

A Prospective Study of Radiological and Functional Outcome of Closed Reduction and Internal Fixation with TENS (Titanium Elastic Nailing System) in Midshaft Clavicle Fractures

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Abstract

Introduction: Clavicle fractures represent 5%–10% of all fractures, with 70%–80% occurring in the middle third. Displacement is common, and conservative management of displaced midshaft fractures may lead to persistent disability despite union. Surgery is indicated for significant displacement or neurovascular injury. Although plate osteosynthesis remains the standard, intramedullary fixation with TENS is an increasingly popular and effective option for simple displaced midshaft clavicle fractures.

Materials and Methods: A prospective study was performed on 42 patients aged 16–60 years with midshaft clavicle fractures who underwent TENS at our institution from May 2025 to Jan 2026. Functional outcomes were evaluated using the Constant-Murley score, and fracture union was assessed radiographically.

Observation: TENS yielded favourable results, with mean union at 3.9 months and a mean 6-month Constant score of 86.7. Complications were minimal, limited to infection, intraoperative blood loss, and hardware irritation. These findings support TENS as a minimally invasive, effective treatment for displaced midshaft clavicle fractures with cosmetic and early functional benefits.

Conclusion: TENS proved safe and effective for displaced midshaft clavicle fractures, delivering faster recovery, improved function, fewer complications, and better cosmesis, meeting the study's aim to assess its effectiveness.

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Introduction

Clavicle fractures are common, representing 2.6–4% of all adult fractures and 35% of shoulder girdle injuries.[1] Midshaft fractures are the most frequent subtype, comprising up to 82% of all clavicular fractures.[2]

The range of treatment options and the rate of operative management for clavicle fractures have both increased. Surgeons face several technical challenges, and outcomes across different treatment methods remain inconsistent. Debate persists regarding optimal treatment selection, indications for nonoperative management, whether surgery improves clinical outcomes, and how to select surgical approaches and implants.

Historically, clavicle fractures were managed nonoperatively with slings or figure-of-eight bandages. Early studies reported non-union rates under 1% with conservative treatment. However,

these studies often lacked standardization and included heterogeneous populations, with varying ages and fracture patterns, as well as pediatric patients who have greater healing and remodelling potential.[3,4,5,6]

More recent data indicate non-union rates as high as 15%, and some patients have poor functional outcomes despite fracture union. Malunion has also emerged as a distinct complication contributing to unsatisfactory results. These findings suggest that displaced midshaft clavicle fractures may not be uniformly suitable for conservative management due to variable outcomes.

Surgical intervention has become increasingly favoured for displaced fractures, offering lower rates of non-union and malunion. Options include open reduction and internal fixation (ORIF) with plates and screws, and intramedullary fixation using

devices such as the Titanium Elastic Nailing System (TENS). Although ORIF with plating is considered the gold standard, it is associated with larger incisions, extensive soft tissue dissection, greater blood loss, and risk of neurovascular injury. Other concerns include infection, cosmetic scarring, and stress shielding after plate removal, which can lead to refracture.[7,8,9]

In contrast, TENS, introduced in 2002, offers advantages such as smaller incisions, reduced soft tissue disruption, and load-sharing fixation that permits micromotion at the fracture site to promote callus formation. While risks like hardware irritation and implant migration exist, TENS has shown good clinical and functional outcomes. This study addresses the challenges of managing displaced midshaft clavicle fractures.

Conservative treatment carries risks of non-union and malunion, while plating requires significant soft tissue disruption and leaves visible scars. TENS provides a less invasive option aimed at improving recovery, reducing complications, and yielding better cosmetic results. By evaluating functional recovery using the Constant-Murley score, along with radiological outcomes and complications, this research aims to assess the efficacy of TENS for these fractures.

Materials and Methods

This prospective study included patients with displaced midshaft clavicle fractures treated with TENS at our institution between May 2025 and January 2026. Thirty-five patients aged 16–60 years with a minimum 6-month follow-up were enrolled.

Positioning & Technique: Under general or regional anesthesia, the patient was positioned supine with a sandbag beneath the affected shoulder. After prepping and draping, a 1 cm horizontal incision was made lateral to the sternoclavicular joint. Soft tissues were dissected and the entry point was made with an awl or 2.7 mm drill. An appropriately sized TENS nail, determined by $0.4 \times$ canal diameter, was inserted under C-arm guidance. Closed reduction was attempted, with percutaneous clamps as needed. If unsuccessful, a mini-open incision was used for direct reduction. The nail was cut short to reduce irritation but left long enough for removal.

Wound closure was done in layers.

Results

42 patients were evaluated. Mean age was 38.3 years. Males comprised 81 % of the study. RTA was the most common injury mechanism (92.7%), with 65% involving the right side.

Robinson types were 2B1 in 53.7% and 2B2 in 46%.

Mean hospital stay was 7.2 days. Mean union time was 3.9 months, with one case each of delayed union and malunion. Mean Constant scores improved from 9.8 preoperatively to 66.1, 78.8, and 81.7 at 6 weeks, 3 months, and 6 months, respectively. Seven patients had complications: infection (1), implant breakage(2) , hardware irritation (2), delayed union(1), and malunion (1)

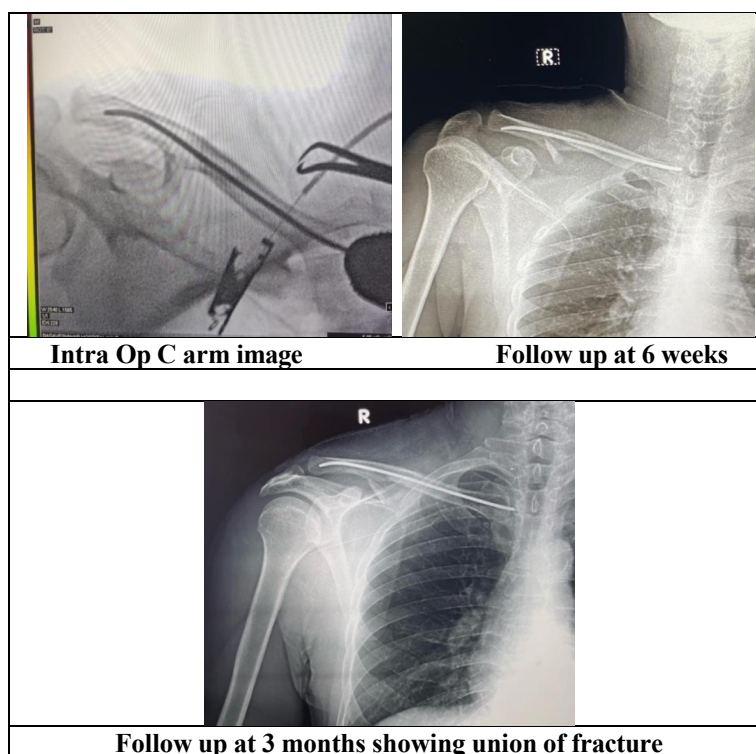


Figure 1:

Discussion

Clavicle fractures are often managed nonoperatively, but displaced midshaft fractures have poor outcomes with conservative care. Hill et al. (1997) reported 31% poor results due to shortening or non-union in 242 conservatively treated midshaft fractures followed for 38 months. Nordqvist and Petersson (1998) found ~50% of 71 midclavicular fractures healed with ≥ 5 mm shortening and malunion. Davis (2004) also noted poor outcomes with non-surgical treatment of displaced middle-third fractures. Robinson Type 2B1 and 2B2 fractures are now indications for surgery.[3]

Early surgical fixation improves outcomes, with higher Constant scores, faster pain relief, quicker return to activity, and greater satisfaction. ORIF with plating has drawbacks including large incisions, soft tissue disruption, blood loss, longer operative time, and risks of infection, neurovascular injury, scarring, and refracture from stress shielding after removal.

In this study, clavicle fractures were more common in males (78%) compared to females (22%), consistent with the findings of Jan et al., Mohammed et al., and Dhoju et al.[10,11,12]

Intramedullary devices like TENS offer smaller incisions, less tissue damage, and load-sharing fixation that permits micromotion to promote callus formation. Correcting >20 mm shortening is key for function, and intramedullary implants enhance healing due to biomechanical compatibility and minimal invasiveness.

In this study, 78% of patients were male, consistent with prior reports. Mean age was 37.1 years, with 39% aged 20–30 years, similar to Elidrisi et al. (34 years) and Javali et al. (38 years). RTAs caused 92.7% of fractures, falls caused 7.3%, aligning with Postacchini et al. (47% RTAs) and Shakeel and Sreenivasa (80% RTAs). Mean time to union was 18 weeks, with one delayed union and one malunion. Kadakia et al. reported 11.3 weeks with TENS, Fu reported 11.58 weeks, and a Danish study reported 19.6 ± 6.67 weeks [13,14,15]. Mean Constant score at 6 months was 81.7, compared to 80.32 in Kumar et al., and 93.3 in Fu and Idris & Subash. Complications included infection (5.71%), implant breakage (5.71%), and hardware irritation (8.57%), plus one delayed union and one malunion. Altamimi et al. and Smekal et al. also reported hardware-related issues, including infection, non-union, and implant failure[16]

Overall, complications were infrequent and did not significantly affect outcomes.

Conclusion

This study found TENS to be a highly effective,

minimally invasive treatment for displaced midshaft clavicle fractures. It resulted in significant functional improvement with higher Constant-Murley scores, faster fracture union, and fewer complications. Compared to conventional plating, TENS offered superior cosmetic results, shorter recovery, and earlier mobilization. These findings support TENS as a preferred alternative that provides both functional and aesthetic benefits for displaced midshaft clavicle fractures, consistent with the study's aim to evaluate its effectiveness and complications.

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