

Management of Comminuted Midshaft Clavicle Fractures with Interfragmentary Screws, Non-Invasive Screw Fixation Knot Technique and Plating in 83 Patients

Sahil Kale¹, Dinesh Kale¹, Omkar Kerkar¹, Kavya Botta¹, Arvind Vatkar^{2,3}, Sachin Kale⁴

Learning Point of the Article:

Surgical fixation with interfragmentary screws and the NISE knot approach provides dependable results for complex midshaft clavicle fractures. This approach ensures anatomical alignment, resulting in high union rates, early shoulder movement, and minimum complications, lowering the likelihood of non-union, malunion, and long-term functional impairment.

Abstract

Introduction: Midshaft clavicle fractures are common, with comminuted variants posing a higher risk of non-union, often necessitating surgical intervention. Anatomical repair is critical due to the clavicle's sole osseous connection between the shoulder and trunk, impacting functional outcomes.

Case Series: This retrospective study evaluated 83 patients (74 males, nine females, aged 18–65 years) surgically treated for midshaft clavicle fractures (2010–2023). Dominant-side fractures accounted for 87% of cases. Severe comminution was managed using 2.7 mm cortical interfragmentary screws and the NISE knot technique with plating. Follow-up spanned 18 months, assessing clinical and radiological outcomes. Patients regained near-complete shoulder motion within 3 weeks. Complications included visible deformity (n = 4), keloid formation (n = 3), scar hypoesthesia (n = 5), and one refracture with plate failure. No non-unions occurred, though two cases exhibited delayed union. Radiological and functional recovery was achieved in 97.6% of cases, with minimal long-term sequelae.

Conclusion: Surgical fixation of 3- or 4-part comminuted midshaft clavicle fractures using plate and screws demonstrates high union rates, rapid functional recovery, and low complication rates. This approach is recommended for complex fractures, as non-operative management risks non-union, malunion, and functional deficits.

Keywords: (according to MeSH)-clavicle fractures, midshaft clavicle fractures, comminuted fractures, Surgical fixation, suture techniques (including NISE knot technique), interfragmentary screws, anatomical plates, functional outcomes, union rates, oxford shoulder score.

Introduction

Clavicular fractures are common injuries, accounting for 2.6–4% of all fractures [1]. Midshaft fractures make up 80% of these, and their significant displacement and comminution can hinder healing and functional recovery [2]. Conservative management

is often sufficient to manage these fractures [3]. However, This can lead to non-union and malunion, decreased shoulder function, long-term disability, pain, limited range of motion, and reduced strength, significantly affecting a patient's quality of life [4].

Author's Photo Gallery



Dr. Sahil Kale



Dr. Dinesh Kale



Dr. Omkar Kerkar



Dr. Kavya Botta



Dr. Arvind Vatkar



Dr. Sachin Kale

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¹Department of Orthopaedic, JN Medical College and KAHAR University, Belgavi, Karnataka, India,

²Department of Orthopaedics, Spine Surgery Unit, Fortis Hiranandani Hospital, Vashi, Navi Mumbai, Maharashtra, India,

³Department of Orthopaedics, MGM Medical College, Nerul, Navi Mumbai, Maharashtra, India,

⁴Department of Orthopaedics, D.Y Patil School of Medicine and Hospital, Nerul, Navi Mumbai, Maharashtra, India.

Address of Correspondence:

Dr. Arvind Vatkar,

Consultant Orthopaedic Spine Surgeon, Fortis Hiranandani Hospital, Vashi, Navi Mumbai, Maharashtra, India. Department of Orthopaedics, MGM Medical College, Nerul, Navi Mumbai, Maharashtra, India.

E-mail: vatkararvind@gmail.com

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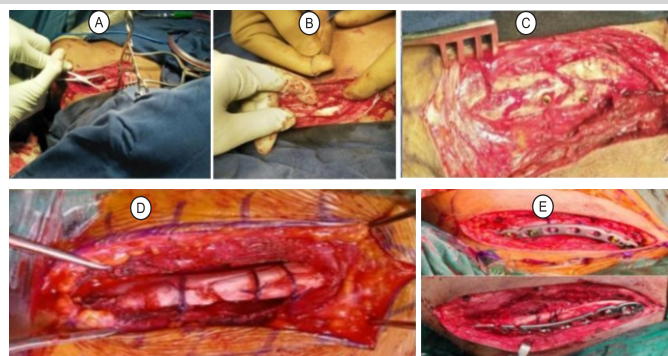


Figure 1: (a) Reduction of fracture with reduction clamps. (b) The passing of suture for NISE knot in the subperiosteal region. (c) Fixation of fracture with interfragmentary screws. (d) NISE knot fixation of the fracture with 3 knots. (e) Anatomical plate fixation over the reduced fracture fragments.

Anatomical plating is a surgical procedure that enhances union rates and functional results by restoring the clavicle's native structure and biomechanics [5]. It promotes early mobilization, increases shoulder range of motion, and decreases stiffness, improving functional recovery [6]. The use of interfragmentary screw fixation improves stability and facilitates bone repair [7]. The NISE (Non-Invasive Screw Fixation) approach may improve fixation strength while reducing soft tissue irritation [8].

Hence, we conducted a retrospective study to review the results of the anatomical plating and interfragmentary screw fixation and NISE knot technique at our institute.

Materials and Methods

At our institute, retrospective interventional research on comminuted midshaft clavicular fractures was carried out. 951 admitted clavicle fractures treated between 2010 and 2023 were included in the hospital database from which the data were gathered. 83 patients with 3- or 4-part midshaft comminuted fractures who had surgery were included in the research. In their native language, each patient received information on the advantages and disadvantages of both surgical and non-operative care.

The inclusion and exclusion criteria- The study included patients with comminuted midshaft clavicle fractures aged 18–65. Exclusion criteria included clavicle fractures not associated with segmental fractures, pathological fractures, chronic smokers and drug addicts, epilepsy patients, patients who refused surgery, refractures of previously operated clavicles, hemiplegic conditions, and those deemed medically unfit.

Outcomes measured- The follow-up period was 18 months. The study assessed clinical and radiological outcomes of a



Figure 2: Nice Knot method. (a) The tissue is wrapped with a doubled-over suture. (b) One knot is thrown, square. (c) The two free limbs traverse the loop. (d) A nice knot illustration. (e) A knot has been fashioned. (f) The knot is ready to be fastened with three alternating half-hitches or a surgeon's knot after it has been slid down by drawing the two free limbs apart [9].

shoulder joint injury. Clinical outcomes included range of motion, patient dependency, union rates, complications, such as visible deformity, keloid formation, hypoesthesia, and refracture, scores on the disabilities of the arm, shoulder, and hand (DASH) and Oxford Shoulder Score (OSS), and radiological outcomes, such as union rates, clavicular length restoration, malunion presence, and plate lift-off.

Written informed consent had been obtained from the patient or guardian for participation and publication.

Surgical technique

The surgical technique involved general anesthesia, aseptic precautions, and antibiotic coverage. A supra-clavicular incision was used to access the fracture site, preserving superficial nerves. Pointed reduction forceps were used to handle fracture fragments (Fig. 1a) and extra periosteal suture material was used for fragment reduction (Fig. 1b). In comminuted fractures, 2.7 mm cortical interfragmentary screws were used (Fig. 1c), with the NISE knot technique

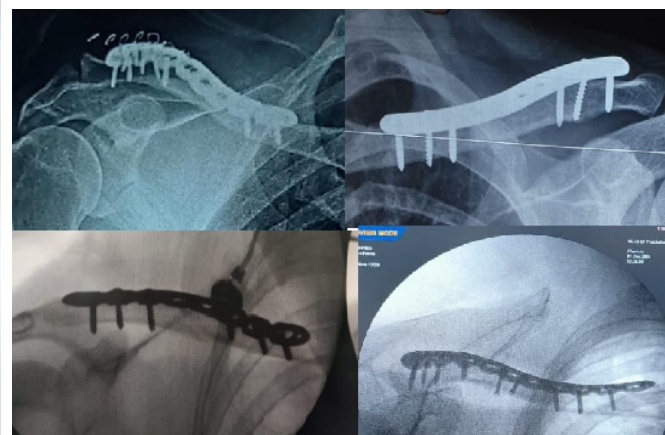


Figure 3: Immediate post-operative X-rays of patients in this study.



Figure 4: Cases showing pre-operative photos, final post-operative photos, and clinical photos of Range of motion of shoulders at the end of the follow-up period.

applied for severe comminution (Fig. 1d). The simplified method of the NISE knot is shown in Fig. 2, referenced from Hu et al. paper [9]. An anatomical clavicular plate was fixed with both non-locking and locking screws (Fig. 1e). Post-surgery, X-rays were taken (Fig. 3). Arm-to-body strapping was implemented for the early post-operative phase. Patients were discharged on the third post-operative day after one dressing change and given a body banian for protection. Suture removal was scheduled for the 11th day post-operation.

Statistical analysis

The study was done in SPSS version 21, with the descriptive analysis done for demographics and Oxford shoulder scores and a mixed design ANOVA test was done for Disability of arm, shoulder, and hand scores.

Results

The research comprised 83 patients who had surgery for 3- or 4-part midshaft clavicle fractures; the average age of patient's was 43.5 (± 4.6 years) (range: 18–65 years), showing a wide demography within that age group. The research included 74 male patients and nine female individuals. Notably, the dominant side was affected in 87% of fractures.

The study found a near complete union rate with no malunions, surgical intervention, and no non-unions observed. The study showed effective restoration of clavicular length through superficial plating, interfragmentary screw fixation, and the NISE knot technique. NISE knot was applied in all cases, as in comminuted fractures, very often interfragmentary screws cant provide almost complete reduction with NISE Knot reinforces (Fig. 4).

Complications

Lateral lift-off was observed in two individuals due to varied clavicular curvatures. Two patients experienced delayed union, taking 4.5 months to show bony union.

Functional scores

The movements at the shoulder joint improved throughout 12 months, good SF-36 scores of 84–93 ($SD \pm 2.5$) (Range 0–100) for surgical patients at the end of follow-up of 18 months.

- Patients experienced no dependency after 3–4 months of post-operative treatment, except for limb-bearing forces.

Disability of arm, shoulder, and hand (DASH) scores were taken from conservatively managed patients (92 patients) and operative patients (83 patients). A mixed-design ANOVA test was applied, with an independent t-test at each time period with Bonferroni correction (adjusted $\alpha = 0.01$).

There's a statistically significant difference in how well people recover, depending on whether they had surgery for clavicle fracture or not, with the P-value being = 0.0029.

The statistical significant difference between the surgery group and the non-surgery group changes over time ($P = 0.0031$) (Table 1).

The Oxford Shoulder Score (OSS) were:

Table 1: The results and statistical analysis of DASH score in operative and non-operative techniques				
Time point	Non-Operative mean	Operative	Mean difference	P-value*
3 months	11.8	13.4	1.6	0.021
6 months	12.66	15	2.34	0.003
9 months	13	17	4	<0.001
12 months	15	17.55	2.55	0.008
18 months	16.33	19.88	3.55	<0.001

Scores: 22 (3 months) → 26 (6 months) → 30 (9 months) → 35 (12 months) → 40 (18 months), - Presumed scale: 0–48 (higher = better function).

OSS in operated patients' data showed significant improvement over time. The study found that 86% of the variance in OSS scores can be explained by time, suggesting that time is a strong factor for shoulder scores. The shoulder function improved faster in the early months (3–9 months) compared to later months (9–18 months). By 6 months, OSS scores reached the "Minimal Clinically Important Difference" (MCID). By 18 months, 83% of the maximum OSS (40/48) had been recovered.

Discussion

Our study involved 83 patients with midshaft clavicle fractures, with an average age of 43.5 years. The dominant side experienced 87% of fractures, and the study found a near complete union rate. The study showed effective restoration of clavicular length through superficial plating, interfragmentary screw fixation, or the NISE knot technique. Functional scores improved throughout 12 months, with good SF-36 scores at 18 months. The Oxford shoulder score (OSS) significantly improved over time, with 86% of the variance explained by time.

Dhadak et al. showed that the operative group saw 19 patients with excellent functional outcomes, four with good outcomes, and two with fair outcomes. Two patients had hypertrophic skin scars, 8% experienced plate prominence, 8% had superficial infection, 4% experienced plate loosening, 8% experienced delayed union, and 4% experienced plate breakage [10].

Annichirico et al. in her retrospective study on 32 patients with midshaft clavicle fractures treated with plate and screws between 2009 and 2014 found that all patients healed clinically and radiographically without deformities or non-unions. They returned to pre-injury sports activities with a mean Constant Score of 93.8 and a mean DASH score of 42 at 1 year follow-up [11]. Lui et al. evaluated the effectiveness of an Endobutton plate combined with high-strength suture Nice knot fixation in treating distal clavicular fractures with coracoclavicular ligament injuries. It involved 43 patients. The operative group showed an average shorter bone healing time (12.82 weeks) and

improved VAS scores (9.25), Constant-Murley scores, and ASES scores post-operatively compared to the control group [7]. Hu et al. examine the effectiveness and prognosis of Nice Knots-assisted reduction in treating displaced comminuted clavicle fractures. Thirty-eight patients were treated with open reduction and internal fixation and the NISE knot technique. The Nise Knots group significantly reduced operation time, fluoroscopy time, and intraoperative blood loss ($P < 0.001$) [9].

Our study is among the first in the Indian population to use the NISE knot approach for fixing midshaft clavicle fractures.

However, our study has a few drawbacks. This was a retrospective research. The study had a smaller number of patients and no control group.

As a result, we advocate a multicenter randomized control trial with a control group comparing traditional plating to the NISE knot approach and plating for clavicle midshaft fractures, with a long follow-up period.

Conclusion

Anatomical plating combined with interfragmentary screw fixation and the NISE knot approach results in good union rates and efficient restoration of clavicular length in comminuted midshaft clavicle fractures. This method can surgically address these fractures with good functional outcomes and high union rates. Future multicenter randomized controlled trials with a control group comparing traditional plating to the NISE knot approach and plating and longer follow-up periods are required to confirm these findings and provide more support for the NISE knot technique's superiority.

Clinical Message

Early surgical treatment is highly beneficial for comminuted midshaft clavicle fractures. Cortical screws and the NISE knot with plate fixation provide early mobility and strong healing. Surgeons should consider surgical repair in multi-part fractures to minimize problems associated with conservative therapy, such as non-union and impaired shoulder function.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None



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