



Functional and clinical outcome of fracture clavicle treated by nailing vs plating technique: a comparative study

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Introduction: Clavicle bone fractures are among of the most common bony injuries encountered in orthopaedic opd and emergencies. Clavicle fractures are commonly seen in young adult. The most common site of fracture in the clavicle occurs at the middle third and which accounts for almost 80% of all clavicle fractures. This study is done to compare the functional and clinical outcome of fracture clavicle treated with nailing vs plating.

Material and method: This study includes 44 patients with diagnosed clavicle fractures. After admission thoroughly history was taken and clinical examination done with general condition, vitals and radiological assessment was also done. After getting PAC fitness patients taken randomly by chit system for surgical fixation of fracture either by nailing or plating technique.

Results: Our study shows that nailing technique is better than plating technique on the basis of CMS score.

Conclusion: Based on the data of 44 patients, the TENS method appears to be a favourable option than plating for orthopaedic treatment due to its less invasive nature, faster recovery times, and better early functional outcomes. However, the final decision should also consider the specific fracture pattern, clinical scenario, patient preferences and the potential for long-term complications.

Keywords: Clavicle fracture, Nailing, Plating, CMS score

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Introduction

Clavicle bone fractures are among of the most common bony injuries encountered in orthopaedics. They are most common in children and half of fracture are below age of 7 years and comprise around 2.4% to 2.6% of all fractures attended in orthopaedic department [1]. Approximate 50% of clavicle are displaced fracture. This fracture also has the high rate of shoulder dysfunctions and, which affect the daily routine of patients.

Clavicle fractures are commonly seen in young adult. The most common site of fracture in the clavicle occurs at the middle third and which accounts for almost 80% of all clavicle fractures [2,3]. As it is the thinnest part of the bone devoid of any muscular or ligamentous attachment [4,5]. Incidence varies between 29 and 64 per 100000 population [1]. In young adults they usually occur as a result of high velocity trauma and sometime have associated injuries.

Research has shown that surgical procedures led to better functional outcomes and higher rates of union compared to conservative approaches [5]. Other problem with non-operative method is immobilization of shoulder for at least 6-8 weeks and the further time required to regain the functions of shoulder joint by physiotherapy. During this entire time of management, patient's ability to carry out day to day movements and activities is affected. It can also be complicated with venous congestion of arms & neuropraxia (as the displaced fragment compresses the brachial plexus) and malalignment of fracture may lead to shortening of clavicle >1-2 cm [6]. Numerous other methods of treating injuries of displaced fracture clavicle like closed intramedullary nailing, open intramedullary nailing, clavicle plating have enjoyed recognition from time to time due to early mobilization and less time needed for physiotherapy which testifying the fact that there is no ideal modality of treatment.

The functional outcome of treatment of fracture clavicle is influenced by the anatomical reduction. By directly restoring the anatomy, plating allows secure internal fixation with resultant early return of clavicle function. Intramedullary nail fixation is a less invasive procedure with less blood loss and shorter duration of stay in the hospital, smaller post operative scar and better cosmetic results as well as the chances of preserving the blood supply to the clavicle. It has disadvantages like malrotation, overriding of fragments, irritation at the entry site, implant migration and needs implant removal [7].

Plate osteosyntheses fixation is a more stable procedure with less chances of malrotation and overriding, but has disadvantages like bigger scar, prominence of plate leading to skin necrosis and infection [6]. But protection of reduction and chances of loss of reduction is little more concern in nailing compared to plating. We have done study on 44 patients, 22 in Intramedullary Nailing group (Group A) and 22 in Plating group (Group B) with the aim to evaluate the functional and clinical results of clavicle plates vs nailing for treating fractures of the clavicle.

Materials and methods

This study was conducted in the department of orthopaedics of R.D Gardi Medical College and associated C.R.G.H, Ujjain during the year April 2022 to December 2023. In this study, 44 cases of Fracture Clavicle were admitted and divided into two procedure groups, Intramedullary Nailing and Plating and operated via either of the procedure and the outcome after the surgery was assessed by the Constant Murley Shoulder (CMS) Score.

For collection of data ethical clearance was taken from Human Research Ethical Committee of R.D Gardi Medical College, Ujjain. Inclusion criteria was adult patients with displaced clavicle fractures who require surgical intervention, age >18years and < 65 years both male and female and patients who have given consent for surgery

Exclusion criteria was patients with pathological fractures, open fractures Gustilo and Anderson type II or type III fracture with vascular injury, patients with neurovascular injuries, patients >18 years and <65 years, patients not willing for surgery and patients with moderate to severe comorbidities Patient showing positive clinical findings for fractures and on imaging modality like X-RAY. Constant Murley Shoulder (CMS) Score pre operatively evaluate and recorded for post operative follow-up comparison.

Patient then Randomly taken through chit system for surgery either for Nailing or Plating after getting PAC fitness. 22 patients were operated with Intramedullary nailing and 22 patients were operated with Plating by superior approach.

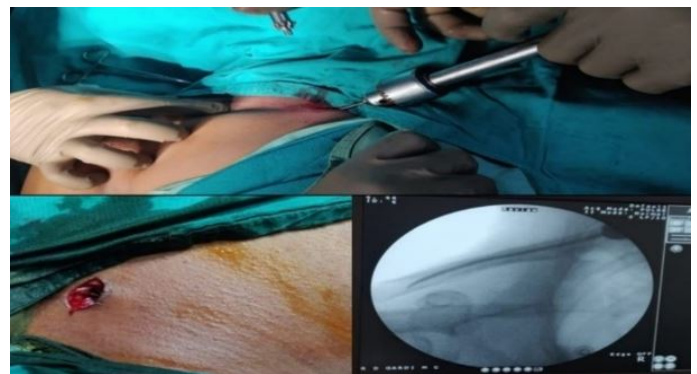


Figure 1: Intra op pics of Intramedullary nailing

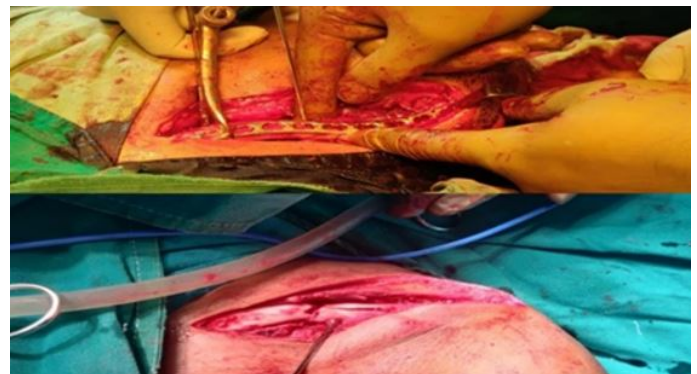


Figure 2: Intraoperative pic of plating

Patients were regularly followed after 1, 3 and 6 months. At 1, 3 and 6 months CMS was calculated and noted. X ray Clavicle (ap, lateral and oblique views) taken. Functional outcome was assessed according to Constant Murley Shoulder (CMS) Score post operatively. Post operative management is done by patient were given universal shoulder immobilizer. Symptomatic treatment was given. Active elbow movement started from pod 2 and shoulder pendulum exercises started as early as possible when patient was able to tolerate pain. Suture removal done on pod 12.



Figure 3,4, 5 and 6: Case 1 (TENS) A 36 Y old male with follow up

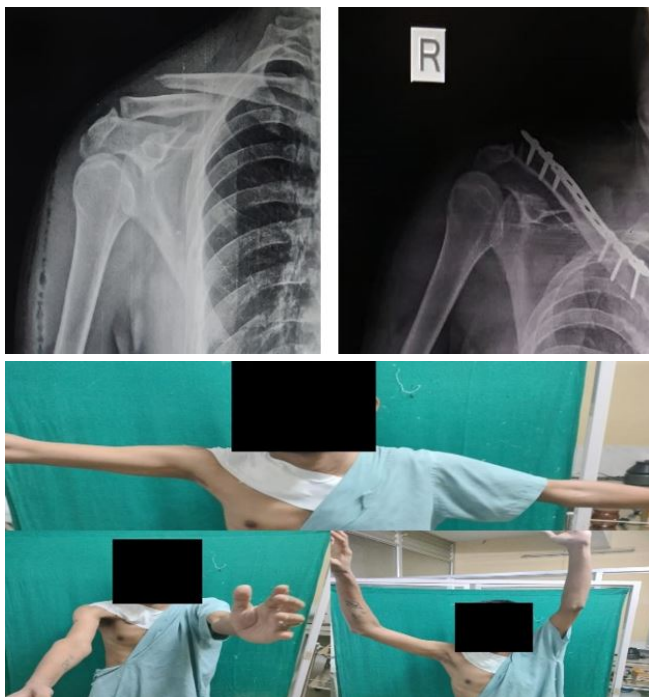


Figure 7, 8, 9, 10 11 and 12: Case 2 Clavicle plating with follow up

Three patients of TENS have protrusion of nail from medial side after 3-4 months. Since patient present after 3 months so fracture have united radiological and clinical and nail removal done. There was no complication after removal of nail like infection or fracture.

Results

In our study mean age was found 36.91±10.39 years, median age 36 years. Minimum age 20 years and maximum age 60 years. The distribution of cases across different age groups reveals that the majority are in the 31-40 years age groups, comprising 16(36.4%) of the total.

Those aged 30 years or younger account for 29.5%, while the 41-50 years group represents 25.0%. Participants over 50 years make up the smallest segment at 9.1% TENS group has a mean skin incision length of 1.2 cm with a standard deviation of 0.37 cm, while CPS group has a mean skin incision length of 9.68 cm with a standard deviation of 0.72 cm.

The calculated t-value is 49.405, and the corresponding p-value is 0.000. This indicates a highly significant difference in the mean skin incision length between both study groups.

Table 1: Duration of surgery (in min) comparison between two study groups

	TENS		CPS		T	P
	Mean	SD	Mean	SD		
DURATION OF SURGERY (in min)	49.77	7.32	69.32	9.04	7.885	0.000

TENS group has a mean duration of surgery of 49.77 minutes with a standard deviation of 7.32 minutes, while CPS group has a mean duration of surgery of 69.32 minutes with a standard deviation of 9.04 minutes. This indicates a highly significant difference in the mean duration of surgery between TENS and CPS group.

TENS has a mean blood loss of 7.95 ml with a standard deviation of 2.95 ml, while CPS has a mean blood loss of 94.55 ml with a standard deviation of 26.14 ml. This indicates a highly significant (p<0.01) difference in the mean blood loss between both groups.

Table 2: Mean CONSTANT-MURLEY SHOULDER (CMS) score pre and post operative comparison between two study groups

CMS SCORE	TENS		CPS		T	P	
	Mean	SD	Mean	SD			
Pre operative	31.23	3.49	29.59	3.33	1.590	0.119	
Post-operative	1M	65.64	3.24	61.77	2.99	4.107	0.000
	3M	80.68	1.91	78.91	1.72	3.237	0.002
	6M	94.14	2.34	93.64	1.68	0.815	0.419

The pre-operative Constant-Murley Shoulder (CMS) scores for TENS and CPS were 31.23 (SD = 3.49) and 29.59 (SD = 3.33), respectively, showing no statistically significant difference between the two groups (p = 0.119).

However, significant differences emerged post-operatively. At 1 month, Group A had a mean CMS score of 65.64 (SD = 3.24), while CPS had a mean of 61.77 (SD = 2.99), with TENS group showing significantly higher scores ($p = 0.000$). This trend continued at 3 months, where TENS had a mean CMS score of 80.68 (SD = 1.91) compared to CPS group 78.91 (SD = 1.72), again indicating a significant difference ($p = 0.002$). By 6 months post-operatively, the CMS scores for TENS group (94.14, SD = 2.34) and CPS group (93.64, SD = 1.68) were similar, with no statistically significant difference observed ($p = 0.419$).

The mean radiological union time for fractures in TENS was 11 weeks (SD = 1.63), while in CPS, it was 12.86 weeks (SD = 1.36). The independent samples t-test revealed a statistically significant difference between the two groups ($t = 4.119$, $p = 0.000$), indicating that fractures in TENS group tended to achieve radiological union faster compared to CPS group. This finding suggests that the intervention or treatment protocol associated with TENS group may have contributed to accelerated bone healing compared to CPS group. The results highlight the potential effectiveness of the approach used in TENS group for promoting faster fracture healing based on radiological assessments.

The mean duration of hospital stay for patients in TENS group was 2.64 days (SD = 0.85), whereas for those in CPS group, it was 5.05 days (SD = 0.72). The difference between the two groups was statistically significant ($t = 10.146$, $p = 0.000$), indicating that patients in TENS group had a significantly shorter hospital stay compared to CPS group. This suggests that the management or treatment approach used in TENS group may have led to quicker recovery or more efficient care delivery, resulting in reduced hospitalization periods. These findings underscore the potential benefits of the protocols implemented in TENS group for optimizing hospital resource utilization and improving patient outcomes related to the duration of hospital stay.

Majority of cases, 40(90.9%), did not had complications. However, 3(6.8%) of the cases had medial migration, and 1(2.3%) case had to implant loosening.

Table 3: Association between complications and our study groups

COMPLICATION	Group		Total
	TENS	CPS	
PLATE LOOSNING (RE PLATING)	0	1	1
	0.0%	4.5%	2.3%
MEDIAL MIGRATION OF NAIL	3	0	3
	13.6%	0.0%	6.8%
NIL	19	21	40
	86.4%	95.5%	90.9%
Total	22	22	44
	100.0%	100.0%	100.0%

Chi-square=5.231, p=0.264

The table indicates that, there is no statistically significant association between complications and study groups with $p=0.264$. In TENS group, there was 1 case of Implant Loosening (4.5%), 3 cases of Medial Migration (13.6%), and 19 cases with no complications (86.4%).

In CPS group had 1 case of Implant Loosening (2.3%), no cases of Medial Migration (0.0%), and 21 cases with no complications (95.5%).

Discussion

The present study involved 44 cases with a predominant number of male participants (86.4%). The age distribution showed that most participants were between 31-40 years (36.4%), followed by those aged ≤ 30 years (29.5%), 41-50 years (25.0%), and >50 years (9.1%). There was no statistically significant difference in the mean age between the TENS group (35.77 years) and the CPS group (38.05 years). Minimum age were 18 years and maximum age were 60 years. In present study out of 44 cases majority of 38(86.4%) cases were males and 6(13.6%) cases were females.

In study by **Vajrangi a et al** total of 38 patients were included and mean Age in years was 42.74 in plating and 31.32 in nailing and the difference of the age between the groups was found to be significant ($p=0.008$). Male and female ratio was 15:4 in plating and 16:3 in nailing [3].

Studies by **Nowak et al** on 185 patients found a higher incidence of clavicle fractures among males (70 per 100,000) compared to females (30 per 100,000) [8].

Postacchini et al reported that 68% of isolated clavicle fractures occur in men, with the left clavicle being affected in 61% of cases [9].

In other study by **Siddharth Yadav et al** in prospective comparative study, the functional outcome and union time for TENS and plate fixation has been compared across 62 patients presenting with clavicle fracture. Among them, 40 patients (65%) were male, and the remaining were female. While most patients (48.39%) were between 21 and 30 years, the age range varied from 17 to 60 years [10].

In study by **Pan Hong et al** a total of 73 patients were included. Patients were categorized into two groups ($n = 45$; 27 males, 18 females) and plate ($n = 28$; 17 males, 11 females), according to surgical technique. The average age of patients in group was 12.2 ± 1.5 years, and that in plate group was 12.2 ± 1.4 years [88]. A total of 45 patients, including 27 males and 18 females, were included in elastic stable intramedullary nailing (ESIN) group, and 28 patients, including 17 males and 11 females, were included in plate group. There was no significant difference between ESIN group and plate group in terms of sex, age, operated side, body weight, and time from injury to surgery [11]. In present study the most common cause of injury was road traffic accidents (RTA), accounting for 61.4% of cases. Falls were second most frequent cause (27.3%), followed by assaults (11.3%).

In study by **Vajrangi et al** most common mechanism of injury was fall on an outstretched hand which accounted for nearly 52.6% of cases in plating group and 63.2% of cases in intramedullary nailing group [3].

Postacchini et al identified motor vehicle accidents as a significant cause of such direct trauma leading to clavicle fractures [12].

Zhu et al.'s study on an urban Chinese population found that road traffic accidents were predominant cause of clavicle fractures in that demographic [13].

Siddharth et al study shows that in total of 62 patients, 42 (67.74%) patients had clavicle fractures from road accidents, 15 (24.19%) from falls, and five(8.06%) from assaults [10].

Saeed Asadollahi et al studied on 134 patients and concluded that most common mechanism of injury was a road traffic accident (78%). Sixty percent (n=83) had an injury severity score of ≥ 15 indicating major trauma [14].

In a study by **Gadegone and Lokhande et al** (36 patients), causes of injuries were distributed as follows: 21 cases (58.3%) were due to road traffic accidents (RTA), 12 cases (33.3%) were due to falls, and 3 cases (8.3%) resulted from sports injuries [15].

By **Bostmann et al**, injury mechanisms included falls from two-wheelers in 38 patients (36.8%), slipping and falling in 24 patients (23.3%), RTAs in 19 patients (18.45%), and sports injuries in 22 patients (21.36%) [16].

Hartmann et al. reported that 46% of cases were caused by RTAs, 34% by sports injuries, and 20% by falls [17]. In present study TENS group required significantly smaller skin incisions (mean 1.2 cm) compared to CPS group (mean 9.68 cm). This indicates that TENS method is less invasive.

In study by **Siddharth et al** plating procedure requires large incisions and can injure soft tissues to cause several postoperative complications. Thus, intramedullary fixation (TENS) stands out as a minimally invasive alternative to plate fixation [10].

Meta analysis done by **Gao y et al** included six randomized controlled trials (RCTs) and nine non-randomized controlled trials (non-RCTs). The study included 513 patients in intramedullary fixation group and 521 patients in plating group. This analysis shows advantage of nailing in small incision site [18].

Pan Hong et al study concluded that ESIN group demonstrated a significantly shorter incision length (2.4 vs. 5.4cm) than plate group ($P < 0.001$). The SCAR scale was higher in plate than in ESIN group at all time points ($P < 0.001$), and rate at which cosmetic counsel was sought due to esthetic concerns was also much higher in plate group (71.4%) than in ESIN group (22.2%) ($P < 0.001$) [11]. In present study duration of surgery was significantly shorter in TENS group (mean 49.77 minutes) compared to CPS group (mean 69.32 minutes). This suggests that TENS procedure is quicker. Blood loss during surgery was significantly less in TENS group (mean 7.95 ml) compared to CPS group (mean 94.55 ml). This highlights less invasive nature of TENS procedure.

Siddharth y et al study concluded that plate fixation had greater intraoperative and postoperative problems than TENS, including more blood loss and more operative time [10].

Meta analysis done by **Gao y et al** shows less blood loss and less operative time in nailing compare to plating [18].

Pan hong et al, ESIN group demonstrated a significantly shorter operative time (31.1 vs. 59.8min) [11].

Weina Ju et al, Meta-analysis of 1420 records show increased surgical time and soft-tissue stripping with plate fixation [19].

K F Braun et al, Open reduction increases operative time significantly versus closed reduction (open 80.8 ± 35.9 min; closed 30.5 ± 8.5 min) [20].

In present study duration of hospital stay was significantly shorter for TENS group (mean 2.64 days) compared to CPS group (mean 5.05 days). This indicates a quicker recovery for patients treated with TENS method. By **vajrangi et al** The hospital stay for nailing group (mean 7.95 days) was shorter than that for plating group (mean 9.74 days). This difference was statistically significant ($p=0.048$) [3].

Pan hong et al ESIN group demonstrated a significantly shorter hospital stay (1.5 vs. 2.5days) [11].

In present study Pre-operative CMS scores were similar between two groups. However, post-operative scores were better in TENS group at 1 month and 3 months. By 6 months, scores were similar between two groups.

Study done by **Amit Rahangdale et al** research showed that study found that both titanium elastic nails (TENS) and plate fixation have their advantages and disadvantages for treating displaced mid-shaft clavicle fractures. However, choice of surgical method does not significantly impact final functional outcomes measured by DASH and Constant Murley scores [5].

By **Siddharth y et al**, distribution of scores was very similar between two groups, where 29 (93.55%) patients had an excellent functional outcome. While remaining two patients from CPS group had a good functional outcome, for TENS group, one had a poor, and other had a good functional outcome. During follow-up period of 12 month, Constant-Murley scores were not statistically different between two groups. Still, average score for CPS group (95.45 ± 4.28) was slightly higher than for TENS group (94.19 ± 8.88). deviation of Constant-Murley scores from its average for TENS group ($SD=8.88$) was twice that of CPS group ($SD=4.28$) [10].

Jun Sung Park et al done research on 97 patients and conclude that clavicle plate and intramedullary nail (TEN) fixation methods showed very good outcomes in terms of bone union rates and functional scores across all types of clavicle fractures. Patient satisfaction was notably higher with intramedullary nail (TEN) fixation compared to plate fixation [21].

Meta analysis done by **Gao y et al** shows there were no statistically significant differences found between two groups in terms of shoulder function [18].

Weina Ju et al in their meta-analysis of 1420 records found sufficient data on Constant-Murley scores for meta-analysis were available from 7 studies. Analysis of pooled data of 215 patients undergoing plate fixation and 216 patients undergoing intramedullary fixation revealed no statistically significant difference in Constant-Murley scores between two groups [19].

K F Braun et al, no significant differences were found regarding Constant score (87.4 ± 9 points closed group vs. 85.3 ± 7.2 points open group) [20].

Marijn Houwert et al systemic review on 4 studies found no significant difference between plate fixation and intramedullary fixation after 12 months in functional outcome (Constant score $p = 0.37$) [90]. He also found that Bohme et al. reported in an observational cohort study a Constant score of 97 for the intramedullary fixation group and of 94 for the plate fixation group after eight months [22].

XinDuanMD et al did a randomized clinical trial on four studies which involved 305 clavicular fractures. There were no significant differences between plating and intramedullary pinning with regard to outcome for Constant Shoulder Score [23]. In present study the mean radiological union time was significantly faster in the TENS group (11 weeks) compared to the CPS group (12.86 weeks). This suggests that the TENS method promotes faster bone healing. **Vajrangi et al**, The difference in time taken for union in weeks between the plating group (12.89 with SD of 3.23) and nailing group (12.67 with SD of 1.53) was statistically not significant ($p = 0.675$) [3].

Siddharth et al, comparing the healing time, the early formation of callus facilitated swift healing in TENS group [10].

Meta analysis done by **Gao y et al** shows faster union rate in nailing group. The study included 513 patients in the intramedullary fixation group and 521 patients in the plating group. [18].

Wei Zhang et al found that the mean union time was 11.5 weeks in nailing group [24].

In present study the majority of the cases (90.9%) did not experience any complications. However, there were differences in complications between the two groups. In the TENS group, 13.6% of the cases had medial migration, whereas in the CPS group, 4.5% had implant loosening.

In study by **vajrangi et al** there were complications seen in six patients (31.5%) in each group. Three patients (15.8%) developed implant loosening in plating group. They also had restriction of movement of the shoulder as they were immobilised for longer periods. One of these cases (5.3%) led to non-union. One patient (5.3%) had prominence of plate with irritation of skin. Four patients (21.05%) required implant removal out of which three had implant loosening and one had plate prominence. In the nailing group, one patient (5.3%) had superficial infection on the medial side at point of entry of nail. Three patients (15.8%) had irritation of the skin on the medial end of clavicle from where the nail was inserted. Implant removal was performed in all the patients after six months of surgery. No difficulties were encountered during the implant removal in both the groups. Two patients (10.5%) had implant failure and non-union of which one re-fractured due to a fall and the other had migration of implant through the comminuted fragment. There was no statistically significant difference on comparing the complications in both the groups ($p = 0.189$) [3].

Study by **Siddharth et al** observed a higher occurrence of superficial infection among group I (TENS) patients. However, none of the patients had deep infections at the operating site when treated by TENS. Still, other complications, including ugly scar, implant protuberance, pin migration, and non-union, were encountered [10].

In study by **Pan Hong et al** it was shown that two patients (7.1%) in the plate group suffered a refracture after implant removal. The rate of implant prominence was higher in the ESIN group (44.4%) than in the plate group (32.1%). The rate of surgical site infection (SSI) was low in the ESIN group (4.4%) and the plate group (7.1%) [11].

In study by **Saeed Asadollahi et al** the overall incidence of complication was 14.5% ($n = 20$). The overall nonunion rate was 6%. Postoperative wound infection occurred in 3.6% of cases. The incidence of complication associated with plate fixation was 10% (11 of 110 cases) compared to 32% associated with intramedullary fixation (nine of 28 cases; $P = 0.003$). Thirty-five percent of complications were related to inadequate surgical technique and were potentially avoidable. Symptomatic hardware requiring removal occurred in 23% ($n = 31$) of patients. Symptomatic metalware was more frequent after plate fixation compared to intramedullary fixation (26% vs 7%, $P = 0.03$) [14].

Weina Ju et al, Meta-analysis of 20 study on 1999 patients indicated a statistically significant 2.74-fold increased risk of nerve injury-related complications with plate fixation. Implant associated complications, including implant protrusion, skin irritation and pain over hardware were also reported. Results indicated that plate fixation was associated with a 2.38-fold increased risk of complications not requiring non-routine surgery, as compared to intramedullary fixation [19].

A systemic review by **R. Marijn Houwert** on 4 studies shows complications in 12% of the intramedullary fixation group and in 40% of the plate fixation group [22].

Conclusion

Based on the data, the TENS method appears to be a favourable option than plating for orthopaedic treatment due to its less invasive nature, faster recovery times, and better early functional outcomes. However, the final decision should also consider the specific clinical scenario, patient preferences, and the potential for long-term complications.

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