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Original Research Article

Management of Fracture Midshaft Clavicle with Plating versus Titanium Elastic Nail System: A Comparative Study

Anuj Dixit[1], Nishanth VP[2], Ashish Dubey[3], Surya Kiran Killi[4]

[1]Senior Resident, Dept. of Orthopaedics, Sri Siddhartha Medical College, Tumkur, Karnataka

[2]Senior Registrar, Centre of Excellence for Bone and Joint, Kokilaben Dhirubhai Ambhani Hospital, Indore, Madhya Pradesh

[3]Assistant Professor, Dept. of Surgery, Govt Bundelkhand Medical College, Sagar, Madhya Pradesh

[4]Senior Resident, Dept .of Orthopaedics, Sri Siddhartha Medical College, Tumkur, Karnataka

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Corresponding author: Dr. Anuj Dixit

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Abstract

Introduction: One of the most frequent injuries in the body as a result of a direct trauma or fall on an extended arm is a fracture of the clavicle. Clavicle fractures, which constitute 2.6% to 10% of all fractures, are frequent injuries. Because more than 50% of clavicle fractures are displaced, recent studies have found that surgical intervention produces better functional outcomes than conservative treatment. The two surgical techniques that are most frequently used to treat midshaft clavicle fractures are plating and the Titanium Elastic Nail System. In the management of midshaft clavicle fractures, this study compares the functional outcome and complications of plating and titanium elastic nail systems.

Aims and Objectives: To compare the functional outcome of plating and intramedullary titanium elastic nail system in patients with displaced midshaft clavicle fracture, evaluate radiological union in both the groups and analyze complications associated with surgical procedure.

Methodology: This prospective study conducted on 56 patients in South Indian population between September-2019 to September-2021 with displaced mid shaft clavicle fracture.

Results and Observation: In our study as per Constant and Murley scoring system, out of the 28 patients who were treated with TENS, 25patients showed excellent, 3 of them showed good functional outcome. Out of the 28 patients who were treated with open reduction and internal fixation (ORIF),21 patients showed excellent,7 of them showed good functional outcome. As per DASH scoring system, of the 28 patients who were treated with TENS, 26 patients showed excellent,2 of them showed good functional outcome. Out of 28 patients who were treated with open reduction and internal fixation (ORIF), 21 patients showed excellent,7 of them showed good functional outcome.

We came across complications like shoulder stiffness for 3patients in TENS group,4 patients in plate group. superficial wound infection in 1 patient and hypertrophic scar in 2 patients in plate group.

Conclusion: TENS nailing has better functional outcome, fewer complications, lesser hospital stay & cosmetically more acceptable than plating. TENS nailing has advantages over plating in terms of lesser blood loss and duration of surgery in our study. Patients treated with TENS nailing were better in terms of Constant & DASH scoring than comparing with plating group. Hence TENS is a promising minimally invasive treatment for displaced midshaft clavicular fracture which may be an alternative to ORIF or even non operative treatment.

Keywords: Clavicle Fracture, Displaced, Titanium Elastic Nailing System, Plating, Functional Outcome, Constante Murley Score, DASH Score.

Introduction

From time immemorial the humankind has been plagued by clavicle fractures. First documented evidence is in the "Edwin smith" papyrus from 16th -17th century BC and its roots traced all the way to 30th century BC [1,2]. The Edwin smith papyrus recorded the first reported attempt at closed reduction of a clavicle fracture. Hippocrates described the typical deformity and emphasized on the necessity of trying to correct it [1].

The name Clavicle is derived from the Latin word "clavis", which means "the key". Clavicle is the bony connection between shoulder girdle and thorax contributing to movement at the shoulder girdle. The clavicle is a S -shaped bone that acts as a strut between the glenohumeral joint and the sternum and contributes to movements at the shoulder girdle. The shoulder is suspended from the clavicle by the coracoclavicular ligament [2].

Clavicle fractures, which constitute 2.6% to 10% of all fractures, are frequent injuries. Around 44% of injuries to the shoulder are clavicle fractures. Either a high-energy or a low-energy collision is what causes it. The centre third of the clavicle account for roughly 70% to 80% of clavicle fractures, respectively [2-4,7].

Open fracture of clavicle is an absolute rarity. Middle one third clavicle fractures is twice more common in men around 3rd decade [8]. Clavicle provides attachment to numerous muscles and ligaments hence numerous forces act on the clavicle once it is fractured. Understanding the muscular forces is crucial to comprehend the nature of clavicle displacement and why certain fracture patterns result in challenges if not precisely reduced and surgically fixed. Most of the midshaft fractures are displaced [3]. Clavicle fractures have been traditionally treated conservatively even when displaced substantially. Adults should anticipate some degree of impairment and deformity because it is practically impossible to sustain the reduction. Failure of closed reduction results from persistent wide separation of fragments with soft tissue interposition [7].

Previous studies claim that less than 1% of patients with conservative therapy experience nonunion. According to recent research, conservative treatment alone can result in nonunion rates of 15% to 20%, loss of shoulder muscle strength of 18% to 33%, and poor early shoulder function in up to 42% of patients. [5,11-14].

Due to relatively frequent and major consequences, surgery was not recommended for the treatment of acute midshaft fractures. The operational management of displaced midshaft clavicle fractures has increased over the previous ten years.

During conservative care of displaced midshaft clavicular fractures, there is a higher rate of nonunion and greater functional

impairments, which is the justification for surgical fixation [2,13-17].

However, recent evidence has emerged indicating that operative fixation presents lower nonunion rates, better functional outcomes, improved cosmesis, and greater patient satisfaction compared with closed treatment. As there is lack of studies in comparing TENS nailing versus plating objectively, this study is conducted.

Aim

To compare the outcome of plating and intramedullary titanium elastic nail system in patients with displaced Midshaft clavicle fracture.

Objectives

1. To compare the functional outcome of plating and intramedullary titanium elastic nail system in patients with displaced Midshaft clavicle fracture.
2. To evaluate radiological union in both the groups
3. To analyse complications associated with surgical procedure.

Materials and Method

This prospective study conducted on 56 patients between September-2019 to September-2021 with displaced mid shaft clavicle fracture. Allmans classification of clavicle fractures used to find ideal patients for the surgery. Patients in Group-1 considered for the study

Inclusion Criteria

1. Displaced midshaft clavicle fracture.
2. Age between 18 to 70 years
3. Fresh fractures
4. Closed fractures.

Exclusion Criteria

1. Associated head injury, neurovascular injuries, poly trauma.
2. Ipsilateral upper limb fractures (other bone fracture) and associated pathologies
3. Fracture more than 3 weeks old.
4. Refracture with implant in situ
5. Pathological fracture.

Result

Table 1: Age distribution

Age (in years)	Frequency	Percent
<=30	10	17.9
31-40	15	26.8
41-50	13	23.2
51-60	10	17.9
>60	8	14.3
Total	56	100.0

Study includes patients ranging from the age of 18 to70

Table 2: Sex distribution

Sex	Frequency	Percent
Male	38	67.9
Female	18	32.1
Total	56	100.0

Female which shows male predominance seen due to maximum mobility of male patients.

Table 3: Mode of Injury

Mode of Injury	Frequency	Percent
Slip And Fall	32	57.1
RTA	23	41.1
Assault	1	1.8
Total	56	100.0

According to the chart & data obtained slip & fall(57.14%) seems to be as the most common mode of injury followed by RTA(41.07%) and Assault (1.79%)

Table 4: Affected Side

Affected Side	Frequency	Percent
Left	15	26.8
Right	41	73.2
Total	56	100.0

According to data collected it is clear that Major involvement was seen on the dominant right upper extremity (73.21%).

Table 5: Associated Injury

Associated injury	Frequency	Percent
Nil	46	82.1
Contusion over right thigh	1	1.8
Contra lateral ac joint dislocation	1	1.8
Ipsilateral patella fracture	1	1.8
Soft tissue injuries	5	8.9
Ipsilateral proximal tibia fracture	1	1.8
Maxillo facial injuries	1	1.8
Total	56	100.0

In the above data shows that associated injuries were less. Among 56 patients 5 patients had soft tissue injury and 3 had other bony injuries and 1 had maxillofacial injury.

Table 6: Procedure

Procedure	Frequency	Percent
CRIF with TENS	28	50.0
ORIF with plate and screw	28	50.0
Total	56	100.0

Patients undergone for the procedure equally with random allocation of cases

Table 7: Age distribution as per procedure

Age (in years)	Procedure		Total
	CRIF with TENS	ORIF with plate and screw	
<=30	6 (21.4%)	4 (14.3%)	10 (17.9%)
31-40	7 (25.0%)	8 (28.6%)	15 (26.8%)
41-50	7 (25.0%)	6 (21.4%)	13 (23.2%)
51-60	5 (17.9%)	5 (17.9%)	10 (17.9%)
>60	3 (10.7%)	5 (17.9%)	8 (14.3%)
Total	28 (100.0%)	28 100.0%)	56 (100.0%)

According to the statistical data obtained maximum cases operated in between 31-50 years. In age group between 31-40years more cases operated with plating and in age group between 41-50 years more case operated with TENS.

Table 8: Sex distribution as per procedure

Sex	Procedure		Total
	CRIF with TENS	ORIF with plate and screw	
Male	18 (64.3%)	20 (71.4%)	38 (67.9%)
Female	10 (35.7%)	8 (28.6%)	18 (32.1%)
Total	28 (100.0%)	28 (100.0%)	56 (100.0%)

In above data 71.4% male patients undergone plating compare to TENS group. In females more patients (35.7%) undergone TENS compare to plating group.

Table 9: Mode of Injury as per procedure

Mode of Injury	Procedure		Total
	CRIF with TENS	ORIF With Plate And Screw	
Slip And Fall	15 (53.6%)	17 (60.7%)	32 (57.1%)
RTA	13 (46.4%)	10 (35.7%)	23 (41.1%)
Assault	0 (0.0%)	1 (3.6%)	1 (1.8%)
Total	28 (100.0%)	28 (100.0%)	56 (100.0%)

In above chart it shows that in slip and fall group most of the patient operated with plating and most of the RTA group patients operated with TENS.

Table 10: Comparison of parameters between procedures

Parameter	Procedure	N	Mean	Std. Deviation	T-value	P-value¶
Time intreval between trauma & surgery (in days)	Crif With Tens	28	3.04	0.79	0.000	1.000
	Orif With Plate And Screw	28	3.04	0.84		
Duration of hospital stay (in days)	Crif With Tens	28	7.61	1.59	-4.136	0.136
	Orif With Plate And Screw	28	9.64	2.06		
Time of union (in weeks)	Crif With Tens	28	11.50	1.40	0.803	0.426
	Orif With Plate And Screw	28	11.21	1.26		

¶ *Independent Sample t-test*

According to the above data the mean time interval from trauma to surgery was same in both the groups (3.04). Duration of stay was less (7.61 days) in TENS group than plating group (9.64). Time of union was almost same in both the group (11.50 & 11.21 weeks respectively).

Table 11: Comparison of Constant Murrey Score between and within procedures

Cms	N	Crif With Tens	Orif With Plate And Screw	T-Value	P-Value¶
1 Month	28	90.82+2.48	90.82+2.58	0.000	1.000
3 Month	28	92.57+2.01	92.46+2.20	0.190	0.850
6 Month	28	93.46+2.19	93.64+2.11	-0.311	0.757
F-Value		74.289	66.660		
P-Value¥		<0.001	<0.001		

¶ *Independent Sample t-test,* ¥ *Repeated measure ANOVA*

In the above data and graph shows that functional outcome after surgery improves every follow ups in both the group which assessed by using Constant Murley scoring system

Table 12: Comparison of DASH SCORE between and within procedures

Dash Score	N	Crif with Tens	Orif With Plate And Screw	T-Value	P-Value¶
1 Month	28	26.82+1.83	27.46+2.35	-1.143	0.258
3 Month	28	24.18+1.61	24.00+1.87	0.383	0.703
6 Month	28	23.82+1.54	23.75+1.92	0.154	0.878
F-Value		187.81	66.968		
P-Value¥		<0.001	<0.001		

¶ *Independent Sample t-test,* ¥ *Repeated measure ANOVA*

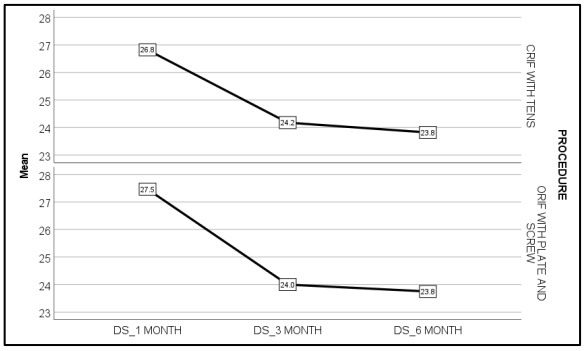

Chart 1: Comparison of DS between and within procedures

According to above data the functional outcome after 1 month follow up is better in TENS group but at end of follow ups the functional outcome in both groups are same.

Table 13: Comparison of CMS results between procedures

Cms_Result	Procedure		Total	Chi-Square, P-Value¶
	CRIF With Tens	ORIF With Plate And Screw		
Good	3 (10.71%)	7(21.4%)	10(17.85%)	0.113, 0.073
Excellent	25 (89.2%)	21 (78.6%)	46(82.4%)	
Total	28 (100.0%)	28 (100.0%)	56 (100.0%)	

¶ *Chi-Square test*

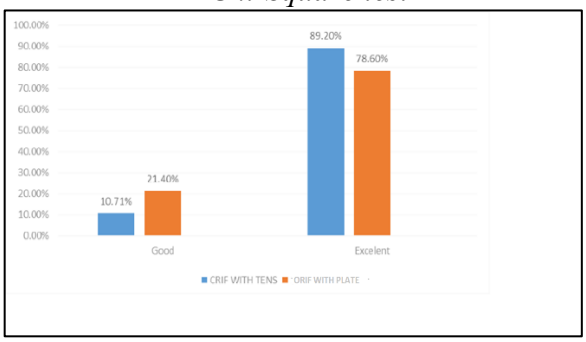

Chart 2: Comparison of CMS results between procedures

In our study as per Constant Murrey score it shows 89.2% patients had excellent result and 10.71% patients had good result in TENS group and 78.6% patient had excellent result and 21.4 good result in plating group.

Table 14: Comparison of DASH SCORE results between procedures

Dash Result	Procedure		Total	Chi-Square, P-Value¶
	CRIF with Tens	ORIF with Plate And Screw		
Good	2 (7.1%)	7(21.4%)	9(16.07%)	0.000, 0.053
Excellent	26(92.8%)	21(78.6%)	47 (83.9%)	
Total	28 (100.0%)	28 (100.0%)	56 (100.0%)	

¶ *Chi-Square test*

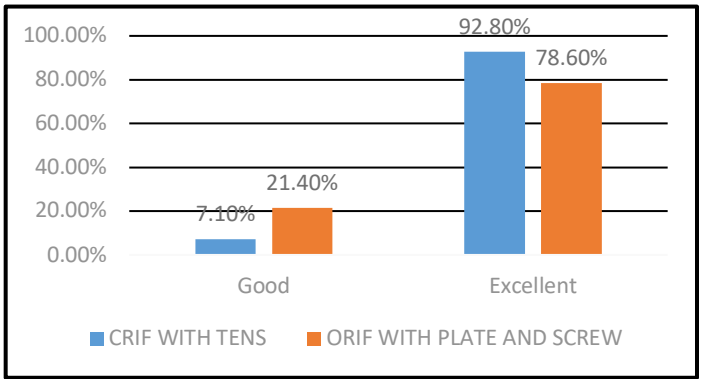

Chart 3: Comparison of DASH results between procedures

In our study as per DASH score excellent result more in TENS group while comparing with plating group.

Table 15: Comparison of Complications between procedures

Complication	Procedure		Total	Chi-Square, P-Value¶
	Crif With Tens	Orif With Plate And Screw		
Nil	24 (85.7%)	21 (75.0%)	45 (80.4%)	4.343, 0.362
Hypertrophic Scar	0 (0.0%)	2 (7.1%)	2 (3.6%)	
Lateral Migration Of Nail	1 (3.6%)	0 (0.0%)	1 (1.8%)	
Stiffness Of Shoulder	3 (10.7%)	4 (14.3%)	7 (12.5%)	
Surgical Wound Infection	0 (0.0%)	1 (3.6%)	1 (1.8%)	
Total	28 (100.0%)	28 (100.0%)	56 (100%)	

¶ *Chi-Square test*

In our study most of the patients had no complications. In TENS group 3 patients had shoulder stiffness and 1patient had lateral migration of implant. In plating group 4 patient had shoulder stiffness, 2 patients had hypertrophic scar and 1 patient had surgical scar infection.

Discussion

The best treatment strategy for displaced mid-shaft clavicular fractures remains controversial. Conservative treatment of these fractures leads to a nonunion rate of approximately 5%. There are three types of fixation available for middle third clavicle fractures: intramedullary devices, plates, and external fixators.

Plating for acute clavicular fractures is recommended by many authors as the preferred method of fixation. From a biomechanical point of view, plate fixation is superior to intramedullary fixation as it is better able to withstand the bending and twisting forces that occur when the upper extremity is raised above shoulder level. Patients treated with plate fixation can have complete freedom of movement after soft tissues have healed.

Disadvantages of plate fixation are the need for greater soft tissue exposure, an increased risk of supraclavicular nerve damage, slightly higher infection rates, and the risk of refracture after plate removal.

Age incidence

In the current study the mean age was 35 years with a maximum age of 61 years and a minimum age of 18 years. The majority of patients belonged to third to fourth decade of life which is the productive age group. Mean age of our study was 35.5±14.14 years in both group.

In a study done by Yaseen m *et al* [18] states that mean age in TENS group was 29.61±10.73 years and 36.48±11.82 years in plating group.

In another study done by Anil k sahu *et al* [19]found that mean age in TENS was 33.28±10.73 years and 34.76±11.87 years in plating group.

Partha saha *et al*[20] states that mean age in plating group was 33.03±12.64 years and 33.32±11.84years in TENS group.

This comparison between various studies and the current shows that the clavicle fractures commonly occurred in third to fourth decade of life. Hence clavicle fractures are common in the active or the productive age group.

Gender

Most of the patients enrolled in this study were male which constituted 67.9% of the patients.

In Yaseen *et al*[18]study there were 27 males and 4 females in plating group whereas nailing group had 25 males and 3 females.

In comparative study done by Pramod b Itagi *et al* [21]also shows male predominance in clavicle fractures.

Partha saha *et al.* [20] included 84.5% male patients and 15.4% female patients with clavicle fracture in their study.

On comparing the above studies, the results obtained from my study is consistent with other published studies. Male predominance can be drawn from this inference.

Affected side

Clavicle fractures were more common on the right side (41 patients) about 73.2% of the patients and 26.8% of patients (15patients) had fracture on the left side.

In Anil k sahu *et al*[19] study 64% patients were affected dominant right side and 36% affected on Left clavicle.

Shirish virupanna Tumbal *et al*[22] study also shows right clavicle (66.7%) is more affected than left clavicle (33.3%).

In Hemanth Kumar *et al*[23] study also states Right clavicle was more affected.

On comparing the above studies, the results obtained from my study is consistent with other published studies.

Mode of injury

The majority of trauma was due to slip and fall which constituted to 57.1% while 41.1% by the road traffic accident.

In Yaseen M *et al*·[18] study RTA(67%) was most common mode of injury followed by fall(25%) and assult(7%)

Hemanth Kumar *et al*.[23] study also shows 60% of injury due to RTA, 24% due to fall and 6% due to assault.

In Anil K Sahu *et al*[19] study common mode of injury was due to RTA (66%) and then by fall (44%)

The current study values was not in accordance with the previous studies done and it can be inferred that domestic confinement of population due to covid 19 pandemic.

Time interval to surgery

All patients in this study were operated at the earliest. The mean duration to surgery was 3.04 days.

In Hemanth kumar *et al* [23]study time interval to surgery was < 1week.

Pramod b Itagi[21] *et al* study also shows time interval to surgery was < 6days.

Duration of hospital stay

In current study mean duration of hospital stay in TENS group is 7.61±1.59 and for plate group is 9.64±2.06

In study of Yaseen M *et al*.[18] observed mean postoperative hospital stay was 5±3.09 days (Plating group) and 4±2.73 days (nailing group).

In Pramod itagi *et al*[21] study they concluded that and hospital stay was less in TENS group while comparing with Plating

On comparing with other studies, the result obtained in my study shows that TENS group having short hospital stay while comparing with Plating group.

Duration of surgery

For plating group the duration was 60 mins to 90 mins (mean-75 mins) whereas for TENS group it was 50 mins to 70 mins (mean-60 mins), in TENS group the duration of surgery was less when compared to plating group.

In a study done by Pramod Itagi[21] *et al* states that mean operative time was 36.2 mins in TENS group and 59 mins in plating group.

Blood loss

Plating group when compared with TENS group had more blood loss around 80 ml to100 ml (mean -90ml), where as in TENS group it was less than 30ml.

In a study Pramod itagi *et al* [21] states that Mean intra-operative blood loss was 30 ml in TENS group and 130 ml in plating group.

Duration to union

All patients were followed up on a regular basis and serial Xrays were taken and evaluated by the treating surgeon. Union was defined as complete cortical bridging between the medial and lateral fragments

The average time for union is 11.50±1.40 weeks for TENS group an 11.21±1.26 weeks for plate group which shows there is no significant difference in duration of union. There were no instances of nonunion.

According to Yaseen *et al* [18], good union was observed in the plating group at a mean average of 12.23±1.94 weeks, while it took

an average of 10.89±1.79 weeks for the nailing group to achieve union.

Anil Sahu *et al* [19] also observed early union in TENS group patients when compared with plating group.

Complications

The current study did not have any major complications like non-union , osteomyelitis, brachial plexus injury, vascular injury. Though 1 patient had superficial wound infection in plate group. 2patients had hypertrophic scar and 4 patients had shoulder stiffness.

In TENS group 3 patient had shoulder stiffness.one patient had lateral migration of nail but it was not involving in shoulder joint movements.

All patients improved with physiotherapy on follow up between 3 to 6 months. In study of Partha saha *et al* [20] major complications noted in 5 patients in plate group, while none in TENS group.

In Anil k sahu *et al*. [19] study, plating group patients had complications like nonunion (4%), delayed union (4%), mal-union (4%), hypertrophic scar (12%), plates loosening (8%), superficial infection (8%), re-fracture (4%) whereas nailing group found to be associated with very few complications like delayed union in 4%, infection in 4%.

In Yaseen M *et al* [18] study the complications were noted in 4 cases (6.8%) with 3 cases in plating group and one case in nailing group.

In our study we did not encounter any major complications which were seen in other studies except shoulder stiffness which was improved after 3months onwards after initiation of physiotherapy, superficial wound infection which was dealt accordingly with appropriate antibiotics. one patient, known case of diabetes and smoker came with surgical scar infection with partially exposed implant(LCP) after 8 months of surgery.

Another patient had contusion injury on right thigh with left side clavicle fracture, was a known case of diabetes, developed swelling (Hematoma) after discharge from hospital which was aspirated and treated with antibiotics.

There was no clinically obvious deformity compare to opposite (normal) side.

Functional outcome

Functional outcome measured by Constant Murrey score and DASH score. In Costant Murley scoring Tens group shows better outcome while comparing to plating group. We obtained an excellent outcome in 89.2% (25 patients) of the patients assessed, with 10.71% (3 patients) having good outcome in TENS group. In Plating group 78.6% (21 patients) excellent results and 21.4%(7 patients) good results obtained. In DASH scoring significant difference in outcome obtained between TENS group and plating Group. we obtained 92.8% excellent results and 7.1% good results in TENS group, while 78.6% excellent and 21.4 % good result in plating group.(p value = 0.053)

In study of Yaseem m *et al*.[18] using CMS scoring system showed better functional outcome in nailing group when compared to plating group (p=0.0285). In Anil k Sahu *et al*.[19] TENS group showed excellent outcome in CMS score in 21 (84%) patients whereas, 15 patients (60%) showed excellent result in plating group.

In Partha saha *et al*.[20] study the overall results using the constant Murley score were 26 excellent,9 good,2 fair in plate group while in TENS group it was 28 excellent and 2 good results.

In comparison with other studies present study shows better functional outcome

obtained in TENS group while comparing with Plating group.

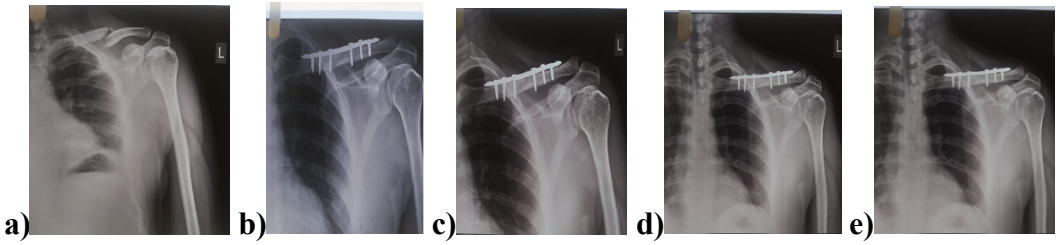

Figure 1: plate and screw fixation, a) pre operative, b) post operative, c) 1 month follow up, d) 3 month follow up, e) 6 month follow up

Figure 2 : ROM at final follow up (plating patient)

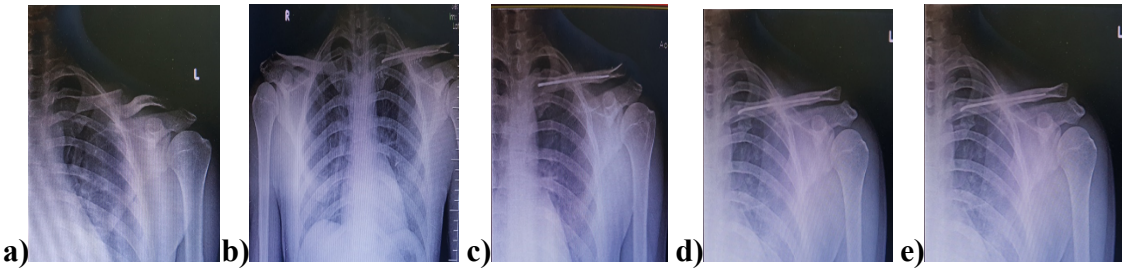

Figure 3: TENS fixation, a) pre operative, b) post operative, c) 1 month follow up, d) 3 month follow up, e) 6 month follow up

Figure 2 : ROM at final follow up (TENS patient)

Conclusion

TENS nailing has better functional outcome, fewer complications, lesser hospital stay & cosmetically more acceptable than plating with bigger scar.

TENS nailing has advantages over plating in terms of lesser blood loss and duration of surgery in our study. Patients treated with

TENS nailing were better in terms of CMS & DASH scoring.

Hence TENS is a potentially effective, minimally invasive alternative to ORIF or even non-operative treatment for displaced midshaft clavicular fracture.

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