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Functional and radiological outcome of comminuted middle third clavicle fractures treated with plate osteosynthesis and primary bone grafting

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Abstract

Clavicle fractures are very common accounting for 5–10% of all fractures and 44% of all shoulder injuries. Biomechanical studies reveal that the middle third is the weakest and accounts for 80% of all clavicle fractures and more than 50 percent of these fractures are displaced. Traditionally displaced middle third clavicle fractures were treated conservatively with figure of '8' harness with its own complications such as malunion, shortening of the clavicle and non-union in cases of increased displacement. Modern day trend in treating them with internal fixation provide rigid immobilization and pain relief avoiding non-union, shortening and deformity. Earlier studies reported non-union rate of less than 1% with conservative management. But those studies were not standardized. They had variable proportions of patients in various ages, with variable sites of fracture and of variable fracture configuration. Recent studies have shown that displaced mid-shaft clavicular fractures do not have assured favourable outcomes with non-operative management and non-union rates could be as high as 20%. In this study we evaluated 30 patients with middle third displaced comminuted clavicular fractures treated by open reduction and internal fixation with anatomical S plate and primary bone grafting. These patients were followed up at 6 weeks, 12 weeks and 6 months with radiological (X-rays) and functional assessment with DASH score and Constant shoulder score questionnaire. At the end of 6 months all these patients went on to union with a statistically significant functional outcome at various study intervals (DASH score with p value <0.05 and Constant scoring with p value <0.05). Hence we conclude as mid third comminuted clavicle fractures treated with open reduction and internal fixation with anatomical S plate and primary bone grafting, unite early with excellent functional outcome, assessed by DASH and Constant shoulder score.

Keywords: Clavicle fracture, anatomical plating, primary bone grafting

Introduction

Clavicle fractures are common, representing 44% to 66% of all fractures about the shoulder [1]. They are among the more frequent injuries seen in the emergency room, primary care setting, and Orthopaedic clinics. Middle 3rd fractures are more common accounting for 80% of all the clavicular fractures. The rate of mid clavicular fractures is twice as high in men as in women. The peak incidence is in the third decade of life [2]. Based on historic data suggesting extremely low rates of non-union, midshaft clavicle fractures have traditionally been treated nonoperatively with a simple sling or figure-8 brace. In a frequently cited article from 1960⁽³⁾, the rate of midshaft clavicular non-unions treated nonoperatively was 3 (~0.1%) in 2235 patients, compared with 2 (4.4%) in 45 patients treated with open reduction and internal fixation (ORIF). This prompted the author to cite improper surgery as the leading cause of non-union [3] and perhaps led to the near-universal conservative treatment of these fractures over the following decades [4]. In the past 20 years, however, the conservative approach has been questioned, especially when considering displaced, comminuted, or shortened midshaft clavicle fractures [5, 6]. Using patient-centered outcome measures that were unavailable in the 1960s, several recent prospective series of conservative management revealed significantly higher non-union rates (7%–15%), pain scores, and dissatisfaction than previously reported [7, 8]. Moreover, malunion of the fracture clavicle has been described as a separate complication [9].

These inferior results warrant a randomized study to demonstrate the union rates, and functional outcomes with operative management of midshaft clavicle fractures. The availability and anatomical fit of pre contoured plates designed to match the complex shape of the bone have also eased the transition to operative management of these fractures. Operative management of these fractures had better outcomes and a lower rate of non-union and symptomatic malunion when compared with non-operative treatment. Primary internal fixation of displaced middle third clavicle fractures leads to predictable and early return to function [10]. Even though there are number of studies in literature which say that open reduction and internal fixation of clavicle results in good outcome, there is no study to our knowledge, which analyzes the functional and radiological outcome of midshaft comminuted clavicle fractures treated with fixation and primary bone grafting. Hence, we have taken up this study to evaluate the radiological and functional outcome (Using DASH and Constant Score) [11, 12] after fixation of comminuted clavicular fractures with anatomical S plate and primary bone grafting, and also to study the complications associated with the procedure.

Materials and Methods

All patients with midshaft comminuted clavicular fracture presented to our institute between July 2016 to May 2018, fulfilling inclusion and exclusion criteria were recruited for the study after obtaining approval from Institutional review board and the Ethical committee (IEC: RC/16/106).

Inclusion criteria:

Patients above the age of 18 years with comminuted clavicle fracture (OTA classification – Type B2 and Type B3) were included in this study.

Exclusion criteria

- Open fractures
- Fractures associated with neurovascular injuries
- Poly trauma patients
- Patients with upper limb injuries which may delay patient mobilization & pathological fractures were excluded from the study.

Based on the inclusion and exclusion criteria 36 patients with middle third comminuted clavicular fractures were taken into consideration. Out of 36 patients, 4 patients were lost during follow up, 1 patient withdrew from the study due to logistical reasons and 1 patient expired during the study. So 30 patients were included in the study.

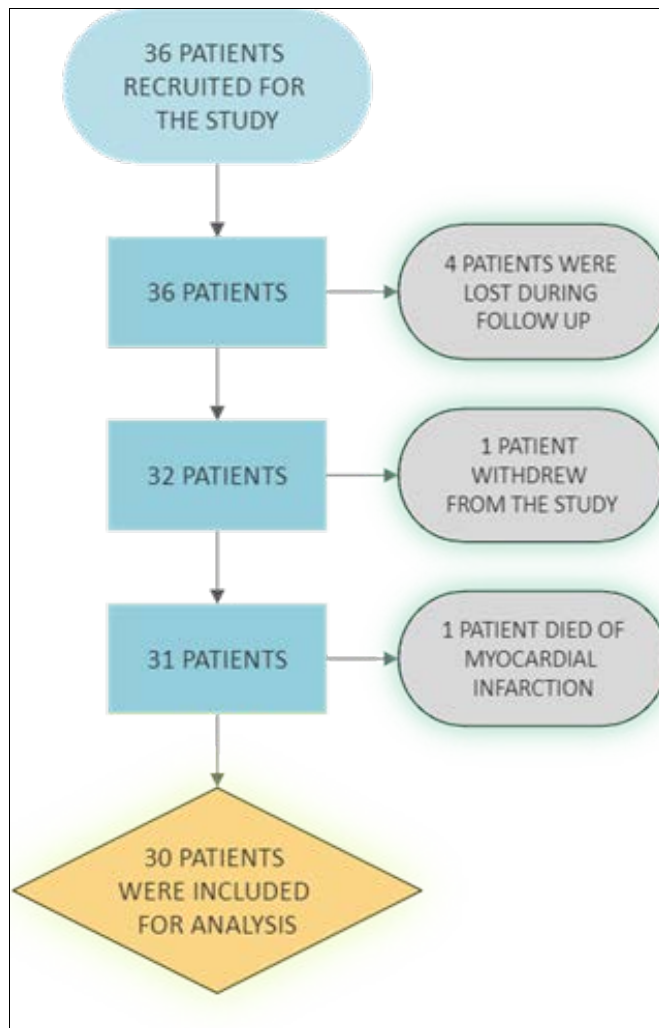


Fig 1: Patient flow chart

All these patients were splinted immediately, general condition, vitals and condition of the affected limb examined and documented. After adequate analgesia, radiological investigations were done. Informed written consent obtained from these patients and they were taken up for Open reduction and internal fixation with anatomical S plate and bone grafting under antibiotic coverage (Ceftriaxone – 3 doses as per our institutional protocol).

Postoperative care and rehabilitation

The arm was maintained in a sling on a full-time basis for two weeks. The patients are instructed not to lift objects > 2 kg on the operated side for 6 weeks.

Table 1: Post-operative protocol

1st week	Pendulum exercises. Isometric exercises of rotator cuff are started.
2nd – 4th week	Suture removal at 2 weeks. Gentle pulley for shoulder ROM 2 times per day.
5th – 8th week	Active and light resistance exercises without shoulder elevation.
9th – 12th week	Full shoulder Active ROM in all planes.
12 weeks & beyond	More aggressive strengthening program as tolerated were started.

During follow up, radiological evaluation of the union was done by taking serial radiographs. Radiological union was said to be achieved when there was bridging trabeculations

across the fracture line. Functional evaluation with DASH score and Constant shoulder score questionnaires were done.

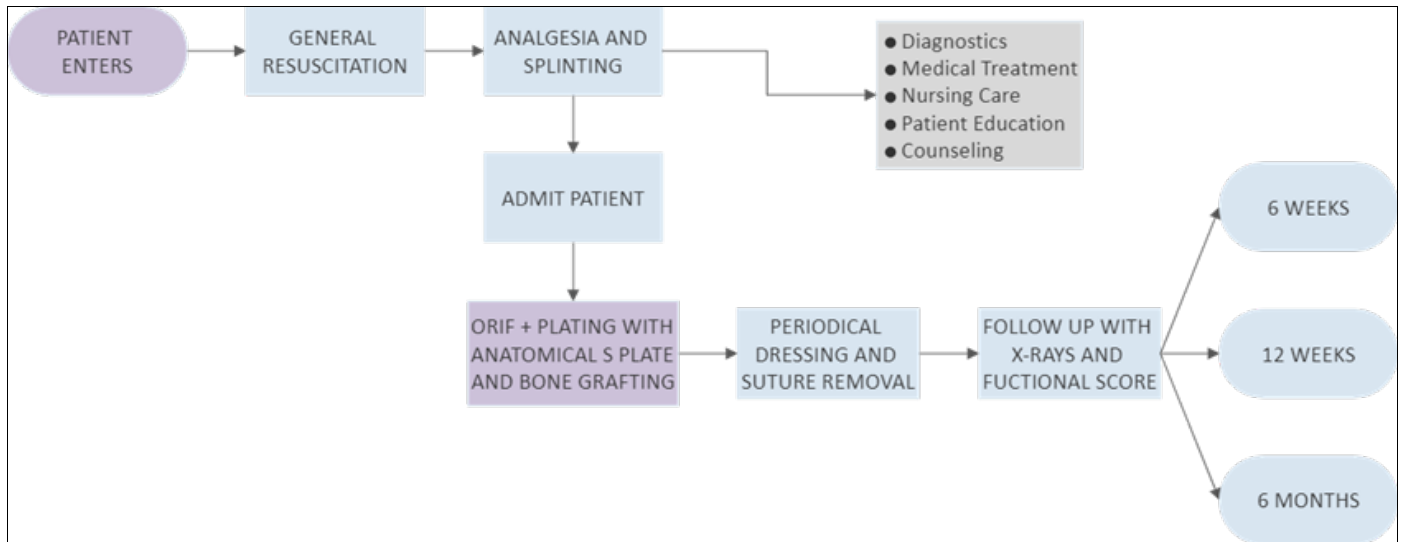


Fig 2: Methodology

Results

Among 30 patients, most of the patients were between 31-45 years of age (53.3%) followed by 15-30 years (33.3%) and > 45 years (13.3%) respectively, with the mean age of 35 years. There were 9 females & 21 males in our study. Mode of injury was RTA in all 30 patients. Out of 30, 16 patients had right side (53.3%) and 14 patients had left side (46.7%)

clavicular fractures.

Radiological outcome

In this study, fracture union was achieved in 29 individuals (96.7%) as early at 6 weeks. At 12 weeks follow up all patients included in the study showed union at the fracture site

Table 2: Distribution of patients based on radiographic findings

Follow-up	No signs of union n (%)	United n (%)	Total n (%)
6 weeks	1 (3.3)	29 (96.7)	30 (100)
12 weeks	0 (0)	30 (100)	30 (100)
6 months	0 (0)	30 (100)	30 (100)

Functional outcome

DASH score at 6 weeks showed minimum of 50 & maximum of 82 with a mean of 67.27 (7.524 standard deviation). Constant shoulder score at 6 weeks showed minimum of 17 & maximum of 27 with a mean of 22.43 (2.635 standard deviation). DASH score at 12 weeks showed minimum of 14 & maximum of 28 with a mean of 21.07 (3.619 standard

deviation). Constant shoulder score at 12 weeks showed minimum of 11 & maximum of 20 with a mean of 14.27 (2.9 standard deviation). DASH score at 6 months showed minimum of 6 & maximum of 15 with a mean of 10.97(2.297 standard deviation). Constant shoulder score at 6 months showed minimum of 3 & maximum of 9 with a mean of 5.67(1.863 standard deviation)

Table 3: DASH and constant scores during follow up period (n=30)

Follow up period	Mean 1 (standard deviation)	Mean 2 (standard deviation)	p-value (paired sample test)
Dash Score			
6 weeks-12 weeks	67.27 (7.52)	21.07(3.61)	0.01
12 weeks- 6 months	21.07(3.61)	10.97 (2.29)	0.01
6 weeks- 6 months	67.27 (7.52)	10.97 (2.29)	0.01
Constant shoulder score			
6 weeks-12 weeks	22.43 (2.64)	14.27 (2.90)	0.01
12 weeks- 6 months	14.27 (2.90)	5.67 (1.86)	0.01
6 weeks- 6 months	22.43 (2.64)	5.67 (1.86)	0.01

Complications

In 4 (13.3%) patients hypertrophied scar was noted. One patient developed deep wound infection on postoperative day 5 for which patient taken up for wound debridement and wound culture showed MRSA growth for which sensitive antibiotics started. In spite of wound debridement and IV antibiotics, in spite of infection fracture union achieved at 12 weeks. Due to the persistence of infection, implant removal done at 3 months post primary surgery. 6 patients had implant irritation due to the prominent hardware.

Discussion

Clavicle fractures, one of the most common fractures of the adult population are often treated non-operatively. The deforming forces, the degree of comminution and overriding causes shortening of the clavicle. Shortening more than 2 cm influences the outcome in the midshaft clavicle fractures [13]. In clavicle fractures, the major determining factor for restoration of function is the restoration of clavicular length. As early as 1790, Therselben described that the chief function of clavicle is to keep the shoulder blade away from the axial skeleton which helps in proper functioning of the shoulder [14]. His postulates were confirmed by our study with the

restoration of clavicular length after surgery resulting in better functional outcome. For a long period of time clavicle fractures were traditionally managed non-operatively. There was unanimous thought to treat these fractures non-operatively with a simple sling or figure of 8 bandage. Based on review of various recent studies on the management of clavicle fractures by non-operative methods, the effectiveness of non-operative management was found to be deficient in providing optimal outcome particularly in young population and had unsatisfactory results [15]. Recent studies suggest that operative management of middle third clavicle fractures resulted in lower non-union rates, improved functional outcome, faster mobilization, better cosmesis and increased patient satisfaction [16, 17].

In our study, the DASH scoring was done after surgery at 6 weeks, 12 weeks and 6 months in patients with mid shaft comminuted clavicle fractures and the mean score values are 67.27, 21.07 and 10.97 respectively. The difference in mean at various study intervals was statistically significant ($p < 0.05$). The Constant scoring was done after surgery at 6 weeks, 12 weeks and 6 months in patients with mid shaft comminuted clavicle fractures and the mean score values are 22.43, 14.27 and 5.67 respectively. The difference in mean at various study intervals was statistically significant ($p < 0.05$). In this study patients with mid shaft comminuted clavicular fractures treated with ORIF + plating with anatomical S plate and bone grafting showed high rates of fracture union with good long-term functional outcomes with DASH and Constant shoulder score. This led to significantly shorter time to fracture union in patients with mid shaft comminuted clavicle fractures. However 6 patients complained of prominent hardware, not necessitating removal. One patient had deep infection who underwent wound debridement followed by implant removal. The fracture united in all 30 patients with high patient satisfaction on the Disability of the Arm Shoulder and Hand (DASH) score and constant shoulder score.

Conclusion

In this study, all mid third comminuted clavicle fractures treated with open reduction and internal fixation with anatomical S plate and primary bone grafting had united early with excellent functional outcome assessed by DASH and Constant shoulder score. Patients had excellent radiological outcome with no complications like delayed union or non-union. Since it is a descriptive study, comparative study using controls and larger sample size would be a better option to analyze the outcome of this surgical procedure.

Case illustration



Fig 3: Case illustration 1



Fig 4: Case illustration 2

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