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Tens for clavicle fractures: A surrogate method

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Abstract

Background: Fractures of the clavicle are common injuries with an incidence of 5-10% of all fractures. These fractures are generally managed conservatively. Most commonly, these fractures occur within the middle third of the clavicle and with some degree of displacement. Most fractures of the medial or lateral end of the clavicle can be treated nonsurgically if fracture fragments remain stable. Surgery may be required in cases of neurovascular compromise or significant fracture displacement. Fractures that require internal fixation are treated by plate osteosynthesis as the standard procedure. Intramedullary Nailing (TENS) is an increasingly popular alternative for the internal fixation of displaced mid-clavicular fractures.

Material & methods: A study of 50 cases was conducted at Department of orthopaedics, ESIC Kalaburagi & Kamareddy Ortho& Trauma Care Hospital Kalaburgi, Karnataka from 1st May 2015 to Sept 30th 2016. These patients underwent flexible intramedullary nailing with titanium elastic nail (TENS). Clinical and radiological assessments were performed at regular intervals. Implant removal was performed in all the patients after the fracture united completely/3-4 months period due to pain.

Results: Length of incision, operation time, blood loss and duration of hospital stay were significantly less for the TENS. Easy implant removal and fewer complications. Its a simple procedure with excellent functional outcome in terms of quick return to daily activities and a high patient satisfaction rate

Conclusion: Intramedullary nailing (TENS) of displaced midclavicular fractures is a safe, cosmetically preferred, minimally invasive technique with fewer complications, excellent functional results and early pain relief. It is an equally effective Surrogate method to plate fixation in mid-clavicular fractures.

Keywords: Clavicle fractures, intramedullary clavicle nailing, middle 1/3rd clavicle fractures, minimally invasive, titanium elastic nailing system (TENS)

1. Introduction

“Midclavicular fractures heal without the doctor, with the doctor, and despite the doctor!”⁽¹⁾. Fractures of the clavicle are common injuries with an incidence of 5-10% of all fractures^[1-3]. Most commonly, these fractures occur at middle third of the clavicle and exhibit some degree of displacement. The average age of patients sustaining a midshaft clavicular fracture is 30 years; 65-70 % of the patients are male. Many midshaft clavicle fractures can be treated non-surgically. A fall or a direct blow to the shoulder, gives an axial compressive force on the clavicle, is the most common mechanism of injury for any clavicular fracture^[4, 5]. Mid-clavicular fractures are generally managed conservatively, e.g. with a figure-of-eight-bandage. Imminent perforation of the skin, impending or existing neurovascular compromise and the floating shoulder represent absolute indications for operative treatment. Gross displacement of fracture fragments, as well as non-unions, are seen as relative indications for surgical fixation. While fracture healing and functional outcome is generally good for non-operatively treated mid-clavicular fractures, a poor cosmetic result due to shortening and angulation is common^[6]. Non-unions occur in an average of 5%^[7] Furthermore, decreased shoulder function due to clavicular shortening of more than 1-2 cm after non-operative fracture treatment has been reported^[8].

The aim of this study was to evaluate the functional and radiological results of intramedullary fixation of mid-clavicular fractures.

1.1 Inclusion Criteria

- Closed mid-clavicular fractures.
- Lack of interfragmentary contact.

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1.2 Exclusion Criteria

- Clavicular fractures with marked comminution.
- Duration of more than 4 weeks.
- Open fractures.
- Pre-existent morbidity of the ipsilateral arm, shoulder or hand.
- Presence of neurovascular injury, and ipsilateral injuries.

2. Materials and methods

We analyzed the outcome of a consecutive series of 50 patients with mid-clavicular fractures that were treated with Titanium Elastic Nails (TENS) between 1ST May 2015 and 30TH September 2016 in Department of Orthopaedics, ESIC Medical College & Hospital Kalaburagi and Kamareddy Ortho and Trauma Care Hospital Kalaburagi, Karnataka.

Patients were selected according to inclusion and exclusion criteria. Informed consent was obtained. Only isolated closed fractures of the mid-clavicle (OTA 06-A/B) with a clavicular shortening of at least 1 cm and/or lack of interfragmentary contact were included. Patients between the age of 16-50 years for whom impairment of shoulder function would interfere with their activities were accepted for the study like young adult labourers, sports persons, or with police department recruitments. Patients were excluded if they had fractures with marked comminution, duration of more than 4 weeks, open fractures, pre-existent morbidity of the ipsilateral arm, shoulder or hand, presence of neurovascular injury, and ipsilateral injuries. Radiographs of the fractured clavicle were obtained in anteroposterior and 45° cephalic tilt views. No additional imaging was performed.

All patients with relative indications for surgical fixation were young; they did not want a brace and wanted to return to their pre-injury status as soon as possible. The intra-operative complication observed consistently was the difficulty in negotiating the nail at the lateral end of the clavicle as it curves posteriorly and flattens out laterally. Opening the fracture site with a two centimetre incision and use of a towel clip/reduction forceps aided in smooth passage of nail laterally.

Clinical examinations and radiological studies were performed on post-operative day 1, and follow-up at 6 weeks and at 3 and 6 months and after implant removal. Clavicular length was clinically measured when bony consolidation was evident (distance from the centre of the jugular fossa to the lateral tip of the acromion) and compared with the contralateral side. Functional outcome was assessed using the Constant shoulder score [9]. Implant removal was done once fracture site consolidation was evident or later after 3-6 months interval or earlier due to implant impingement on skin.

2.1 Surgical Procedure: The operation was performed under interscalene nerve block. Standard antibiotic single shot prophylaxis (Cefuroxime 1.5 g IV) was given. The patient was placed on a radiolucent operating table in the supine position. A sandbag was placed between the scapulae to provide extension of the shoulder. The whole ipsilateral upper limb was scrubbed to allow free movement of shoulder and arm during the procedure. Image intensifier(C-ARM) was used for the procedure. Small stab skin incision of about 0.5-1 cm was made just lateral to the sternoclavicular joint centred above the medial end of the clavicle (Fig. 1). The medullary canal of the clavicle was opened using a k-wire (3mm) about 1 cm lateral to the sternoclavicular joint. The k-wire was pointed laterally in-line with the clavicle and angled at about 30 degrees to the coronal plane. Care was taken not to perforate the opposite

cortex in order to avoid major complications. Once the medullary cavity was opened, a 3 mm bone awl was used to widen the entry point and a preselected TENS was carefully inserted. The nails had diameters between 2.0 and 3.0 mm according to the patient's dimensions. No reaming was necessary. The nail was fixed in a universal chuck with a T-handle and advanced with oscillating movements once the Titanium nail reached the fracture site (Fig. 3), closed reduction by direct pressure on the fragments combined with manipulation of the arm was performed. Usually, reduction was facilitated when a small pointed reduction forceps was applied percutaneously to the lateral fragment. (fig 3) The fracture was bridged using the rounded and angled tip of the Titanium nail to guide into the lateral fragment. To determine the exact position of the Titanium nail, fluoroscopy with true perpendicular views is crucial. In some cases, closed reduction was not possible so, a short skin incision directly over the fracture site (2 cm) with minimal dissection was used to reduce the fracture. The TENS was then pushed gradually into the distal part of the clavicle close to its extremity by oscillating it. The protruding medial end of the nail was left out of the cortex and shortened close to its entry point into the bone followed by wound closure. (fig 4)

After surgery, the patient was put on an arm sling & clavicular brace. All patients were started on passive shoulder mobilization exercises on the 2nd post-operative day. Check x-ray was done 3 weeks post-surgery to assess for alignment. Active mobilization was started 3 weeks after surgery. Arm sling was discontinued after 6 weeks.



Fig 1: A small skin incision of 1-2 cm is made parallel to the clavicle about 1.5 cm lateral to the sternoclavicular joint.



Fig 2: Radiographs showing-Pre-op fracture clavicle middle third-
fluoroscopic image after nail insertion

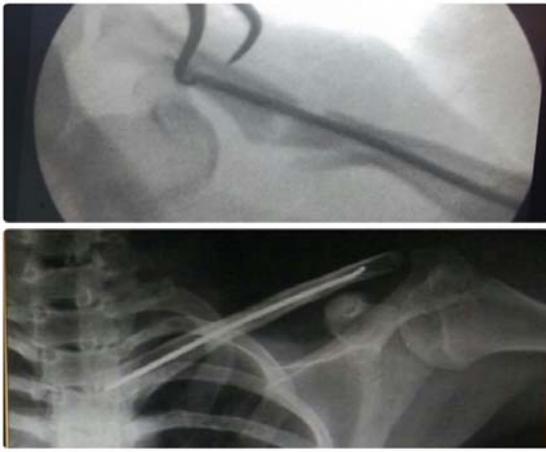


Fig 3: radiographs showing-Per-op manipulation of lateral fragment using towel clip-follow-up 6 months healed fracture.



Fig 4: picture of closure of incision

3. Results

A total of 50 patients (37 male, 13 female) qualified for the study according to the inclusion criteria between 05/2015 and 09/2016.

No potential candidate refused to enter the study by preferring non-operative treatment. Mean age was 30 years (Range: 12 to 60). The mechanism of injury was a direct trauma to the shoulder in 47 patients, 3 patients fell on their extended arm. Thirty Six fractures were caused by road traffic accidents and 14 were sports injuries. The fractures were graded according to the Orthopaedic Trauma Association classification (OTA). There were twelve 06-A1, eighteen 06-A2 and eleven 06-A3 fractures in our series. Wedge fractures were found in 09 patients (06-B2 and 3 06-B3 fractures). The operation was performed 6 days (1-26 days) after trauma. Only Titanium nail diameters of 2.0, 2.5 and 3.0 mm were used. Closed reduction was possible in 32 cases. A short incision of about 2 cm above the fracture site was necessary to obtain fracture reduction in 18 patients. Mean operation time was 45 minutes. Operation time was much shorter when closed reduction was successful compared with the open technique.

No correlation was found between reduction technique and fracture classification.

When the operation was delayed for more than 7 days, closed reduction was never achieved suggesting that patients benefit from an early intervention with better chances for successful closed reduction. A smaller implant should be chosen if it is not possible to advance the Titanium nail by oscillating movements only. No metal fatigue failure was observed with either size of implant. No other intraoperative complication occurred.

Hospital stay was 2.4 days (range: 1 to 5).

Post-operatively, painless shoulder range of movements was

possible in all patients. All the patients could be followed according to the study protocol. Mean follow-up was 16 months (range: 12 to 24). No infection or migration of the Titanium nail was observed. All fractures healed, except one with nonunion was observed. Time to healing was 7.7 Weeks (range: 6 to 12) Determined by visible osseous callus formation on the radiographs. Clavicular Shortening was 1.7mm (range: 0 to 7) compared with the contralateral side measured after fracture healing. Hardware removal was performed electively in 35 patients within 18 to 56 weeks after implantation (Mean: 29 weeks) as day cases. The Constant shoulder score averaged 80 (Range: 37 to 96) after 7 days. Mean Constant shoulder score was 96 (Range: 85 to 100) after 6 weeks. After 6 months and after hardware removal, all patients (n= 50) presented with basically normal shoulder function (Mean: 98, range: 93 to 100). Until the date of the last clinical follow-up (Mean: 16 months, range: 12 to 24) no re-fracture was observed. All patients returned to their activities within four weeks after the procedure.

4. Discussion

Mid-clavicular fractures in our country are being treated conservatively until date. Rowe^[10] and Neer^[2] in the 1960's recommended non-operative treatment, because they observed a very small number of non-unions. Conservative treatment subsequently became the standard procedure for the management of non-displaced and displaced mid-clavicular fractures as well. The treatment of displaced mid-shaft clavicle fractures has evolved over the past several years based on recent clinical studies demonstrating high rates non-union and symptomatic malunion with non-operative treatment^[9-12].

Also, more recent studies had observed satisfactory functional and radiological outcome after non-operative treatment. The indications for operative treatment were limited to skin perforation or tenting, gross displacement and associated neurovascular complications^[13].

Proponents of intramedullary fixation of clavicle fractures believe that this method of fixation avoids periosteum stripping and can be achieved through a smaller and more cosmetically acceptable scar than plating^[22].

However, in a retrospective review of cases, Grassi *et al*^[14], found that adverse events such as infection, re-fracture, and non-union occurred in 35% of patients undergoing intramedullary fixation; a significantly higher complication rate than non-operative treatment. Their method, however, involved a transverse incision much like the incision used for plating today, and they removed the pin within 60 days^[14].

Jubel *et al*^[15] have described elastic nailing of the clavicle from medial to lateral, with the lateral end of the clavicle closed to prevent migration in 55 patients. They described 1 non-union, requiring plating and 3 patients having their metalwork trimmed due to soft tissue irritation¹⁵. This may be because of a medial entry point, where there is little soft tissue cover.

The results regarding the outcome of conservative treatment of displaced mid-clavicular fractures nowadays, however, are seen in a more differentiated manner and they are controversially discussed.

Wick *et al*^[12] observed high rates of non-union, shoulder pain and poor functional results when the fracture had healed with shortening of more than 2 cm^[12, 17]. These findings were confirmed by Lazarides *et al*.^[16] and by Hill^[18]. These studies favour operative treatment of displaced mid-clavicular fractures by describing high rates of good and excellent results.

Although plate fixation provides adequate stability, Rowe *et al* [10] described complications like non-union, re-fracture or loosening of implants. Similar complications have been described with intramedullary pinning [17]. Minimally invasive elastic titanium nailing was established as an alternative to plate fixation [19, 20].

Jubel *et al* [15] showed that the correction of clavicular shortening is a pre-requisite of good functional outcome. They did not observe non-union or poor post-operative outcome.

In our study, intramedullary nailing (TENS) provided early functional recovery. Patients today have high expectations of the functional outcome. They expect rapid and pain-free functional recovery following a fracture. In contrast to conservative treatment, minimally invasive techniques can fulfil these objectives with a reduced rate of complications [21].

TENS however has its own complication rate: the sternal ends of the TENS can cause skin irritation and pain. Most of the patients complained about the nail prominence at the sternal end but tolerated it well till removal.

In summary, we believe that operative management of mid-shaft clavicle fractures with flexible intramedullary nailing is a safe procedure with excellent clinical and functional outcomes and can be considered as surrogate method to plating.

5. Conclusion

The treatment of middle-third clavicle fractures remains a subject of debate. Comparing with plate fixation, TENS is less invasive and requires smaller incisions. In comminuted fractures that are at risk of telescoping, plate fixation however remains the procedure of choice.

The data here demonstrates length of incision, operation time, blood loss and duration of hospital stay were significantly less for the TENS. Easy implant removal and fewer complications. It's a simple procedure with excellent functional outcome in terms of quick return to daily activities for daily wage labour & sports activities and a high patient satisfaction rate. Titanium elastic nails are a promising minimally invasive treatment for displaced mid-clavicular fractures, which can be considered as surrogate method to plate fixation (ORIF) or even non-operative treatment.

6. Acknowledgement

Consent: All patients have given their informed consent for the publication of this case series.

"The author(s) declare that they have no competing interests".

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Ethical clearance from the ethical committee has been obtained for the above study.

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