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INTRAMEDULLARY FIXATION OF MIDCLAVICULAR FRACTURES OF CLAVICLE

Orthopaedics

Dr. Irrinki Suresh* Associate Professor, Department of Orthopaedics, Alluri Sitarama Raju Academy of Medical Sciences, Eluru, Andhra Pradesh 534005. *Corresponding Author

ABSTRACT

Introduction: Clavicle fracture is a very common injury with a incidence of 3-5% of all fractures[1,2]. These are managed conservatively regularly. Though many options are available for fixing clavicle fractures Titanium elastic nails are a promising minimally invasive treatment for displaced mid-clavicle fractures. The aim of the present study was to evaluate the functional and radiological results of intramedullary fixation of mid-clavicular fractures.

Methods: It is a prospective study of 25 patients who presented to our institute between January 2013 and June 2016 with displaced midshaft clavicle fractures and treated with titanium ESIN fixation. Implant removal was performed in all the patients after the fracture united completely.

Results: Out of all 25 patients 17 patients required open reduction which accounts to about 71%. The mean oxford shoulder score is 45.6 patients at 12 weeks and there is no significant difference from till 6 months. The mean quick DASH score is 7.6 at the last follow up .

Conclusion: Flexible intramedullary nailing, a minimally invasive technique for stabilization of displaced midshaft clavicle fractures is a simple procedure with excellent functional outcome in terms of quick return to sporting activities and a high patient satisfaction rate.

KEYWORDS

Clavicle plating, Intramedullary clavicle nailing, middle 1/3 rd clavicle fractures, Titanium elastic nailing System (TENS).

Introduction:

The midshaft clavicle fractures account for 3 to 5% of all injuries and 70 to 80% of all clavicle fractures.[1,2] In young adults, these fractures are usually related to sports or vehicle accidents, whereas in children and elderly, they are usually related to falls.[1,2] In general, clavicle fractures are treated conservatively and have a good outcome. Recent studies showed various unsatisfactory complications such as nonunion, malunion and shoulders asymmetry[3-5] .

Neer in 1960 reported a non-union rate of 0.1% with conservative treatment [6] and Rowe in 1968 showed a non-union rate of 0.8% in conservatively managed patients[7] . Other authors have failed to demonstrate similar good results with conservative treatment[8,9], this may be due inclusion of more number of children and adolescents and their enormous potential for bone healing, that patient-based scoring systems were not used in the initial series to record the outcome.[10] Hill *et al*. showed that displacement of more than 20 mm resulted in 15% non-union and 18% of the patients had thoracic outlet syndrome following union.[8] McKee *et al*. noted reduced patient satisfaction due to asymmetry and cosmesis following malunion in patients with more than 20 mm shortening.[9] Hence, more recently, there has been a trend toward surgical fixation. Surgery has been indicated for completely displaced fractures, potential skin perforation, shortening of clavicle by more than 20 mm, neurovascular injury, and floating injury.[8] The gold standard for the surgical treatment has been open reduction and plate fixation through a large incision.[8]Other surgical options include intramedullary pinning with Kirschner wire, Rush pins, Knolwes pin, Steinman pin, Haige pin, ESIN (elastic stable intramedullary nailing), and external fixation.[11] Intramedullary fixation treatment for midclavicular fractures has been favored due to its strengths including small incision, less periosteal striping, dispersion of stress and simple to operate.[12] However, early intramedullary implants, such as Hagie pins and Kirschner wires, have been gradually replaced due to insufficient stability[13,14]. The titanium ESIN has been successfully used in fixation of pediatric long bone fractures. One advantage of the titanium ESIN is that it can block itself in the bone and provide a three-point fixation within the S-shaped clavicle.[15,16] However, some studies have shown a relatively high complication rate and technical difficulties with intramedullary nailing.[10,15]

The aim of this study was to investigate the union rate and complication rate of our patients with displaced midshaft clavicle fractures treated with titanium ESIN.

MATERIAL AND METHODS:

It is a prospective study of 25 patients who presented to our institute between January 2013 and June 2016 with displaced midshaft clavicle fractures and treated with titanium ESIN was carried out.

Inclusion criteria and exclusion criteria

Inclusion criteria:

(1) Type IIA_2 (angulation > 45°) or IIB_1 (shortening or overlapping displacement length > 2 cm) fresh unilateral midshaft clavicular fractures according to Robinson classification;
(2) The range of age were 21–50 years old; (3) patient without high risk for anesthesia.
(3) Minimum follow up of 6 months.

Exclusion criteria:

(1) Pathological fractures;
(2) Multiple injuries of upper limbs;
(3) Combined with injuries of blood vessels or nerves;
(4) Other diseases which affected the functions of upper limbs.

There were 21 males and 4 females in this study. The mean age was 27.6 years (range, 21 to 50 years). The patients were operated by a single surgeon. All the cases were followed up serially at 3 weeks, 6 weeks and 12 weeks. All the implants were removed after visible radiological healing.

We defined radiological union as visible bridging callus or absent fracture line. The clinical union was described as no bony tenderness on clinical examination. All the patients had Oxford Shoulder score and QuickDASH score. The QuickDASH is a shortened version of the DASH outcome score and uses 11 items instead of the 30 items in the full questionnaire to measure physical function and symptoms in patients with any or multiple musculoskeletal disorders of the upper limb.[15]

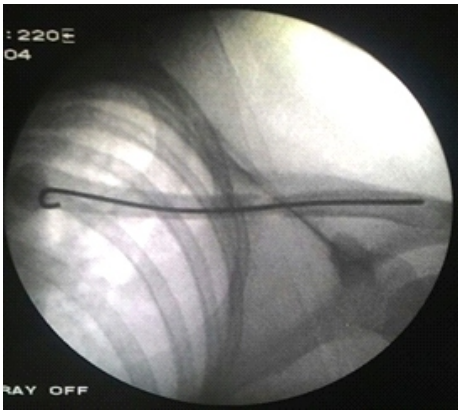
Surgical technique:

After administration of anesthesia, the patient was placed in beach chair position with injured extremity prepared and draped from the midline to the upper arm. Care was taken to make sure that the sternoclavicular joint was accessible for the entry point. Preoperatively, the shoulder region was screened using image intensifier to confirm this access.

Through a horizontal skin incision just lateral to the sternoclavicular joint, the pectoral fascia was divided in line with the skin incision. This is followed by careful elevation of the underlying musculature from the clavicle. The entry point was then made using the awl and appropriate sized titanium ESIN was inserted (The size of the nail was measured using this formula = 0.4×canal diameter in mm). Attempt was made to close reduce the fracture. open reduction with a small horizontal incision is done in cases with failed closed reduction . Incision was taken parallel to Langer's lines and minimized the risk of damage to supraclavicular nerves to avoid dysesthesia of skin and scar neuromas. At that time, the nail was used to create a path in the lateral end of the clavicle for subsequent easy access. The nail was then passed from the medial side and across the reduced fracture into the lateral end of clavicle. Shoulder sling support was given postoperatively and rehabilitation regime of early gentle mobilization

till tolerable pain limits was allowed, with no overhead abduction for first six weeks. The shoulder sling was discarded at 2 weeks and active-assisted exercises were started, but the patients were advised not to lift any heavy object for 6 weeks. At that time, passive and strengthening exercises were started.

Preop midshaft clavicle fracture



Intra op midclavicle fracture

Post op midclavicle fracture

Results:

25 patients who met the inclusion criteria of diaphyseal midshaft, non-comminuted clavicle fractures with more than 20mm shortening /displacement were studied.Of these 25 patients, 15 patients had a fall on outstretched hand, 3 had a fall from bicycle, 1 had a fall onto the point of shoulder, and 6 had road traffic accident. The average follow up was 12 months (Range, 6-24 weeks).

All the patients achieved clinical and radiological union at a mean of 12.5 weeks (Range, 8-18 weeks). Eight of the 25 patients had closed nailing while 17 patients (71%) required open reduction of their fracture. The average size of the titanium flexible nail used was 2 mm (range, 1.5 -3 mm).

The patients were followed up postoperatively and oxford shoulder score and Quick DASH scores were calculated 6 weeks, 3 months, 6 months, and at the last follow-up. There was no statistical difference between the functional scores and the range of movement when the scores were compared at 3, 6 months and the last follow-up. The average Oxford Shoulder score was 45.6 (range, 39-51). The average Quick DASH score was 7.6 (range, 0-12.9) at the last follow-up.

Eighteen of 25 patients had removal of the implant for symptomatic medial irritation, 6 months after the initial operation and after their fracture had clinically and radiologically healed. One patient required trimming of medial end of nail and one patient had lateral protrusion of the nail which was subsequently removed. One patient developed keloid which is a common complication if any other surgery.

There were no major complications in our series with no cases of infections, scar neuromas, non-unions or perforation of the posterior cortex.

Patient who had lateral protrusion of the nail leading to irritation of skin.

Discussion:

Mid-clavicular fractures in our country are being treated conservatively until date. Neer[6] and Rowe[7] in the 1960's recommended non-operative treatment, because they observed a very small number of non-unions with conservative osteosynthesis. External fixation[17], plating and intramedullary fixation [11,16,18–20] have all been described for surgical treatment of clavicle fractures. Plate osteosynthesis is still considered the standard method for the surgical treatment of clavicle shaft fractures. The advantage of this technique is good reduction with compression and rigid fixation[21]. However, severe complications occur in 10% of the patients and include deep infection, non-union, implant failure, and fracture after implant removal. Lesser complications include superficial infection, keloid scar, dysesthesia in the region of scar, as well as implant loosening with loss of reduction.[10]

Schuind *et al*. in 1988 reported results of 20 patients treated with Hoffmann external fixation with no non-union and return to full range of movements of the shoulder. However, there was no objective measurement of patient satisfaction.[17]

Intramedullary stabilization evolved as an efficient alternative fixation method. Intramedullary fixation is optimal from biomechanical point of view as the tension side of clavicle changes with respect to rotation of arm and direction of loading[10,16].This technique has the advantages of smaller incision, minimal periosteal stripping, and load sharing device properties.[22] Micro motion supports copious callus formation during the healing process. Skin irritation from the prominent medial end of the nail is frequent and this frequently leads to either trimming of the nail or its premature removal.[22] Multifragmentary fracture can lead to telescoping of the nail with shortening of the clavicle. Severely comminuted fractures were excluded because we believe that this fixation system cannot maintain length of the clavicle in these situations.Hence Smekal *et al*. discourage the use of ESIN in severely comminuted fractures with fear of shortening[10]. Duan *et al*. in a meta-analysis of randomized controlled trials supported intramedullary fixation and gave an opinion that hardware problems were more with plating .[1] Zolowodzki *et al*. in a systematic review of 2144 cases found non-union rate of 1.6% with intramedullary fixation as compared with 2.5% with plate fixation.[23]

The use of titanium elastic nails in the treatment of midshaft clavicle fractures was first described by Jubel *et al*.[24]. He showed faster functional recovery with greater patient satisfaction with cosmesis and overall outcome in the TEN group[24]. Smekal *et al*. showed, in a randomized control trail between intramedullary nailing and non-operative treatment, better DASH and Constant scores and 100% union rate with intramedullary nailing.[10]Liu *et al*. found no significant difference between functional outcome and non-union rate following plate fixation and intramedullary fixation (titanium elastic nails) of displaced midshaft clavicle fractures.[20]

Frigg *et al*. in their study expressed concerns about the increased complication rate like medial irritation, keloid formation [15]. One of our patients, medial incision turned out to be keloid and resulted in cosmetic problem as the patient is female. The other patient with lateral protrusion (without any involvement of the acromioclavicular joint) had minimal discomfort from it and this nail was removed once the fracture had healed. Though migration of intramedullary implant was reported in many of the previous studies we had no such complication.[10,20]

47% of our patients had the implant removed, most of them for symptomatic medial irritation. In our study we he a closed reduction rate of 32% and open reduction rate of 68%. Smekal *et al*.[10] reported rate a similar rates of 36:64 comparable with our study. Open reduction was done through a small horizontal incision at the fracture site with a minimally invasive approach. We do not consider open reduction of the fracture as unsatisfactory as despite its high rate, in our series, we achieved 100% union.

In our series, the procedure was performed by only one surgeon using a standardized surgical technique as detailed earlier. We achieved good functional and cosmetic outcome in diaphyseal midshaft, non-comminuted clavicle fractures with more than 20 mm shortening/displacement with titanium ESIN with no major complications.

This is a relatively small retrospective series of patients treated by author with mean follow-up of 6 months . Another drawback is it is not a comparative study. All the patients were reviewed at out patient department at 2 weeks, 6 weeks and 12 weeks and 6 months by two senior orthopaedic surgeons including the surgeon. However, functional outcome was measured using objective patient-based scoring systems. These scores were done at least six months after the trauma with an average follow-up of one year.

In conclusion, the intramedullary fixation of midshaft clavicle fractures is a safe minimally invasive technique in indicated cases and in our hands it provides good functional outcome and cosmetic results.

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