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INTRAMEDULLARY FIXATION OF MIDDLE-THIRD CLAVICLE FRACTURES USING TITANIUM ELASTIC NAILS – A RETROSPECTIVE STUDY

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Abstract:

Background: Middle-third clavicle fractures in adults have traditionally been treated nonoperatively. Recent studies in the literature have shown a higher prevalence of symptomatic malunion, nonunion, and poor functional outcome after nonoperative treatment of displaced fractures. The purpose of this study was to evaluate the results of intramedullary fixation with titanium elastic nails of displaced middle-third clavicle fractures in adults.

Materials and Methods: Adults who sustained closed middle-third clavicle fractures between Oct 2013 and Sep 2014 were identified in operation theatre register of our institution. Medical records were reviewed for patient demographics, injury characteristics, treatment, and outcomes.

Results: Twenty-two consecutive patients (mean age 45.3y) with 23 closed middle-third clavicle fractures were identified. All twenty-two patients were treated operatively with titanium elastic nail. The average shortening at injury was 26.5mm in the operative group. Five fractures were reduced in closed manner and 18 fractures had to be opened at the time of operation. The mean time to radiographic union was 12.8 weeks. There were no nonunions. The mean time to return to activities was 16 weeks. Complications were reported in 8 patients. Second operation was required in 7 patients.

Conclusions: Intramedullary fixation of displaced middle-third clavicle fracture reliably restores length and alignment. It resulted in shorter time to union with low complication rates. Most complications were related to symptomatic hardware.

Key words: *Middle-third clavicle fractures (MCF), titanium elastic nail (TEN), intramedullary fixation (IF)..*

Introduction

Clavicle fractures are common injuries accounting for 8-10 % of all fractures.[1] Middle-third fractures comprise upto 80% of these injuries.[2,3] Management of these fractures remains controversial. Three treatment options exist namely conservative, plate fixation and intramedullary fixation. Because these fractures are common, and treatment of these fractures is controversial that makes them really important.

Functional results of middle third clavicle fractures are not only related to its union but also to its length. Clavicle acts as "stick" which keeps upper limb away from the rib cage and helps in function of upper limb and shoulder. Displaced MCF carries a risk of malunion, painful nonunion and poor functional outcome. Rarely projecting bone fragments threaten to pierce the skin. Recent meta-analysis favoured operative fixation citing fewer nonunion rates. There is little evidence to choose between plate fixation and intramedullary nail fixation.[4] Titanium elastic nail appears to provide minimal complication and high success rate for the surgical treatment of non-comminuted displaced clavicle shaft fractures.[5] A baysenian network meta-analysis suggested that intramedullary pin fixation is the optimum treatment method for displaced midshaft clavicle fracture because of the low probabilities of nonunion and infection.[6]

The aim of this study was to assess the effectiveness of antegrade TEN for the treatment of middle third clavicle fractures and to compare its outcome results of plate fixation from literature.

Material and Methods

23 displaced middle-third clavicle fractures in 22 patients operated between October 2013 and Sep 2014. Of these 23 fractures were included in the study. This retrospective study was approved by the local ethical committee. Inclusion criteria for this study were unilateral or bilateral MCFs (AO classification B1 and B2) with a displacement of more than shaft width, shortening by over 2 cm or threat of skin perforation at the fracture ends. Our exclusion criteria were (1) moderate to severe head injury (Glasgow coma scale <12); (2) multitrauma patients; (3) open fractures; (4) pathological fractures; (5) fractures of >1 month duration; (6) segmental fracture; (7) fractures with associated neurovascular injury; (8) Patients with preexistent morbidity concerning arm, shoulder or hand; (9) patients who refused to participate in the study. All the patients included in the study were operated within 2 weeks from the date of injury.

Operative procedure

After general anesthesia, patient was placed in supine position. The sternoclavicular joint was palpated. We used image intensification in 45°-cephalad and 45°-caudal directions. This provided us with images in two-planes, 90° apart. A small incision was made approximately 1 cm lateral to the sternoclavicular joint. The anterior cortex was opened using a sharp, pointed awl. A TEN was introduced. Before introduction, the original small and flat curved nail tip was straightened so that I can negotiate in the small medullary canal of clavicle. [Figure]. Closed reduction was performed under image intensifier guidance using two percutaneously introduced pointed reduction clamps [Figure] If closed reduction was not successful , an additional incision (miniopen) was made above the fracture site for direct manipulation of the main fragments. The nail was then advanced manually (not hammered) until it was just medial to the acromioclavicular joint. While advancing the nail we were careful not penetrate the thin dorsal cortex. After reaching the end point, the fracture was compressed and the nail was cut near the entry point to minimize soft tissue irritation. The fascia and skin were closed in layers.

Results

At the end of the study, we had 22 patients. There were 18 male and 4 female patients.. The mean age was 45.3 years (range 15-53 years). The trauma surgery delay was 7.84 ± 3.90 days. 12 fractures were AO class B1 and 11 were AO class B2 fractures. . Out of the 23 fractures, a nail diameter of 2 mm was used in 6 fractures, 2.5 mm in 13 fractures and 3 mm in 4 fractures. Closed reduction and nailing was achieved in 5 fractures and open reduction was done in 18 fractures. Patients were followed radiologically at 6 weeks; 6, 12, 18 months. Clinical evaluation was done at 6, 12 and 18 months. Patients with a minimum follow-up of 18 months were included in the study. The mean follow-up period was 22 months (range 19-25 months). The constant scores improved between 6 to 12 months and did not change thereafter. At final evaluation, 16 patients had excellent and 6 patients had good results.

Complications

Eight patients had one or the other complication. (Table 1) One developed hypertrophic callus and seven patients had medial hardware prominence. An important, although minor, complication was the medial prominence of hardware causing skin

irritation or perforation, which was noted in 7 patients (30.43%). In the literature, it is reported to be in the range of 5.2-38.8%.[7,8,9] Two causes for medial hardware prominence are discussed in literature.[10] Inadequately cut medial end of the nail at primary surgery and nail displacement due to secondary clavicle shortening or telescoping. The first cause, being a surgeon related factor, may be tackled after primary surgery by adequately cutting the nail. The second cause is somewhat difficult to address however can be minimized by anatomical reduction, intraoperative compression and avoiding shoulder abduction beyond 90° in the first 2 weeks postoperatively.[11]

Harrasser N et al have reported a case report of clavicular nonunion and bent TEN due to repeat trauma.[12] We did not encounter such complication in our series as all of our cases went onto clinical and radiological union. But, we recommend rigorous follow-up of patients after operative intervention of clavicle fractures and manage nonunion, if detected.

Table 1: Complications

Name of complications	Number of cases
Hypertrophic callus	1(4.35%)
Medial hardware prominence	7(30.43%)

Table 2: Constant Score

Postoperative period	Mean Score
6 months	86.81
12 months	91.27
18 months	91.65

Table 3: Mean value

Variable	Mean Value
Radiographic Union (weeks)	12.8
Operative time (min)	45.19 +/- 16.24
Blood loss (ml)	52.34 +/- 42.53

Table 4: Average shortening

AO type	Number	Shortening
B1	14	5.1+/-2.5
B2	9	8.6+/-4.2

Discussion

Conventionally, midshaft clavicle fractures had been treated nonoperatively. Neer and Rowe in the 1960's recommended conservative treatment for clavicular fractures in view of very small incidence of nonunion rates in their studies (0.1% and 0.8% respectively). No one has been able to reproduce these results till dates.[13,14] Of late, studies have shown significantly higher nonunion rates in conservatively treated patients (ranging between 10% and 15%).

Nowadays, many authors favour operative treatment for displaced midshaft clavicle fractures.[4,5,6,15] Several options are available for the surgical treatment of clavicle shaft fractures, including plating and nailing. Plating is the most commonly used surgical treatment; however, plating requires relatively extensive periosteal stripping, which may increase destruction of the blood supply at the fracture site, thus hindering fracture healing. Stress shielding produced by rigid plates can lead to an 8% refracture rate after plate removal. Surgical time is considerable, and infection rates of up to 18% have been reported. Additionally, the relatively long scar can be a cosmetic issue in some patients, and some individuals experience discomfort induced by the plate underneath the skin. Fixation with TENs, though a newer therapeutic method, provides fixation that is more consistent with the physiologic bone structure to permit early functional exercise, leads to faster functional recovery, provides early pain relief and avoids the complications associated with longer operating time and periosteal stripping.

In this study, we evaluated the results of antegrade IM fixation with TEN. Anatomically, the clavicle has an irregular S shape. Titanium elastic nails, manufactured from titanium alloy, are elastic enough to match the shape of the medullary cavity and strong enough to stabilize the fragment ends. Their curved tip facilitates nail passage within the medullary cavity and allows it to be anchored to the distal cortex and fit tightly to the inner wall of the cavity, thus improving fixation stability. When placed, each nail provides 3 points for support within the medullary canal to effectively control rotation, angulation and shortening of the fragments. Clavicular lengths were significantly better maintained by TEN in our study, in AO type-B1 fractures as compared to AO type B2 fractures .[Table 4]. However, this much of clavicular shortening does not affect functional outcome significantly, because as per Lazarides and Zafiropoulos, only clavicular shortening of more than 18 mm in males and of more than 14 mm in females results with unsatisfactory outcome.[16] Eventually, in comminuted MCF or those with large butterfly fragments plate fixation remains the operative procedure of choice as it maintains clavicular length in better way.

In this study, we found that limited open reduction and internal fixation with TENs in the treatment of midclavicular fractures in adults resulted in a high fracture healing rate, rapid functional recovery and minimal complications. The procedure is minimally invasive and achieved high patient satisfaction. All 22 patients had good to excellent results in our study. Overall, there were no unsatisfactory

results in our study, whereas the incidence of unsatisfactory results after operative treatment of MCFs is 5.3% in literature.[17] The average time to achieve union in this study was faster. This can be explained by the less soft tissue dissection in patients operated using TEN. The plating provides absolute stability resulting in primary bone healing, whereas TEN provides relative stability leading to secondary bone healing by callus formation. Our study, with a mean follow-up of 22 months, revealed union in all 23 fractures in 22 patients and the final mean Constant score was 91.65.

Wang et al in their metaanalysis on clavicle fractures had nonunion rates of 0.9%, 2.4%, and 11.4% for intramedullary pin fixation, plate fixation, and conservative method, respectively.[6] Nonunion occurred more commonly in patients treated with conservative method than in patients treated with either plate fixation or intramedullary pin fixation . There was no significant difference between plate and intramedullary pin fixation in nonunion. Infection rates were 3.6% and 3.9% for intramedullary pin fixation and plate fixation, respectively. There was no significant difference between plate and intramedullary pin fixation in infection. Their network meta - analysis suggested that intramedullary pin fixation is the optimum treatment method for displaced midshaft clavicle fracture because of the low probabilities of nonunion and infection.

The limitation of our study was a small sample size. However, from this study, we recommend the use of minimally invasive antegrade TEN for fixation of displaced midshaft clavicle fractures in view of faster fracture union, lesser morbidity, easier implant removal and fewer complications; although for comminuted fractures plating remains the procedure of choice. Another limitation of our study was that we did not compare our results with plate fixation.

Conclusion

Intramedullary fixation of displaced midshaft clavicle fracture reliably restores length and alignment. It resulted in shorter time to union with low complication rates. All complications were related to symptomatic hardware.

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