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Clinical and radiological outcome of anterior inferior plating of middle third fracture of clavicle

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Abstract

Introduction: Various techniques have been documented for managing fractures of the middle third of the clavicle. This prospective study aimed to assess the outcomes of anterior-inferior plating using a 3.5-mm reconstruction locking plate for middle-third clavicle fractures.

Method: Sixty-eight patients presenting with middle-third clavicle fractures underwent treatment via anterior-inferior plating. Surgical indications included complete displacement, severe comminution, and significant shortening of the clavicle (greater than two cm).

Result: The mean duration for fracture union was 14 weeks . At the most recent follow-up, all patients had resumed their pre-injury activity levels. No cases required plate removal due to implant-related complications till final follow-up.

Conclusion: Anterior-inferior plating is an effective treatment modality for middle-third clavicle fractures, offering stable fixation with minimal complications. This technique mitigates the risk to vital structures beneath the clavicle and is associated with a low incidence of implant prominence issues.

Keywords: anterior inferior plating; clavicle fracture; reconstruction plate

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Introduction

Fracture clavicle accounts for 2.6-4% of all adult fracture, 35% of all injuries to the shoulder and 69-82% of these occur in middle third with a displacement rate of about 73%.[1,2]These fractures have traditionally been treated nonoperatively believing that nonunion were very rare and without clinical importance.[3,4]Recent studies focus on higher rate of delayed union, nonunion, shoulder pain and shoulder weakness and residual pain.[5] Furthermore, the anterior inferior plating and superior plating are two techniques that are used in plate fixation. Nevertheless, the position of the plate remains controversial.[4]Anterior inferior plating may reduce the risk of damaging the underlying neurovascular bundle and implant prominence. There has only been a hand full study on anterior inferior plating as superior plating is still a common practice.[6-10]

Method

This prospective descriptive cross-sectional study was conducted from September 2022 to May 2024. The study protocol was reviewed and approved by Institutional Review Committee Ref: IRC-PA-255/2023. Written informed consents were taken from all the participants. This study involved 68 patients with mid third clavicle fracture treated by anterior inferior plating using 3.5 mm reconstruction plate. Inclusion criteria for surgery were complete displacement of clavicle more than 2 cm at mid 1/3rd region. Patients with minimal displacement of fragment, open fracture or poly-trauma were excluded from the study. Preoperative radiograph was assessed for fracture pattern and degree of communition. Fractures were classified according to the AO (Association of the Study of Internal Fixation) classification system[11] and managed within 24 hours of hospital admission.

All the surgeries were performed by senior orthopedic surgeon either under general anesthesia or block. Patients were positioned supine on radiolucent table with a rolled towel between shoulder blades. Then affected upper limb was draped free to allow easy manipulation during surgery. After proper painting and draping an incision parallel to the lower border of the clavicle was made around 8-10 cm centering the fracture site and surgical dissection was carried out up-to the fracture site making adequate sub-periosteal exposure of medial and lateral fragment for plate placement. Fracture fragments were identified, and meticulous reduction was done and temporarily stabilized with k-wires, when reduced encircleage wiring of the spiral fragments were done with wire before placement of the reconstruction plate. Lag screws were preferred in cases where screw placement didn't hinder the placement of plate. An adequate length of 3.5 mm recon locking plate was contoured with plate bender for application to the curved surface of the anterior inferior border of the clavicle. While securing fixation surgeon made sure there was at-least 6 cortices purchase in either of medial and lateral fragments otherwise lagscrews were placed and reconstruction plate was used as neutralizing plate. Usually, cortical screws were used for fixation but when necessary, locking screws were also applied as required.

After fixation freely draped upper extremity was taken through the gentle range of motion to ensure adequate stability. Then wound was thoroughly washed with normal saline and closure was done in layers without drain and sterile dressing was done. Arm was placed in arm pouch sling and shifted to ward. Total 3 doses of Intravenous antibiotic injection (Cefuroxime 1.5 grams) were given 12 hrs apart, 1st dose being administered half hour before surgical incision. Adequate analgesia was managed, and 1st post operative dressing was done on 2nd post-operative day and if surgical wound was dry and healthy then patient was discharged on oral analgesics. Physical therapy was initiated as soon as the pain was tolerable with gentle assisted pendular exercises. The patient was advised to continue sling for at least 4 weeks post-surgery with gradually increasing physical activity. At 4 weeks after surgery active and passive range of motion was initiated as tolerated, but lifting and resistance activity was prohibited till 8-12 weeks depending of the radiological appearance on follow-up radiograph. Clinical and radiological outcome, hospitalization status, clinical and radiological outcome were assessed at each follow-up. Hospitalization status included length of stay, operation time and time to implant removal. For clinical outcome we evaluated Disability of Arm, Shoulder and Hand (DASH) score, time to regain normal Range of Motion (ROM) after surgery and cosmetic satisfaction (using the survey and scar length). A 5-point scale (1, dissatisfied to 5, satisfied) was used for the cosmetic satisfaction survey.[12]

Fracture healing was assessed radiologically and clinically at each follow-up. Radiological outcome was assessed by evaluating shortening and angulation at the final follow-up and time to bony union. Clavicle length and angulation were measured on anteroposterior clavicle radiographs.

Result

Out of 68 patients 40(58.82%) were male and 28(41.18%) were female with 31(45.59%) were type B fracture, Table 1. Age group was from 18-64 years (37±13). Mean hospital stay was 4±2 days. The average operation time was 58.2±10.8 minutes. The

mean DASH score was 2.2±2.7. Average union time was 14 weeks (range from 10-18 weeks). No patient went in non-union in our study. Most of the patient regained normal range of motion of shoulder by the end of 3 months (12±2 weeks). At final follow-up mean angulation at fracture site was 4.46±2.84 degree and mean shortening was 3.9±1.3 mm. cosmetic satisfaction score was 4.1±0.9 (Table 2). Superficial surgical site infection was observed in 3 patients, which was managed by antibiotics and one had surgical scar tenderness but all were managed non surgically. No patient came for implant removal till last follow-up. And no patient complained of metal induced irritation.

Discussion

Open reduction and internal fixation of clavicle fracture with plates and screw has been considered as effective treatment modality for middle third clavicle fracture.[13] Operative treatment gave advantage of shorter union time, improved functional outcome, and lower rate of mal-union and nonunion.[12]Antero-inferior plating and superior plating are two different approaches and fixation technique with their own advantages and surgery related complications. Hence which approach is more effective and safer is still in controversy. In this study we operated all displaced middle third clavicle fracture with anterior inferior plating technique using 3.5 mm reconstruction plate and analyzed difficulties during surgery and post-surgery to assess its effectiveness in management in clavicle fracture.

Jupiter and leffert advocated in favor of superior plating because they suggested that biomechanically superior surface of clavicle is load bearing surface and hence by principle of plate fixation, superior plating is the ideal technique.[14]

A biomechanical evaluation of clavicle fracture done on twenty four pre osteotomized synthetic clavicles reported that superior plating is better than anterior-inferior plating in terms of load to failure and bending failure stiffness, however in terms of

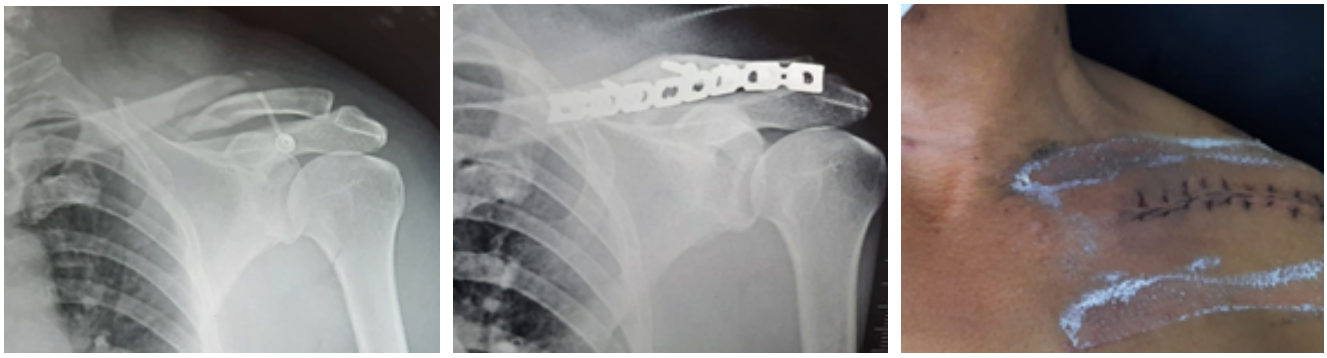
Table 1. Distribution of fracture according to gender, side and type, (n=68)

Gender		Side		AO-Type		
Male	Female	Right	Left	A	B	C
40(58.82%)	28(41.18%)	38(55.88%)	30(44.12%)	22(32.35%)	31(45.59%)	15(22.06%)

Table 2. Clinical outcome after anterior inferior plating in clavicle fracture

Variables	Mean±SD
Length of stay (Days)	3.8±2.4
Operation time (mins)	58.2±10.8
DASH Score	2.2±2.7
Time to regain Range of Motion (wks)	12.75±2.06
Time to boney union (wks)	14.13±2.17
Angulation at fracture site (degree)	4.46±2.84
Shortening (mm)	3.9±1.3
Satisfaction score	4.1±0.9
Scar length (mm)	8.2±2.3

SD: Standard Deviation



1(A) 1(B) 1(C)

Figure 1. (A) Preoperative AP radiograph showing AO Type B2.2 fracture of left clavicle. (B) Postoperative AP radiograph showing in anterior inferior plating with reconstruction plate and 2 lag screw. (C) Clinical picture showing incision site after suture removal on 10th post operative day

axial compression stiffness anterior inferior plating was superior to superior plating.[15]A similar study employing a transverse osteotomy model led to the conclusion that clavicles plated at the superior aspect demonstrate significantly enhanced biomechanical stability compared to those plated at the anterior aspect.[16] Despite this finding, the study did not identify any statistically significant difference in load to failure between the two plate locations. The results contribute valuable insights into the considerations surrounding plate placement in the treatment of middle-third clavicle fractures, highlighting the biomechanical implications associated with varying plate positions.[16]

A meta-analysis concluded that anterior inferior plating group was better than superior plating group in operation time and blood loss ($p<0.005$). Furthermore, in terms of clinical indices, anterior inferior plating was better than superior plating in reducing the union time, and the two kinds of plate fixation methods were comparable in constant score, and the rate of infection, nonunion, and complications.[17]

By placing the plate antero-inferior, screws with greater length can be used which offer more stability, especially against rotational force.[18-20] On the other hand, some studies reported that antero-inferior plating led to greater resistance to cantilever bending, although there was no significant difference in resisting axial or torsional forces.[17, 21, 22]

A Level I randomized clinical trial conducted in 2015 demonstrated no significant difference in implant outcomes between the two techniques.[23] Additionally, a multi-center study across three tertiary academic institutions reported no incidence of implant prominence.[6] Since the location of the clavicle is superficial just beneath the skin.

In our study, we did not do any implant removal till final follow up, but our hypothesis is that implant removal in clavicle is done mostly because its superficial but the advantage in anterior inferior plating is that the reason for implant removal is not the early implant related irritation.

Conclusion

Open reduction and internal fixation with plates is preferred treatment modality in displaced mid shaft clavicle fracture. However, antero-inferior plating techniques has advantages over superior plating with comparable surgical, clinical and post-surgical outcome with minimal or no implant related complications like skin irritation.

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Conflict of Interest

None

Author's Contribution

Concept, design, planning:SCJ; Literature review: SK; Data collection: SCJ; Data analysis: SK; Draft manuscript: SCJ; Revision of draft: SK; Final manuscript: SCJ, SK; Accountability of the work: SCJ, SK.

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