The Surgical Management of Clavicle Fractures: A Prospective Comparative Study of Plating versus Intramedullary Nailing

Vineet Agarwal ¹, Sachin Yadav ¹, D C Srivastava ¹, Manish Shukla ¹

Background: With changing trends in the treatment of clavicle fractures, plating remains the standard procedure for fixation. An attracting alternative method of fixation is the titanium elastic nailing (TEN). We assessed the effectiveness of minimally invasive antegrade TEN and plating technique for the treatment of clavicle fractures.

Materials and Methods: Hundred unilateral displaced clavicle fractures operated between July 2015 and August 2017 were included in the study. This prospective comparative study was approved by the local ethical committee. Follow-ups were at the 2nd and 6th weeks and subsequently at the 3, 6, and 12 months postoperatively. The primary outcome was measured by the Constant score, union rate, and difference in the clavicular length after fracture union. The secondary outcome was measured by operative time, intraoperative blood loss, wound size, cosmetic results, and complications.

Results: During analysis, we had 48 patients in the plate group and 42 patients in the TEN group. There was no significant difference in Constant scores between the two groups. However, faster fracture union (20.1 ± 2.47 weeks vs. 28 ± 4.56 weeks, respectively, P = 0.0003), lesser operative time (41.95 ± 13.08 min vs. 68.63 ± 14.90 min, respectively, P = 0.0001), lesser blood loss (73.48 ± 38.87 ml vs. 131.75 ± 43.36 ml, respectively, P = 0.0001), greater clavicle shortening (6.85 ± 4.16 mm vs. 3.04 ± 2.26 mm, respectively, P = 0.0003), easier implant removal, and fewer complications were noted in the TEN group.

Conclusion: The use of minimally invasive antegrade TEN for fixation of displaced midshaft clavicle fractures is recommended in view of faster fracture union, lesser morbidity, better cosmetic results, easier implant removal, and fewer complications, although for comminuted fractures, plating remains the procedure of choice.

Keywords: Comminuted, antegrade titanium elastic nailing, clavicle, plating.
which includes the Constant score, union rate, and difference in the clavicular length after fracture union. Moreover, the secondary outcome includes operative time, intraoperative blood loss, wound size, cosmetic results, and complications.

**Materials and Methods**

The present study was conducted at the Department of Orthopaedic Surgery, Motilal Nehru Medical College, Allahabad, after taking clearance of the ethical committee of MLN Medical College during the period between July 2016 and August 2017. All cases of clavicle fractures presenting to the emergency or outdoor were included in the study with adherence to the inclusion and exclusion criteria, subject to written informed consent. Patients were followed up at the 2nd and 6th weeks and subsequently at the 3, 6, and 12 months postoperatively.

**Inclusion criteria**

Patients with unilateral displaced clavicle fracture of Allman Group I and III with displacement being more than the width of the shaft and shortening of over 2 cm or threat of skin perforation by the fracture ends were included in the study. Patients with floating shoulder too were included in the study.

**Exclusion criteria**

Patients not giving consent were not fit for the surgery after proper workup, pre-anesthetic checkup, and lack of follow-up for at least 6 months.

Age, sex; Allman Group; trauma-surgery delay; operative time; perioperative blood loss; union time; clavicle shortening; Constant score at 6, 12, 24, and 48 weeks; and complications in terms of infection, nonunion, scar, and hardware prominence were recorded using a pilot-tested proforma.

Simple Antero Posterior (AP) radiograph of the involved side was used to classify patients according to the Allman classification. The chest radiograph was also used to evaluate the deformity of the involved clavicle relative to the normal side. All the patients had similar antibiotic coverage and spinal which includes the Constant score, union rate, and difference in the clavicular length after fracture union. Moreover, the secondary outcome includes operative time, intraoperative blood loss, wound size, cosmetic results, and complications.
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Results

A total of 100 patients with clavicle fractures presented to the emergency department or outdoor. Of these, 10 patients could not be followed. There were 36 males and 12 females in the plating group, whereas 30 males and 12 females were in the intramedullary nailing group. The mean age in the plating group was found to be 29.38±7.75 years, whereas it was 29.28±8.29 years in the intramedullary nailing group. Sixty-two patients had Allman Group I fracture, of which 32 were managed by plating and 30 by intramedullary nailing. Twenty-eight patients had Allman Group III fracture, of which 16 were managed by plating and 12 by intramedullary nailing (Table 1). The mean operative time (68.63±14.90 min for plating and 41.95±13.08 min for intramedullary nailing; P=0.0001), the mean perioperative blood loss (131.75±43.36 ml for plating and 73.48±38.87 ml for intramedullary nailing; P=0.0001), and the mean time for fracture union (28±4.56 weeks for plating and 20.1±2.47 weeks for intramedullary nailing; P=0.0003) were found to be less in intramedullary nailing group as compared to the plating group (Table 2). Easier implant removal and fewer complications (scar and hardware prominence) were found in intramedullary nailing group compared to the complications in the plating group (infection, nonunion, scar, and hardware prominence) (Table 2).

However, post-operative clavicle shortening (6.85±4.16 mm for intramedullary nailing and 3.04±2.26 mm for plating) was found to be greater in intramedullary nailing group (Table 2). No significant difference was found in trauma-surgery delay and Constant score at 6, 12, 24, and 48 weeks postoperatively between both the management groups (Table 2).

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<th>Table 1</th>
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<tr>
<td><strong>Variable</strong></td>
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<td>No. of patients</td>
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<td>Females</td>
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<td>Mean age (years)</td>
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<td>Allman Group I</td>
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<tr>
<td><strong>Variable</strong></td>
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<tr>
<td>Trauma-surgery delay (days)</td>
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<td>Operative time (minutes)</td>
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<td>Perioperative blood loss (ml)</td>
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<td>Clavicle shortening (mm)</td>
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SD: Standard deviation
Discussion
In 2007, Gaston and Simpson [10] stated in their study about the effects of gender and age on the healing of fractures. They stated that younger age was associated with an early union of fractures owing to the faster accretion of mineral to callus. The chances of health union of fractures were slightly less in males owing to the history of high-velocity injury in males. The age of the patients assigned to both the groups in this study showed no significant difference (P=0.97), thus nullifying the effect of age on the final outcome of the study. The gender of the patients assigned to both the groups in this study showed no significant difference (P=0.86), thus sideling the effect of gender on the final outcome of the study.

The duration between the infliction of trauma to the surgical management of the fracture (trauma-surgery delay) was tried to keep minimum in the best possible ways in both the groups of patients. Thus, there was no significant difference in trauma-surgery delay in both groups of patients (P=0.21). Hence, the effect of delay in the surgical management of the fracture on the final outcome of the study was nullified.

Of the 42 patients in the intramedullary nailing group, a nail diameter of 2 mm was used in 12 patients, 2.5 mm in 20 patients, and 3 mm in 10 patients. Closed reduction and nailing was achieved in 28 patients, while the remaining 14 cases required open reduction (mini-open).

In this study, the perioperative blood loss was found to be significantly lower in the intramedullary nailing group than the plating group (P<0.001). This can be explained by a number of cases of intramedullary nailing being done percutaneously or by mini-incision. However, the surgeon's exposure to radiation due to C-arm images was found to be more in the intramedullary nailing group than in the plating group.

In a meta-analysis done by Zhang et al. [13] in 2015, the intramedullary nailing technique for the surgical management of clavicle fractures was found to be associated with the rapid union and better shoulder function recovery at 6 months. In this study, the average time to achieve union in this study was significantly faster in the intramedullary nailing group than in the plate group (P<0.001). This can be explained by the less soft-tissue dissection in the intramedullary nailing group. The plating provides absolute stability resulting in primary bone healing, whereas intramedullary nailing provides relative stability leading to secondary bone healing by callus formation.

In 2008, Hartmann et al. [14] reported a study on 15 fractures of the clavicle treated by intramedullary nailing and stated the advantages of intramedullary nailing over the plate fixation considering various parameters. However, in this study, clavicular lengths were significantly better maintained by plating (P<0.001) than by intramedullary nailing. Although this much of clavicular shortening does not affect functional outcome significantly, because as per Lazarides and Zaropoulos [4], only final clavicular shortening of more than 18 mm in males and of more than 14 mm in females are significantly associated with unsatisfactory results.

In this study, in comminuted clavicle fractures or those with large butterfly fragments, the plate fixation remains the operative procedure of choice as it offers better clavicular length maintenance.

The difference in functional outcome in terms of Constant score between the two groups was not found to be statistically significant (P=0.69).

In this study, there were eight major complications in the plate group (infection [n=6] and nonunion [n=2]). The incidence of infection after plating in this study was 12.5%, whereas the reported rates in literature range from 0 to 18%[19].

An important, although minor, complication of intramedullary nailing group was the medial prominence of hardware causing skin irritation or perforation, which was noted in 14 patients (33.33%). In the literature, it is reported to be in the range of 5.2–38.8%[20]. Two causes for this problem are discussed in the literature: [7] Inadequately cut medial end of the nail at primary surgery and nail displacement due to secondary clavicle shortening or telescoping. The first cause, being a surgeon-related factor, may be tackled after primary surgery by adequately cutting the nail. The second cause which is somewhat difficult to address, however, can be minimized by anatomical reduction, intraoperative compression, and avoiding shoulder abduction beyond 90° in the first 2 weeks postoperatively[21]. Another option for reducing medial protrusion is the use of medial end caps[20].

Conclusion
In this study, the surgical management of indicated clavicle fractures is advocated in lieu of low nonunion rates compared to the conservative management. The surgical management included either plating or intramedullary nailing.

There was no significant difference between the two groups with respect to age, sex, and trauma-surgery delay.

The operative time, perioperative blood loss, and the average time to achieve union was found to be significantly lower in the intramedullary nailing group.

However, the maintenance of clavicular length in simple as well as comminuted clavicle fractures was found to be better with plate fixation.

The difference in functional outcomes in terms of Constant score between the two groups was not found to be statistically significant.
In this study, the major complications associated with the plate fixation were found to be hardware prominence, infection, ugly scars, and nonunion. On the contrary, the complication associated with the intramedullary nailing was found to be of medial prominence of hardware causing skin irritation or perforation.

Thus, in this study, the use of minimally invasive intramedullary nailing for fixation of clavicle fractures is advocated in view of faster fracture union, lesser morbidity, easier implant removal, and fewer complications, although for comminuted fractures, plating remains the procedure of choice.

References