Reduction and internal fixation for acute midshaft clavicular fractures by mini-incision using cannulated screws

Mahmoud A. Mahran, Elhussein M. Elmoatasem, Mohamed A. ElGebeily

From the Department of Orthopaedics, Hospital of Ain shams University, Cairo, Egypt

Open reduction and internal fixation of fracture clavicle has typically been done by variable types of plates. Plates carry the disadvantages of longer incisions, prominence of the plates and wound complications. The purpose of this study is to present an alternative surgical technique for acute midshaft clavicular fracture using cannulated 6.5 screws with minimal incision over the fracture site. Twenty seven adult patients with acute midshaft clavicular fractures were surgically treated with mini open technique using 6.5mm cannulated screws. The modified shoulder rating scale by Chuang was used for outcome evaluation. Union occurred in a mean of 8.3 weeks range 6-12 weeks. Restoration of clavicular length was achieved in all cases. Twenty-four patients experienced no pain on all activity at latest follow-up. All patients expressed their willingness to have the surgery again should they have the same problem. One patient stated that she would not have the surgery again. Conclusion : reduction and internal fixation with a cannulated screw is an alternative economic technique for the treatment of acute midshaft clavicular fractures that is useful in selected cases where surgery is indicated.

Keywords : midshaft fracture clavicle ; internal fixation ; cannulated screws ; mini-incision.

INTRODUCTION

Although there is uniform consensus regarding non-operative treatment of undisplaced midshaft clavicle fractures, the optimal treatment option for isolated acute displaced midshaft clavicle fractures remains controversial (*15-17*). The classic literature suggested that the nonunion rate for clavicle fractures was under 1% and that very few patients had long-term functional deficits related to the fracture (*10,16,17*). However, more recent studies of non-operative treatment of displaced midshaft clavicle fractures have demonstrated nonunion rates of 13% to 15% and a 20% to 25% decrease in shoulder and arm strength at 5-year follow up.

Internal fixation has been performed with plates and screws, whereas the use of percutaneous intramedullary smooth pins has been frowned on because of the dangers of pin migration (*3*).

■ Mahmoud A. Mahran, MD, PhD (ortho.), MRCS (England)
  Lecturer of Orthopedic surgery.
■ Elhussein Elmoatasem, MD, PhD (ortho.)
  Assistant professor of Orthopedic surgery.
■ Mohamed A. ElGebeily MD, PhD (ortho.)
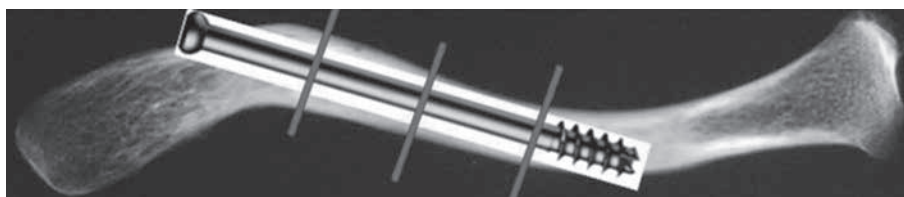 Lecturer of Orthopedic surgery.
  Department of Orthopaedics, Hospital of Ain shams University, Cairo, Egypt.
  Correspondence : Mahmoud A. Mahran, Department of Orthopaedics, Hospital of Ain shams University, Khalifa El-Maamon st, Abbasiya sq., Cairo 11566, Egypt.
  E-mail : mmahran@med.asu.edu.eg
  © 2014, Acta Orthopædica Belgica.

Fig. 1. — An illustration demonstrating the 6.5 cannulated screw fitting the clavicular contour. Outermost diameter : 6.5 mm, shaft diameter : 4.8 mm, available length : 20-150 mm.

Table I. — Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
Completely displaced midshaft fracture of the clavicle midshaft (with no contact between the main fracture fragments)	Open fractures
Age between 16 and 50 years (young active adults)	Pathological fractures
Presentation within 2 weeks of injury.	Ipsilateral upper limb fracture

This study presents an alternative safe surgical technique for fixing acute mid-shaft clavicular fracture using cannulated 6.5 threaded screws and minimal incision over the fracture site to insure compression at the fracture site and intramedullary application of the screw in the medial fragment.

MATERIAL AND METHODS

From February 2009 to December 2013, 27 adult patients with acute midshaft clavicular were prospectively enrolled in the study, which was approved by the department Review Board committee. They were surgically treated with mini incision using a cannulated screw (6.5 mm, short thread, steel, Synthes/ Mathys Medical Ltd., Switzerland) (Fig. 1). Inclusion and exclusion criteria are shown in (Table I).

Once identified as eligible for the study, patients received detailed information from the surgeon regarding the advantages and disadvantages of operative care.

All midshaft clavicle fractures (Orthopaedic Trauma Association (*13*) classification 15B) with greater than 100% translation of major fragments were classified as Type 2B according to the Robinson classification (*16*). These fractures were further subdivided into the following categories : B1 and B2, in which B1 are two-part fractures with or without wedge comminution (displaced OTA 15B1 and B2 ; figure 1) and B2 are isolated segmental or segmentally comminuted fractures (OTA classification 15B3).

We treated 27 patients aged from 16 to 50 years (mean, 27.4 years), there were 19 males and 8 females. The mechanism of injury was motor car accident in 21 cases and fall on the shoulder in 6 patients, In 20 pateints (74%) cases the injury was located on the dominant side. the commonest configuration being the Type 2B1 (23, 85.1%), according to Robinson's system.

For all the cases, the fracture was approached with a 3-5 cm incision centered over the fracture site identified by the marker and the fluoroscopy.

The fracture site is exposed and a guide wire 2.8 mm was inserted in the lateral fragment in a retrograde direction posteriorly, then reduction of the fracture is done under vision The guide wire advanced under vision in the medial fragment and checked by fluoroscopy in 2 planes. The screw length is measured by a measuring tape to the length of the protruding K-wire and the distal fragment is drilled and reamed by a 3.2 mm cannulated drill bit. The appropriate length of 6.5 mm-cannulated screw (short thread, steel, Synthes/Mathys Medical Ltd., Switzerland) is chosen and then inserted from the lateral to the medial site on the guide wire.

The arm is held in a sling for the first three days after surgery and then light daily activities are allowed.

At follow-up complete clinical and radiographic assessments were done. Fracture healing was defined as bony integration without a radiolucent gap. We used modified shoulder rating scale by Chuang *et al* (*4*) for outcome evaluation. The patients were rated in seven categories, including range of motion, muscle power, subjective evaluation of pain and weakness, ability to
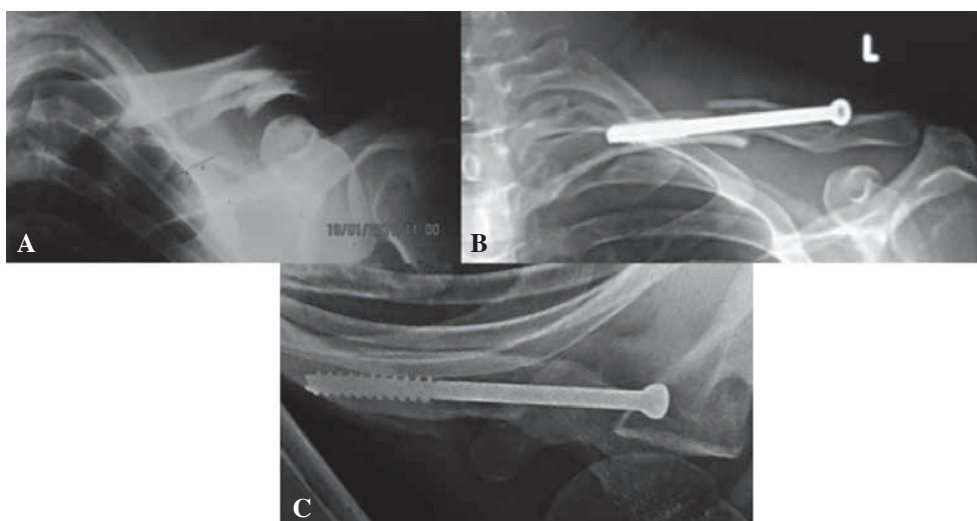
Fig. 2. — A, plain x ray AP shoulder view showing fracture midshaft clavicle ; B, final AP x ray after full union ; C, axial x ray after full union.

return to the previous occupation, patient satisfaction, and operation-associated complication. The highest possible scores were 20 points. The overall clinical results were stratified into excellent (18-20 points), good (15-17 points), fair (12-14), and poor (less than 11 points).

RESULTS

There were no intraoperative complications. The most common problem encountered postoperatively was discomfort due to subcutaneous screw prominence medially in three patients (11.1%) which resolved following screw removal. One patient had wound infection (0.27%) that was treated by frequent dressing and antibiotic according to culture and sensitivity testing. Infection resolved and the wound eventually healed with an unsightly scar. Union was achieved in all 27 cases in a mean of 8.3 weeks range (6-12 weeks). Restoration of clavicular length was achieved in all cases. At the latest follow up, all patients were asymptomatic, and had a normal mobility of the shoulder with an acceptable cosmetic results (Table II).

Twenty- five patients demonstrated a full range of motion. Active motion was limited for the remaining two patients, who revealed a mild restriction at forward elevation and external rotation. Twenty-four patients experienced no pain on all activity at latest follow-up. Two reported pain only

with strenuous activity (heavy objects lifting) and one had pain with moderate activity (lifting light objects).

Twenty six patients were able to return to their previous level of activity and working ability. One patient changed to a less-strenuous job because of shoulder discomfort. All patients except the one patient, who developed wound infection with an ugly scar, expressed their willingness to have the surgery again should they have the same problem.

DISCUSSION

There has been emerging evidence supporting operative reduction for displaced clavicular fractures for the sake of insuring optimal shoulder function (*5,6,20*). The amount of pain and disability during the first three weeks of conservative treatment has been underrated (*17*) and the common view that nonunion does not occur is wrong (*6,19*). Pressure from a displaced fragment on the retro-clavicular part of the brachial plexus may cause symptoms after conservative treatment.

Internal fixation with plates and screws offers anatomical reduction and rigid fixation. The optimal ability to resist bending and rotational forces permits early use of the extremity during the fracture healing process. However, in involves extensive

Table II. — Details of 27 patients with midshaft clavicular fractures treated by open reduction and internal fixation using cannulated screws

Case	Age (y)/ Gender/ Side	Mechanism Of injury	Isolated/ polytrauma	Fracture type	Time of union wks	Follow-up Month	Shoulder score	Result
1	23/M/R	MCC	Polytrauma	2B1	8	12	20	Excellent
2	19/M/L	MCC	Isolated	2B1	6	18	15	Excellent
3	32/M/L	MCC	Isolated	2B1	7	12	18	Excellent
4	18/M/R	Fall	Isolated	2B1	8	12	20	Excellent
5	22/F/L	MCC	Isolated	2B1	6	10	20	Excellent
6	20/M/L	MCC	Isolated	2B1	8	12	20	Excellent
7	35/F/R	MCC	Polytrauma	2B1	8	18	20	Excellent
8	32/M/L	MCC	Polytrauma	2B1	8	12	18	Excellent
9	18/M/R	MCC	Isolated	2B2	8	6	20	Excellent
10	45/F/L	Fall	Isolated	2B2	10	8	12	Fair
11	28/M/L	Fall	Isolated	2B1	8	12	20	Good
12	25/M/R	MCC	Isolated	2B1	12	18	18	Excellent
13	35/M/R	MCC	Polytrauma	2B1	8	12	20	Excellent
14	36/M/L	Fall	Isolated	2B1	8	12	20	Excellent
15	24/M/L	MCC	Isolated	2B1	8	18	15	Good
16	16/F./R	MCC	Isolated	2B1	6	24	20	Excellent
17	27/F/L	MCC	Isolated	2B1	8	12	20	Excellent
18	21/M/R	MCC	Isolated	2B2	6	12	15	Good
19	32/M/R	MCC	Isolated	2B1	10	12	20	Excellent
20	48/M/L	MCC	Isolated	2B1	6	6	20	Excellent
21	24/F/R	MCC	Isolated	2B2	10	10	20	Excellent
22	20/F/R	Fall	Polytrauma	2B1	8	12	18	Excellent
23	23/M/R	MCC	Isolated	2B1	8	12	20	Excellent
24	22/M/L	MCC	Isolated	2B1	10	18	20	Excellent
25	19/F/R	Fall	Isolated	2B1	8	12	20	Good
26	50/M/R	MCC	Isolated	2B1	14	6	20	Excellent
27	27/M/L	MCC	Polytrauma	2B1	8	12	15	Excellent

periosteal stripping and thus higher rates of non-union. Despite the advent of anatomical low profile plates, hard ware prominence and unsightly scar over a subcutaneous bone remains an issue.

The advantages of intramedullary pinning over plates, include the limited extent of the incision with less dissection and stripping of the soft tissues, and the use of the intramedullary pin to serve as a load-sharing device. In this aspect, osteoporosis (which occurs under a plate as a result of stress shielding) is less severe. With an intramedullary device, the likelihood of recurrent fracture through osteoporotic bone after hardware removal is also minimized (2,12). A closed technique would offer shorter healing periods with minimal scarring at the operation site. But, the procedure has a steep learning curve, more operative time, exposes the surgeon to more radiation and has high complication rate (4,7).

Disadvantages of intramedullary fixation with smooth elastic pins include the difficulty to insert the device because of the curvature of the clavicle and the lack of control of rotational forces at the mid-third of the bone. The utilization of such devices often requires external plaster support and this interferes with the rehabilitation regimen, particularly if stiffness of the gleno-humeral joint exists. Therefore when a smooth rod is used, the stability is poor and migration with its potential disastrous is not uncommon. External fixation avoids the problem of pin migration but it is cumbersome and more expensive (18).

Fixation by a plate has been advocated on the grounds that a single and small diameter medullary

pin cannot control rotation (*1,7,11*). The 6.5 mm cannulated screw could bear theoretically more rotational and bending stresses, because of its larger shaft diameter (4.5 mm) in a curved bone and the better purchase of the cancellous threaded portion. This allows early activity. A better purchase in the medial fragment provided the added advantages of reducing lateral implant migration. Because of the smooth and spherical head in the design of the cannulated screw, the skin irritation by the screw head was not apparent in this study. There remains the problem of possible medial screw end protrusion and irritation which occurred with three patients and necessitated screw removal after union was achieved. This can be prevented by proper screw-length selection.

Like other intramedullary devices, The cannulated screw has the advantage that it could be inserted by closed reduction technique ensuring no disturbance to the fracture biology and eventually rapid union (*17,19*). However, we used a minimal incision with minimal soft tissue dissection to decrease the operative time, the radiation exposure and to insure intramedullary application of the screw in the medial fracture fragment. None of the cases developed delayed or nonunion. The scar after intramedullary pin fixation is also smaller and more cosmetically acceptable than after plate fixation (*11*). Screw removal required a small incision, and there was no fracture at the potential stress riser site located at the hole remaining after screw removal.

The technique miniopen reduction and internal fixation with a cannulated screw is an alternative, relatively biological and economic technique for the treatment of acute midshaft clavicular fractures that is useful in selected cases where surgery is indicated. Satisfactory results were achieved for such cases with no major complications. The weaknesses of this study included the relatively smaller case number and absence of a control group.

REFERENCES

1. **Ali Khan MA, Lucas HK.** Plating of fractures of the middle third of the clavicle. *Injury* 1978 ; 9 : 263-7.
2. **Bostman O, Manninen M, Pihlajamaki H.** Complications of plate fixation in fresh displaced midclavicular fractures. *J Trauma* 1997 ; 43 : 778-83.
3. **Chou NS, Wu MH, Chan CS et al.** Intrathoracic migration of Kirschner wires. *J Formos Med Assoc* 1994 ; 93 : 974-6.
4. **Chuang TY, Ho WP, Hsieh PH et al.** Closed reduction and internal fixation for acute midshaft clavicular fractures using cannulated screws. *J Trauma* 2006 ; 60 : 1315-20 ; discussion 20-1.
5. **Healy WL, Jupiter JB, Kristiansen TK et al.** Nonunion of the proximal humerus. A review of 25 cases. *J Orthop Trauma* 1990 ; 4 : 424-31.
6. **Hill JM, McGuire MH, Crosby LA.** Closed treatment of displaced middle-third fractures of the clavicle gives poor results. *J Bone Joint Surg Br* 1997 ; 79 : 537-9.
7. **Jupiter JB, Leffert RD.** Non-union of the clavicle. Associated complications and surgical management. *J Bone Joint Surg Am* 1987 ; 69 : 753-60.
8. **Lyons FA, Rockwood CA, Jr.** Migration of pins used in operations on the shoulder. *J Bone Joint Surg Am* 1990 ; 72 : 1262-7.
9. **McKee MD, Pedersen EM, Jones C et al.** Deficits following nonoperative treatment of displaced midshaft clavicular fractures. *J Bone Joint Surg Am* 2006 ; 88 : 35-40.
10. **Neer CS 2nd**. Nonunion of the clavicle. *J Am Med Assoc* 1960 ; 172 : 1006-11.
11. **Neviaser RJ, Neviaser JS, Neviaser TJ.** A simple technique for internal fixation of the clavicle. A long term evaluation. *Clin Orthop Relat Res* 1975 ; 109 : 103-7.
12. **Ngarmukos C, Parkpian V, Patradul A.** Fixation of fractures of the midshaft of the clavicle with Kirschner wires. Results in 108 patients. *J Bone Joint Surg Br* 1998 ; 80 : 106-8.
13. **Nordqvist A, Petersson C.** The incidence of fractures of the clavicle. *Clin Orthop Relat Res* 1994 ; 300 : 127-32.
14. **Postacchini F, Gumina S, De Santis P, Albo F.** Epidemiology of clavicle fractures. *Journal of Shoulder & Elbow Surgery* 2002 ; 11 : 452-6.
15. **Robinson CM, Court-Brown CM, McQueen MM et al.** Estimating the risk of nonunion following nonoperative treatment of a clavicular fracture. *J Bone Joint Surg Am* 2004 ; 86-A : 1359-65.
16. **Robinson CM.** Fractures of the clavicle in the adult. Epidemiology and classification. *J Bone Joint Surg Br* 1998 ; 80 : 476-84.
17. **Rowe C.** An atlas of anatomy and treatment of midclavicular fracture : s. *Clin Orthop Relat Res* 1968 ; 58 : 29-42.
18. **Schuind F, Pay-Pay E, Andrianne Y et al.** External fixation of the clavicle for fracture or non-union in adults. *J Bone Joint Surg Am* 1988 ; 70 : 692-5.
19. **Zenni EJ, Jr., Krieg JK, Rosen MJ.** Open reduction and internal fixation of clavicular fractures. *J Bone Joint Surg Am* 1981 ; 63 : 147-51.
20. **Zlowodzki M, Zelle BA, Cole PA et al.** Treatment of acute midshaft clavicle fractures : systematic review of 2144 fractures : on behalf of the Evidence-Based Orthopaedic Trauma Working Group. *J Orthop Trauma* 2005 ; 19 : 504-7.