Functional Outcome of Surgical Treatment for Displaced Clavicle Fracture

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ABSTRACT

Introduction: Clavicle fracture is commonest of all shoulder girdle injuries and common among all fractures with the incidence more common in men than women. Fractures of the middle third clavicle are common of all clavicle fractures. Traditionally the fracture has been treated non operatively. The consensus of management is inclining towards the open reduction and internal fixation for displaced mid-clavicular fractures, as the conservative management gives poor results. In adults, non-operative treatment of a displaced middle-third clavicle fractures results poor. The aim of this interventional prospective study was to analyze the outcome of surgical management of displaced clavicle fracture managed with open reduction and plate and screws.

Method: This is a hospital-based, interventional, prospective study that includes all patients between 16 -65 years with displaced midshaft fracture of clavicle admitted at Universal College of Medical Sciences (UCMS), Bhairahawa treated by Open reduction and internal fixation with plate and screw from October 2017 to February 2019 follow up was done in 1.5 months, 3 months and 6 months, respectively.

Result: There were 30 patients, 23 were male and 7 were female. The mean age of patient was 31.9 years range 16-65 years. Road traffic accident was the most common cause of fractures. The mean time of union was 10.2 weeks. Left side was involved more than right clavicle. The mean duration of surgery was about 87.6 minutes and the mean duration of hospital stay was 12.1 days. The Robinsons type 2B1 fracture was most common. Most common complication was hardware prominence. There was one malunion following plate back out, mean disable arm shoulder and hand DASH score at 1.5 months, 3 months and 6 months were 43%, 24%, and 9% respectively.

Conclusion: Displaced mid-shaft clavicle can be effectively treated by open reduction and internal fixation with plate and screw (ORIF) as it improves the functional outcome, DASH score and promotes earlier union.

Keywords: Mid shaft clavicle fracture, Open reduction and internal fixation with plate and screw (ORIF), Disability of arm shoulder and hand score (DASH), Union

Introduction

The clavicle is a crank-shaped cantilever that carries the scapula and helps to transmit part of the weight of the limb to the axial skeleton[1]. It forms the crane-like structure through which the scapula and upper limb are suspended and helps to keep them away from the trunk[2]. The word clavicle was derived from the Latin: word (clavicula) which means little key because the bone rotates along its axis like a key when the shoulder is abducted[3]. The growth plates of the medial and lateral clavicular epiphyses do not fuse until the age of 25 years[1]. Hence young adults are more prone to develop fractures. The change of contour, which is acute at the junction of the middle and outer third, explains the frequency of fractures at this area[4].

The clavicle is the first bone in the human body to begin intramembranous ossification directly from mesenchyme during the fifth week of fetal life[5]. It can easily be fractured due to impacts to the shoulder[6]. It comprises of 5% to10% of all fractures[7]. A direct blow on the shoulder is the commonest reported mechanism of injury that produces a mid shaft fracture of the clavicle[8]. The incidence of clavicle fractures in adults is 71 per 100,000 men and 30 per 100,000 women[9]. Middle third fracture account for approximately 80% of all clavicle fractures[10]. A study found that 87% of clavicle injuries resulted from a fall onto the shoulder, 7% resulted from a direct blow,

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and 6% resulted from a fall on an out stretched hand[11].The consensus of management is inclining towards the open reduction and internal fixation for displaced mid clavicular fractures, as the conservative management gives poor results[12].

However, recent studies have shown sub optimal outcomes and a very high nonunion rates when displaced fractures are managed conservatively[13]. Nonoperative treatment brought out were functional impairment of the shoulder and a non-cosmetic bump at the base of the neck possibly due to shortening of the clavicle and exuberant callus formation[14]. Plate fixation provides immediate rigid stabilization, pain relief, facilitates early mobilization and return to pre- injury activities[15]. In this study the functional outcome after surgery union time, complications, demographical data has been studied.

Method

This study was done from August 2017 to February 2019 in Department of Orthopaedics, Universal College of Medical Science (UCMS), Bhairahawa, Nepal. Patients were evaluated at 1.5 months, 3 months and at 6 months. The patients who were followed up for up to 6 months were included in the study.

This was a prospective, observational hospital based interventional study; 30 patients with inclusion criteria under went open reduction and internal fixation (ORIF) with plate and screw.

Ethical Consideration: Ethical clearance was obtained from the Institutional Review Board (IRB) of UCMS-TH.

Inclusion criteria

Age 16 to 65 years, displaced midshaft clavicle fracture, domminuted fracture, segmental fracture, fracture duration <2 weeks, fracture at junction of middle and lateral third, fracture at junction of middle third and medial third, shortening by more than 2 cm, open fracture (type I and II), threat of skin perforation by fracture ends (skin tenting), need for earlier functional mobilization in the patients with an isolated injury, clavicle fracture with brachial plexus injury.

Exclusion criteria

Undisplaced clavicle fracture, Medial third clavicle fracture, Lateral third clavicle fracture, Pathological fracture, those who are not fit for anesthesia, those who does not want to participate in research work, those who are unable to come for follow-up.

Sampling procedure

Data was collected by structured interviews using the preformed proforma and data entered in Microsoft excel data base. Cases of the clavicle fracture presenting in the OPD or Emergency department, who meet the inclusion criteria were included in the study. Radiographs of the fractured clavicle on Antero-Posterior (AP) were done and the necessary Pre-anesthetic check-up along with Pre-operative investigations (CBC, RFT, Blood Group, RBS, chest x-ray, ECG) were done.

Pre-operative preparation

Patients were kept fasting for 8 hours before surgery, written/ informed consent for surgery was taken from the patient party. The neck, chest, axilla, shoulders, and arm were prepared. A systemic antibiotic cefuroxime (15 mg per kg body weight) was administered 30 minutes before surgery. An adequate amount of compatible blood was kept ready for any eventuality.

Procedure

General anesthesia was given in all patients and patient placed supine in a beach chair position with abolster between the scapulae. The head was turned to the opposite side to clear the field. Part preparation, painting with 10% povidone iodine solution after primary preparation done with scrub (7.5% povidone iodine) and draping was done. An incision of 7-9 cm centering the fracture site was made. Subcutaneous tissue along with platysma incised together and mobilized. The myofascial layer over the clavicle was incised and elevated in one continuous layer. Fracture site was exposed, Periosteum was elevated, freshened, curettaged. The fracture was reduced using bone clamps or was held temporarily with a Kireschiner-wire.

Then anatomical clavicular plate was placed over the superior surface of the clavicle, a 2.5 mm drill bit was used. At the junction of the medial and middle third of the clavicle, the inferior surface was exposed so that a protective instrument can be inserted during drilling to prevent injury to neurovascular structure. Screw size measured with depth gauge. Tapping was done with 3.5 mm then 3.5 mm cortical screws were used. Wound thoroughly washed with normal saline and closed in layers sterile dressing applied. Elastic shoulder immobilizer and arm sling were applied.

Intra operative photographs

Fig No1: Instruments for plating

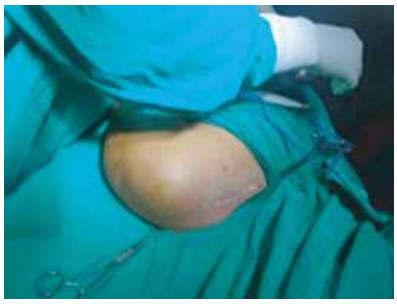

Fig No2: Incision over the supraclavicular region

Fig No 3: After plate insertion

Follow-up

The patient was generally discharged on 7-10 days according to wound condition, associated injuries, patient compliance to immobilization of affected limb before discharge he/she was well counseled for continuity of brace /sling, and dressing of wound every second day till 14th postoperative days. Then the patient was seen in the outpatient department (OPD) at 14th postoperative day, the wound was checked and suture removed. The sling was discontinued and unrestricted range-of-motion exercises were allowed. At 1.5 months, 3 months, 6 months post operatively, radiographs was done. The functional outcome was assessed by Disability of arm, shoulder, and hand (DASH) score.

Evaluation of outcome

The Disabilities of the arm shoulder and hand (DASH) score[16] was used to evaluate the functional outcome.

Table No 1: DASH score

Response	Points
No difficulty or no symptom	0
Slight difficulty or mild symptom	1
Moderate difficulty or symptom	2
Severe difficulty or symptom	3
Unable to perform or very severe symptom	4

Score of 0-29 is no longer considered their upper limb disorder

If there is 10 points difference between two consecutive follow-up score then it is taken as a good improvement

Data Analysis

Data were entered in Excel master-sheet and data analysis was done using Microsoft excel 2013.

Paired t test was used and p value was calculated Mean value, standard deviations were calculated.

Results

There were 23 males (77%) and 7 females (23%) and the male to female ratio was 3.2:1.The mean age group was 31.9 years with range of 18 years to 62 years with standard deviation of 6 years. The mode of injury was road traffic accident in 16 (53%), followed by fall injury in 10 (33. 3), physical assault in 3 (10%) and farm injury in 1 (3%). Right side was affected more then left side 51.5% and 48.4% respectively. Farmers were affected more than others 7 (23%) then students (20%) followed by a businessman (17%) and housewives (17%) then labors (13%) and officers (10%). Robinsons 2B1 was more common then 2B2, 57%, 43% respectively, which shows simple or wedged comminuted was more common, 17 out of 30 patients sustained this fracture. The average hospital stay was 12.1 days and 67% patients had no complication, 17% of cases had hard ware prominence, 7% postoperative pain, 3% infraclavicular hypo aesthesia, plate back out encountered in 3% i.e one case and surgical site infection was seen in one case.

Table 2: DASH score on follow up

Time	Average DASH Score (%)
1.5 Months	43%
3 Months	24%
6 Months	9%

Table 3: Paired Samples Statistics

Time	Mean DASH	N	Standard Deviation	Mean difference	t-Value	P-Value
1.5 months	43.47	30	10.775	17.378		
3 months	26.09	30	13.364		13.017	<0.001
3 months	26.09	30	13.364	13.857		
6 months	12.19	30	15.160		13.897	<0.001

This paired sample statistics shows that mean DASH score at 1.5 months was 43.47, and at 3 months it was 26.09 with a standard deviation of 10.7 and 13.3 respectively. The mean difference was 17.37 with t-value 13.017 and p-value was <0.001, which was significant.
Mean DASH score at 3 months and 6 months was 26.09 and 12.19 respectively where as standard deviation was 13.36 and 15.16 for 3 and 6 months, respectively. The mean difference was 13.89 and t-value was 13.89, the p-value was <0.001, which was significant.

Discussion

Among all the clavicle fractures, midshaft fracture accounts for about 81%[17].The incidence of clavicle fractures in adults is 71 per 100,000 men and 30 per 100,000 women[9]. The middle third of the clavicle is fractured in 69% of cases, the distal third is fractured in 28% of cases, and the proximal third is fractured in 3% of cases[18]. Recent studies of displaced midshaft clavicular fractures treated conservatively have shown a nonunion rate of 15% in one series as well as a rate of unsatisfactory patient oriented outcomes of 31% in one report and 32%, in another, which are much higher rates[12]. The Canadian Orthopedic Trauma Society reported internal fixation with plates resulted in a more rapid union, excellent clinical outcomes, and lower complication rates in 132 patients with displaced clavicle fractures than nonoperative treatments[19]. The mean age was 31.9 years, maximum number of patients were in-between 21-30 years age group (57%) which was similar to the study done by Mohammed et al., 31 years.[12], Onta et al 37.19 years (21-59 years)[20].
According to gender wise distribution, there were 23 males (77%) and 7 females (23%), males are more in this study as males are outgoing and they involved in road traffic accidents, which was similar to the study done by Gurung et al. 85.3% male, 14.7% were female[21] Similarly, Caroline et al found 68% male, 32% female, male: female ratio of 2.2:1.[22]
This study shows that both sides of the clavicle are equally vulnerable to fracture with right side affected more than the left side 57% and 53% respectively. Whereas Gurung et al. showed left side (58.22%) affected more than right (41.78%)[21]. That was similar to the study by Postacchini et al[23] and Caroline et al.[22] that showed left clavicle fracture more common than right and that was different than a study by Mohammed et al.[12], where out of 34 cases 28 were on right side and 6 were left side. In this study, Road Traffic Accident was the most common cause for clavicle fractures; 53% followed by fall injury 34 %. And similar result was described by Gurung et al.[21], Zlowodzki et al.[24] and Onta et al.[20] In this study, diaphyseal clavicle fracture was encountered more than others, among them, clavicle diaphyseal fracture with complex fracture pattern was more often than simple and wedge pattern, 43%, 17%, and 40% respectively. According to AO/OTA classification 15B3 was common.
Here, the interval between injury and surgery was less than 5 days in 80% of cases, a similar finding was noted in a study done by Gurung et al. [21] where meantime gap between injury and operation was 4.32 days. A similar finding was noted in the study done by Caroline et al.[22]; 11% of all fractures were treated operatively in acute stage after a median of 5 days ranging from 4-10 days but a study by Naveen et al.[25] found operation done within first days from the time of injury. In this study the mean duration of surgery was 87.6 minutes ranging from 55-120 minutes. While Chul-Hun et al.[19] found the mean operative time was 102.1 minutes (range, 70 to 175 minutes) in the reconstruction group and 99.3 minutes (range, 40 to 180 minutes) in the reconstruction Locking Compression Plate group. In this study average duration of callus formation was 10.2 weeks that is similar to Naveen et al.[25]; who found 9.27 weeks, while Gurung et al.[21] reported 16.24 weeks for callus formation. According to McKee et al.[26] reported the mean time for fracture healing were 14-16 weeks for operated patients and 24-28 weeks for non-operated patients. Similar finding was found by Onta et al.[20] and Jha et al.[27].
The mean DASH score at 1.5 months was 43.47, and at 3 months 26.09 with standard deviation of 10.7 and 13.3 respectively. The mean difference was 17.37 with t-value 13.017 and p-value was <0.001, which was significant. Mean DASH score at 3 months and 6 months was 26.09 and 12.19 respectively and standard deviation was 13.36 and 15.16 for 3 and 6 months respectively. The mean difference was 13.89 and t-value was 13.89, the p-value was <0.001 which was significant similar to the study by Gurung et al.[21] that was13.58. Cho CH et al.[19] the average DASH score of patients on reconstruction plate group was 33.85 and reconstruction locking compression plate group was 34.8.
Virtanen et al.[28] found average Dash score was 4.3 in operative group whereas in the non-operative group average DASH score was 7.7. In 2007, Canadian Orthopedic Trauma Society (COTS)[29] operated 62 cases among 111 found DASH score significant improvement 5.2 than non-operated group.
In this study, 67% patients had no complication, 5 patients had hardware prominence. Two patients

complained of postoperative pain that was managed with analgesic and counseling. One patient developed infraclavicular hypoesthesia for which no active intervention was done, the patient was well counseled following which symptoms subsided after two months. One patient developed plate back out following fall injury at home, plate was removed and counseling was done for re-plating but refused which resulted into malunion.

One case had superficial infection which was managed with intravenous(iv) antibiotics. Similarly, Elidrissi et al.[12] encountered 3% deep infection, Dhoju et al.[30] encountered 5% deep infection, while Onta et al.[20] encountered 4.8% wound site infection.

Similarly, Attia et al.[31] encountered one patient out of 15 presented prominent hardware and required removal of implant after union. In this study, there is no evidence of non-union, However two patients (3.2%) had non union[20]. The study done by Robinson[32] showed nonunion in 9.5% of cases, similarly the study done by Hill et al.[13] and White et al.[33] showed nonunion rate of 15% and 13% respectively. In this study, one case was malunited which was due to plate back out following postoperative fall, following which she was counseled for replating but she refused. Similar study done by Heyworth[34] showed symptomatic malunion in 0.4%.

Limitation: Small sample size, short time of follow-up

Conflict of interest: No conflict of interest

Conclusion

There is a high prevalence of symptomatic malunion and nonunion after non-operative treatment of displaced midshaft clavicle fracture so operative fixation improves functional outcome and lower the rate of malunion and nonunion. Open reduction and internal fixation with plate and screw is gold standard in displaced, comminuted fractures.

By using anatomical plate there is a reduction in the net operative time, decrease the soft tissue irritation, improve the functional ability of shoulder, improves DASH score, improve patient-oriented outcomes improve surgeon-oriented outcomes, earlier return to function decreases complications. This study supports plate fixation of displaced midshaft clavicular fractures in adult patients.

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Follow-up X-rays

Case 1:



Pre-op x-ray (Case 1) Immediate Post-op X-ray (Case 1) 1st follow up (Case 1)



2nd follow up (Case 1) Pre-op x-ray (Case 2) Immediate Post-op X-ray (Case 2)


1st follow up (Case 2) 2nd follow up (Case 2)