Original article

Closed vs open nailing for displaced middle third fracture of clavicle. Does it matter?

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ABSTRACT

Background: Intramedullary nailing for fractures of middle third clavicle has become increasingly popular. Though open nailing has been widely described, closed nailing finds less mention.

Objectives: In this study we compared closed nailing with open nailing in fractures of middle third of clavicle to assess if the former holds any advantage.

Material and methods: 34 patients with closed nailing were compared to 31 patients with open nailing in terms of operative time, length of incision, pain, time to union and functional outcome.

Results: Only operative time and length of incision were significantly more in open group than in closed group.

Discussion: We believe that closed reduction can be attempted in all patients undergoing nailing for middle third clavicle fracture but surgeon should have a low threshold to open the fracture if closed reduction fails as functional outcome and time to union remains unaffected.

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1. Introduction

Fracture of middle third of clavicle is one of the most common injuries an orthopaedic surgeon confronts.¹ Though conservative treatment is most common, certain situations like open fracture, polytrauma, floating shoulders and need for early mobilization in displaced isolated injuries may warrant operative intervention.² Plate fixation has traditionally been operative treatment of choice but nail fixation has proven to be less invasive and better alternative with fewer complications.^{3–8} Most of the techniques of nailing involve open reduction of the fracture with antegrade or retrograde nail insertion.^{3,5,6} Though we believe that closed reduction will be tried in majority before proceeding to open reduction it is less often described in the literature.^{9,10} Orthopaedic principles prefer closed reduction of any long bone fracture with the view that the preserved biology around the fracture will promote healing. Hence, we compared closed nailing with open nailing in fractures of middle third of clavicle to evaluate if this principle holds true in clavicle fractures as well.

2. Materials and methods

This was a prospective cohort study with the objective of comparing the outcomes of closed vs open titanium elastic nailing (TENS) for displaced middle third clavicle fractures. The primary outcome measure was to assess the rate of union and functional outcome after closed and open nailing while operating time, length of incision, pain and time to discharge were assessed as secondary outcome measures. Local ethical committee approval was taken. Informed consent was obtained from each patient included in the study and the study protocol conforms to the ethical guidelines of the 1964 Declaration of Helsinki and revised in 2008. Those adult patients with non-comminuted, displaced, middle third fracture of clavicle were included in the study (Fig. 1). Displaced fractures were defined as >5 mm gap between the fracture fragments on standard AP and 30° cephalad views for clavicle. Any paediatric patients, those with compound injuries, polytrauma or ipsilateral upper limb injuries were excluded from the study as they may interfere with the rehabilitation process. Similarly, patients with medial or lateral end fractures and segmental fractures were excluded from the study.

2.1. Surgical technique

A standard surgical and post-operative protocol is followed in this institute. All cases were performed by a single experienced

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Fig. 1. Preoperative X-ray of mid shaft fracture of the clavicle.

Fig. 3. Fracture union in progress with TENS in situ.

trauma surgeon. The principles of surgical techniques were similar to those described previously.^{11,12} Size of the nail to be inserted was decided preoperatively by measuring the diameter of the medullary canal. Measurements were taken at 2.5 cm from either end of the bone and at middle third. The smallest measurement of the three was considered and nail of the size 0.5 mm less than the diameter was selected for insertion. A prophylactic single dose of intravenous third generation cephalosporin was administered preoperatively. Patient was placed supine. A 1 cm transverse incision was taken about 2 cm lateral to the sterno-clavicular joint. A drill hole was made into the anterior cortex using a 2.7 mm drill bit and the medullary canal was entered using awl. A preselected size of TEN was advanced along the medullary canal unto the fracture site under image intensifier control. Closed reduction of the fracture was attempted by elevating the inferiorly displaced lateral fragment. If the alignment was satisfactory under the image intensifier guidance the nail was advanced in a controlled fashion. We prefer a gentle tap on the T-handle to advance the nail in controlled fashion rather than a vigorous push. Continuous visualization under image intensifier using antero-posterior and oblique views aided advancement of the nail. The bend tip of the nail was rotated to negotiate the entry into the lateral fragment. The nail was advanced only when the surgeon was absolutely sure that it has engaged the lateral fragment. If the fracture could not be reduced by closed method then open reduction was performed. For open reduction a two cm incision was taken at the fracture site. The fracture ends were reduced under vision using bone holding clamps and the nail was then advanced into the lateral fragment. The medial end of the nail was bent and buried in the soft tissue to facilitate easy removal at a later date (Fig. 2). The incision site was

sutured. All patients were discharged on the next day after the operation. Sutures were removed after 2 weeks.

The patient was kept in an arm-sling support for 4 weeks. Intermittent pendulum movement was started after 2 weeks and range of shoulder movement was started after 6 weeks. All patients were followed up after every 2 weeks. VAS score was noted on the day of discharge and at every visit to assess pain. Similarly functional assessment was made using Constant–Murley score for shoulder at 3 months and 6 months. The radiographs were taken at monthly interval to assess status of union (Figs. 3 and 4). Patients were also assessed for any complications like infection, hardware related problems, etc. The minimum follow up of the patients in this study is 6 months.

2.2. Statistical analysis

SPSS 17.0 version (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. Chi square test was used demographic data. Independent *t* test, Mann Whitney test, Wilcoxon signed test and Friedman test were the tests used.

3. Results

In the study period between June 2010 to December 2013, 128 consecutive adult patients presented with fracture of middle third of clavicle out of which 52 were treated conservatively due to simple, non comminuted fracture pattern and displacement of less

Fig. 2. Post-operative X-ray of fracture middle third clavicle with TES in situ.

Fig. 4. Fracture union with TES in situ.

Table 1

Demographic data.

	CR group	OR group	p-Value
Sex (n)	34	31	0.701
Male	24	22	
Female	10	9	
Age (in years) $\pm$ SD (range)	30.31 $\pm$ 8.39 (21–58)	29.73 $\pm$ 10.26 (20–61)	0.575
Weight (in kg) $\pm$ SD (range)	61.55 $\pm$ 7.75 (50–78)	63.56 $\pm$ 5.51 (55–78)	0.284

Table 2

Fracture pattern.

Fracture pattern	CR group	OR group
Transverse	10	8
Short oblique	19	17
Long oblique/spiral	5	6

than 5 mm between the fracture fragments. Eight patients underwent plate fixation as the fracture pattern was highly comminuted with large displaced butterfly fragment and nail fixation was considered unsuitable. Three polytrauma patients though treated operatively were excluded from the study as they had ipsilateral upper limb trauma. Titanium elastic nail is the preferred mode of internal fixation at this institute. Sixty-five patients satisfied the inclusion criteria and were operated with titanium elastic nail fixation. Thirty-one required open fixation (OR group) while 34 were managed by closed nailing (CR group). Demographic data of both the groups is given in Table 1. Both the groups were comparable in terms of age, sex and weight. Fracture patterns in both the groups are summarized in Table 2. The most common indication of surgery was wide displacement of the fracture fragments. Short oblique fracture was the commonest pattern observed in both the groups. Majority of the patients in both the groups sustained clavicular fracture after a vehicular accident and fall on the ipsilateral shoulder. Two patients from CR group and five from OR group sustained fracture after domestic fall.

The results are summarized in Table 3. There was no statistically significant difference in times from trauma to surgery in both groups. The operative time in closed reduction group was significantly lesser in CR group as compared to OR group. Similarly, the length of incision was significantly smaller in CR group as compared to OR group. But the difference in the time to discharge, time to union, Constant–Murley score at 3 and 6 months and pain as assessed by VAS was not statistically significant (Figs. 5 and 6). There were no major intraoperative or postoperative complications noted. Two patients, one each from CR and OR groups, complained of prominent hardware at the medial end of the

Fig. 5. Error bars with 95% CI for Constant–Murley scores at 3 and 6 months. **Fig. 6.** Error bars with 95% CI for VAS at discharge, 1 month and union.

clavicle. In both the cases the nail was removed after the radiological union was confirmed. One patient from the CR group had superficial infection at the incision site which resolved after a course of oral antibiotics. All patients returned to pre-injury level of activity 4 months after the surgery.

4. Discussion

Fractures of middle third clavicle have been conventionally treated conservatively. Though in majority of the times, the results in terms of union are satisfactory but continued pain during treatment and phlebostasis of superficial veins are known complications.¹³ Operative treatment mainly involves either plate fixation or intramedullary nail fixation. Plate fixation allows

Table 3

Comparative analysis of results of CR and OR groups.

	CR group [mean $\pm$ SD (range)]	OR group [mean $\pm$ SD (range)]	p-Value
Operative time in min	33.86 $\pm$ 8.81 (19–54)	47.69 $\pm$ 6.91 (36–63)	0.0001
Length of incision in cm	1.66 $\pm$ 0.28 (1.1–2.1)	4.85 $\pm$ 0.47 (4.0–5.8)	0.0001
Time from trauma to surgery in days	2.75 $\pm$ 1.53 (0–7)	2.89 $\pm$ 2.07 (0–8)	0.911
Time of discharge in days	2.31 $\pm$ 0.47 (2–3)	2.35 $\pm$ 0.48 (2–3)	0.782
Time to union in weeks	10.62 $\pm$ 2.67 (8–16)	10.92 $\pm$ 2.89 (8–16)	0.689
Constant–Murley score at 3 months	84.21 $\pm$ 3.73 (78–90)	83.69 $\pm$ 3.04 (77–90)	0.514
Constant–Murley score at 6 months	93.55 $\pm$ 2.84 (89–98)	92.23 $\pm$ 1.92 (90–97)	0.631
VAS at discharge	2.90 $\pm$ 0.72 (2–4)	3.27 $\pm$ 0.87 (2–5)	0.114
VAS at 1 month	1.59 $\pm$ 0.56 (1–3)	1.62 $\pm$ 0.57 (1–3)	0.848
VAS at union	0.24 $\pm$ 0.43 (0–1)	0.23 $\pm$ 0.43 (0–1)	0.928

anatomic reduction and rigid fixation but the hardware related problems are more common.^{1,14} Intramedullary nail fixation offers a less invasive operative option for the fractures of middle third of clavicle.^{3,4} While comparing nail fixation to plate fixation for displaced middle third clavicle fractures, some studies have reported superior outcome with nailing while others have reported complications of nailing or no statistical difference in the outcome with these two modalities.^{5,6,15,16} Different types of intramedullary devices like Enders nails, Knowles pins etc. have been described with good results.¹³ Titanium elastic nail are currently most popular implant used. Similarly, many surgical techniques for insertion of nail by retrograde or antegrade method have been described.^{3,4} Most of the studies recommend open reduction and very few studies describe closed reduction for nail fixation.^{3,4,9,10} Closed reduction with stable internal fixation with preferably an intramedullary implant has been a favoured technique in any long bone fracture management as it preserves the biology required for fracture healing. This concept can be applied to clavicle fracture as well. But closed reduction of clavicle fracture involves a theoretical risk of injury to major neurovascular structures.¹⁰ Therefore we felt the need to study if open reduction of clavicle has any detrimental effect on fracture healing or functional outcome when compared to closed nailing.

We at this institute regularly perform intramedullary nailing for displaced fractures of middle third of clavicle and controlled closed reduction of the fracture is attempted for not more than two or three times. If it fails then open reduction is performed. We compared the closed reduction patients with the open reduction ones to determine if there was any difference in the functional outcome and the union rates.

In the present study, operative time and the length of incision were significantly more in the open reduction group when compared to the closed reduction group. We understand that the operating time for open reduction group has increased as it also included the time for attempted closed reduction. Similarly, the length of incision in OR group is bound to be more as it included the incision at the fracture site. But none of these factors have contributed to increased pain postoperatively. We understand that visual analogue score (VAS) is a subjective tool for assessment for pain but we believe that this is the most simple and easy tool to assess pain in outpatient department. Most importantly, there was no statistical difference in the time to union and functional outcome between the two groups. This suggests that for middle third clavicle fractures, open reduction may not be detrimental to fracture union. To our knowledge there is no published study in English literature comparing the outcome of open and closed nailing in fractures of middle third of clavicle.

There are very few studies in English literature describing closed reduction and internal fixation with intramedullary nail for mid-shaft clavicle fracture.^{9,10} Chen et al. described the technique of closed reduction for midclavicular fractures with good outcome, though it was not a comparative study.⁹ Similarly Chuang et al. described the technique of closed reduction of displaced middle third clavicle fracture and fixation with cannulated screw with good results.¹⁰ Many studies with open nailing have demonstrated good results with less pain and early rehabilitation but none compared with the closed technique.^{17–20}

The results of this study show that the concept of closed reduction and internal fixation being better than open reduction and internal fixation may not hold true in case of midclavicular fractures in terms of functional outcome or time to union. But the advantage of short operative time and better cosmetic result remains. Non-union after nailing is a known complication and has been reported in literature.^{21,22} None of the patients in this study had non-union or delayed union probably because comminuted fractures were excluded. We also believe that larger sample size

will be required to study these complications. Similarly, we did not encounter any major intraoperative or postoperative complications, indicating that these complications are rare. Yet the importance of gentle manipulation and careful advancement of the nail across the fracture site cannot be overemphasized. The surgeon in this study have practiced extremely careful technique of closed reduction with careful advancement of nail by gentle tapping, continuous monitoring with image intensifier and low threshold for open reduction. We believe that closed reduction can be tried in all the patients undergoing nail fixation for middle third fracture of clavicle keeping a very low threshold for open reduction.

5. Conclusion

This study suggests that there is no difference in the functional outcome or rate of union after closed or open reduction and intramedullary nail fixation for displaced middle third fracture of the clavicle. This study will serve as a pilot study for further randomized controlled trials.

Conflicts of interest

The authors have none to declare.

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