomes, low nonunion rates, reduced pain, early mobilization and increased patient satisfaction in the surgical groups [18]. Potential infections, plate braking, vascular damage, pneumothorax and surgical scar formation have been reported as disadvantages of surgical treatment. Zlowodzki *et al.* [19] reported complication rates after plating in displaced acute midshaft clavicle fractures of 2.2% nonunion, 4.6% infection, and 2% fixation failure. Schiffer *et al.* [20] reported implant failure and refracture after implant removal in ~10% of cases. In the current study, no patient had neurovascular damage, pneumothorax or nonunion or developed superficial or deep infection.

Fixation by plate and screw is always an acceptable choice but has some disadvantages such as the need for wider exposure and periosteal striping which can disturb the blood supply and healing process also; removal of hardware leads to an increasing risk of refracture due to osteoporosis and stress riser after screw removal but less is serious than pin migration with injury of vital organs that can develop from intramedullary fixation. In consideration of plate fixation methods, the shape and location of the plate have been debated. Reconstruction plates, dynamic compression plates and locking compression plates are among the options. It has been reported that while reconstruction plates are better adapted to the clavicle by giving them shapes, these plates offered less stability. In a biomechanical study comparing dynamic compression plates and locking compression plates, it was found that locking plates were more stable compared with dynamic compression plates against cyclic, torsional and twisting forces. Anatomical locking plates are less likely to require extraction because they are more stable and less evident subcutaneously postunion [21]. In our series, fixation by plate and screw was carried out in all cases. In our series, I used nonlocked reconstruction plate in 14 cases and small DCP in two cases; reconstruction plate is easily contoured to adapt the curvature of the clavicle and give a better fixation and I used small DCP in two cases but it is difficult to contour, to adapt the curvature of the clavicle and it is more prominent under the skin but gives rigid fixation. In this study, I used the superior surface as a side of fixation; some authors have recommended that the clavicle plate be placed interiorly and it is possible that this might decrease the incidence of symptomatic hardware removal because of plate prominence or serious complications because of injury of vital structures [22] but I found that the majority in our patients had larger superior clavicle surface that was most amenable to satisfactory plate placement and there was no injury of the lung pleura or vascular structures with slow speed drilling. In addition, it was found that the superior placement was biomechanically more stable than the anterior plate placement [23]. There is an increasing trend towards stabilization and fixation of markedly displaced midshaft clavicle fractures. Recent studies have shown a greater prevalence of symptomatic malunion, nonunion, and poor function outcomes after nonsurgical management of displaced fractures. Fixation of displaced midshaft clavicle fracture can restore length and alignment, resulting in short time to union [24] (Figs. 1–3).

Figure 3



(a) Preoperative radiograph of displaced right midshaft clavicular fracture. (b) 1 month postoperative. (c) 2 months postoperative. (d) 4 months postoperative. (e) The last follow-up radiograph with complete union.

Conclusion

Surgical treatment of acute displaced midshaft clavicular fractures by open reduction and internal fixation by plate is a safe procedure resulting in excellent function outcomes with an early return to normal activities.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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