



## Original Article

# Management of Displaced Mid Shaft Clavicle Fractures by Flexible Intramedullary Nail

Authors

**Dr Jaspal Singh<sup>1</sup>, Dr Bharat Singla<sup>2</sup>, Dr Sanjeev Kumar<sup>3</sup>, Dr Randhir Singh<sup>4</sup>**

<sup>1</sup>M.S., Associate Professor, Department of Orthopaedics, GMC Amritsar

<sup>2,3</sup>Junior Resident, Department of Orthopaedics, GMC Amritsar

<sup>4</sup>M.S., Ex-Professor, Department of Orthopaedics, GMC Amritsar

Corresponding Author

**Dr Bharat Singla**

Address –14-A, Dhillon Colony, Opposite-Mohindra College, Patiala-147001

Email: [bharat\\_761@yahoo.co.in](mailto:bharat_761@yahoo.co.in)

## Abstract

**Background:** Most clavicle fractures heal uneventfully without serious consequences with non operative treatment. With changing trends in treatment of displaced mid shaft clavicle fracture (DMCF), plating remains the standard procedure for fixation. An attractive alternate method of fixation is Titanium Elastic Nailing (TEN).

**Material and Method:** 25 unilateral displaced mid shaft clavicular fracture of either sex operated with TEN were included in the study. This prospective study was approved by ethical committee. They were operated with TEN. They were evaluated clinically and radiologically and outcome was assessed by constant score.

**Result:** In this study of 25 cases, TENS led to significantly shorter time to union especially for simple fractures. All patients got fracture union. At 15 months after intramedullary fixation patients were more satisfied with the appearance of shoulder and overall outcome. DASH scores were lower and constant score higher.

**Conclusion:** Use of minimal invasive TEN for fixation of displaced mid shaft clavicle fracture is recommended in view of faster fracture union, lesser morbidity, better cosmetic results, easier implant removal and fewer complications.

**Keywords;** Clavicle fracture, Internal Fixation of clavicle fracture, Titanium Elastic Nail.

## Introduction

Fractures of clavicle are common injuries with an incidence of 2.6-10% of all #s. About 80% of the fractures involve mid shaft and over half of these fractures are displaced. Traditionally mid shaft fractures were treated conservatively with figure of 8 bandage and sling.

Functional outcome of mid shaft clavicle fractures is not only related to its union but also to its length. Clavicle acts as a strut that keeps the upper limb away from the body for efficient shoulder and upper limb function. Thus comminuted or displaced fracture clavicle carries risk of

symptomatic malunion, nonunion, poor functional outcome and cosmetic deformity.

Recent evidence from prospective and randomized clinical trials has suggested that there is a subset of individuals who benefit from primary operative care. Operative repair in this setting should be reserved for medically well, physically active patients who stand to benefit the most from rapid repair of normal anatomy and stable fixation.

Two operative techniques are commonly used for internal fixation of clavicle fracture: Plate fixation and TENS. Functional outcome after both the techniques proved to be superior compared with conservative treatment of these fractures in recently reported prospective studies. The aim of present study was to assess the effectiveness of minimally invasive TEN for the treatment of mid shaft clavicle fractures.

### Materials and Methods

A prospective study of 25 cases of unilateral closed displaced # of clavicle fixed with TENS was done. Patients of age from 18 to 54 years and of both sexes were included in this study. This study was approved by local ethical committee. Inclusion criteria for this study was DMCF's(AO classification B1 and B2) with displacement of more than shaft width shortening by over 2 cm or threat of skin perforation at fracture ends. Our exclusion criteria were

1. Segmental clavicle fracture.
2. Moderate to severe head injury.
3. Multi trauma patients.
4. Patient with previous morbidity concerning arm, shoulder or hand.
5. Open fractures.
6. Pathological fractures.
7. Fracture of > 1 month old.
8. Bilateral clavicle fracture.
9. With associated neurovascular injury.

Majority of the patients were operated within 1 week from date of injury.

### TENS

#### Operative Technique

After anesthesia patients were patients were placed in supine position. Sterno-clavicular joint was palpated and marked on the affected side. We used C-arm in 45° cephalad and 45° caudal directions, this provides us images in two planes 90° apart. Just 1 cm lateral to sterno-clavicular joint a small incision was given with a sharp pointed awl and anterior cortex of clavicle was opened and a TEN was inserted (the diameter 2-3mm and length 12-15 cm). Before making entry of TEN tip of nail was straightened slightly to allow better gliding in the small medullary canal. Closed reduction was performed under C-arm control using the percutaneously introduced pointed reduction clamps. If closed reduction failed then fracture site was opened and was reduced by direct manipulation of the main fragments. The nail was then advanced until it was just medial to the acromio-clavicular joint. Careful maneuvering of nail tip was necessary under fluoroscopic control to avoid penetration of thin dorsal cortex. After reaching the end point, the fracture was compressed and nail was cut close to the entry point to minimize soft tissue damage at the same time leaving sufficient length behind for easy extraction later on. Fascia and skin were closed in layers.

Post operatively patients were given a sling but were encouraged for early shoulder mobilization starting with pendular exercises from the 2<sup>nd</sup> day.

After about 1 week, active range of movement exercises were started except overhead shoulder abduction. All patients were reviewed in OPD at 2 and 6 weeks, 3 and 12 months after surgery. At every visit patients were assessed both clinically and radiologically for primary and secondary outcome measures.

Functional outcome was assessed by constant score. Radiographic union was defined as evidence of bridging callus or obliteration of fracture lines. Clinical evidence was considered as absence of tenderness at the fracture site and time to achieve union was recorded.

Secondary outcome measures include peri-operative data like operation time, amount of blood loss and size of surgical wound. Complications such as neurovascular injury, non union, malunion, implant failure, implant migration, re-fracture after implant removal and cosmetic outcome with regards to visible deformity, hypertrophic scars and hardware prominence under the skin were noted, if any. Implant removal was not done routinely in our study. It was done as per the need and will of the patients after fracture union.

### Results

In this study 25 cases of displaced mid shaft fracture clavicle were taken. In this study 17 males (68%) and 8 females (32%) patients of age group 18 years to 54 years were taken [mean age of 31.2 years.] Study showed that displaced mid shaft clavicle # were most common in age group of 21-40 years consisting of 18 cases (72%).

**Table 1**

Age group in years	Total	Males	Females	%
0-20	04	04	0	16
21-40	18	12	06	72
41-60	03	01	02	12

Right sided # 15 cases (60%) were more than left side (40%). There were 17 cases (68%) due to road side accidents followed by 5 cases (20%) due to fall, assault 2 (8%) and 1 case (4%) was due to sports injury.

Most common pattern of fracture as per AO classification was diaphysial wedge type B2 (60%) and diaphysial non comminuted fracture type B (36%). 13 cases (52%) had only clavicle fracture but 12 cases (48%) had associated #s and injuries which were treated accordingly. 23 cases (92%) were operated within 7days of injury whereas 2 cases(08%) were treated within 1 month. In this study closed reduction was done in 13 cases (52%) and mini open was needed in 12 cases (48%).

**Table 2**

Type of Fracture	No of Cases	Percentage
Type B1	09	36
Type B2	15	60
Type B3	01	04

Average duration of surgery was 54.8 minutes ranging from minimum of 25 minutes to maximum of 85 minutes.

Average duration of hospital stay was 7.6 days and average blood loss during surgery 30 ml.

Mean duration of radiological union was 7.3 weeks ranging from minimum of 6 weeks to maximum 14 weeks.

19 cases (76%) showed union at 6 weeks of follow up. 4 cases (16%) showed union at 10 weeks and rest 2 (8%) at 14 weeks of follow up.

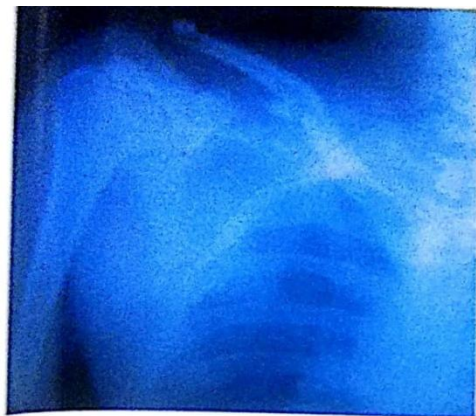
**Table 3**

Period of Union	No of cases	%
Within 6 weeks	19	76
6-10 weeks	04	16
10-14 weeks	02	08

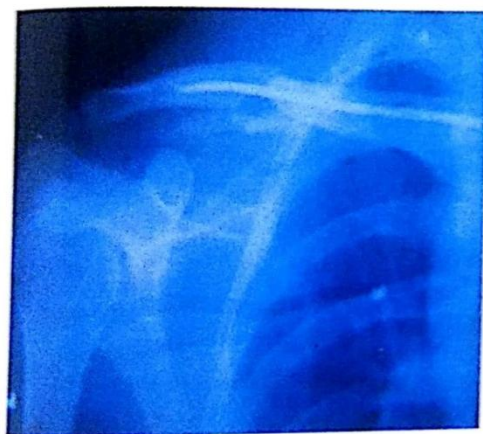
19 patients (76%) had full range of movement in flexion and abduction at shoulder and 6 patients (24%) had deficient movement at shoulder.

**Table 4**

Range of shoulder movement (Flexion and abduction)	No of cases	%
More than 165 °	19	76
150-165 °	06	24
Less than 150 °	Nil	0



Pre-operative X-Ray

1<sup>st</sup> Post Operative X-Ray

Final Follow up X-Ray



Showing Single Scar



At Final Follow-up

Operative complications such as infection, incision numbness, scar hyperplasia, irritation of nail end, withdrawal and breakage of nails were not found.

### Discussion

The present prospective study was done on 25 cases of displaced mid shaft clavicle fracture admitted in Deptt. Of Orthopaedics, GMC, Amritsar. This study was done with the following objective.

1. To study outcome of operative treatment of clavicle # with flexible intra medullary nail.

2. To study technical problems, complication and simplicity of the procedure.
3. To evaluate functional outcome after flexible intramedullary nailing.
4. To evaluate hardware problems after flexible intramedullary nailing.

In this prospective study incidence of displaced mid shaft clavicle fracture were most common in working age group 21-40 years in 72% of cases.

Cases upto age of 20 years were 16% and cases with age group 41-60 years were 12%. Middle third of clavicle is thinnest portion of the bone and is devoid of any protective muscular or ligamentous attachment, rendering it as the weakest point.

Goal of treatment is to relieve pain and gain a complete restoration of shoulder functions. Clavicular shaft fractures are not considered to be problematic and non operative treatment played the key role for a long time. Recent studies have reported that non union rates can go upto 15% and a more no. of unsatisfactory functional results were found in adults especially, when fracture shortening was more than 2 cm or comminuted. Lower rate of malunion and non union is found in operative fixation. There is an increasing body of evidence pointing to an operative standard of caring for adult clavicle fracture. One of the operation is flexible intramedullary nailing. This operation consists of extensive intramedullary three point stabilization of S shaped clavicle with a flexible nail. In contrast to K wires, screws or pins, TEN is flexible and not fixed in the cortex. From the biomechanical point of view, intramedullary positioning of the implant is ideal because tension side of clavicle depends upon direction of loading and the rotation of the arm.

We used a vertical incision running across the bone in order to provide a superior cosmetic result due to smaller incision (avg. 1.5 cm) with less soft tissue dissection. The excellent cosmetic appearance might be made which is important for young women & patients with scar diathesis. This is not only the requirements of the minimally invasive technique but also the essence of modern surgery and more important patients demand. Compared with intramedullary nailing with unreamed or reamed steel wires, the site of implant dislocation, is lower because of stable jamming of the flexible titanium nail in the clavicle at its flat outer end. After nailing, early post operative shoulder exercises may result in sustained stress stimulation and osteoblasts proliferation and promote bone callus formation. TEN doesn't

denude the soft tissue around the fracture site so as not to induce the incidence of complications such as infection and damage of the surrounding tissues. This leads to faster osseous healing, lower rates of non union and delayed union and better functional results. The reported non union rate was 0 – 1.2 % which was similar with ours.

Recent studies comparing the intramedullary nailing with conservative treatment provide a basis for comparison with our intramedullary nailing results. In terms of operative technique, DASH score, constant shoulder score, complications, union time & the improvement of clavicular shortening after union, our results were similar with them and we can say flexible nailing is an easy technique with low complication rate, fast return to daily activities, excellent cosmetic appearance as well as good functional results. However, their outcome measures were better than ours, which might be because of differences in surgical experience, patients age, time to return to work, and nutritional status.

Although, this procedure is simple & less invasive, attention should be paid to

1. Be more careful in order not to damage the vial structures & the medial protruding end of the nail should be shortened to the point where it just exceeds the bone, so as to get rid of skin irritation.
2. Diameter of nail should be  $\frac{1}{3}$ <sup>rd</sup> to  $\frac{1}{2}$  of medullary cavity diameter
3. Bone entry should be changed from the centre of the medial clavicle to the lower bone edge, & nail should simply be advanced laterally by hand rather than a hammer which may perforate the lateral cortex or lead to distortion & rotation of the nail & result in fixation failure.
4. If closed reduction is difficult the mini open reduction should be done. A percutaneously applied reduction clamps might help to accomplish this procedure successfully.

Most frequent complication is skin irritation caused by subcutaneous position of nail at its insertion

point. Post operative clavicular shortening result in telescoping which does not stop until the lateral main fragment gets in contact with the medial main fragment. Clavicular shortening leads to static changes in the shoulder girdle, increase in SC joint angle and changes of resting position of scapula that might lead to limitations in overhead motion, pain and weakness.

The study has several limitations, the first is the small number of cases and short follow up there is a bias among individual surgeons towards the more familiar procedure. For example some surgeons are better at ESIN, whereas others are not. Some factors that may affect union are not included as smoking and drinking.

In conclusion, intramedullary fixation of mid shaft clavicle fractures with TENS is a safe, easy minimally invasive technique achieving primary stability for practice. It produces low complication rates, rapid post traumatic pain relief, early mobilization and fast return to daily activities, excellent cosmetic appearance and shoulder functional results.

### Bibliography

1. Wijdicles F.J., Houwert M. ,Millett P.J. Verleisdonk E.J. and Vander MEigdew O.A. systematic review of complications after intramedullary fixator for mid shaft clavicle fracture .Can J surg . 56 (1) 58-64(2013)
2. Lenza M. & Faloppa F. Surgical interventions for treating acute fractures and non union of the middle third of clavicle .Coc rone Database system Rev.5,CD007428 (2015)
3. Duan X., Zhong G. , Cew S. , Huang F. & Xiang Z. plating versus intramedullary treatment for mid shaft fractur<sup>3e</sup> od clacicle : a meta analysis if randomized control trials .J Shoulder Elbow Surgery.20 (6) 1008-1015(2015)
4. Mckee R.C., Whelen D.B. schemit sche E.H. & Mckee M.D. operative versus non operative case of displaced mid shaft clavicular fracture: a Metaanalysis of randomized clinical trials J bone Joint Surg Am 94(8), 675-684 (2012)
5. Harrington MA. keller TS JGD . Geometric properties and the<sup>3</sup> predicted mechanical behavior of adult human clavicle .J Biomech 1993; 26: 417-26
6. Nordqvist A, Peterson C. the incidence of fracture of clavicle .Clin Orthop 1994; 127-32.
7. Klein SM Badman B, Keating CJ, Devinney DS, Frankle MA Mighell MA. Results of surgical treatment of unstable distal clavicular fracture .J Shoulder Elbow Surgery.(2010)19,1049-55
8. Craig EV ,Basamania CJ Rockwood CA Fracture of clavicle .chapter-11,In : rockwood CA Masten FA Wirth MA Lippitt SB editors, The shoulder .3<sup>rd</sup> edition Philadelphia : Saunders , 2004 ; 455-519
9. Harrington MA Jr Keller TS , Seiler JGD , et al . Geometric properties and the predicted mechanical behavior of adult human clavicles, J Biomech 1993; 26;417-26.
10. Moseley HF. The clavicle; its anatomy and function. Clinorthop 1968;17-27
11. Chen CE, JuHn RJ, Ko JY. Anterior-inferior plating of middle third fracture of the clavicle .Arch orthop Trauma Surg . 2010April 130(4); 507 -11.
12. Edlson JG. The bony anatomy of clavicular malunions. , .J Shoulder Elbow Surgery.2003 Mar-Apr; 12(12):17-35.
13. Wick M, Muller EJ, Kolling E, et al . Midshaft fracture of clavicle with a shortening of more than 2 cm predisposes to nin union.Arch Orthop trauma Surg 2001;121(4):207-11
14. Grassi FA, Tajana MS, D AngeloF Management of midclavicular fracture ; comparison between non operative treatment and open intramedullary fixation in 80 pt . J Trauma 2001;50:1096-100

15. Hartmann F ,Hessmann MH , Gercerk E , Rommens PM Elastic Intramedullary Nailing of Midclavicular fracture. Acta Chir Belg. 2008;108:428-32
16. Powell HD W Ununited Fractures of clavicle .Br Med J. 1952 September 20; 2(4785): 651-
17. Johnson EW, Collins HR. Nonunion of the clavicle .Arch Surg.1963; 87(6);963-6.
18. Neviasser RJ Neviasser JS NeviasserTJ , Neviasser JS . A simple technique for internal fixation of clavicle. A long term evaluation. Clin Orthop Relat Res.1975 ;(109):103-7.
19. Schuind F ,Pay EP Andrienne Y Donkerwolcke M, Rasquin C , B urny F External fixation OF THE CLAVICLE FOR FRACTURE OR NON UNION in adults .Injury . 1978 may; 9(4):263-7.
20. Paffen PJ, Jansen EW. Surgical treatment of clavicular fracture with Kirschner wires: a comparative study Arch ChirNeerl 1978; 30:43-53.
21. Zenni EJ. Krieg JK, Rosent MJ. Open reduction and internal fixation of clavicular fractures. J Bone Joint Surg Am 1981; 63:147-51.