

# Pre-contoured LCP Vs TENS in treatment of displaced mid-clavicle fractures: Comparative study

Pramod B Itagi<sup>1\*</sup>, Nishanth Panegaon<sup>2</sup>

<sup>1</sup>Professor and Head, <sup>2</sup>Assistant Professor, Department of Orthopaedics, M. R. Medical College, Gulbarga, Karnataka, INDIA.

Email: [pramodortho123@gmail.com](mailto:pramodortho123@gmail.com)

## Abstract

**Background:** Fracture of the clavicle is a frequently seen injury which represents about 10-15% of all fractures in adults. About 80% of all clavicular fractures involve the middle third of the bone. The present study was undertaken to study the comparison between intramedullary nailing by TEN-titanium elastic nail and pre-contoured plates for the fracture of the middle third clavicle. **Methods:** A total of 40 unilateral displaced simple mid-shaft clavicular fractures operated between Jan. 2013 to Jan. 2015 were included in this study. Patients fitting into the inclusion criteria were selected. 20 patients were treated with TEN and 20 by pre-contoured plates, comparison was made and outcome was measured by the Constant score, union rate and difference in clavicular length after fracture union. **Results:** During analysis, in 20 patients treated by TEN, excellent results were observed in 17 patients (85%) and 3 patients (15%) with good results and in the plating group, 16 patients (80%) had excellent results, 3 patients (15%) had good results and 1 patient (5%) had fair result. **Conclusion:** The use of minimally invasive TENS for fixation of displaced midshaft clavicle fractures has faster fracture healing, lesser morbidity, better cosmetic results, easier implant removal and fewer complications, with restoration of clavicular length in simple fractures. Although for comminuted fractures plating remains the procedure of choice.

**Key Word:** Displaced mid-shaft clavicle fracture, pre-contoured plates, titanium elastic nail, constant score, minimally invasive

## \*Address for Correspondence:

Dr. Pramod itagi Professor and Head, Department of Orthopaedics, M. R. Medical College, Gulbarga, Karnataka, INDIA.

Email: [pramodortho123@gmail.com](mailto:pramodortho123@gmail.com)

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## INTRODUCTION

Clavicle fracture is a common traumatic injury around shoulder girdle due to their subcutaneous position. It is caused by either low-energy or high-energy impact. Fracture of the clavicle accounts for approximately 5 to 10% of all fractures and upto 44% of injuries to the shoulder girdle. Traditionally, the midshaft clavicle fractures have been treated conservatively with a sling

and figure-of-eight bandage<sup>1,2,3</sup>. Surgical treatment of acute midshaft clavicle fractures was not favoured due to relatively frequent and serious complications. However, the prevalence of nonunion or malunion in displaced midshaft clavicle fractures after conservative treatment is higher than previously presumed and fixation methods have evolved. Surgery is accepted more and more as primary treatment for displaced midshaft clavicle fractures, mainly because the results of non-operative treatment are interpreted as inferior to operative treatment both clinically and functionally<sup>4,5,6</sup>. For operative treatment, the available methods of fixation are fixation with elastic nail, DCP, LCP, Kirschner wires, pins (Rush pin, Rockwood pin), plates with screws and external fixation<sup>7,8</sup>. The aim of this study is to compare the outcomes of ORIF using antero-superior precontoured plate and CRIF using TEN in view of faster fracture healing, better cosmetic results, easier implant removal and quicker surgical procedure.

## **MATERIAL AND METHODS**

A total of 40 unilateral displaced simple mid-shaft clavicular fractures operated between Jan 2013 to Jan 2015 were included in this study. Patients fitting into the inclusion criteria were selected. 20 patients were treated with TEN and 20 by pre-contoured plates, comparison was made and outcome was measured by the Constant score, union rate and difference in clavicular length after fracture union.

### **Inclusion criteria**

1. Age >18years
2. Closed fractures
3. Robinson Classification 2B1 and 2B2 (displaced fractures) 5
4. No medical contradictions to general anaesthesia

### **Exclusion criteria**

1. Age < 18 years
2. Gustilo type III B and C open fractures
3. Fracture in medial or lateral end of clavicle.
4. Pathological fractures
5. Undisplaced fractures
6. Associated with neuro vascular injury
7. Established non-union from previous fracture
8. Associated acromioclavicular joint dislocation.

### **Operative procedure:**

#### **Pre-contoured plating-**

1. Patient in supine on OT table in beach chair position with one towel in between the scapula.
2. Entire upper limb from base of neck to hand were prepared and draped.
3. About 7-9 cms, incision was made in the anterior aspect centering of clavicle over the fracture site.
4. The skin subcutaneous tissue and platysma were divided without undermining the edges.
5. The overlying fascia and periosteum were next divided. The osseous ends were freed from surrounding tissue.
6. Minimal soft tissue and periosteum dissection was done.
7. Fracture fragments were reduced and precontoured locking compression plate was applied over the superior aspect of the clavicle.
8. At the junction of the medial and middle third of the clavicle, the inferior surface is exposed so that a protective instrument can be inserted during drilling to prevent injury to neurovascular structure underneath it .
9. The precontoured locking compression plate was fixed to the medial and lateral fragment with 4.0 mm locking screw and atleast three screws in medial and lateral fragment were applied.

10. Wound was closed in layers after ensuring meticulous hemostasis and sterile dressing was applied.

#### **Titanium elastic nailing:**

1. The patient was placed on a radiolucent operating table in the supine position.
2. A towel roll was placed between the scapulae to provide extension of the shoulder girdle.
3. Important to scrub the whole ipsilateral upper extremities to allow free manipulation of shoulder and arm during the procedure
4. Incision is taken 1cm lateral to the sternoclavicular joint centered above the medial end of the clavicle
5. The medullary cavity of the clavicle was opened using a k-wire about 1cm lateral to the sternoclavicular joint
6. The k-wire was pointed laterally in-line with the clavicle and angled at about 300 degrees to the coronal plane.
7. Once the medullary cavity was opened, a 3mm awl was used to widen the entry point.
8. The nail was fixed in a universal chuck with a T handle and advanced with oscillating movements.
9. Once the nail reaches the fracture site the lateral end of the clavicle is held in position with a reduction forceps (if needed) and pushed further under fluoroscopy guidance

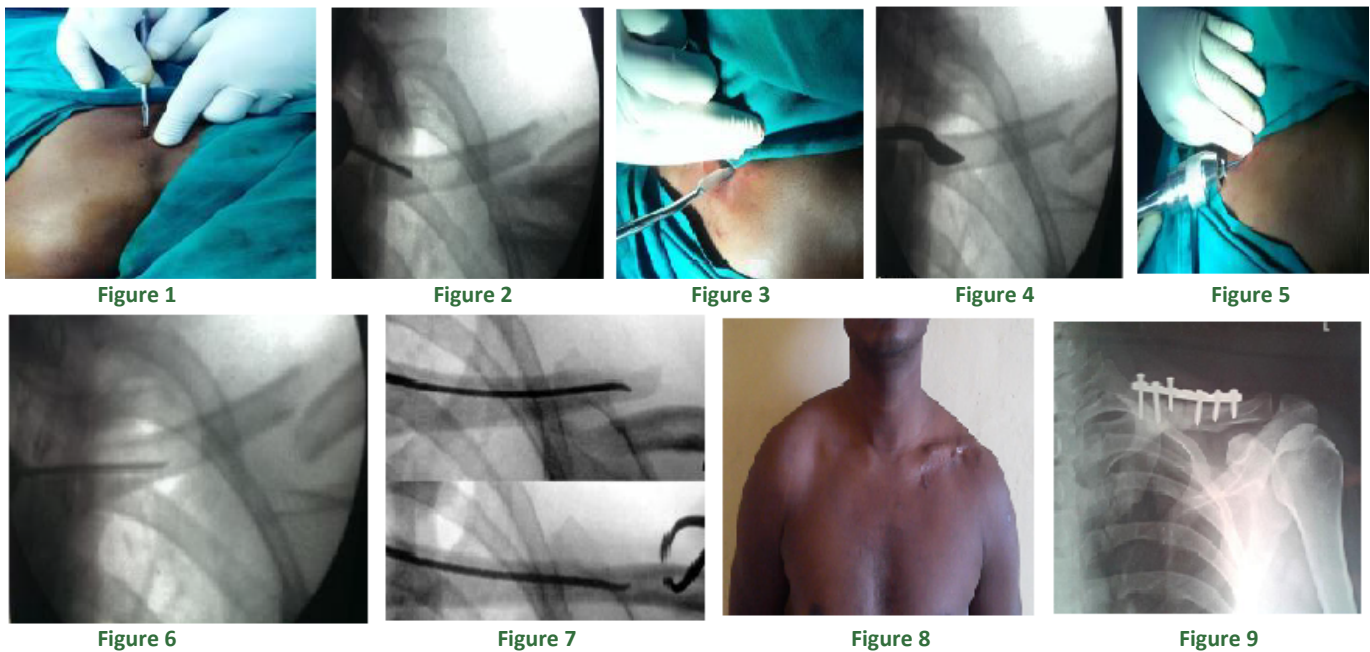
Entry wound is closed by using a stitch/staple to the skin. Post-op antibiotic and dressing was done. Suture removal was done on 10th postoperative day. Patients were discharged with the arm pouch. Rehabilitation of the affected arm was started at the end of 2 weeks. Gentle pendulum exercises to the shoulder in the arm pouch were allowed. At 4 to 6 weeks gentle active range of motion of the shoulder was allowed but abduction in limited to 80 degrees. At 6 to 8 weeks active range of motion in all planes were allowed. Regular follow up for every 4 weeks was done. Local examination of the affected clavicle for tenderness, instability deformity and shoulder movements were assessed. The functional outcomes were assessed by Constant and Murley score. shortening of clavicular length was measured clinically as the linear difference of clavicle lengths from sternal end to acromial end between operated and normal side other perioperative and post-operative data like operative time, amount of blood loss and size of the surgical wound; complications such as neurovascular injury, wound infection, nonunion, malunion, implant migration, implant failure, soft tissue irritation, refracture after implant removal and cosmetic outcome with regards to visible deformity, hypertrophic

scars and hardware prominence under the skin was recorded.

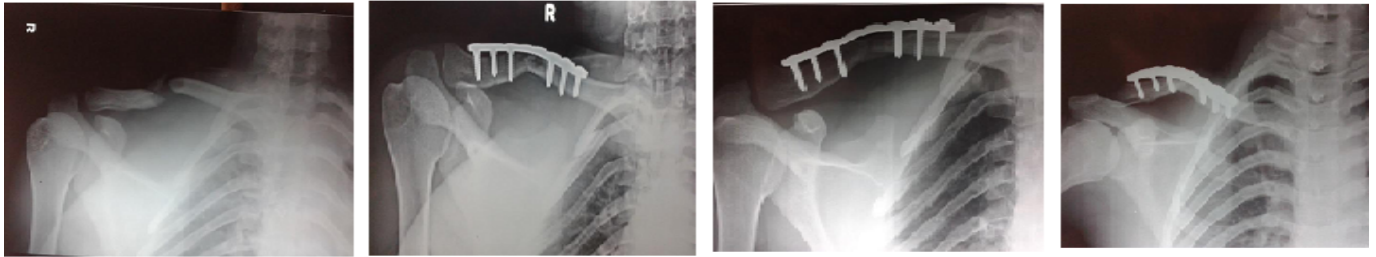
**RESULTS**

A total of 20 patients in the TEN groups (16 male and 4 female) were studied from Jan 2013 to Jan 2015 who met the inclusion criteria. The mechanism of injury was a direct trauma to the shoulder in 19 patients, 1 patient fell on their extended arm. Based on Robinson classification, there were 4 fractures belonged to A1, 8 fractures in A2 and 8 fractures in B1. Operation was performed 6 days (1-26 days) after trauma; closed reduction was possible in 16 cases. A small incision of about 2 cm above the fracture site was necessary to obtain fracture reduction in 4 patients. Operation time was around 20-55 mins (mean - 36.2 mins). Mean intra-operative blood loss was around 30 ml. No metal fatigue failure was observed with either size of implant. Post-operatively, painless shoulder range of movements was possible in all patients. All fractures healed, no delayed or non-union was observed. Time to healing was 7.7 weeks (range: 6 to 12) determined by no pain and tenderness at fracture site and visible osseous callus formation on the radiographs. Patient returned back to his routine activities after suture removal with arm pouch supporting the injured limb. All patients got the normal range of shoulder activities by 6 weeks. Hardware removal was performed electively in 19 patients between 18 to 56 weeks after surgery (mean: 29 weeks) as day

care procedure. Constant shoulder score observed was with 17 patients (85%) having excellent results and 3 patients (15%) with good results. All patients returned to their activities within four weeks after the procedure and in the plating group with 20 patients (17 male and 3 female) the following results were observed, The mechanism of injury was a direct trauma to the shoulder in 17 patients, 3 patient fell on their extended arm. Based on Robinson classification, there were 1 fracture belonged to A1, 7 fractures in A2 and 9 fractures in B1 and 3 in B2. Operation was performed 6 days (1-26 days) after trauma, Operation time was around 50-84 mins (mean - 59 mins). Mean intra-operative blood loss was around 80-160 ml (mean - 130 ml). Complications such as hypertrophic skin scar were seen in 1 patient, 1 patient had presented with plate prominence and plate loosening was seen in 1 patient. Delayed union was seen in 2 patients. All fractures healed, no non-union was observed. Time to healing was determined by visible osseous callus formation on the radiographs. Hardware removal was performed electively in 19 patients within 18 to 56 weeks after implantation (mean: 29 weeks) as day cases. The following is the Constant shoulder score, 16 patients (80%) with excellent results, 3 patients(15%) with good results and 1 patient(5%) having fair result. All patients returned to their activities within four weeks after the procedure.



**Case -1**



**Figure 1**

**Figure 2**

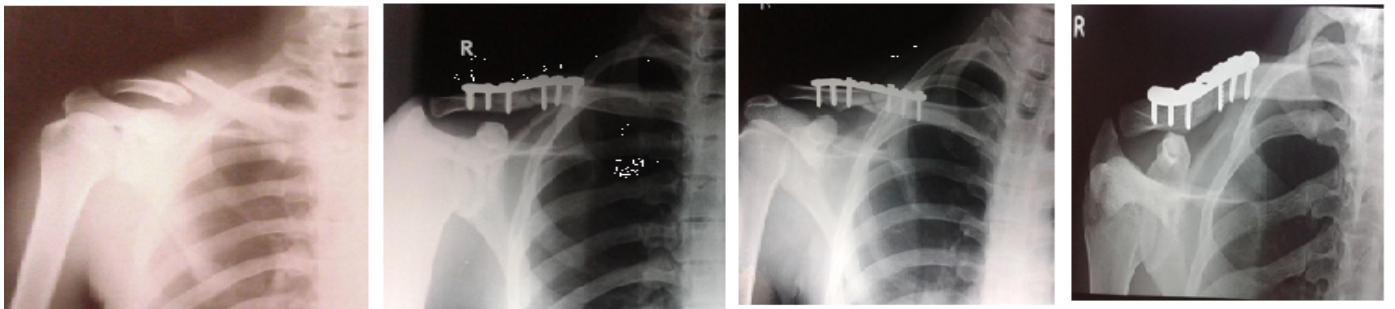
**Figure 3**

**Figure 4**

**Legend**

**Figure 1:** Pre-operative X-rays; **Figure 2:** Immediate post-operative X-ray; **Figure 3:** 6 Weeks post-operative; **Figure 4:** 12 Weeks post-operative.

**Case -2**



**Figure 1**

**Figure 2**

**Figure 3**

**Figure 4**



**Figure 5**

**Figure 6**

**Figure 7**

**Legend**

**Figure 1:** Pre-operative X-ray; **Figure 2:** Pre-operative X-ray; **Figure 3:** 6 Weeks post-operative; **Figure 4:** 12 Weeks post-operative; **Figure 5,6,7:** Post-operative range of motion

**Case - A**

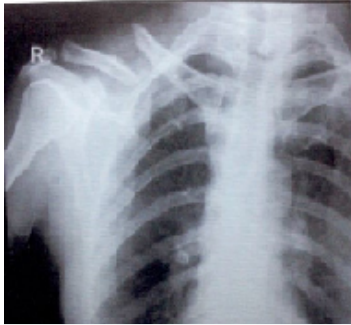


Figure 1



Figure 2



Figure 3



Figure 4



Figure 5

**Legend**

Figure 1: Pre-Operative X-ray; Figure 2: Immediate Post-Operative X-ray; Figure 3: 4 weeks follow up; Figure 4: 8 weeks follow up; Figure 5: Post-Operative range of Motion

**Case- B**



Figure 1



Figure 2



Figure 3



Figure 4

**Legend**

Figure 1: Pre-Operative X-ray; Figure 2: Immediate Post-Operative X-ray; Figure 3: 4 Weeks Post-Operative X-ray; Figure 4: 8 Weeks Post-Operative X-ray

**DISCUSSION**

The best treatment strategy for displaced midshaft clavicle fractures remains a topic of debate. Conservative management of these fractures results in an approximately 5% nonunion rate.<sup>9</sup> Three types of fixation are available for middle-third clavicle fractures: intramedullary devices, plates, and external fixators. Intramedullary fixation can be done by smooth or threaded K-wires, Steinman pins, Knowles pins, Hagie pins, Rush pins or cannulated screws.<sup>10,11,12</sup> Plate fixation can be done with a 3.5-mm dynamic compression plate

(DCP), low-contact dynamic compression plates, reconstruction plates or locking compression plates with at least three screws (six cortices) in both the medial and lateral fragment each, and an interfragmentary lag screw whenever the fracture pattern allows it. Plating of acute clavicle fractures is advocated as the preferred fixation method by many author.<sup>13,14,15</sup> Biomechanically, plate fixation is superior to intramedullary fixation because it better resists the bending and torsional forces that occur during elevation of the upper extremity above shoulder level.<sup>16</sup> Patients treated with plate fixation can be allowed full range of motion once their soft tissues have healed.

Disadvantages of plate fixation include the necessity for increased exposure and soft tissue stripping, increased risk of damage to the supraclavicular nerve, slightly higher infection rates, and the risk of refracture after plate removal.<sup>17</sup> Currently, open reduction and internal fixation with a 3.5-mm dynamic compression plate is the standard method,<sup>18</sup> here we have considered LCP; however, intramedullary fixation<sup>19</sup>, is an equally effective alternative.<sup>20,21</sup> In this study, both methods of fixation were compared in terms of outcomes and complications. In our study, functional results were comparable to plating and TENS group. Results of our study were comparable to other studies; The Canadian Orthopaedic Trauma Society reported one (1.6%) case of early mechanical failure. Bostman O *et al.*<sup>22</sup> studied 103 patients treated with open reduction and internal fixation using plates; among those patients, 43% had complications; 15%, major complications; 14% required re-operation and there was an implant failure rate of 14.6%. Liu HH *et al.*<sup>23</sup> reported 7.1% implant failure rate and compared titanium elastic nail and reconstruction plate fixation in displaced midshaft clavicle fractures and found no significant difference between intramedullary and plate fixation after 18 months in terms of functional outcome (DASH score  $p=0.42$ , Constant score  $p = 0.17$ ) and complications. They reported an implant failure rate of 8.5%. Ferran *et al.*<sup>24</sup> compared Rockwood pin fixation (17 cases) and low contact dynamic compression plate (LCDCP; 15 cases) in displaced midshaft clavicle fractures and found no significant difference after 12 months in functional outcome (Constant score  $p=0.37$ ). Complications occurred in 12% of the intramedullary fixation group and in 40% of the plate fixation group. The primary limitation of our study was that it was a small prospective comparative study including a small number of patients and done at a single center. Larger randomized controlled trials are needed to further evaluate outcomes and complications of precontoured plates and EIN in displaced midshaft clavicle fractures. Still, we can conclude from our study that both precontoured plating and intramedullary flexible nailing are equally effective alternatives for surgical fixation of displaced midshaft clavicular fractures. Antegrade flexible intramedullary nailing techniques have advantages like less soft tissue injury, shorter operating time and hospital stay, less blood loss, more cosmetic satisfaction and minor surgery needed to remove the implant. TENS is a safe, minimally invasive surgical technique with a lower complication rate, faster return to daily activities, excellent cosmetic and comparable functional results, which can be regard as an alternative to plate fixation of displaced midshaft clavicular fractures.

## CONCLUSION

Though the outcomes are comparable with Plating and the TENS group in terms of functional outcome, with the TENS group mean operative time required was lesser, minimal blood loss was observed, lesser soft tissue stripping and hence vascularity damage was minimal. There were few cases with hardware complications in the plating group. TEN has its restrictions to the segmental and large fragment fracture patterns of the clavicle. However, in selected cases Elastic Stable Intramedullary Nailing is a safe and effective method for midclavicular fractures with a low complication rate once potential technical pitfalls are appreciated. Restoration of clavicular length is reliable. Cosmetic and functional results are excellent.

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