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Original Research Article

Functional results of clavicle fractures in adults treated by open reduction and internal fixation using superior precontoured plate

M. Ahsan Wani*, Mushtaq Ahmed Ganaie, Nuzhat Ul islam, Akther Rasool, Nisar Ahmed Dar

Department of Orthopaedics GMC, Srinagar, Jammu and Kashmir, India

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***Correspondence:**
Dr. M. Ahsan Wani,
E-mail: drehsanwani@gmail.com

ABSTRACT

Background: Observe results of open reduction and internal fixation of fractures of the clavicle in adults using pre-contoured superior clavicle locking plate.
Methods: This study was prospective study carried out in the Govt Medical college Hospital Baramullah Kashmir Department of Orthopaedics from June 2014 to September 2016. A total of 25 patients with fresh fractures were treated with ORIF with a pre-contoured superior clavicle locking plate.
Results: The mean age of patient was 30.08 years, males (64%), right clavicle frequently fractured (52%) Robinson type 2B1 configuraion. (44%) sustained their injury due to a road traffic accident. The average 6 month Quick DASH score was 0.82, whereas the mean constant score was 94.8 at final follow-up. The complications were superficial wound infection in (4%), mechanical pull-out of the plate in (8%), numbness below the incision area in (12%), symptomatic hardware in (4%), and non-union in (4%).
Conclusions: There has been a resurgence of interest in operative treatment for fractures that are displaced, comminuted, or that display significant shortening. Operative treatment is beneficial to only a subset of patients, in whom functional expectations and fracture characteristics have both been taken into account before taking the final decision.

Keywords: Clavicle fracture, Internal fixation, Superior precontoured plate

INTRODUCTION

The clavicle is one of the most commonly fractured bones, accounting for 2.6% to 4% of all fractures.[1,2] The incidence of clavicle fractures in adults is 71 per 100,000 men and 30 per 100,000 women.[3] Bimodal distribution curve for males, with a high incidence in young males less than 25 years old, and a high incidence in older males more than 55 years old. The distribution in females is unimodal, with a high incidence in older females, especially after 75 years age.[4,5] Mid-shaft fractures of the clavicle account for approximately 75% to 80% of all clavicle fractures, and typically occur in younger persons. Medial third fractures are least common, accounting for less than 5% of clavicle fractures.[1,2,6]

Clavicle mid-shaft fractures have classically been treated non-operatively, with a figure-of-8 brace and an arm pouch for the ipsilateral extremity. This belief was bolstered by a study in 1960, by Neer, who reported a non-union rate of just 0.1% with non-operative treatment.[7] Recent studies have shown that closed treatment of displaced middle-third fractures of the clavicle gives poor results.[8-11,13] Moreover, the non-union rate of fractures of the lateral end of the clavicle can rise to 37% upon instituting non-operative treatment.[16] The

non-union rate of fractures of the diaphysis and medial end have also been proven to be higher than that previously reported.[12]

Often, the pain relief associated with stabilizing the fracture is dramatic, and efforts to limit the patient's activity may be needed in the post-operative period.[13]

Despite the recent literature in support of surgical treatment, majority of clavicular fractures should still be managed conservatively. The indications for operating on a fracture of the clavicle include: open fractures, severe displacement, comminution, an imminent lesion of the skin by a sharp edge of the fractured clavicle, and neurovascular injuries.

It has also been shown that the presence of scapular winging (dynamic or static), in association with anterior rotation of the distal clavicle fragment, is a prognostic indicator for poor outcome following non-operative care.[14]

When opting to surgically fix the clavicle, there are several techniques of fixation that can be implemented. These include internal fixation with screws, pins, wire-loops, or plates; and external fixation with external fixators. Bone grafting may also be used.[15-18]

Aims and objectives of the study were to observe results of open reduction and internal fixation of fractures of the clavicle in adults using Pre-contoured Superior Clavicle Locking Plate.

METHODS

This study was carried out in the Government Medical college Hospital Baramullah Kashmir Department of Orthopaedics from june 2014 to sept 2016.

The study consisted of a total of 25 adult patients (both sexes) with fresh clavicles. All of the patients were treated with open reduction and internal fixation of the clavicle with a pre-contoured superior clavicle locking plate.

Inclusion criteria

Patient age >18 years old. Either sex any of the defined indications: comminuted, displaced (>2 cm), shortening (>2 cm), segmental fractures, fractures with tenting of skin.[19,20]

Exclusion criteria

Patient refusal. Associated injuries of the shoulder girdle open fractures pathological fractures established non-union from previous fracture non-compliant or substance abusers.[21,22] Clinically important neuromuscular upper limb disability previous operations to shoulder or clavicle Previous fractures around the clavicle medically unfit for surgery (due to comorbidities, or associated injuries).

The implant used in all our patients was a pre-contoured 3.5 mm superior clavicle locking compression plate. Another set of 2.7 mm lag screws was always kept ready, in order to lag any unstable butterfly fragment(s), if the need arose.

Pre-operative planning

A written, informed consent was taken from all the patients for their inclusion in this study. All the patients were explained in detail the available methods of treatment, with the final treatment decision left to the patient.

All the patients were admitted to the in-patient wards, and, when needed, resuscitated according to ATLS protocols. A detailed history was taken, ascertaining the mode of injury, with particular emphasis placed on ruling out injuries to other areas. AP views of the involved shoulder and 20˚ cranial views were taken, so as to have a full visualization of the clavicle. For fractures of the lateral end, Zanca view.[23,24] Routine blood and radiological investigations were done, as required for anaesthetic clearance.

Operative procedure

The surgery was performed under general anaesthesia. The patient was positioned in either the supine, with the head and neck tilted away from the surgical site with a bump placed behind the scapula to aid in reduction.

The arm was prepared in the field to allow for traction and manipulation to assist in the reduction. Pre-operative intra-venous antibiotic (Cefazolin 1 gram) was given to the patient, at least 30 minutes before making the skin incision. The skin inferior to the fracture site was incised after pulling it up to the fracture site. As the skin was released, it fell 1 to 2 cm below the clavicle and prevented the wound from being in contact with the plate on the clavicle.[25] The subcutaneous tissue and platysma muscle were kept together as one layer and extensively mobilized, especially proximally and distally. Sharp dissection was taken down to the bone, with care to identify, and if possible, preserve the cutaneous supraclavicular nerves. When deemed necessary, they were sacrificed. The myofascial layer over the clavicle was incised and elevated in one continuous layer comminuted fragments, especially the often seen antero-superior fragment was teased back into position, as much as possible, maintaining its soft tissue attachments.

The fractured bone was reduced and the reduction held with the aid of reduction clamps. The pre-contoured plate was placed on the tension side of the bone-for the clavicle, this is the antero-superior position. Biomechanical studies have shown this position to

provide best stability.[26] The clavicle was drilled cautiously keeping in mind the relation of the subclavian vessels to the inferior surface to clavicle.

At least 4 cortices on either side of the fracture were held by cortical screws (or less when using locking screws); if using a lag screw, 3 cortices were sufficient. Once plating was completed, the fascia was repaired over the plate. Skin incision was closed. Antiseptic dressing was applied, and the arm was rested in an arm sling post-operative the patient was kept in the post-operative recovery ward, under observation. Vitals were monitored Pendulum exercises of the shoulder were started, with the arm still rested in the arm sling. The patient was discharged on the second post-operative day, and intravenous antibiotics were stopped on the same day. All patients were followed up at 2 weeks, 6 weeks, 12 weeks, and 6 months. Their constant and quick DASH scores were documented and stored, so as to plot their progress following surgery.[27]

RESULTS

The patients in our study ranged in age from 19-45 years. Of all the patients in our study, 16 patients were males, and 9 were females. In our study, in all age group intervals, males comprised the majority of cases. Of the 25 patients in our study, 13 patients had fractured their right clavicle, whereas 12 had fractured their left clavicle.

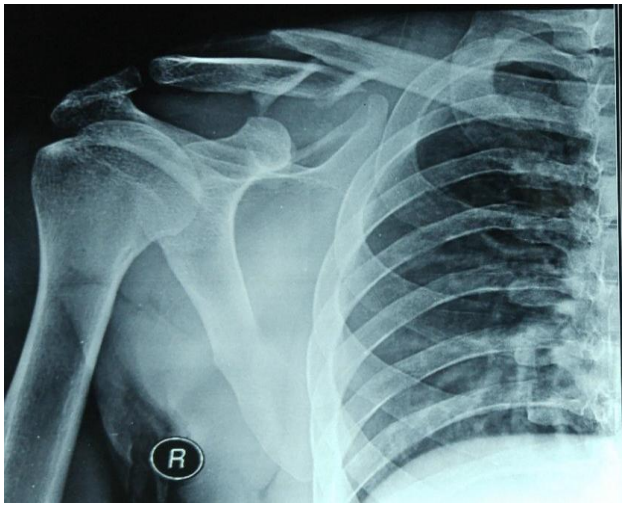

Figure 1: AP X-ray with clavicle fracture.

Of the 25 patients, 20 patients had a Robinson type 2B1 fracture configuration, whereas the 5 other patients had a type 2B2 configuration.

Table 1: Classification of fracture.

Robinson type	Frequency	Percentage (%)
Type 2B1	20	80
Type 2B2	5	20

Mode of trauma

The most common mode of trauma in our study was road traffic accident, followed by fall from standing height, followed by sports injuries.

Fall from height was seen in one case, while another one was because of direct trauma due to assault.

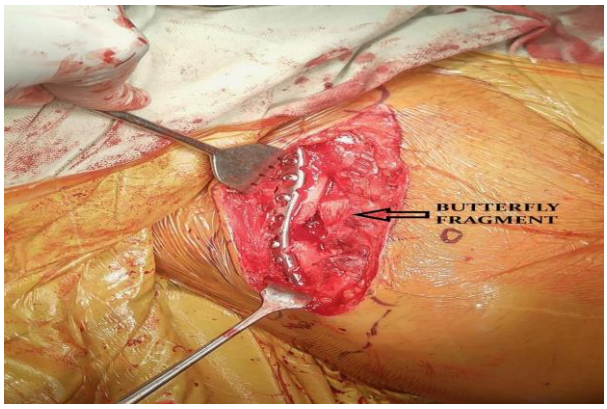

Figure 2: Intraoperative with plate.

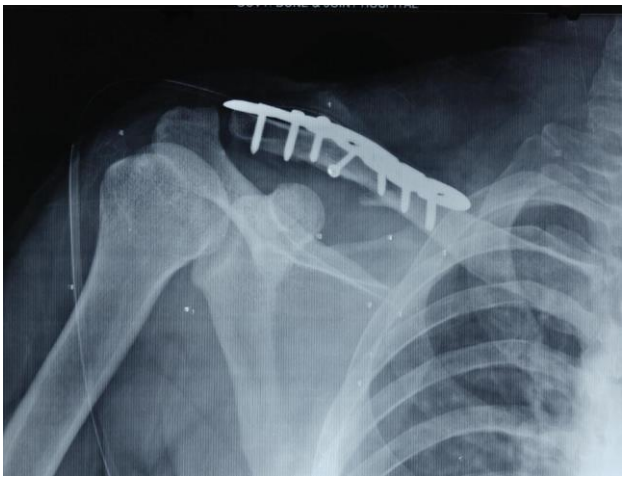

Figure 3: Post op AP X-ray with plating of clavicular plate.

Table 2: Mode of trauma.

Mechanism	Frequency	Percentage (%)
Road traffic accident	11	44
Fall from standing height	9	36
Sports	3	12
Others	2	8
Total	25	10

Injury-surgery interval

The average time to surgery from the time the patient sustained his injury was 8.64 days.

Table 3: Injury-surgery interval.

Duration (days)	Frequency	Percentage (%)
<7	9	36
7-14	14	56
>14	2	8
Total	25	10

Operative time

The average operative time in our study was 82.44 minutes.

Table 4: Operative time.

Duration (minutes)	Frequency	Percentage (%)
60-70	6	24
71-80	7	28
81-90	7	28
91-100	4	16
101-110	1	4
Total	25	100

Length of implant used

The 7-hole superior clavicle locking compression plate was the most commonly used length of implant. Only one patient needed the use of a longer 8-hole plate.

Table 5: Length of implant used.

Length of SCLCP	Frequency	Percentage (%)
6-holes	7	28
7-holes	17	68
8-holes	1	4
Total	25	100

Hospital stay

The average duration of hospital stay was 5 days, and it ranged from 4-6 days.

Table 6: Duration of hospital stay.

Days	Frequency	Percentage (%)
4	2	8
5	21	84
6	2	8
Total	25	100

Time to union

The time to union in our patients ranged from 10 to 16 weeks. Average time to union in our study was 13.04 weeks. Union was assessed by the presence of bridging cortices on AP X-ray projection, and painless range of motion of the shoulder.

Table 7: Time to union.

Weeks	Frequency	Percentage (%)
Up to 12	1	4
12-15	21	84
>15	2	8
Total	24	96

Post-operative scoring

The quick DASH score was calculated each time on follow-up at 2, 6, 12, and 24 weeks. The average quick DASH score at 12 weeks was 2.08, and the same at 24 weeks was 0.82.

Table 8: Quick DASH score.

Weeks	n	Mean	Std. deviation	Min	Max
2	25	27.46	9.62	9.1	56.8
6	25	8.80	1.63	2.3	22.7
12	25	2.08	1.63	0	4.5
24	25	0.82	0	0	4.5

Complications

A total of 6 patients suffered from complications related to the procedure.

Table 9: Complications.

Complication	Frequency	Percentage (%)
Dysesthesia	3	12
Superficial infection	1	4
Plate pullout	2	8
Hardware irritation	1	4
Non-union	1	4

DISCUSSION

The mean age in our study was 30.08 years. This was comparable to the study conducted by Balaji et al, and to other similar studies conducted in the past. The study conducted by Jiang et al had a higher mean age of 45 years.[24]

In our study, males comprised the majority of patients, with 64% being men and the rest, women. This is comparable to the study conducted by Shen et al, Wang et al, and other similar studies conducted in the past, where males comprised the majority of patients. The study conducted by Verborgt et al has an overwhelming majority of males (87.2%) due to the fact that they studied a population of semi-professional athletes.

The mean time to radiographic union in our study was 13.04 weeks, from the date of surgery. This is comparable to the study conducted by Jiang et al.[27] A

study conducted by Shen et al in , reported a mean time to union of only 10 weeks. This could probably because the author operated upon most of his cases within 3 days of injury. Rapid fixation of fresh fractures could possibly be the reason for the comparatively shorter time to union reported by that study

Among all the different studies evaluated, road traffic accident was, by far, the commonest cause of the clavicle fractures. In our study also, we found that the most common cause of sustaining these injuries were road traffic accidents.

Road traffic accident was also the most common cause of injury in male patients, accounting for 81.8% of all fractures seen in men.

Fall from standing height was the next most common mechanism of injury in the studied patients. Our findings were consistent with the findings of other similar studies, where falls from standing height constituted the second largest group of patients who had sustained clavicle fractures.

Also, these simple falls accounted for the majority of fractures in women, with 77.8% of all fractures in women being attributed to falls from standing height.

In our study, we found sports-related injuries to be the third most common cause of these fractures. These findings were comparable to findings by similar studies conducted in the past.

In our study, the mean quick DASH score measured at the end of 6 months was 0.82. This was better than the study conducted by Robinson et al. However, the study conducted by Balaji et al reported a mean quick DASH score of 0.0 at final follow up. The constant shoulder score in our study was 94.8, at final follow-up. This is comparable to other similar studies conducted in the past.

A few complications were encountered during the course of our study. They were dysesthesia of skin inferior to the incision (12%), superficial wound infection (4%), hardware irritation (4%), plate pull-out (8%), and radiological non-union (4%). The rate of occurrence of dysesthesia in our study (12%) is comparable to one study, and much lower than the recent study conducted by Jiang et al in.[32]

Table 10: Comparison of complications with other studies.

Complications study	Shen et al[31](%)	Verborgt et al[26] (%)	Jiang et al[27] (%)	Altamimi et al[18] (%)	Fridberg et al[28] (%)	Present study (%)
Dysesthesia	12	7	31	n/a	n/a	12
Infection	2.2	18	n/a	4.5	0.95	4
Hardware irritation	n/a	n/a	n/a	7.5	29.5	4
Plate pull-out	n/a	n/a	n/a	1.5	5	8
Non-union	3	5	n/a	3	n/a	4

This could be due to differences in care exercised by various surgeons while dissecting the supra-clavicular nerves. While studying rates of infection, one study by Fridberg et al reported an extremely low rate of 0.95% in his study.[29] Other recent studies, when compared with the present study, have similar rates of infection.[25,26] We had one patient (4%) with superficial wound infection.

Our report of only a single case (4%) troubled with hardware irritation is much lower than other studies studying the same effect on their operated patients. This can largely be attributed to the modified anterior skin incision used in our patients, that results in a scar that does not overly either the clavicle, or the implant.

In our study, 2 patients (8%) faced hardware failure, by means of a pull-out of the lateral end of the plate. This complication has been described in two other studies, by Altamimi et al and Fridberg et al, where the rate of hardware failure was 1.5% and 5% respectively. Our slightly higher observation of this particular complication could be attributed to inadequacy of our fixation during the early days of this study. Over time, it was seen that employing more locking screws than cortical added to the stability of the construct, and this complication did not happen subsequently, even in bulky patients subject to large stresses. This finding has been seconded by the observation of Pai et al, who observed lesser rates of failure when using locking plates than when using non-locking constructs.[29] Lastly, we observed one case (4%) who had a non-union. This was comparable to the studies conducted by Shen et al, and Altamimi et al.[30]

CONCLUSION

Clavicle fractures have since long been considered as benign injuries, with a good outcome if treated conservatively. However, several reports now challenge this view, and there has been a resurgence of interest in operative treatment for fractures that are displaced, comminuted, or that display significant shortening. Conservative management of these fractures may result in cosmetically displeasing end-results, delayed union, non-union, chronic shoulder pain, and impaired shoulder function.

The advantage of internal fixation of these fractures is that it rapidly restores anatomy and provides stable fixation, resulting in early pain resolution, a high rate of bony union, and a lower complication rate, when compared to the literature documenting conservative means for clavicle fracture management.

Still, most of the clavicle fractures are best managed conservatively. Operative treatment is beneficial to only a subset of patients, in whom functional expectations and fracture characteristics have both been taken into account before taking the final decision.

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