

ORIGINAL RESEARCH

Surgical management of mid clavicular simple displaced fracture by titanium elastic nailing system with its functional outcome

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ABSTRACT

Background: Fracture of the clavicle is common, accounting for 5 to 12% of all fractures. About 80 to 85% of these fractures are in the middle third of the bone. Fracture of clavicle are commonly seen by a fall on an outstretched hand or by direct injury. Clavicle fractures are common injuries in young active individuals especially those who participate in activities and sports where high speed falls or violent collisions are frequent and account for 2.6% of all fractures. The majority of clavicular fractures 80-85% occur in midshaft of the bone, where the typical compressive forces applied to the shoulder and the narrow cross section of the bone combine and result in bony failure¹. Displaced mid shaft clavicle fractures are common and are generally treated non-operatively. Non-operative treatment of these fractures with axial shortening is associated with non-union, delayed union, and mal-union & Other complications are severe pain, neurological complications, loss of shoulder function and protuberant callus forming swelling and stretching of skin which is cosmetically unacceptable¹

Materials and Method: This study was carried out at the Department of Orthopaedics, Navodaya Medical College, Raichur over a period of 2 years. In this study 30 patients (21 male, 9 females) with displaced mid clavicular simple fracture treated with titanium elastic nailing system Functional outcome was assessed as per constant & murley and cologne clavicle score.

Results: A total of thirty patients were evaluated in our study of which there were 23 males and 7 females. Out of all 30 patients, majority 23 cases (76.6%) had an excellent outcome., 6 cases (20%) Good outcome and only 1 patients (3.3%) is Fair outcome. Not a single patient had poor outcome according to constant & murley and cologne clavicle score.

Conclusion: Displaced Mid clavicular fracture treated with Titanium elastic nail (TENS) is an effective mode of treatment to restore the function in adult patients, consistently providing excellent results with minimal complications and is a safe option in treating clavicle fracture with good recovery despite, patients having several associated injuries.

Key words: Midshaft clavicle fracture, clavicle fracture fixation, Titanium elastic nailing system, intramedullary clavicle nailing, closed reduction clavicle

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Introduction

The clavicle is most frequently and easily fractured bone, due to direct blow or fall on the outstretched hand. Among of all fractures, incidence of clavicle fractures was contributed to 3-5%.¹ Various treatment

techniques are available for clavicular fractures.¹⁻⁸ An operative approach in trend, which consists of two main procedures namely open reduction & plating; and by intramedullary nailing through minimal access² Though plating technique is accepted as a standard

technique, it has some disadvantages like large scar, higher non-union rate and difficult application as well as problem with removal.² Whereas, intramedullary nailing of clavicular fractures is done by numerous techniques and multiple devices which have their own advantages and disadvantages.² Nowadays, due to breakage and migration of the plate, rigid fixation is not used³ First time a new technique Titanium Elastic Nail Systems (TENS) was presented by Jubel *et al* and currently it's being advocated though there are different opinions about its uses.³ Because of less complications, rapid union rate, easy insertion and removal, small scar and lack of breakage, some authors have recommended for its use.² Keeping above facts in mind, the present study was undertaken to assess the effectiveness of minimally invasive method Titanium Elastic Nails (TENS) for the treatment of midshaft clavicle fracture

Materials and Method

This study of 30 patients with mid-shaft clavicle fractures was conducted during the period between Jan 2021 to July 2022. in the Department of Orthopaedics, Navodaya Medical College Hospital and Research Centre, Raichur and were treated with titanium elastic nailing system.

Inclusion Criteria

Patients within age of 16-60 years., displaced middle third clavicle fractures (>2cm displacement). Fractures within the last 4 weeks with no cortical bone contact.

Exclusion Criteria Patients of age less than 16yrs. Fractures with marked comminution. Fractures older than 4 weeks. Pathological fractures.

Open fractures. Congenital anomaly or bone disease. High anaesthetic risk. Any medical contraindication for surgery.

Technique

Step 1: Procedure is performed with the patient either in a beach chair or a supine position with a pillow/bolster in the inter-scapular region that allows the shoulder to drop back helping to restore length and to facilitate the exposure of clavicle Local parts (including some part of same side upper limb) were prepared, painted and draped in a strict aseptic and antiseptic precaution.

Step 2: Using image intensifier, the entry point is obtained using a 2.5 mm drill bit in the anterior cortex of the medial clavicle 1.5 -2.0 cm lateral to the sternoclavicular joint. The entry point is enlarged with a small awl in a lateral direction to allow for ease of insertion.

Step 3: A 2.0 - 3.5 mm titanium elastic nail designed for intramedullary nailing is inserted with the aid of the universal T-handle chuck. The nail is manually inserted with oscillating movements under c arm and advanced to the fracture site.

Step 4: Pointed reduction clamps can be used either percutaneously or through small stab incisions, The tip of the nail is advanced as far lateral as possible without perforating the cortex. The medial end of the nail is then cut and buried subcutaneously

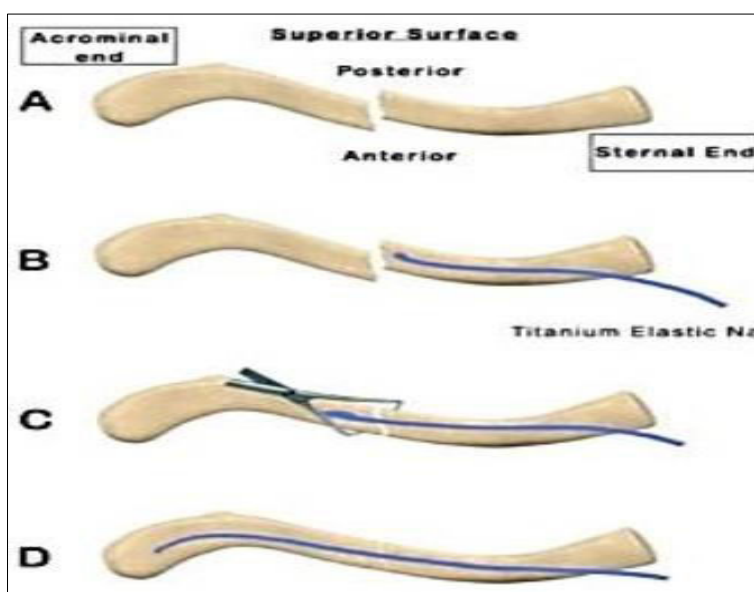


Fig 1: Technique of clavicle tens

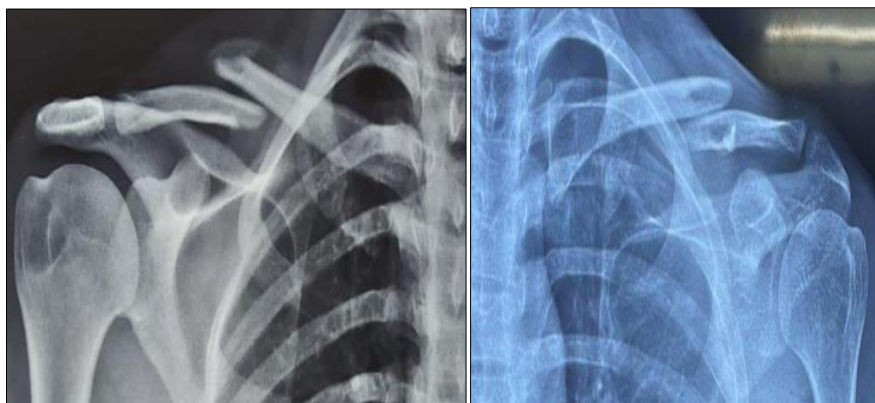


Fig 2: Pre-operative x-ray

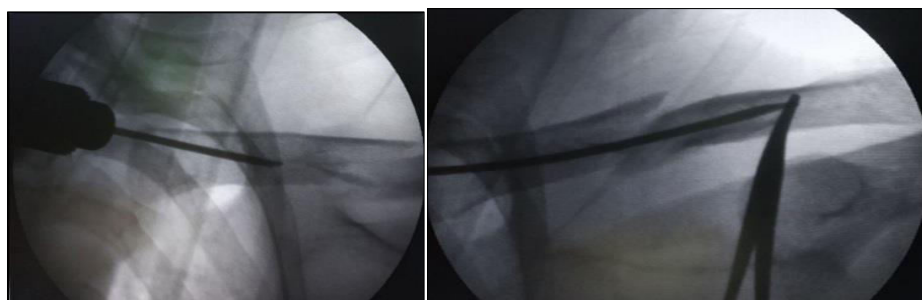


Fig 3: Intra-Operative C-Arm Image

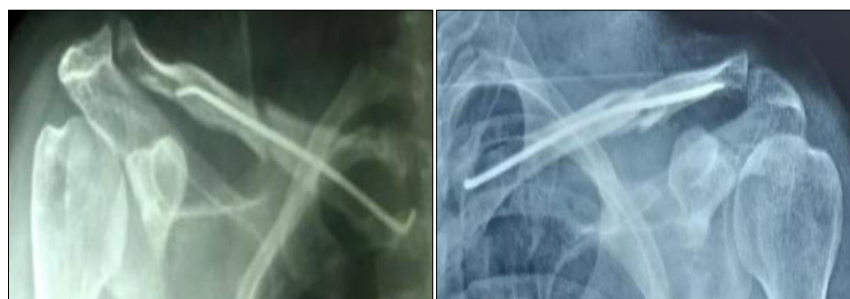


Fig 4: Post operative xray



Fig 5: x-ray at 14 weeks



Fig 5: Function outcome at end of study period -1. Flexion and Abduction,2. Adduction, 3. Internal rotation & Adduction



Fig 6: Complications -1. Medial end nail prominence., 2. skin irritation, 3. Superficial skin Infection

Post surgery collar-cuff sling or a shoulder immobilizer Overhead activity was restricted for 3 weeks. After 6 weeks when radiological union was seen, strengthening exercises were started

Results

-Majority 24 cases (80%) had final Constant and Murley shoulder score around 86 to 100, 5 cases (16.6%) had 71 to 85 score & 1 case (3.3%) had 56 to 70 score. 30 patients had full range of motion at final

follow up without any limitation. - Majority 24 cases (80%) had final Cologne Clavicle score between 0 to 3, 5 cases (16.6%) had between 4 to 8 score & only 1 case (3.3%) score was 10.

- Among 30 patients with middle third clavicle fracture treated with Titanium Elastic Nailing System, shows Excellent functional outcome was seen in 23 patients (76.6%) and good outcome in 6 patients (20%) and fair outcome in 1 patient (3.3%).

Table 1: According time Interval between Trauma & surgery

Time interval between trauma & surgery	Number of cases	Percent
<4 Days	16	53.3
4-7 Days	14	46.6
Total	30	100

Table 2: According to mode of injury

Mode of injury	Number of cases	Percent %
Accidental Fall	12	40
RTA	18	60
Total	30	100

Table 3: Distribution of cases According to nail size used

Nail size(diameter in mm)	Number of cases	Percent
3	3	10
2.5	18	60
2	9	30
Total	30	100

Table 4: Distribution of cases according to side affected

Side affected	Number of cases	Percent
Closed	16	53.3
Open	14	46.6
Total	30	100.0

Table 5: Funtional outcome according to constant & murley score and cologne clavicle score

Functional outcome	Number of patients	Percent
Poor	0	0
Fair	1	3.3

Good	6	20
Excellent	23	76.6
Total	30	100

Discussion

Clavicle fractures were usually treated conservatively. Rowe *et al* stated that mid clavicular fractures are underrated regarding disability and pain especially during the first weeks.⁶ Whereas, Hill *et al*, Nordqvist *et al*, Robinson *et al*, Suhail Ahmad Bhat *et al*⁴, found that conservative treatment of midshaft clavicular fractures had poorer results. In order to obtain good results with patient comfort and satisfaction various methods of fixation methods gained attention. This broadly can be divided into two plating and intramedullary nailing techniques (external fixation technique is rarely used). Among the surgical treatment methods locking compression plating is considered as the main stay of treatment currently. However, it had disadvantages like soft tissue stripping and exposure, supra clavicular nerve damage and slightly higher infection rates along with risk of re-fracture after plate removal.³⁹ To replace the LCP intramedullary nailing with various implants like Rockwood pin, Steinman pin, Knowles pin have been tried. But they were not effective enough to replace the LCP due to their inferior biomechanical properties. The newest intramedullary device showing similar biomechanical properties to a clavicle is an elastic nail made of titanium. The present study aims to see the outcome following TENS nailing in mid shaft clavicle fractures clinically, radiologically and functionally. This study with TENS for patients with midshaft clavicle fractures is compared with A) Meier C *et al* study with 14 cases treated with TENS⁴ B) Mueller M *et al* study with 31 cases treated with TENS⁴ and C) Radwan *et al* where 46 underwent TENS for mid shaft clavicle fractures

Mechanism of injury

In our study, majority cases 18 (60%) injury occurred due to road traffic accidents, 6cases (20%) as a result of fall on an outstretched hand, 3 cases (10.0%) due to fall and 3 cases (10%) due to direct trauma, whereas in Meier *et al* study showed direct injury to the shoulder in 13 patients, 1 patient fell on his extended arm, 10 fractures were caused by road traffic accidents and 4 by sports injuries⁴⁰ In Mueller *et al* study, 19 patients sustained their fractures in

highenergy impact traffic injuries such as car and motorcycle injuries. 8 patients performed sports, 1 patient attributed his injury to the direct impact of rolling trunks, and 2 patients fell after a vasovagal syncope.⁴¹ Radwan *et al* had 32 cases due to RTA, 8 cases were due to work related causes, 3 during sport activity and 3 by other causes⁵ From the above observations it can be concluded that indirect injury caused by road traffic accidents is the most common cause for clavicular fractures

Age Incidence

The average age in our study group is 27 years in that 3 cases (10%) were between 18- 20years, 17 cases (56.6%) between 21-30 years, 5 cases (16.6%) between 31-40 years, 3 cases (10%) between 41-50 years and 2cases (6.6%) between 51-60 years. In Radwan *et al* study patients, the average age at the time of operation was 36±11 years for groupI versus 39±9 years for group II.⁴² In Mueller *et al* mean age was 40 years (range, 19–66, group 1: 40.2 years, group 2: 39.9 years, group 3: 39.1 years).⁴¹ Whereas Meier *et al* had mean age of 28 years (range: 16 to 40).⁴

Time interval for surgery

In 16 cases (53.3%), the time interval before surgery was less than 3 days after trauma, 14(46.6%) cases surgery took place between 3-7 days. In Mueller *et al* study surgery was performed on average 14.5 days after trauma. Meier *et al* conducted surgery on 6th day post trauma⁴Radwan *et al* had a mean time interval of 4.5 days after trauma. Thus, on comparing the results of all the four studies, it was observed that majority of cases were intervened at similar time interval after trauma.

Associated injuries

In our study around 27 cases (90%) did not have any associated injuries. 1case (3.3%) had ipsilateral humerus fracture, 1 case (3.3%) had facial injuries and 1 case (3.3%) had ipsilateral rib fracture. In Mueller *et al* series in 9 patients had isolated clavicular fractures without any associated injuries.⁶

Table 6: Comparison of different studies according to age, sex, side affected, time interval, mode of reduction and time of union.

	Avg Age (years)	Sex (M/F)	Side (R/L)	Avg. time till surgery (days)	reduction (open/close d)	Avg. time of union (Weeks)
Present study(N=30)	27	21/9	17/13	4.8	14/16	12
Mueller <i>et al</i> (N=31)	37.5	24/7	14/17	14.5	15/16	-
Meier <i>et al</i> (N=14)	28	12/2	-	6	7/7	7.7

Radwan <i>et al</i> (N=46)	40	15/31	23/23	4.5	21/25	11.6
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Table 7: Comparison of complications in different studies.

Complication	Present study (%)	Meier <i>et al.</i> (%)	Mueller <i>et al.</i> (%)	Radwan <i>et al.</i> (%)
Entry site skin irritation	6.6	14	22.5	32.6
Medial protrusion	13.3	-	12.9	2.1
Lateral protrusion	-	-	3.2	10.8
Intra- op dorsal cortex perforation	10	-	-	-
Superficial entry site Infection	3.3	-	3.2	6.5
Nail breakage	-	-	6.4	-
Nail loosening	-	-	-	-
Shoulder stiffness	-	-	-	-
Hypertrophic scar	-	-	25.8	6.5
Non-union	-	-	-	2.1
Malunion	-	-	-	-
Delayed union	6.6	-	-	-

Functional outcome:

The functional outcome according to Constant and Murley shoulder score in this study of 30 patients presented with midshaft clavicle fracture treated with titanium elastic nailing system showed excellent outcome in 24 cases (80%), good outcome in 5 cases (16.6%) and fair outcome in 1 patient (3.3%). No case had poor outcome. Meier *et al* showed that in his study Constant shoulder score averaged 81 (range: 37 to 96) after 7 days and was 96 (range: 85 to 100) after 6 weeks. After 6 months and after hardware removal, all 13 patients presented with basically normal shoulder function (mean: 98, range: 93 to 100).40 Mueller *et al* had Constant Score in group 1 as 91.6 points, in group 2 as 99.0 and in group 3 as 88.6 points whereas Radwan *et al* at final follow-up, the median Constant score was 92.^{5,6} Our present study had simple displaced and mild to moderately comminuted clavicle fractures like other studies and the results of functional outcome give promising evidence that TENS can be used as a surgical option. Thus, titanium elastic nailing system is a reliable and effective option in management of middle third clavicle fractures.

Conclusion

To conclude, clavicular fracture treated with Titanium elastic nail is an effective mode of treatment to restore the function in adult patients, consistently providing excellent results with minimal complications and is a safe option in treating clavicle fracture with good recovery despite, patients having several associated injuries

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