ORIGINAL ARTICLE ASIAN JOURNAL OF MEDICAL SCIENCES

Tension band wiring of fracture distal end of clavicle: Favorable clinical outcome among the patients

Ashoke Kumar Chanda[1], Kallol Banerjee[2], Abhimanyu Mondal[3], Dipayan Sarkar[4], Rajiv Roy[5], Bivas Bank[6]

[1]Assistant Professor, [2]Professor, [5]Professor and Head, [3]Senior Resident, [4,6]Postgraduate Trainee, Department of Orthopedics, Calcutta National Medical College and Hospital, Kolkata, West Bengal, India

Submission: 06-01-2023 Revision: 30-04-2023 Publication: 01-06-2023

ABSTRACT

Background: A fracture of the clavicle is common traumatic injury. It can be classified into middle third, medial third, and distal third fractures. Around 10–15% of clavicle fractures occur in the distal third. The ideal method of fixation in distal third clavicle fracture remains controversial till date. **Aims and Objectives:** The clinical outcome of the patients having fracture of the distal end clavicle using rigid fixation with tension band wiring (TBW) with Kirshner wires and SS wire to be assessed instead of other conventional procedures. **Materials and Methods:** Eight patients of Neer type II closed distal-third clavicle fracture of <3 weeks of duration were included in our study. The fractures were reduced by open reduction and fixed with TBW with two K-wires and SS wire. **Results:** The mean average age of patients was 41.87 years. All fractures united clinically and radiologically. The mean average time of union was 12 weeks. There was two case of hardware prominence, no fracture related complications. One case of superficial infection was found in study. All of them regained near normal range of motion, and the mean average constant Murley score for distal clavicle fracture at the end of 1 year was 88. At the end of 1 year follow-up, all patients had reached their pre-injury performance levels. **Conclusion:** There was an encouraging result with TBW in distal third clavicle fracture in our study. This technique is simple with lesser need of expertise and is also cost effective.

Key words: Distal-clavicle; Fracture; Neer classification; Murley score; Tension band wiring; Displaced

Access this article online

Website: http://nepjol.info/index.php/AJMS

DOI: 10.3126/ajms.v14i6.51176

E-ISSN: 2091-0576

P-ISSN: 2467-9100

INTRODUCTION

A clavicle fracture is common traumatic injury that comprises 44% of shoulder girdle injuries and 5% of all skeletal injuries. Fractures of the clavicle are classified by Allman according to its localization as middle, distal, and medial third fractures. Distal end of clavicle fractures comprises approximately 10–15% of clavicle fractures.[1-3] Neer divided distal clavicle fractures into three subgroups, based on their ligamentous attachments and degree of displacement (type II was subsequently modified by Rockwood).[4,5]

The ideal method of fixation in distal third clavicle fracture remains controversial till date. However, a few series of coracoclavicular screws,[6-8] tension bands,[9-11] Kirshner wires,[1,13] hook plates,[14,15] and contoured locked and nonlocked plates[16-18] have been published with encouraging results in all series. Feared complications of open reduction and internal fixation include fixation failure, pin migration, refracture, malunion, and extensive tissue dissection during hardware removal.[11,19] Levy[20] described a minimally invasive suture fixation with good outcome, which obviates the need for implant removal. Badhe et al.,[21] modified the Levy technique and mentioned tension band suturing for such displaced type 2 lateral end clavicle fractures with 100% union in their series.

We share our results using modified tension band fixation of displaced fracture of the distal end clavicle. We favor rigid fixation with tension band wiring (TBW) with

Address for Correspondence:
Dr. Bivas Bank, Postgraduate Trainee, Department of Orthopedics, Calcutta National Medical College, Kolkata - 700 014, West Bengal, India. **Mobile:** +91-9831338492. **E-mail:** bivasbank@gmail.com

Kirshner wires and SS wire. With our modified tension band fixation, we achieved encouraging results in a small cohort of eight patients.

Aims and objectives

The clinical outcome of the patients having fracture of the distal end clavicle using rigid fixation with tension band wiring with Kirshner wires and ss wire to be assessed instead of other conventional procedures.

MATERIALS AND METHODS

This prospective study was conducted at the tertiary care Hospital of Kolkata from 2020 to 2022 with a minimum of 1-year follow-up. Neer type 2 closed displaced distal third clavicle fracture of <3 weeks duration of an adult patient without had any medical comorbidities at time of admission and not associated any other fractures in the body included in this study. Pre-operative assessment with anteroposterior X-ray of clavicle and preanesthetic checkup was undertaken in all patients (Figure 1).

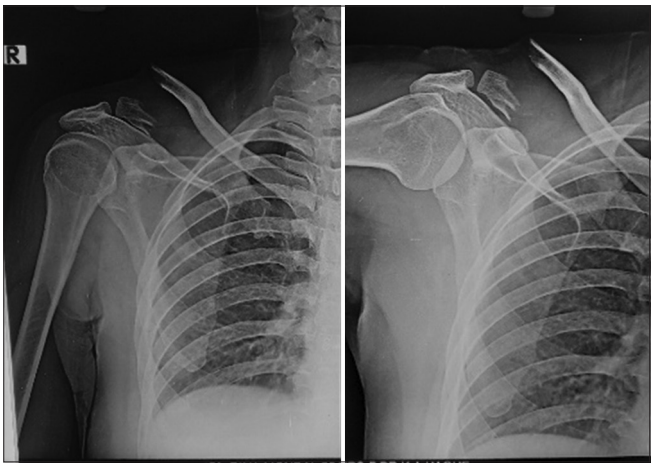

Figure 1: Pre-operative X-ray of distal third clavicle fracture of P3

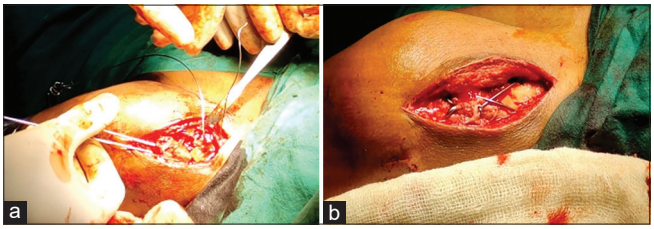

Figure 2: (a and b) intraoperative pictures of clavicular tension band wiring

All operations were done in the beach chair position with placing a towel roll in between two scapulae. A small skin incision of about 5 cm was made along with soft-tissue dissection down to the bone followed by periosteal elevation, exposure of fracture ends, and reduction maintained by reduction clamp. Cautery dissection was carried out to minimize bleeding from the subcutaneous plane onwards. Every care was taken not to disturb acromioclavicular ligaments. The fracture site was visualized, and the hematoma was curetted and washed. An anteroposterior drill hole was made with 2-mm drill bit through proximal fracture fragment and a pretensioned SS wire was passed through the hole. The fracture was reduced with the help of a clamp and fixed with two 1.8-mm Kirshner wires given from distal end of clavicle. SS wire was tied in a figure of eight manner with keeping the knot superiorly. The tip of the Kirshner wire was bent and buried inside the skin. The wound was irrigated and closed in layers (Figures 2a and b).

Postoperatively, the arm was supported in an arm pouch for 6 weeks. Pendulum exercises were commenced from the 3rd post-operative day. However, supported gradual abduction was started after suture removal on the 14th post-operative day. Return to sports activities was only allowed after clinicoradiological union. We had followed up our patients in the 6th post-operative week and thereafter at a 2 weeks of interval until union, and 6-monthly evaluation was done after established union. We confirmed union with two plane radiographs, anteroposterior, and axillary view of shoulder. Cortical continuity in three cortices, medullary cavity reconstitution, no increase in fracture line gap in

Figure 3: (a and b) post-operative X-ray and clinical photographs showing ROM

Table 1: Demographic data and clinical features of the patients

S. No.	Code	Sex	Age	Occupation	Side	Comorbidities	Mode of trauma
1.	P1	Male	54	Light manual	Left	Nil	Fall from standing height
2.	P2	Male	40	Light manual	Right	Nil	RTA
3.	P3	Female	45	Light manual	Right	Diabetes	Fall from standing height
4.	P4	Female	56	Light manual	Left	Diabetes	Fall from height
5.	P5	Male	36	Heavy manual	Left	Nil	RTA
6.	P6	Female	35	Heavy manual	Right	Nil	Fall from standing height
7.	P7	Male	28	Heavy manual	Left	Hypertension	Sports injury
8.	P8	Male	41	Light manual	Left	Nil	RTA

Table 2: Operative and post-operative features of the patients

S. No.	Code	Operative time (min)	Union time (weeks)	Constant-Murley Score	Fracture complication	Wound complication
1.	P1	48	10	90	Nil	Nil
2.	P2	62	14	92	Nil	Nil
3.	P3	56	14	80	Hardware prominence	Nil
4.	P4	46	12	84	Nil	Superficial infection
5.	P5	49	12	96	Nil	Nil
6.	P6	51	12	88	Nil	Nil
7.	P7	58	10	84	Hardware prominence	Nil
8.	P8	44	12	90	Nil	Nil

consecutive radiographs, and a non-tender at fracture site clinically were considered evidence of union of fracture.

RESULTS

The mean average age of patients was 41.87 years. Out of eight patients five were male and 3 were female. Common mode of injury in our study was RTA and fall from standing height, whereas other mode of injuries was sports related injury and fall from height. Three patients were associated with comorbidities, two patients had diabetes, and one patient had hypertension.

All eight fractures united clinically and radiologically. The mean average time of operation was 51.75 min and mean average time of union was 12 weeks. There were two case of hardware prominence, otherwise no as such fracture related complications in our study. We found a case of superficial infection in our study. All of them regained near normal range of motion, and the mean average constant Murley score for distal clavicle fracture at the end of 1 year was 88. At the end of 1 year, all patients had reached their pre-injury performance level. Range of movements at 1 year remained the same in those who were followed-up in successive years. The clinical features and operative details had been elucidated in details in Tables 1 and 2.

DISCUSSION

Neer classified distal clavicle fractures according to the location in relation to the coracoclavicular ligaments.[12] The deforming forces and the rotational movements acting in the clavicle is the reason for the displacement of the fragments which are the reason for delayed or non-union. Neer suggested operative treatment for displaced distal third clavicle fractures. He showed successful results with K-wire fixation with few complications.[12]

Subsequently various surgical modalities have been used with various techniques of fixation with better outcomes. But still, there is no gold standard method of fixation for displaced lateral end clavicle fractures. Edward et al.,[22] Yamaguchi et al.,[8] and Ballmer and Gerber[6] reported 100% success rate in their series with Bosworth coracoclavicular fixation. Bosworth screw fixation has possible complications like screw cut-out and peri-implant fractures. Stabilization with clavicular hook plate has yielded a success rate of up to 88–12% nonunion in a series of 18 patients by Tambe et al.[23] However, acromion osteolysis has been reported in 30% with such hook plates. For these reasons, there is need of another procedure to remove hook plate early. Along with acromial osteolysis, subacromial impingement, high rate of loosening, and fatigue failure are several complications that mentioned in the literature; however, Lee at al.[24] described the advantageous role of hook plate fixation in their comparative study between hook plate and tension band. Andersen et al.,[25] reported 94% union rate with precountered superior locking plate fixation for displaced distal clavicle fractures. Peri-implant fracture has been reported in one case and infected nonunion in the other in their study. However, they required additional surgical techniques for anatomical reduction in the form of suture augmentation with coracoid, anchor suture fixation, or coracoclavicular screws in half of their cases

resulting in wider surgical exposures. Poor screw purchase associated with precontoured plate is mentioned in several studies. Levy had described single figure of eight suture fixation technique with PDS suture that had shown a success rate of 100%.[20] Although alignment is secured, rotational stress during mobilization may weaken suture fixation. Badhe et al., had modified the suturing technique which consists of two figure-eight sutures with non-absorbable polyester.[21] However, the distal fragment is often too small to make two drill holes. Neer original series of clavicle fractures observed unusually high rate of non-union or delayed union in displaced lateral third clavicle.[22]

In our study subjects, we found all the fractures united clinically and radiologically. Neer reported 100% union with Kirshner wire fixation and suggested displaced fracture to be stabilized for better results. Kona et al., and Eskola et al., reported 52.6% and 95.6%, respectively, success rate with Kirshner wires.[13,27] Rigid fixation with no rotational movement can be achieved with TBW in distal third clavicle fracture.

Acromioclavicular reconstruction is generally not required as the ligaments are intact and attached to the distal clavicle in this type of fractures. Coracoclavicular ligaments are torn in some fractures, but anatomical alignment and prevention of rotation will be sufficient for such fractures to unite.

Loosening of Kirshner wires, migration, undue stress during active mobilization, breakage, hardware prominence, and skin impingement are known complications with Kirshner wires fixation. In our study, two patients had hardware prominence and we removed implant early after fracture union. We had one patient with superficial infection, in which we managed with intravenous antibiotics.

Limitations of the study

The sample size has been smaller, it needs to be done over larger number of study subjects in multiple centers to accurately measure the functional outcome. Comparison with other methods of fixation would have been much helpful to assess the functional outcome.

CONCLUSION

The advantages of TBW are higher anti-rotation and anti-bending force compared with that in K-wire fixation and lower profile compared with the bone plate, which reduces tendon irritation and prominent implant. The use of K-wires and TBW requires the exposure of the fracture site only. Moreover, the soft tissue around the clavicle suffers from little damage, leading to a lower rate of infection as well as more rigid fixation than K-wires only. Hence, we conclude surgical treatment of distal end clavicular fractures using TBW results in a good functional outcome in resource-limited setups.

ACKNOWLEDGMENT

We are indebted to all patients and their family members who actively participated in our study.

REFERENCES

1. Jin CZ, Kim HK and Min BH. Surgical treatment for distal clavicle fracture associated with coracoclavicular ligament rupture using a cannulated screw fixation technique. J Trauma. 2006;60(6):1358-1361.
   https://doi.org/10.1097/01.ta.0000220385.34197.f9
2. Levy O. Simple, minimally invasive surgical technique for treatment of Type 2 fractures of the distal clavicle. J Shoulder Elbow Surg. 2003;12(1):24-28.
   https://doi.org/10.1067/mse.2003.128564
3. Chen CH, Chen WJ and Shih CH. Surgical treatment for distal clavicle fracture with coracoclavicular ligament disruption. J Trauma. 2002;52(1):72-78.
   https://doi.org/10.1097/00005373-200201000-00013
4. Craig EV. Fractures of the clavicle. In: Rockwood CA and Matsen FA, editors. The Shoulder. 3rd ed. Philadelphia, PA: WB Saunders; 1998. p. 428-482.
5. Neer CS 2nd. Fractures of the distal clavicle with detachment of the coracoclavicular ligaments in adults. J Trauma. 1963;3:99-110.
   https://doi.org/10.1097/00005373-196303000-00001
6. Ballmer FT and Gerber C. Coracoclavicular screw fixation for unstable fractures of the distal clavicle. A report of five cases. J Bone Joint Surg Br. 1991;73(2):291-294.
   https://doi.org/10.1302/0301-620X.73B2.2005158
7. Macheras G, Kateros KT, Savvidou OD, Sofianos J, Fawzy EA and Papagelopoulos PJ. Coracoclavicular screw fixation for unstable distal clavicle fractures. Orthopedics. 2005;28(7):693-696.
   https://doi.org/10.3928/0147-7447-20050701-18
8. Yamaguchi H, Arakawa H and Kobayashi M. Results of the Bosworth method for unstable fractures of the distal clavicle. Int Orthop. 1998;22(6):366-368.
   https://doi.org/10.1007/s002640050279
9. Bezer M, Aydin N and Guven O. The treatment of distal clavicle fractures with coracoclavicular ligament disruption: A report of 10 cases. J Orthop Trauma. 2005;19(8):524-528.
   https://doi.org/10.1097/01.bot.0000164593.04348.e5
10. Chen CH, Chen WJ and Shih CH. Surgical treatment for distal clavicle fracture with coracoclavicular ligament disruption. J Trauma. 2002;52(1):72-78.
    https://doi.org/10.1097/00005373-200201000-00013
11. Shin SJ, Roh KJ, Kim JO and Sohn HS. Treatment of unstable distal clavicle fractures using two suture anchors and suture tension bands. Injury. 2009;40(12):1308-1312.
    https://doi.org/10.1016/j.injury.2009.03.013
12. Neer CS 2nd. Fractures of the distal third of the clavicle. Clin Orthop Relat Res. 1968;58:43-50.
13. Kona J, Bosse MJ, Staeheli JW and Rosseau RL. Type II distal clavicle fractures: A retrospective review of surgical treatment. J Orthop Trauma. 1990;4(2):115-120.

https://doi.org/10.1097/00005131-199004020-00002

14. Haidar SG, Krishnan KM and Deshmukh SC. Hook plate fixation for Type II fractures of the lateral end of the clavicle. J Shoulder Elbow Surg. 2006;15(4):419-423.
https://doi.org/10.1016/j.jse.2005.11.012
15. Klein SM, Badman BL, Keating CJ, Devinney DS, Frankle MA and Mighell MA. Results of surgical treatment for unstable distal clavicular fractures. J Shoulder Elbow Surg. 2010;19(7):1049-1055.
https://doi.org/10.1016/j.jse.2009.11.056
16. Herrmann S, Schmidmaier G and Greiner S. Stabilisation of vertical unstable distal clavicular fractures (Neer 2b) using locking T-plates and suture anchors. Injury. 2009;40(3):236-239.
https://doi.org/10.1016/j.injury.2008.07.021
17. Kaipel M, Majewski M and Regazzoni P. Double-plate fixation in lateral clavicle fractures-a new strategy. J Trauma. 2010;69(4):896-900.
https://doi.org/10.1097/TA.0b013e3181bedf28
18. Yu C, Sun YH, Zhao CQ, Shi DW and Wang Y. Treatment of distal clavicle fracture with distal radius volar locking compression plate. Chin J Traumatol. 2009;12(5):299-301.
19. Brouwer KM, Wright TC and Ring DC. Failure of superior locking clavicle plate by axial pull-out of the lateral screws: A report of four cases. J Shoulder Elbow Surg. 2009;18(1):e22-e25.
https://doi.org/10.1016/j.jse.2008.05.042
20. Levy O. Simple, minimally invasive surgical technique for treatment of Type 2 fractures of the distal clavicle. J Shoulder Elbow Surg. 2003;12(1):24-28.
https://doi.org/10.1067/mse.2003.128564
21. Badhe SP, Lawrence TM and Clark DI. Tension band suturing for the treatment of displaced Type 2 lateral end clavicle fractures. Arch Orthop Trauma Surg. 2007;127(1):25-28.
https://doi.org/10.1007/s00402-006-0197-3
22. Edwards DJ, Kavanagh TG and Flannery MC. Fractures of the distal clavicle: A case for fixation. Injury. 1992;23(1):44-46.
https://doi.org/10.1016/0020-1383(92)90125-c
23. Tambe AD, Motkar P, Qamar A, Drew S and Turner SM. Fracture of distal third of the clavicle treated by hook plate. Int Orthop. 2006;30(1):7-10.
https://doi.org/10.1007/s00264-005-0019-1
24. Lee YS, Lau MJ, Tseng YC, Chen WC, Kao HY and Wei JD. Comparison of the efficacy of hook plate versus tension band wire in the treatment of unstable fractures of the distal clavicle. Int Orthop. 2009;33(5):1401-1405.
https://doi.org/10.1007/s00264-008-0696-7
25. Andersen JR, Willis MP, Nelson R and Mighell MA. Precontoured superior locked plating of distal clavicle fractures: A new strategy. Clin Orthop Relat Res. 2011;469(12):3344-3350.
https://doi.org/10.1007/s11999-011-2009-5
26. Neer CS 2nd. Nonunion of the clavicle. J Am Med Assoc. 1960;172:1006-1011.
https://doi.org/10.1001/jama.1960.03020100014003
27. Eskola A, Vainionpaa S, Patiala H and Rokkanen P. Outcome of operative treatment in fresh lateral clavicular fracture. Ann Chir Gynaecol. 1987;76:167-169.

Authors' Contributions:
AKC and **BB-** Designed the research; **KB, RR, DS**, and **BB**- Conducted the research; **BB**- Analyzed data; **AM** and **BB**- Wrote the paper and all authors have checked the final content before submission.

Work attributed to:
All patients who attended the Department of Orthopedics, Calcutta National Medical College and Hospital, Kolkata and participated in this study.

Orcid ID:
Ashoke Kumar Chanda - https://orcid.org/0009-0003-6055-4769
Kallol Banerjee - https://orcid.org/0009-0008-3814-0961
Dipayan Sarkar - https://orcid.org/0009-0001-5907-9943
Rajiv Roy - https://orcid.org/0000-0003-3018-3306
Bivas Bank - https://orcid.org/0009-0002-7456-4039

Source of Support: Nil, **Conflicts of Interest:** None declared.