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ORIGINAL ARTICLE

Clinical Outcomes of Treatment of Mid-Shaft Clavicle Fractures Using Anatomical Plating

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ABSTRACT

BACKGROUND

Clavicle fractures are among the most common fractures in traumatic injuries around the shoulder girdle. Different treatment options are tried for its management, which include conservative as well as operative. Open reduction and internal fixation have become the mainstay of treatment for most midshaft clavicle fractures as this method restores the normal anatomy and biomechanics of the clavicle. This prospective study evaluated the effectiveness of anatomical pre-contoured plates in clavicle fractures.

METHODS

This study was carried out on a total of 40 patients above 18 years. The functional outcome was evaluated postoperatively using the Constant and Murley scoring system, which is based on eight parameters, namely: pain, activity level, arm positioning, the strength of abduction, forward flexion, lateral elevation, external rotation, and internal rotation.

RESULTS

There were thirty-one males and nine females with a mean age of 34±14 years. Six patients had associated injuries. The mean duration of surgery was 66±15 minutes. All fractures united in anatomical position and complications were noted in eight patients. Three patients had hardware prominence, one developed a postoperative infection, one had local hypoesthesia, two had a hypertrophic scar, and one had a hardware failure. At the end of the study, 75% of patients had excellent results with an overall Constant shoulder score of 90.9.

CONCLUSION

This study shows that displaced midshaft clavicle treated with pre-contoured plate osteosynthesis gives an anatomical reduction, early return to pre-injury level activity, and excellent functional results in most patients.

KEYWORDS

Clavicle fractures, Constant-Murley score, Pre-countered plating

INTRODUCTION

Clavicle fractures are common, accounting for 2.6 % to 4.0 % of adult fractures and representing 35% to 44% of injuries to the shoulder girdle.[1-3] Due to its biomechanics and unique shape and configuration, the central third is the weakest, with 69.2% to 81.3% of fractures occurring in this region.[2,4] Traditionally, these fractures were managed non-operatively with a sling or figure-of-eight bandages.[5,6] However, recent studies highlight increased risk of nonunion, symptomatic malunion, and poor functional outcomes with conservative treatment, particularly in displaced midshaft clavicle fractures.[7,8]

Functional outcomes of midshaft clavicle fractures depend on both bone union and length, as shortening deformities from malunion can impair shoulder function.[9-11] A decrease in mechanical efficacy is seen in shoulder girdle musculature, particularly affecting athletes if the shortening is more than 15 mm due to a change in the length-tension relationship.[12] While surgical fixation has potential complications, including implant failures, scars, and hardware irritation, it offers benefits such as improved functional outcomes, low nonunion rates, and early return to activities.[13]

Current trends favor surgical management of displaced midshaft clavicle fractures using plates or intramedullary implants, with plating showing lower nonunion rates but some risk of implant prominences and scar-related concerns.[7,14,15] Given the clavicle's role in shoulder biomechanics, abnormalities may alter kinematics, impacting overall function.

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This study aims to evaluate the functional outcomes of midshaft clavicle fractures treated with anatomically countered plates using the Constant scoring system, assessing their impact on shoulder function.

METHODS

A prospective clinical study was carried out on 40 patients with midshaft clavicle fractures who attended the Outpatient department and Emergency department of Manipal College of Medical Sciences from September 2017 to August 2019. The sample size was calculated by using the following formula,

$N = (Z\alpha/2)^2 pq/d^2$

N= Number of sample size estimated

Z= Standard normal deviate: usually set at 1.96, which corresponds to a 95% confidence level

p= Proportional in the target population estimated to have particular characteristics

q= 1-p

d degree of accuracy required

In my study,

p=0.026 [1]

q= 0.974

d= 0.05

N= 38.91= 39

Hence, we decided to take a sample size of 40.

Ethical Clearance was taken from the Institutional Review Committee (incorporating Ethics and Research Committee) and Post Graduate committee, Manipal College of Medical Sciences. This study includes all patients with completely displaced midshaft fracture of the clavicle, ages above 18 years, type I and II open fracture, patients fit for surgery, and who provided informed consent.

Those aged less than 18 years with fractures in the proximal or distal third of the clavicle, pathological fracture, and those who were unable to comply with follow-up were excluded from this study. After informed and written consent for the study was obtained from each selected patient, a careful physical examination was done. Plain radiographs (Fig. 1) of the injured clavicle were usually sufficient for diagnosis and planning of surgery.

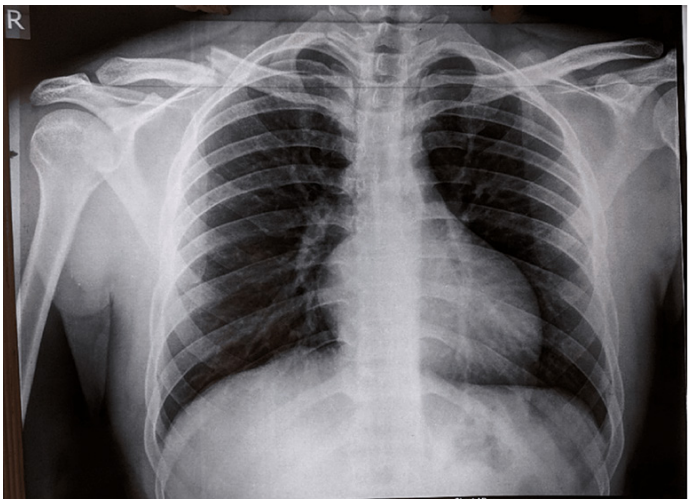

Fig. 1: Pre-operative X-ray showing mid-shaft clavicle fracture

Surgery is performed under general anesthesia, and the patient was placed in a beach chair position on a regular operation table. A superior oblique skin incision was made centered over the fracture site. After fracture reduction (Fig. 2a) anatomical pre-contoured plate of proper length was then applied to the superior surface and fixation was done with screws (Fig. 2b). Following fixation, soft tissue layers were closed with interrupted, absorbable sutures. The subcutaneous layer was sutured with a non-absorbable suture (Fig. 2c), which was removed after 14 days postoperatively. Patients were shifted into the recovery room, where the postoperative radiographs were taken (Fig. 2d).

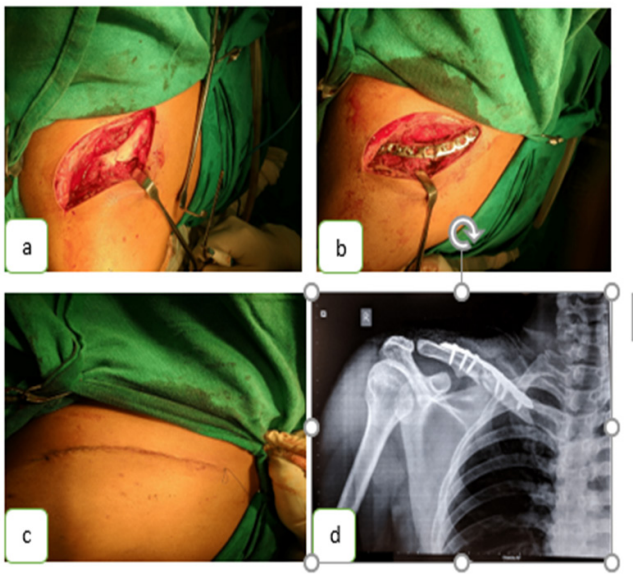

Fig. 2: Intraoperative pictures showing: a) clavicle fracture reduction; b) anatomical pre-countered plate application; c) skin after final closure; d) post-operative X-ray

The operation time was recorded. An intravenous antibiotic for 3 days, along with an analgesic as per requirement, is administered. The application of an arm sling for comfort and dressing of the surgical wound twice a week was advised. The patient will be hospitalized for five days. Postoperatively, gentle pendulum exercises were prescribed. The Constant Score was noted at 6 weeks, 12 weeks, and 24 weeks post-operatively.

RESULTS

The flow of participants is shown in Figure 1. The mean age of the selected 40 patients was 34.55 ± 14 years. Among them, 31 patients were males, and 9 were females. Twenty-two patients had right-sided clavicle fractures, and 18 patients had left-sided clavicle fractures. Thirty-one patients sustained clavicle fractures due to a fall on the shoulder, 5 patients gave a history of a fall on an outstretched hand, and 4 patients had clavicle fractures due to a direct blow on the shoulder. All patients were operated on within 15 days of trauma with a mean duration of 2.57 ± 3 days. Thirty-six patients were operated on within 5 days, three patients within 5-10 days, and one patient between 10-15 days of injury. Fourteen patients had associated injuries to the chest and head. The mean duration of surgery was 66.82 ± 15 minutes, and the mean duration of hospital stay was 3.75 ± 1 day. Most operated patients returned to pre-injury level of activity within 16 weeks of surgery except for one patient who developed complications such as hardware failure

(Table 1).

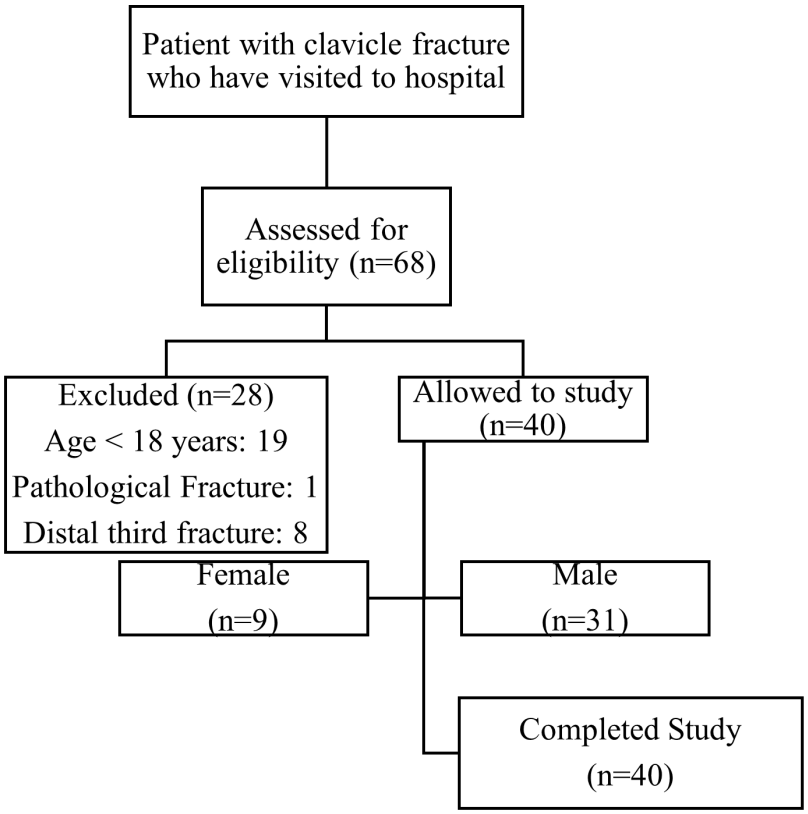

Fig. 3: Flow of participants

Table 1: Distribution of patients returning to work following surgery

Durations(weeks)	Number of Patients	Percentage (%)
4-6	1	2.50%
6-8	4	10%
8-10	8	20%
10-12	15	37.50%
12-14	9	22.50%
14-16	2	5%
>16	1	2.50%

Eight patients from our study developed postoperative complications. Three patients (7.50%) had hardware prominence, 1 (2.50%) patient developed the postoperative infection, 1 (2.50%) had local hypoesthesia, two (5%) patients had hypertrophic scar, and 1 (2.50%) had hardware failure (Fig. 4).

According to the 100-point scoring system of Constant and Murley, the mean constant Score for the shoulder was found to be 79.25 ± 6 at 12 weeks' follow-up and 90.9 ± 7 at 24 weeks' follow-up. At the end of 12 weeks, 23 patients had good results, 15 cases had fair results, and 2 patients had poor results. At the 24-week follow-up, 30 patients had an excellent result, 8 patients had a good result, and 1 case had a fair result. Only one case had a poor result.

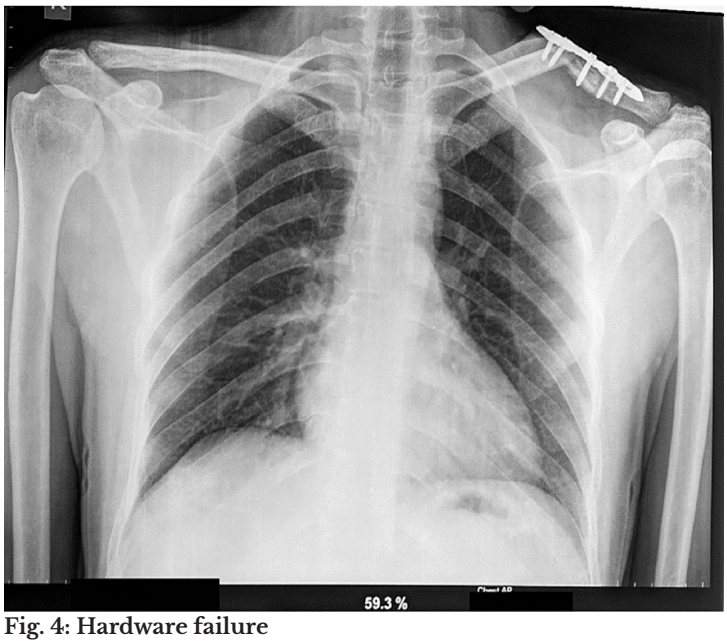

Fig. 4: Hardware failure

DISCUSSION

With previously purposed treatment modalities, it is difficult to provide rigid fixation and early mobilization, and still, there is a dilemma regarding the optimal treatment of the fracture. Various methods of surgical treatment are there which include plate and screw fixation and Titanium elastic nailing systems but we have

used an anatomically pre-contoured locking plate that aids to provide rigid fixation, allows early mobilization, and secures bony union.

The first to describe the treatment of clavicular fractures were the Ancient Egyptians in the Edwin Smith Papyrus in 1600 BC, which was a copy of an older document that originated around 3000 BC. In this writing, a construction similar to the now-called "figure-of-eight" bandage is explained.[16] Later in 400 BC, Hippocrates recognized that the treatment of clavicular fractures may pose a challenge. He suggested using compresses and bandages, even though he knew that these materials would not keep the fracture in place and the fracture would finally heal itself.[17]

Conservative measures had been used traditionally by Neer and Rowe in the 1960s for the treatment of midshaft clavicle fractures with a very small incidence of nonunion rate in their studies (0.1% and 0.8% respectively).[6,18] However, in the study done by Zlowodzki et al., among 1145 clavicle midshaft fracture cases, the nonunion rate was higher, i.e., 6%, and further increased in its rate in severely displaced cases.[15] In the same study, the nonunion rate is only 2 % when operated. Robinson CM et al.. also demonstrated that fracture union is related to the extent of its displacement.[19]

A randomized controlled trial (RCT) published in 2007 by the Canadian Orthopaedic Society further strengthened surgeons' preference for treatment with plate fixation for displaced midshaft clavicular fractures, as the RCT showed less non-union and better functional scores in the operative treatment group.[7] The scapulothoracic to glenohumeral movement ratio is 1:2 as per the kinematics of the shoulder joint. These two articulations with an axial rotation of the clavicle act as a bridge that connects the shoulder girdle to the torso. So, the clavicle is part of this complex joint, and disturbance to any one component of the joint will hamper the normal rhythmic movement of the joint [20]. After 90° of humeral elevation, for every 10° of humeral elevation, there is 4° of clavicular elevation with some rotation. So, shortening with malunion will affect the normal kinematics of the shoulder joint and may lead to a possible increased risk of glenohumeral arthritis.[21] Hill et al.. demonstrated that shortening more than 2 cm is associated with poor outcomes when managed with conservative treatment.[10]

A meta-analysis of randomized control trials by McKee MD et al and Ladermann observed that the functional outcome is excellent following the treatment of both fresh and old ununited clavicle fractures, but recovery occurs earlier following acute treatment with early mobilization protocol and it can be safely recommended for both types of conditions without increasing complication rate and decreasing patient satisfaction.[8,22] The use of an anatomically pre-contoured plate with a locking principle added more beneficial outcomes in comparison to a reconstruction plate as it promotes more rapid union with less periosteum stripping. The plate is not necessarily compressed onto the bone for stability which preserves the periosteal blood supply and the plate thread and locking principle will prevent screw loosening or instability.[23]

Brachial plexus injuries and injuries to the subclavian artery could be major complications following surgical management, but none occurred in our study. Unfortunately, hypertrophic scar could be a complication for patients who undergo surgical treatment which could be addressed by improving surgical techniques which were seen in one of our patients. Hardware failure and local hypoesthesia can occur following operative fixation.[24,25]

Our mean Constant score was 90.9±7 in patients at 24 weeks' follow-up. The Constant Score following operative fixation access pain, activity level, arm positioning, strength, and range of motion. Operative fixation following plate fixation shows a better outcome and overall improvement in the Constant score.[25]

This study has some limitations, including a small sample size (40 patients), a short follow-up period (24 weeks), and potential selection bias, as only patients fit for surgery were included. Being a single-center study, the findings may not be fully generalizable to diverse populations or different healthcare settings. While the results specifically apply to displaced mid-shaft clavicle fractures, they cannot be extrapolated to non-displaced or other clavicle fracture types. However, the study has notable strengths, including a high follow-up rate with no reported loss to follow-up, ensured through strategies such as detailed patient information collection, maintaining constant contact with patients, and providing free investigations for participants. Additionally, the use of the validated Constant-Murley Score for functional assessment and a standardized surgical approach using anatomical pre-contoured plates further strengthened the study's reliability.

CONCLUSION

Study findings indicate that surgical fixation provides stable fracture union, restores clavicular anatomy, and allows an early return to pre-injury activity levels. At 24 weeks postoperatively, the majority of patients demonstrated excellent functional outcomes based on the Constant-Murley Score, with minimal complications. Despite these promising results, the study is limited by its small sample size and short follow-up duration. Future research with larger, multicenter trials and longer follow-up periods is necessary to further validate these findings and assess long-term complications, implant-related concerns, and patient-reported outcomes.

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