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" Plating Versus Titanium Elastic Nailing in Treatment of Midshaft Fracture Clavicle "

Authors

Ahmed Alaa ElBaz [1], Mohamed El-Tabey El-Gritly [2], Yasser Mohamed Saqr [3], Mohamed Abdelaziz Fayed [4]

[1] Orthopedic Department,Faculty of Medicine,PortSaid University ,PortSaid,Egypt

[2] Professor of Orthopedic Surgery Department, Faculty of Medicine, Port Said University, Port Said, Egypt.

[3] Department of Orthopaedic surgery and Traumatology, Faculty of Medicine, Port Said University, Port Said, Egypt.

[4] ortopaedics and traumatology department,Faculty of medicine,Port Said university

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https://muj.journals.ekb.egdean@med.psu.edu.eg

vice_dean_postgraduate@med.psu.edu.eg

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Abstract

Introduction: Clavicle fractures are common, representing 44% of shoulder injuries, with 80-85% occurring at midshaft. While undisplaced fractures are managed conservatively, complex displaced fractures often require surgery to prevent malunion or non-union. Titanium elastic nailing (TENS) and plate fixation are established surgical options. This study aimed to compare their clinical outcomes, complication rates, and overall effectiveness for displaced midshaft clavicle fractures.

Methods: This randomized controlled prospective trial included 30 adult patients (15 TENS, 15 plate fixation) with midshaft clavicle fractures from Suez Canal University Hospital. Inclusion criteria involved patients aged 16-60 years with specific displacement features. Fractures were classified using the AO/OTA system. Outcome measures included time to union, functional scores, perioperative data (e.g., operative time, blood loss), and various complications.

Results: Baseline characteristics were comparable between groups, and open reduction was performed in all patients. The TENS group demonstrated significantly shorter operation time, lower blood loss, and smaller surgical wound size (all $p<0.009$). TENS also achieved faster fracture union ($p=0.001$). However, clavicular length shortening was more pronounced in the TENS group ($p=0.008$). Pain and functional scores were not statistically significant ($p>0.05$). Overall complication rates were comparable, though specific complications differed; one nonunion occurred in the plate group.

Conclusion: TENS and plate fixation effectively treat midshaft clavicular fractures, providing excellent functional outcomes. TENS offered advantages in operative efficiency and union time, while plate fixation resulted in less clavicular shortening and distinct complication patterns.
Keywords: Clavicle fractures, TENS, Plate fixation, Midshaft clavicle, Functional outcomes

Introduction:

Clavicle fractures are a common injury, constituting 44% of all shoulder injuries and 2.6%–10% of all fracture types. They frequently result from motor vehicle accidents, accidental falls, and shoulder injuries, particularly in individuals under 40 and above 70 years old **(Kim and McKee, 2008)**. Biomechanically, the clavicle is crucial for distributing pressures from the upper limb to the trunk, making its middle portion especially vulnerable to injury due to its superficial location and being the weakest part **(De Giorgi et al., 2011)**. Most clavicular fractures, 80 – 85%, occur at the mid-shaft. These fractures are typically classified using the Allman classification system. **(O'Neill et al., 2011)**.

The primary surgical options for complicated midshaft clavicular fractures are intramedullary fixation using Titanium Elastic Nails (TENS) or open reduction and internal fixation (ORIF) with plates **(Mishra et al., 2014)**. TENS is considered a minimally invasive procedure, offering good functional results, quick healing, and primary stability with minimal side effects. Conversely, plate fixation offers greater stability and better stress shielding, allowing for an earlier recovery period for daily activities **(Oliveira et al., 2017)**.

Plate fixation is the best option for treating displaced midshaft clavicle fractures, as it reduces the incidence of non-union and symptomatic malunion **(Sahu et al., 2018)**. Both plate fixation and TENS are recognized as successful therapies for severe midshaft clavicle fractures, with the choice depending on fracture characteristics, patient comorbidities, and desired functional outcomes. Both surgical

treatments are widely used for managing clavicle midshaft fractures **(Pranav et al., 2016)**.

Patients and methods:

This randomized controlled prospective trial was conducted on 30 patients with midshaft clavicle fractures. Patients were hospitalized in the Orthopedics Department at Suez Canal University Hospital between March 2024 and March 2025. These patients were randomly allocated into two equal groups, each containing 15 individuals: Group 1 underwent TENS treatment, and Group 2 received plate fixation. Randomization was performed blindly using computer software upon patient arrival.

Inclusion criteria for the study were patients aged 16 – 60 years with confirmed midshaft clavicle fractures, exhibiting more than 2 cm of overriding or bone shortening, displaced fractures with skin tethering, and those who provided informed consent. In contrast, excluded patients included those with medial and lateral end clavicle fractures, pediatric clavicle fractures, or severely comminuted fractures.

All patients underwent a full history assessment (including age, sex, BMI), complete blood count (CBC), serum urea and creatinine, serum ferritin, liver enzymes (ALT, AST, ALP), and initial clinical examinations of the shoulder and cervical spine, including neurological and vascular examinations. Primary aid involved oral or parenteral analgesics, antacids, and a pouch arm sling. Radiographic examinations (Anteroposterior view) were performed, and MRIs and CT scans were conducted if deemed essential. Fractures were classified using the AO/OTA classification, which categorizes fractures based on their morphology and complexity into Type A (simple), Type B (wedge component), and Type C (complex), indicating varying needs for operative treatment.

Surgical techniques:

For plating, patients were semi-seated, and an incision was made approximately 2 cm anterior to the clavicle. After careful dissection, fracture ends were identified, reduced, and temporarily stabilized. A contoured Recon plate was applied, fixed with cortical or locking screws, ensuring a minimum of three screws (six cortices) on each side of the fracture, with longer plates used for comminuted fractures.

For TENS, patients were also semi-seated, and a small incision (about 1 cm lateral to the sternoclavicular joint) was made for nail insertion. Open reduction was performed through a 2 cm incision over the fracture site via an anterior approach. The TENS, typically 2 to 3 mm in diameter, were manually advanced under fluoroscopic imaging control, compressed the fracture, and cut near the entry point.

Outcome assessment:

Outcome assessment involved several measures to evaluate both healing and functional recovery. Radiographic healing was defined by bridging callus or fracture line obliteration. Clinical fracture healing involved no tenderness, full range of motion, and normal upper extremity strength. The time to union was recorded for each patient. Subjective pain levels were measured using a Visual Analogue Scale (VAS), ranging from 0 (no pain) to 10 (worst pain imaginable).

Functional outcomes were assessed using the Constant and Murley score (maximum 100 points, combining subjective pain/daily activities and objective range of motion/strength). Additionally, cosmetic results were assessed monthly through a patient satisfaction score ranging from 1 (very unsatisfactory) to 5 (very satisfactory) **(Begum and Hossain, 2019)**.

Statistical analysis:

Statistical analysis was performed using SPSS v27. The Shapiro-Wilks test and histograms assessed the normality of data distribution. Quantitative parametric data used mean and standard deviation (SD) and the Student t-test; quantitative non-parametric data used median and interquartile range (IQR) and the Mann-Whitney test. Qualitative variables used frequency and percentage, analyzed with the Chi-square test or Fisher's exact test. A two-tailed p-value of less than 0.05 was considered statistically significant.

Results:

The study included 30 patients with midshaft clavicle fractures, randomly divided into two equal groups: 15 patients for TENS fixation and 15 for plate fixation. **Table 1** presents the baseline characteristics of the study participants. There were no statistically significant differences between the TENS and Plate groups in terms of age (p = 0.708), sex (p = 0.624), or mechanism of injury (p = 0.486).

Table 1: Demographic data of the studied groups

		TENS group (n=15)	Plate group (n=15)	p-value
Age (years)	Mean ± SD	34.67 ± 13.01	32.67 ± 15.81	0.708
	Range	16 - 52	16 - 59	
Sex	Male	13 (86.67%)	12 (80%)	0.624
	Female	2 (13.33%)	3 (20%)	
Mechanism of injury	Motor vehicle accident	3 (20%)	6 (40%)	0.486
	Fall down	7 (46.67%)	5 (33.33%)	
	Sports	5 (33.33%)	4 (26.67%)	

As shown in **Table 2**, the TENS group demonstrated significantly shorter operation time (47.07 ± 15.04 vs. 64.73 ± 19.21 min, p = 0.009), lower blood loss (46.93 ± 13.13 vs. 80.07 ± 48.78, p <0.001), and smaller surgical wound size (2.47 ± 1.85 vs. 9.4 ± 1.88 cm, p = 0.008) compared to the Plate group.

Table 2: Surgical characteristics of the studied groups

		TENS group (n=15)	Plate group (n=15)	p-value
Operation time (min)	Mean ± SD	47.07 ± 15.04	64.73 ± 19.21	**0.009***
	Range	20 - 80	40 - 100	
Blood loss (ml)	Mean ± SD	46.93 ± 13.13	80.07 ± 48.78	**<0.001***
	Range	30 - 70	51 - 120	
Surgical wound size (cm)	Mean ± SD	2.47 ± 1.85	9.4 ± 1.88	**0.008***
	Range	2 - 4	7 - 12	

*Significantly different as p-value < 0.05

Significant differences were observed between the two groups regarding union time and clavicular shortening, as shown in **Table 3**. The TENS group achieved faster fracture union (11.13 ± 3.68 weeks) than the Plate group (14.67 ± 7.04 weeks), p = 0.001. However, clavicular length shortening was more pronounced in the TENS group (8.8 ± 4.72 mm) than in the Plate group (4.6 ± 3.25 mm), p = 0.008. However, the two groups had no statistically significant difference in VAS. The TENS and Plate groups had a median VAS score of 1, with similar IQR (TENS: 0.5 – 2; Plate: 1 – 2; p = 0.859). In addition, there was no statistically significant difference in the Constant Murley scores between the TENS and Plate groups (69.27 ± 6.66 vs. 71.33 ± 6.07, p = 0.382).

Table 3: Outcomes of the studied groups

		TENS group (n=15)	**Plate group (n=15)**	**p-value**
Time to union (weeks)	Mean ± SD	11.13 ± 3.68	14.67 ± 7.04	**0.001***
	Range	4 - 20	4 - 24	
Clavicular length shortening (mm)	Mean ± SD	8.8 ± 4.72	4.6 ± 3.25	**0.008***
	Range	2 - 20	0 - 9	
VAS	Median	1	1	0.859
	IQR	1 (0.5 – 2)	1 (1 – 2)	
Constant Murley Score	Mean ± SD	69.27 ± 6.66	71.33 ± 6.07	0.382
	Range	60 - 79	61 – 79	

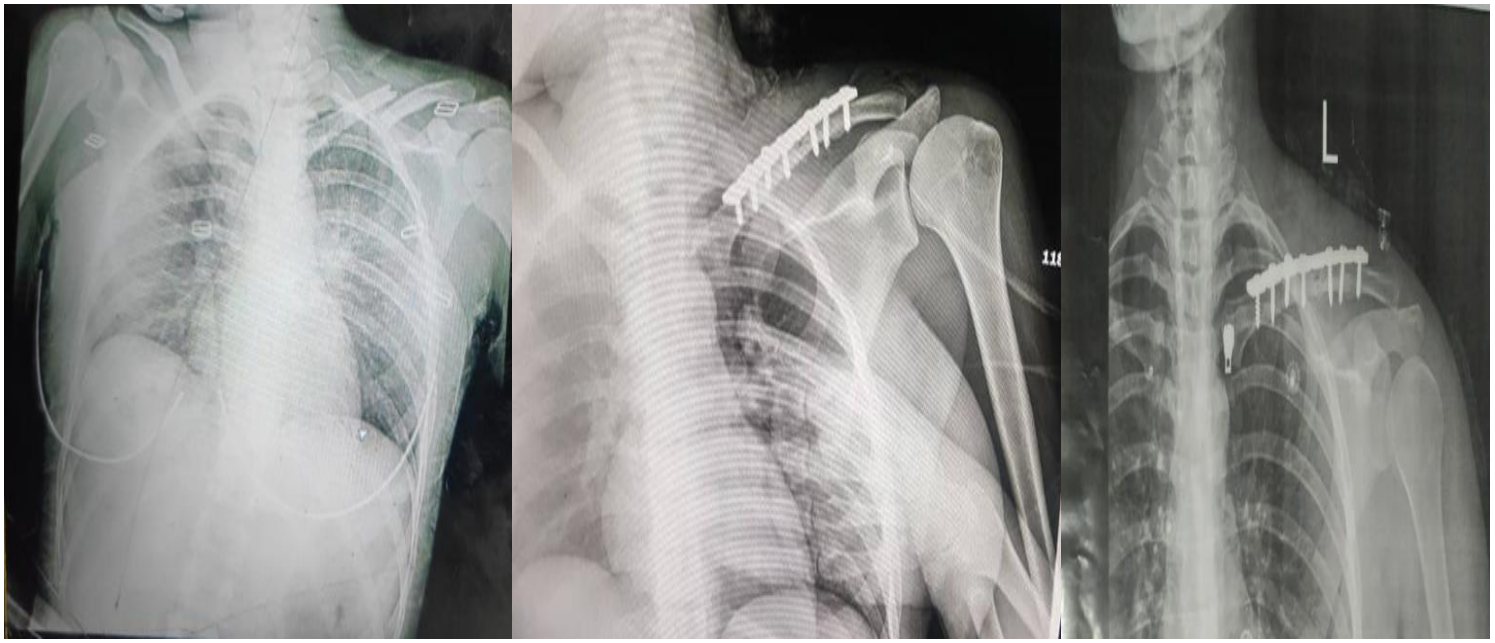
*Significantly different as p-value < 0.05

As presented in **Table 4**, there was no statistically significant difference in the overall complication rates between the two groups (p = 0.193). Both groups experienced various complications, with hardware prominence and skin irritation more frequent in the TENS group. In contrast, ugly scars and hardware prominence were more common in the Plate group. No cases of refracture were reported in either group following implant removal.

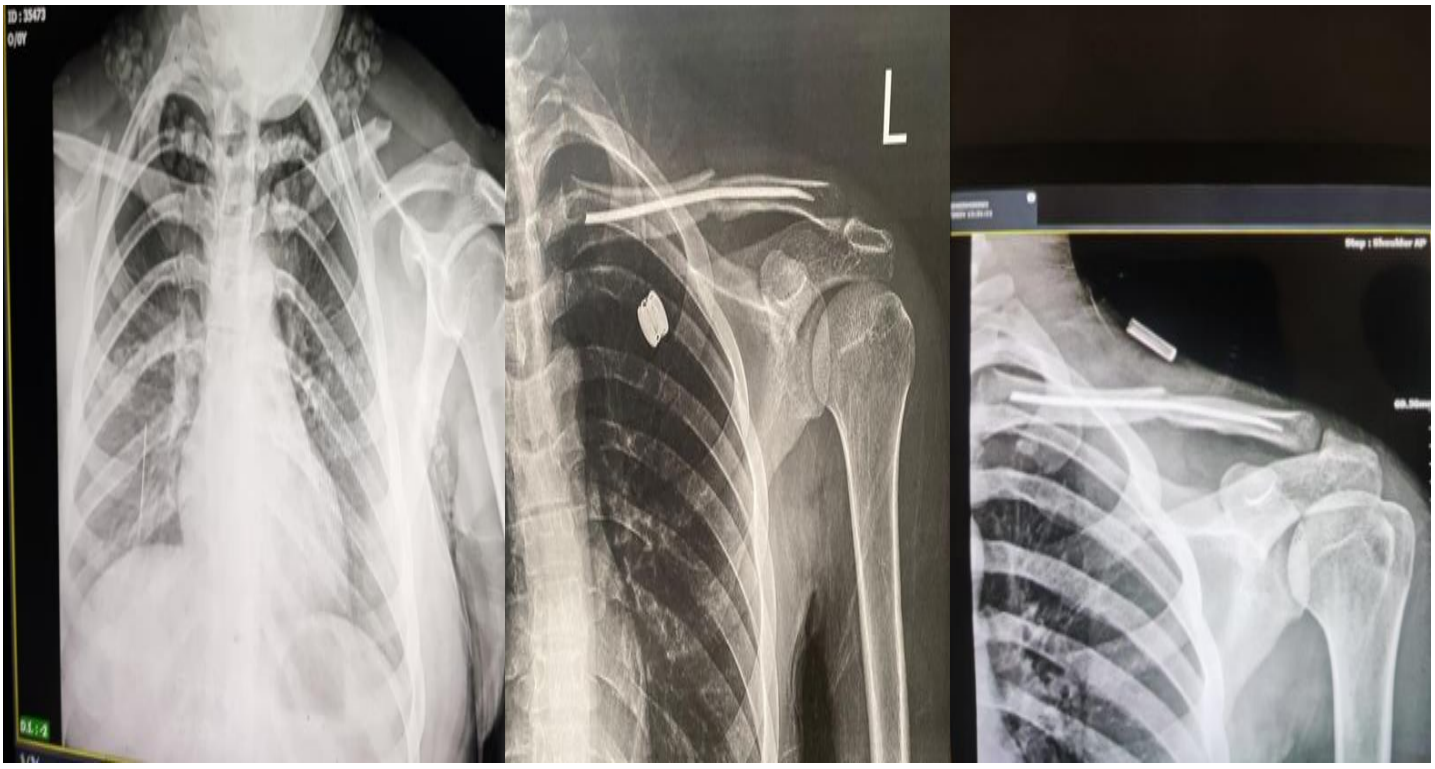
Table 4: Complications of the studied groups

	TENS group (n=15)	Plate group (n=15)	p-value
Infection	2 (13.33%)	1 (6.33%)	0.193
Nonunion	0 (0%)	1 (6.67%)	
Hypertrophic callus	1 (6.67%)	0 (0%)	
Ugly scar	0 (0%)	3 (20%)	
Hardware prominence	3 (20%)	4(26.67%)	
Skin irritation	3 (20%)	1 (6.67%)	
Refracture following implant removal	0 (0%)	0 (0%)	

Case 1:



A 33-year-old female patient presented with a midshaft clavicular fracture and a 3-month follow-up post-operation of plate fixation



A 23-year-old male patient presented with a midshaft clavicular fracture and a 3-month follow-up post-operation of

Discussion:

The treatment of clavicle fractures, particularly mid-third fractures, which account for roughly 80% of all fractures, has evolved significantly. While traditionally managed non-operatively, this study compared plating versus TENS for midshaft clavicle fractures.

Regarding surgical characteristics, the TENS group demonstrated significantly shorter operation times, lower blood loss, and smaller surgical wound sizes when compared to the plate group. This aligns with findings from **Hong et al.**, who also reported a significantly shorter operative time and incision length for the ESIN group **(Hong et al., 2022)**. In terms of functional outcomes, both groups exhibited satisfactory results, with no statistically significant differences in VAS pain scores or Constant Murley scores. This finding is consistent with observations made by **Park et al.**, who also noted no significant differences in VAS pain scores or shoulder range of motion between plate and TENS groups at various follow-up times **(Park et al., 2020)**.

However, the study identified some notable differences in other outcomes. The fracture union time was significantly faster in the TENS group (average: 11 weeks) compared to the plate group (average: 14 weeks). This supports findings from **Kenan et al.**, who reported similar union times for nail (10 weeks) and plate (12 weeks) fixation **(Kenan et al., 2021)**. Conversely, clavicular length shortening was more pronounced in the TENS group (8.8 mm) than in the plate group (4.6 mm), a result consistent with studies by **Wang et al.** and **Tarng et al. (Wang et al., 2015, Tarng et al., 2012)**.

When examining complications, the overall complication rates did not differ significantly between the two groups. However, specific complications showed variations. Hardware prominence and skin irritation were more frequent in the TENS group, a point also highlighted by **Van der Meijden et al.**, who reported significantly higher skin irritation at the nail insertion site for the TENS group patients **(Van der Meijden et al., 2015)**. Conversely, ugly scars and hardware prominence were more common in the plate group. The study found nonunion occurred in one case (6%) in the plate group and none (0%) in the nail group, a result consistent with **Assobhi et al.** and **Narsaria et al.**'s findings **(Assobhi, 2011, and Narsaria et al., 2014)**.

Ultimately, the study concluded that clinical outcomes were satisfactory in both the TENS and plate groups, echoing previous reports. No statistically significant differences were observed in shoulder function or serious complications between the groups, and neither group experienced cases of nonunion or malunion within this study.

Conclusion:

The current study suggests that TENS and plate fixation are effective methods for treating midshaft clavicular fractures. The TENS group demonstrated advantages in terms of shorter time to union, reduced operation time, lower intraoperative blood loss, and smaller surgical wound size. In contrast, the plate group was associated with skin irritation, and less clavicular length shortening. Both techniques provided excellent functional outcomes and facilitated rapid return to daily activities.

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