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Treatment Outcomes of Flexible Intramedullary Nailing in Fracture Shaft of Clavicle

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Abstract: ***Background**: Nonsurgical treatment of midshaft clavicular fractures leads to unsatisfactory results such as nonunion, shortening and limited function of the shoulder. Till date, various implants have been developed for open reduction including intramedullary wires, screws, and plates, each of which having various complications such as blood loss, non-union, implant irritation. TENS fixation is rather a newer modality with less complication and good outcome and is a lesser researched topic, thus this study was carried out to further evaluate the outcomes. **Materials and Methods**: 34 displaced midshaft clavicular fracture patient were included in this study in which 10 patients were included retrospectively from a period of 2016-2018 and 24 patient were included prospectively from 2019 to 2021. Patients of mid shaft clavicular fracture were managed by TENS nail. Patients were followed up post operatively at 2 week, 6 week, 3 month, 6 month and at 12 month postoperatively. Outcome was measured by the Constant-Murley score, and DASH Score and fracture union. Secondary outcome was measured by operative time, wound size, cosmetic results and complications. **Results**: In this study, it was seen that mean Constant Murley score at 12 months duration was 94.88, mean DASH score was 7.45, mean union time was 9.5 weeks and mean operative time was 36.32 mins. However, DASH score was only measured after 8 weeks duration as overhead abduction was not advisable in view of rotation of fracture fragment. **Conclusion**: The use of TENS 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.***

Keywords: Titanium Elastic Nail, Displaced mid-shaft clavicular fractures, Dash Score, Constant Murley score

1. Introduction

Clavicle derives its name from Latin origin word *clavis* from which has been derived the word “clavicula” referring to “little key” as when arm is abducted this bone rotates like key. Fracture of the clavicle are common and account for 5–10% of all fractures[1, 2]men are more commonly (68%) affected. Although the incidence in our country is not available, the yearly global incidence of clavicle fracture is 71 in 100, 000 males to 30 in 100, 000 females.3 Whereas low energy injuries result in minimally displaced fractures of clavicle, high energy injuries are more likely to be severely displaced, Majority of clavicle fractures (70–80%) are located in the mid-diaphyseal region.

Conventionally, acute mid clavicular fractures which are not severely displaced in an adult are successfully treated non-operatively with ether a sling or a figure-of-eight bandage, with non-union[4,5]reported in less than 1% fractures. The recent reports of non-union rates of 29%[6] and mal-union rates of 14-36%, [7, 8] with displaced clavicle fractures treated non-operatively have made many prefer operative treatment in displaced mid-shaft clavicular fractures (DMCF). Shoulder biomechanics are reported to get significantly altered by mal-union of the clavicle[9, 10]. Operative fixation of displaced clavicular fractures have reported improved patient outcomes, early return to function, decreased non-union and mal-union rates, and better cosmesis [11, 12] making the preference move towards surgical fixation of selected clavicle fractures. Mal-union of the clavicle in association with shortening of clavicle results in change in glenoid orientation, and upward angulations of the clavicle at the sternoclavicular joint therefore, it is indicative for surgical fixation of clavicle fractures, especially in the active young group of patients. Both plate fixation and intramedullary fixation theoretically have their own advantages. Plate fixation will give a more rigid stabilization and a stronger construct to allow early rehabilitation. But has some disadvantages like excessive blood loss, risk of injury to supra clavicular nerve, periosteal stripping. The intramedullary nailing is a recent and less researched technique and has the advantage of less soft tissue stripping which preserves vascular integrity during fracture healing thereby generating more callus and decreasing risk of infection, thus this study aims at evaluating the functional outcome of DMCF fixed with intramedullary nailing.

2. Material and Method

The study was carried out on patients of displaced mid-shaft fractures of clavicle in Department of Orthopaedics, N. S. C. B Subharti Medical College, Meerut from August 2019 to July 2021.

Study Design

This is a retrospective and prospective interventional study

Sample Population

A total of 40 patients were enrolled for the study out of which 6 were lost in follow-up 10 patients were taken from

previous study conducted in 2016-2018 by Dr Jatin Bansal after due consent. The rest 24 patients were followed up post operatively at 2 week, 6 week, 3 month, 6 month and at 12 month.

Inclusion criteria: Adult patients with displaced mid-shaft of clavicle fractures, Comminuted mid-shaft clavicle fractures (Robinson displaced fracture type 2A2, 2B1)
Age between 18-60 years, Fractures causing tenting of skin.

Exclusion criteria: Old fracture of clavicle (3 weeks or more), Age: less than 18 and more than 60 years of age, Robinson classification – Type 2-B2, Type 3-A1, A2, B1, B2, Compound fracture. Floating shoulder, Un-displaced fracture clavicle, Moderate to severe head injury. Pathological fractures, Bilateral Clavicular fracture, Fracture associated with neuro-vascular injury, Prior surgery of the shoulder or clavicle, Prior chronic illness of the shoulder

Preoperative evaluation
Preoperative evaluation was done by assessing the patient according to Robinson classification, measurement of length, radiological evaluation (Anteroposterior (AP) view and Cephalic tilt view), Patient were be evaluated for all the necessary investigation required for preanaesthetic fitness.

Technique
After administration of general anaesthesia, the patient was placed in supine position on radiolucent table with a sandbag under the midline between both the scapulae. Preoperatively on the operating table the shoulder region was screened using image intensifier to confirm its access to sternoclavicular joint. The injured extremity prepared and draped from the whole clavicular region to the upper arm. Care was taken to make sure that the sternoclavicular joint was accessible for the entry point. Small incision was made approximately 1 cm lateral to the sterno-clavicular joint and entry point was made in the anterior cortex of medial clavicle 1cm lateral to sternoclavicular joint using Bone Awl. EIN loaded on T-Handle (the diameter from 2-3 mm depending on width of the bone) and inserted from the entry point. Closed reduction was performed under fluoroscopy and held using 2 percutaneously introduced pointed reduction clamps. If closed reduction could not be achieved an additional incision was made above the fracture site for direct manipulation of the main fragments, the nail then was advanced manually until just medial to the acromion-clavicular joint. Accurate maneuvering of the nail tip is necessary under fluoroscopic control to avoid penetration of the thin posterior cortex. After reaching the end point the fracture was compressed and the nail was cut close to the entry point with Jumbo Cutter to minimize soft tissue irritation, at the same time leaving sufficient length behind for easy extraction later on. Surgical wound was then washed with Normal Saline and skin closed using 2-0 polyamide suture. The mentioned nails were procured from both locally available vendors as well as AO (synthes, Switzerland).

Postoperative protocol:
Operated patients were given an arm pouch sling for 3 weeks, IV antibiotics given for 5-6 days and then oral broad spectrum antibiotics for next 5-6 days. Stitches were removed in 10 to 12 days after surgery and mobilization of the shoulder started as pain permits. The mobilization protocol followed was pendulum motion exercises during the first 3 weeks, followed by active abduction and flexion up to the horizontal plane from 3-10 weeks to avoid rotation at fracture site. The full ranges of active motion were permitted after 10 weeks and return to full activity to was permitted after 3 months.

Follow up protocol:
All patients were reviewed in the outpatient department at 2 week and 6 week, 3 month, 6 month and 12 month after surgery. Functional Outcome was measured by the Constant-Murley score, and DASH Score and fracture union.

3. Results

The present study was carried out with an aim to evaluate the functional results of fractures of mid shaft clavicle treated from August 2019 to July 2021 by intramedullary nailing. The study sample comprised of the retrospective group-(from 2016 to 2019) of DMCF of Robinson type 2-A2 and B1 and a prospective follow up group-of those DMCF treated by closed/open reduction and intramedullary nailing both comprising a total of 40 unilateral DMCF and 6 patients were lost in follow up. To homogenize the sample, the retrospective sample of patients were selected on the basis of the age matched groups of prospective cases selected for closed/open reduction and internal fixation with intramedullary nails. All the patients who consented for the study conducted in the Department of Orthopaedic Surgery were included in this study and called for follow-up for observing their outcome periodically for the next 1 year or more. All cases were assessed radiologically pre-operatively and were classified using Robinson classification of clavicular fractures**.**

The Robinson type 2 B1 fractures were observed in 15 subjects, while type 2 B2 fractures were present 19 cases. Skin compromise in the form of stretching, puckering, in drawing, or color change was present in 13 cases,, mean age of the patient at the time of presentation in this study was 35.84 years, □□Max percentage of patient were between the age group of 26-45 years (47%) Majority of the patient were males 62%. Injury due to road traffic accident predominated the series by 69% followed by fall from height 31%.6 patients out of 34 had implant irritation over medial aspect which was managed by trimming of implant. The study observed that 14 patients out of 34 had open reduction of the intramedullary nailing although closed reduction shall have distinct advantages of intramedullary nailing.

It was imperative that the blood loss, though not measured in this study, was less in those fractures which could be reduced closed percutaneously. The length of incision in the intramedullary nailing was lesser as the incision was aimed to achieve optimum reduction and for insertion of TENS under fluoroscopy.

The average union time in this study was 9.5 weeks minimum being 9 weeks and maximum being 10 weeks. The average operative time in this study was 36.32 minutes while maximum being 60 minutes and minimum being 25 minutes.

The Constant-Murley score and DASH scores were obtained at 6-8 week, 3-4 month, 6-8 month, 9-10 month and 12 month or more after surgery. The mean Constant-Murley score was 67.94 at 6-8 week, 73.88 at 3-4 month, 81.64 at 6-8 month, 90.11 at 9-10 month, and 95.58 at >12 month. The mean DASH scores were 21.08 at 3-4 month, 21.08 at 6-8 month, 8.97 at 9-10 month and 7.45 at >12 month. The DASH score was not recorded in initial 6-8 week follow up as >90 degree (overhead) movement was permitted only after union. There was no major implant related problem like breakage or failure in this study. There were no complications related to infection or neurovascular injury.

4. Discussion

Clavicular fractures have traditionally been treated non-operatively with either a sling or figure of "8" bandage with less than 1% rate of non-union.5, [14]Many studies stated that almost all simple DMCF can be treated non-operatively and healed with little or no complications.1[5, 16] However, in most of these publications, the functional outcome was not taken into account.3. More recent studies have shown significantly higher non-union rates in conservatively treated patients[6, 17]hence the current recommendation for treatment of displaced mid-shaft clavicular fracture is operative fixation.

Open reduction and internal fixation with plate or open/closed reduction and intramedullary nail are two of the most commonly used surgical techniques for treating DMCF. Plate fixation is the standard operative technique for DMCF which can be applied antero-superior or antero-inferior surfaces. Another emerging mode of fixation is intramedullary fixation, in clavicles with well-developed medullary cavity, by EIN which is shown in this present study. Despite proposed benefits, plating and intramedullary nailing method both have their own limitations. Although plate fixation gives a more rigid stabilization and stronger construct to allow early rehabilitation the disadvantages include the increased exposure and soft tissue stripping, increased risk of damage to supraclavicular nerve, slightly higher infection rates, hypertrophic scars and re-fracture after plate removal. On the other hand intramedullary nailing has advantages of being less invasive requiring less soft tissue stripping, lesser risk of damage to supraclavicular nerve, and lesser infection rates. The subjective disadvantages include skin irritation, implant migration and need for implant removal.

A total of 40 patients were enrolled for the study out of which 6 were lost in follow-up 10 patients were taken from previous study conducted in 2016-2018 by Dr Jatin Bansal after due consent.

It was necessary to perform open reduction in 10 patients in intramedullary nailing. The widely displaced DMCF theoretically have soft tissue interposition which can make closed reduction difficult in such cases. The study observed that 14 patients out of 34 had open reduction of the intramedullary nailing although closed reduction shall have distinct advantages of intramedullary nailing.6 patients out of 34 had implant irritation over medial aspect which was managed by trimming of implant and followed by removal of implant after 10 weeks.

In this study it was observed that average skin incision size was of 4.2 cm and average union time was 9.5 weeks and the constant Murley score of 94.88 this was comparable to study conducted by **Narsaria N and co-workers (2014)** [18]which observed the length of incision in the nailing group (mean 6.87cm) Constant-Murley score of 94 and mean union time of 8 weeks.

It was observed in this study that average operative time was 36.32 min which was comparable to study conducted by **Zeng L and co-workers (2015)** [19]which observed the mean operative time of 35.20 minutes thus concluding that DMCF fixation is less traumatic to patient and has good functional outcome.

It was imperative that the blood loss, though not measured in this study, was less in those fractures which could be reduced closed percutaneously

5. Conclusion

Clavicle fractures occur frequently and account for 5-10% of all fractures.6Around 70-80% fractures of clavicle occur in the mid-shaft out of which 50% are displaced (DMCF).2[0] It is likely that high energy injuries can displace fractures of clavicle severely. Operative fixation of displaced mid-shaft clavicular fractures with nail as compared to plating have reported improved patient outcomes, earlier return to function, decreased nonunion and mal-union rates and better

cosmesis making the preference to move towards intramedullary fixation of DMCF.

6. Financial support and sponsorship

Nil

7. Conflicts of Interest

There are no conflicts of interest.

References

[1] Khan LA, Bradnock TJ, Scott C, Robinson CM. "Fractures of the clavicle. " *J Bone Joint Surgery (Am),* (2009), 91; 447–460.
[2] Robinson CM, "Fractures of the clavicle in the adult, " *J Bone Joint Surg (Br),* (1998), 80: 3; 476–484.
[3] Nordqvist A., Petersson CJ, "The incidence of fractures of the clavicle, " *Clinical Orthopaedics and Related Research*, (1994) 300; 127–132
[4] BrinkerMR, Edwards TB, O"ConnorDP, RobinsonCM, "Estimating the risk of nonunion following nonoperative treatment of a clavicular fracture, " *J BoneJointSurgery (Am),* (2005), 87: 3: .676–677.
[5] Eiff MP. "Management of clavicle fractures". *JFam Physician (Am),* (1997), 55: 1; 121-128.
[6] Neer CS, "Nonunion of the clavicle", *J AmMedAsso*, (1960), 172; 1006–1011.
[7] ChanKY, JupiterJB, LeffertRD, MartiR, "Clavicle malunion, " *Journal of Shoulder and Elbow Surgery (Am),* (1999), 8: 4; 287–290
[8] Ledger M, Leeks N, Ackland T, Wang A. "Short malunion of the clavicle: An anatomic and functional study. " *Journal of Shoulder and Elbow Surgery*, (2005), 14; 349–354.
[9] Braun KF, Siebenlist S, Sandmann GH, Martetschlager F, Kraus T, Schrodl C, Kirchhoff C, Neumaier M, "Functional Results Following Titanium Elastic-Stable Intramedullary Nailing (ESIN) of Mid Shaft Clavicle Fractures" *ActaChirOrthop Traumatol (Cech), (*2014), 81: 2; 118-121
[10] Neer CS., "Fracture of the distal third of the clavicle". Clinical Orthopedics and Related Research. (1968), 58: 43-50.
[11] Moseley HF. The clavicle: Its anatomy and function. *Clinical Orthopaedics and Related Research*, (1968), 58; 17-27.
[12] Chen Y-f, Zeng B-f, Chen Y-j, Wang H-m, Xue J-f, Chai Y-m, Xie X-t, Zhang C, "Clinicaloutcomes of midclavicular fractures treated with titanium elastic nails" *CanJ Surg* (2010) Dec 53: 6; 379-384.
[13] Eiff MP. "Management of clavicle fractures". *JFam Physician (Am),* (1997), 55: 1; 121-128
[14] Neer CS, "Nonunion of clavicle" J Am Med Asso, (1960), 172; 1006-1011
[15] Meier C, Grueninger P, Platz A "Elastic Stable Intramedullary Nailing for Midclavicular Fractures in Athletes" *ActaOrthopBelg* (2006), 72, 269-275.
[16] Golish SR, Oliviero JA, Francke EI, miller MD, "A biomechanical study of plate versus intramedullary devices for midshaft clavicle fixation" *J Orthop SurgRes* (2008), 16: 3; 28.
[17] Jupiter JB, LeVert RD "Non-union of the clavicle. Associated complications and surgical management". *J Bone Joint Surg (Am), (*1987) 69: 5; 753–760
[18] Narsaria N, Singh AK, Arun GR, Seth RRS, "Surgical fixation of displaced midshaft clavicle fractures: elastic intramedullary nailing versus precontoured plating" *JOrthop Traumatology (*2014), Sept15: 3; 165–171
[19] Zeng L, Wei H, Liu Y, Zhang W, Pan Y, Zhang W, Zhang C, Zeng B, Chen Y, "Titanium Elastic Nail (TEN) Versus Reconstruction Plate Repair of Midshaft Clavicular Fractures: AFinite Element Study" *PLoS One, (*2015), 10: 5; e0126131
[20] Nowak et al. "A prospective study of 222 patients, sequelae from clavicular fractures managed conservatively", Acta Orthop.2005