



Double semi-tubular plating of clavicle using a piggyback technique – An alternative way of treating clavicle mid-shaft fractures in young patients

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The majority of clavicle fractures unite uneventfully. Indications for operative surgery are limited, with high rates of complications. We describe our results with an alternative cost effective method of treating these injuries in young patients. It is a retrospective series of 20 patients treated between January 2005 and January 2009 with a “piggy back” technique using double plating with two 3.5mm drill hole semi-tubular plates. All patients were assessed with DASH (Disability of Arm, Shoulder and Hand) score at last review. Average time to union was 12.5 weeks. The average DASH score was 8.34 (0-34.2). There was one case each of non-union, implant removal and symptomatic numbness around the scar. The overall complication rate was 15% with 5% incidence of non-union. The results compare favourably with previously published series. We propose that this technique allows a cost effective way of treating these fractures in young patients, with a high patient satisfaction rate.

Keywords: clavicle fractures ; plate fixation ; young patients.

recent studies have shown a much higher rate of non-union (15%) and patient dissatisfaction with the final result (31%) with conservative management (5,8,10,21,30).

Widely accepted absolute indications for surgical intervention in mid-shaft clavicle fractures include open fractures, fractures associated with skin compromise, neurological or vascular injury. Relative indications for surgery include fractures with greater than 20 mm of shortening, wide displacement of fragments, patients with chest injuries on intensive care unit, high-energy injuries, a floating shoulder and non-unions (1,4,8,14,17,23). However, surgical intervention has a bad reputation due to a high complication rate ($\geq 23\%$) ; particularly infection, wound breakdown, non-union and implant failure (3,8,20,31). In the current environment of financial downturn, every procedure has to be cost effective.

INTRODUCTION

Clavicle fractures account for 5% to 10% of all fractures and 35% to 45% of all shoulder girdle injuries (24,26). The middle third fractures are the most common and account for 85% of all clavicle fractures (5,9,21,24). These injuries have traditionally been treated conservatively, as Neer in 1960 suggested that only 0.1% of clavicle fractures treated non-operatively failed to unite (20). However, more

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The aim of this study was to investigate the outcome in a group of young patients with mid-shaft clavicle fractures treated with piggyback technique of double plating using two 3.5 mm drill hole semi-tubular plates.

METHODS

A retrospective review was undertaken of all patients with middle third clavicle fractures treated with piggyback technique of double plating using two 3.5 mm drill hole semi-tubular plates at our institute between January 2005 to January 2009. All patients were operated by the senior author or under his direct supervision. Patients were identified from the individual theatre logbooks and operating department's computerised records. Data was then obtained from the patient's medical case notes.

Patients more than 65 years of age, with multiple trauma, brachial plexus or vascular injury or with a floating shoulder were excluded.

Twenty patients met the criteria for the study. Their mean age was 39.15 years (range : 19-63 years). Five out of 20 patients were females.

The patient was immobilised in a shoulder immobiliser for two weeks postoperatively at which point assisted active exercises were started. At 6 weeks, the shoulder immobiliser was removed and passive exercises were started. Once the fracture had united then resisted exercises and strengthening exercises of deltoid and rotator cuff were commenced. All patients were followed up at 6, 12, 26 weeks or until fracture had united clinically and radiologically. Follow-up radiographs included an anteroposterior (AP) and 15° cephalad views. We defined radiological union as visible bridging callus or absent fracture line. The clinical union was described as no bony tenderness on clinical examination.

All patients were sent out a DASH (Disability of Arm Shoulder and Hand) Score in the post at the time of this review. Eight patients did not return the proforma and they were subsequently contacted via telephone and the required information was collected.

Surgical Technique

Under general anaesthetic, the patient was placed supine on the operating room table with 20° head up and head on a head ring. The head was turned away from the operating side and the neck flexed to allow for ease of instrumentation. A sand bag was placed between the two shoulder blades. The surgical field was prepared and the

patient was draped allowing easy access to the clavicle. An incision was made over the clavicle using it as a firm base. The subcutaneous fat was incised along with the platysma. Care was taken to avoid damage to the supraclavicular nerves. In the line of the incision, the pectoral fascia was divided followed by careful elevation of the underlying musculature from the clavicle. The fracture was then reduced and held with reduction forceps and a lag screw was inserted if possible. The fracture was then held using two superiorly placed one-third tubular plates "piggy-backed" onto each other with the lower plate two hole sizes bigger than the upper plate. This ensured that the ends of the plates were less prominent. The plates were contoured together to accommodate the shape of the clavicle. The plates were held secured with screws. In cases of non-unions, demineralised bone matrix was used to aid fracture healing. The pectoral fascia and subcutaneous fat were then closed using 2/0 polyglactin suture. The skin was sutured with continuous monofilament absorbable subcuticular 3/0 suture. The wound was dressed and the arm was held in a shoulder immobiliser.

RESULTS

Out of the 20 patients, 10 had widely displaced (> 15 mm) fracture fragments, 3 patients had a vertical fracture fragment / comminution, 3 patients had shortening of more than 20 mm at the fracture site and 4 out of 20 patients were operated for non-union following conservative treatment.

The average follow-up was 35.95 months (range : 24-66 months). All the patients achieved clinical and radiological union at a mean of 12.5 weeks. The mean DASH outcome score was 8.34 (range : 0-34.2). The detailed breakdown of DASH score is as shown in table I.

We had three complications which included 1 non-union which was symptomatic, 1 patient had symptomatic numbness around the scar and 1 patient had prominent metal work which was subsequently removed. A revision procedure was performed for the non-union and the fracture went on to unite in 14 weeks after the second surgery.

DISCUSSION

Conservative treatment of clavicle fractures has been the tradition and this has been based on Neer's

Table I. — Table showing age (in years), sex, follow-up (in weeks), mechanism of injury and DASH score for patient group

Patient No	Age	Sex	Injury Mechanism	Follow-up (months)	DASH score
1	37	Female	Mechanical Fall	29	0
2	43	Male	RTC/RTA	24	0
3	43	Male	RTC/RTA	58	0.8
4	22	Male	RTC/RTA	56	0
5	23	Male	Football	54	0
6	22	Male	Football	24	6.5
7	57	Male	RTC/RTA	53	2.5
8	34	Male	Football	66	1.7
9	19	Male	RTC/RTA	47	3.3
10	56	Female	RTC/RTA	50	12.5
11	49	Female	Mechanical Fall	24	13.3
12	43	Male	RTC/RTA	24	12.5
13	27	Male	Football	29	1.7
14	27	Male	RTC/RTA	24	17.5
15	62	Male	RTC/RTA	25	0
16	63	Female	Mechanical Fall	24	43.2
17	40	Male	Assault	24	29.2
18	42	Female	Assault	36	0.9
19	42	Male	RTC/RTA	24	5.2
20	39	Male	Football	24	25

original series (20). He stated “the most important causal factor in non-union of fractures of the middle third has been improper open surgery”. However, work of Hill *et al* reported that in their series 15% patients developed non-union and 31% patients had unsatisfactory outcome on the basis of patient oriented measures (10). They concluded that there is a high risk of non-union with displacement of greater than 20 mm. A meta-analysis of recent studies revealed that the rate of non-union for displaced mid-shaft clavicular fractures was 2.2% (ten out of 460 patients) after plate fixation as compared to 15.1% (twenty four of the 159 patients) after non-operative care, a relative risk reduction for non-union of 86% (21).

Previously mal-union of the clavicle (which is typical with displaced fractures) was thought to be of radiographic interest only and required no treatment. However, it is becoming increasingly apparent that clavicle mal-union is a distinct clinical entity with radiographic, orthopaedic, neurologic and cosmetic manifestations. Nowak *et al* examined the late sequelae in 208 adult patients with clavicle fractures and found that, at ten years after the injury, ninety-six patients (46%) still had symptoms despite the fact that only fifteen (7%) had a

non-union (21). While it is unclear why there is such a dramatic difference between the outcome of the clavicle fractures in previous reports and those in contemporary studies, there are several possibilities. The initial reports often included data on clavicle fractures in children, who have inherent healing abilities and remodelling potential, and their data may have artificially improved the overall results (9,20,21). Second, the use of patient-oriented outcome measures, as in the studies by Hill *et al* has been shown to reveal functional deficits in the upper extremity that are not detected by traditional surgeon-based scores (10).

Many techniques have been suggested for the surgical treatment of clavicle fracture fixation including intramedullary fixation (13,16,29), plates and screws (5,16,24,28,30), partial claviclectomy (18,19) and external fixation (16,27).

Proponents of intramedullary pin fixation have reported high rates of union but have also stated that implant removal was often necessary (2,6,13,29).

Schuind *et al* in 1998 reported results of 20 patients treated with Hoffmann external fixation with no non-union and return to full range of movements of the shoulder. However there was no objective measurement of patient satisfaction (26).



Fig. 1. — Pre-operative and post-operative radiographs (3 months) of clavicle fixation for displacement more than 20 mm.

Several authors have described treating clavicle fractures by open reduction and internal fixation with plates and screws. Initially semi tubular, dynamic compression plates and 3.5 mm reconstruction plates were used but more recently studies have shown use of locking plates to be better especially in elderly patients, with lower rates of complications (24). Shen *et al* have described three dimensional 3.5 mm reconstruction plating of mid-shaft clavicle fractures with union rate of 94% as compared to superior plate with union rate of 65% (27). Antero-inferior plating has been shown to have a low complication rate (16), however, biomechanically superior plating has been shown to provide more secure fixation (7,12,15).

We have described a “piggy-back” technique with superior double plating of mid-shaft clavicle fractures using 3.5 mm drill hole semi-tubular plates in indicated cases among younger patients. The early results are good with 5% non-union rate and an overall complication rate of 15%. This is comparable to other types of plate and screw fixation series (3,5,8,18,25,31).

As the clavicle is subcutaneous, the plate can become symptomatically prominent, necessitating removal. Pai *et al* have described implant removal rate of 58% with locking compression plates as



Fig. 2. — Pre-operative and post-operative radiographs (3 months) of clavicle fracture fixation for vertical fragment and comminution.

compared to 68% with non-locking compression plates (dynamic compression plate or reconstruction plate) (23). In our study there was only one patient who needed implant removal. A 3.5 mm drill hole semi-tubular plate is fairly low profile compared to a 3.5 mm drill hole dynamic compression plate or a locking plate. Piggy-backing two semi-tubular plates is also less prominent than either a 3.5 mm compression plate or a locking plate. A semi-tubular plate is 1 mm thick and piggy-backing two would make the overall thickness 2 mm as compared to the 4.5 mm thickness of a locking compression plate. We believe that using two piggy backed 3.5 mm drill hole semi-tubular plates is stronger and should produce less stress shielding at the tip of the plates as the superior plate is two holes shorter than the inferior plate. Also, double semi-tubular plates cost the same as a locking compression plate. The pre-contoured clavicle locking plates are around 10 times more expensive

than double semi-tubular plates. Locking screws are 8 times more expensive than a conventional cortical screw. Thus using our construct would be cheaper compared to a similar construct using an LCP with locking screws or a pre-contoured locking plate.

One weakness of our study is that it is a retrospective study; a randomised control trial with larger groups of patients is recommended with direct comparison between different types of plate fixation. Another weakness of our study is that the patients were not examined at the time of final assessment. The DASH score was either sent in the post or recorded over the telephone. However, none of the patients expressed any concerns regarding hardware problems or any other complication.

Our view is that this technique is more cost effective than use of pre-contoured locking plates which have shown to have a low rate of complications especially in elderly patients. However, we believe in younger patients bone is usually of good quality. Also in these difficult financial times cost effectiveness is a priority. On the basis of our experience, we believe that treating clavicle fractures in indicated cases in younger patients using our technique is effective and bears low cost.

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