

Elastic Intramedullary Nail Fixation of Displaced Midshaft Clavicular Fractures

EHAB A. SHAHEEN, M.Sc.; KAMAL M. HAFEZ, M.D.; OSAMA A. SELEEM, M.D. and OSAMA ALI EL-GEHALY, M.D.

The Department of Orthopedic Surgery, Faculty of Medicine, Tanta University

Abstract

Background: Undisplaced midclavicular fractures are generally managed conservatively. Imminent perforation of the skin, impending or existing neurovascular compromise and the floating shoulder represent absolute indications for operative treatment. Gross displacement of fracture fragments, as well as non-unions, are seen as relative indications for surgical fixation. Plate osteosynthesis is the standard operative treatment, but higher complication rates have been described with this technique.

Aim of Study: The aim of this work was to study the short term results of treatment of displaced fractures of the middle third of the clavicle using percutaneous elastic intramedullary nails.

Patients and Methods: This study was a prospective case series carried out on twenty patients with displaced fractures of the middle third of the clavicle presented to Tanta University Hospital from September 2016 to January 2018 and treated by percutaneous elastic intramedullary nails.

Results: In this study 20 patients were included with a mean age of 26.40 ± 8.91 years, 17 patients (85%) were males and 3 patients (15%) were females. Three patients (15%) had associated medical conditions. The time lapse before surgery in the studied patients ranged from 1 day to 10 days with a mean 4.60 ± 2.93 day. Open reduction was done in 6 cases (30%) out of 20 cases after failed closed reduction of fracture. Time of union in the studied patients ranged from 8 weeks to 12 weeks with a mean 10.0 ± 1.33 weeks with an exception of one case which presented with hypertrophic non-union. Time of union in the studied patients ranged from 8 weeks to 12 weeks with a mean 10.0 ± 1.33 weeks with an exception of one patient which presented with hypertrophic non-union. The final Constant score was 95.70 ± 13.55 . Excellent results in fourteen patients (70%), good in four (20%), fair in one (5%), and poor in one (5%). Pain was moderate in one patient (5%), while 19 (95%) reported absence of pain. Time of union ranged from 8 weeks to 12 weeks with a mean 10.0 ± 1.33 weeks with an exception of one case which, presented with hypertrophic non-union. Complications encountered were infection in one patient (5%), medial skin irritation in two (10%), dorsolateral migration in two (10%) and hypertrophic non-union in one patient (5%).

Conclusions: Elastic stable intramedullary nailing (ESIN) is an image dependant procedure indicated best for young medically free patients with acute simple 2 part middle third clavicle fracture. Main advantage of this technique is providing a more rapid free movement of the shoulder and an earlier return to daily activities than the conservative treatment. In comparison with plate fixation, the procedure is less invasive, no loss of fracture haematoma, rapid union, and less infection. No major surgery for removal with less injury to surrounded neurovascular structures. Smaller incision is required with superior cosmesis. There was statistically significant relationship between the final score and the patients' age and associated medical conditions.

Key Words: Elastic intramedullary – Nail fixation – clavicle bone.

Introduction

THE clavicle is a long, dual-curved bone that forms the only direct link between the axial (via the sternoclavicular joint) and appendicular (via the acromioclavicular joint) skeletons [1,2]. Any force absorbed by the upper extremity is transmitted to the thorax through the clavicle. This fact, in addition to its superficial location, explains why it is vulnerable to injury [3].

The incidence of clavicle fractures in adults appears to be increasing because of several factors, including high-velocity vehicular accidents and the increase of popularity of contact sports [4].

The clavicle is the most commonly broken bone in the human body, accounting for up to 2.6% of all fractures seen in hospital emergency admissions. These injuries are most common in younger patients, often associated with direct or indirect trauma to the clavicle [5].

The clavicle is classically divided into thirds when describing the location of the fracture. Fractures of the middle third, or midshaft, are the most common, accounting for up to 80% of all clavicle

Correspondence to: Dr. Ehab A. Shaheen, The Department of Orthopedic Surgery, Faculty of Medicine, Tanta University

fractures, followed by lateral third fractures (12% to 15%) and lastly medial third fractures, (5% to 6%) [6].

The location of the fracture, along with the degree of displacement and association of surrounding structures, is important to consider for treatment. Traditionally, clavicle fractures have been treated with nonoperative management, but high-quality randomized studies have recently begun to change the evidence-based management of these fractures [7]. Imminent perforation of the skin, impending or existing neurovascular compromise and the floating shoulder represent absolute indications for operative treatment. Gross displacement of fracture fragments, as well as non-unions, are seen as relative indications for surgical fixation. Plate osteosynthesis is the standard operative treatment, but higher complication rates have been described with this technique [8].

Elastic stable intramedullary nailing (ESIN) is a minimally invasive procedure that provide a three-point fixation within the S-shaped clavicle and aims at exact restoration of the clavicular length with early return to full activity, with a good cosmetic result because of a smaller incision, less soft tissue dissection and relative stability that encourages callus formation [9].

Patients and Methods

This study was a prospective case series carried out on twenty patients with displaced fractures of the middle third of the clavicle presented to Tanta University Hospital (from Jan. 2017 to May 2018) and treated by percutaneous elastic intramedullary nails.

The inclusion criteria include:

- Age above 18 and below 65 years of age.
- Duration less than 2 weeks.
- Displaced or angulated mid-shaft fracture with shortening and axial malalignment.

The exclusion criteria include:

- Pre-existent morbidity of the ipsilateral arm, shoulder or hand.
- Presence of neurovascular injury.
- Pathological fractures.

Methods:

Data were collected according to:

- Personal data (Name, Age, Sex, Occupation and Time lag prior to presentation).

- History of the present symptom (Mechanism of injury and Presence of pain and swelling).
- Clinical examination.
- Radiological evaluation.

Treatment:

All patients were treated using percutaneous elastic stable intramedullary nails.

Anaesthesia and positioning: Surgery was performed with the patient under general anaesthesia. Prophylactic antibiotic prophylaxis (3rd generation cephalosporins) was given.

Skin incision: A short skin incision of about 1cm was made just lateral to the sternoclavicular joint centred above the medial end of the clavicle localised by image intensifier.

Procedure: The medullary cavity of the clavicle was opened using an awl about 1cm lateral to the sternoclavicular joint. The awl was pointed laterally in-line with the clavicle and angled at about 30° to the coronal plane. Care was taken not to perforate the dorsal cortex in order to avoid major complications.

Closure: Closure of skin was performed by single simple interrupted suture using 3-0 prolene. In case of open reduction a standard closure of the other wound was then performed in layers using 2-0 absorbable sutures for the myofascia and subcutaneous tissue then subcuticular stitch for the skin.

Follow-up: All patients were followed up clinically and radiologically for at least six months.

Statistical analysis:

The collected data were evaluated and statistically analysed using arithmetic mean, standard deviation, *t*-test, and chi-square. The difference was considered significant when $p < 0.05$.

Results

Final score:

At the end of the follow-up period, the mean score was 89.70 ± 13.55 ranging from 48 to 100 according to the modified Constant and Murley shoulder score. Fourteen patients (70%) had excellent results, four patients (20%) had good results, one patient (5%) had fair result, and one patient (5%) had poor result.

Activity of daily living:

At the end of the follow-up period, the mean final Constant score for activity of daily living was 18.80 ± 3.69 ranging from 8 to 20.

Union:

Time of union in the studied patients ranged from 8 weeks to 12 weeks with a mean 10.0 ± 1.33 weeks with an exception of one patient which, presented with hypertrophic non-union.

Patient presentation:

A 42 year old male manual worker. Total score was 100 (ADL: 20, no pain, full range forward elevation and abduction, full external rotation and internal rotation). Union occurred after 12 weeks. The patient was graded as excellent.

Table (1): Distribution of the studied patients regarding the final score according to a modified Constant and Murley score.

| Final score | No. | % |
|--------------------|-------------------|------|
| Excellent (91-100) | 14 | 70.0 |
| Good (75-90) | 4 | 20.0 |
| Fair (60-74) | 1 | 5.0 |
| Poor (<60) | 1 | 5.0 |
| Min.-Max. | 48.0-100.0 | |
| Mean \pm SD | 89.70 \pm 13.55 | |

Table (2): Distribution of the studied patients regarding Activity of daily living.

| Activity of daily living | No. | % |
|--------------------------|------------------|-------|
| <i>Activity level:</i> | | |
| Full work | 18 | 90.0 |
| Full recreation/sport | 18 | 90.0 |
| Unaffected sleep | 20 | 100.0 |
| <i>Positioning:</i> | | |
| Up to neck | 2 | 10.0 |
| Above head | 18 | 90.0 |
| Min.-Max. | 8.0-20.0 | |
| Mean \pm SD | 18.80 \pm 3.69 | |

Table (3): Distribution of the studied patients regarding union.

| Union (weeks) | No. | % |
|------------------|-----------------|------|
| Non union | 1 | 5.0 |
| Union | 19 | 95.0 |
| Min.-Max. (n=19) | 8.0-12.0 | |
| Mean \pm SD | 10.0 \pm 1.33 | |

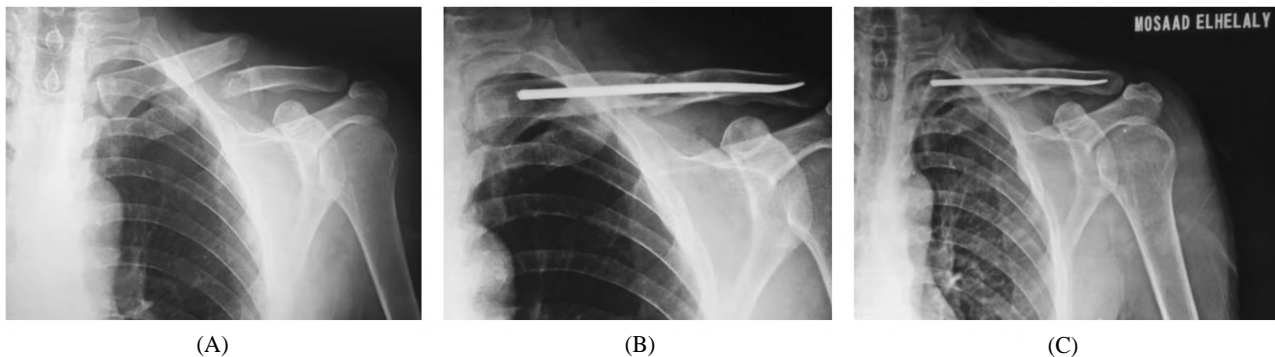


Fig. (1): (A): Preoperative X-ray. (B): Immediate post-operative. (C): X-ray after six months.

Discussion

Many authors advocated primary surgical treatment of displaced injuries. Imminent perforation of the skin, impending or existing neurovascular compromise and the floating shoulder represent absolute indications for operative treatment. Gross displacement of fracture fragments, as well as non-unions, are seen as relative indications for surgical fixation [4].

A variety of intramedullary devices including Knowles pins, Kirschener wires, Hagie pins and Rockwood pins have been used [10]. Implant migration with fatal complications, implant failure and mal- and non-unions have been mentioned as complications [11].

To overcome the disadvantages of previously described methods minimally invasive ESIN was established as an alternative to plate fixation. Jubel et al. [12] showed that the correction of clavicular shortening is a prerequisite of good functional outcome.

Jubel et al. [12] had prospective study on intramedullary fixation techniques using the elastic stable Ti nail for the treatment of displaced mid-clavicular fractures. Radiological assessments documented fracture healing, and clinical outcomes scores were obtained. As a conclusion, intramedullary fixation of displaced midclavicular fracture was successful in terms of clinical outcome and rapid resumption of sporting activities. This treatment should be offered to athletes as an alternative to non-operative treatment [11].

The final Constant score after 6 months was 95.70 ± 13.55 . 14 patients had excellent results, 4 patients had good results, 1 patient had fair result and 1 patient had poor results. In comparison with Narsaria et al. [13] study showed higher score for the plating group, while Assobhi [14] study showed higher score with the nailing group. However, both documented no significant difference between the two groups regarding functional and radiological outcome at the 2-year follow-up. Keihan et al. [15] case study showed that 10 patients out of 13 had a Constant score of 100, two patients were 90 and one patients was 95. Christoph Meier et al. [9] case series showed Constant shoulder score averaged 81 after 7 days. After 6 months and after hardware removal, all patients (n=13) presented with basically normal shoulder function (mean : 98, range : 93 to 100).

Time of union in the studied patients ranged from 8 weeks to 12 weeks with a mean 10.0 ± 1.33 weeks with an exception of one case which started hard work after 2 weeks. He presented with hypertrophic non-union and went through revision by nail removal and fixation by plate and screws. Hartmann et al. [16] study fracture healing was assessed with a mean follow-up time of one year. All fractures healed clinically and radiologically between 8-11 weeks. Non-union was not observed. Kettler et al. [17] case study (95 patients) showed that the bone healing was judged as optimal in 81 patients by the end of the 12th week, while in 4 patients a hypertrophic callus formation but without neurological symptoms. In 2 patients a nonunion persisted. An atrophic non-union was seen in a 42-year-old smoker with the nail in situ for 12 months; however, she remained clinically asymptomatic. A second patient with a nonunion after premature implant removal had a plate fixation after 6 months. In Keihan et al. [18] case study clinical union was achieved in 3-5 weeks and radiographic union appeared in 6-12 weeks.

Conclusions:

Elastic stable intramedullary nailing (ESIN) is an image dependant procedure indicated best for young medically free patients with acute simple 2 part middle third clavicle fracture.

Main advantage of this technique is providing a more rapid free movement of the shoulder and an earlier return to daily activities than the conservative treatment. In comparison with plate fixation, the procedure is less invasive, no loss of fracture haematoma, rapid union, and less infection. No major surgery for removal with less injury to

surrounded neurovascular structures. Smaller incision is required with superior cosmesis.

There was statistically significant relationship between the final score and the patients' age and associated medical conditions.

Recommendation:

- Time lapse before surgery should not exceed 4 days to facilitate closed reduction.
- Trying entry point to be from the lateral end (retrograde) to avoid manipulation medially as it more risky.
- Preoperative CT scan to measure the medullary canal width, which help in selection the best nail size.
- Conservative treatment still have the upper hand in midshaft clavicular fractures unless surgery is truly indicated.

References

- 1- BALCIK B.J., MONSEAU A.J. and KRANTZ W.: Evaluation and treatment of sternoclavicular, clavicular, and acromioclavicular injuries. *Prim Care*, 40 (4): 911-23, 2013.
- 2- PANDYA N.K., NAMDARI S. and HOSALKAR H.S.: Displaced clavicle fractures in adolescents: Facts, controversies, and current trends. *J. Am. Acad. Orthop. Surg.*, 20 (8): 498-5, 2012;.
- 3- WILKINS R.M. and JOHNSTON R.M.: Non united fractures of the clavicle. *J. Bone Joint Surg. Am.*, 65 (6): 773-8, 1983.
- 4- ROBINSON C.M.: Fractures of the clavicle in the adult. *J. Bone Joint Surg. Br.*, 80 (3): 476-84, 1998.
- 5- POSTACCHINI F., GUMINA S., DE SANTIS P. and ALBO F.: Epidemiology of clavicle fractures. *J. Shoulder Elbow Surg.*, 11 (5): 452-6, 2002.
- 6- NORDQVIST A. and PETERSSON C.: The incidence of fractures of the clavicle. *Clin. Orthop. Relat. Res.*, 300: 127-32, 1994.
- 7- BRAVMAN J.T. and VIDAL A.F.: Midshaft clavicle fractures: Are surgical indications changing? *Orthopedics*, 32 (12): 909-13, 2009.
- 8- BUCKLEY R., LEIGHTON R. and TRASK K.: Non-operative treatment compared with plate fixation of displaced midshaft clavicular fractures. A multi-centre, randomised clinical trial. *J. Bone Joint Surg. Am.*, 89 (1): 1-10, 2007.
- 9- MEIER C., GRUENINGER P. and PLATZ A.: Elastic stable intramedullary nailing for midclavicular fractures. *Acta. Orthop. Belg.*, 72 (3): 269-75, 2006.
- 10- CELESTRE P., ROBERSTON C., MAHAR A., OKA R., MEUNIER M. and SCHWARTZ A.: Biomechanical evaluation of clavicle fracture plating techniques: Does a locking plate provide improved stability? *J. Orthop. Trauma*, 22: 241-7, 2008.

- 11- BOSTMAN O., MANNINEN M. and PIHLAJAMAKI H.: Complications of plate fixation in fresh displaced midclavicular fractures. J. Trauma, 43: 778-83, 1997.
- 12- JUBEL A., ANDERMAHR J., SCHIFFER G., TSIRONIS K. and REHM K.E.: Elastic stable intramedullary nailing of midclavicular fractures with a titanium nail. Clin. Orthop., 408: 279-85, 2003.
- 13- NARSARIA N., SINGH A.K., ARUN G.R. and SETH R.R.: Surgical fixation of displaced midshaft clavicle fractures: Elastic intramedullary nailing versus precontoured plating. J. Orthop. Traumatol., 15 (3): 165-71, 2014.
- 14- ASSOBIHI J.E.: Reconstruction plate versus minimal invasive retrograde titanium elastic nail fixation for displaced midclavicular fractures. J. Orthop. Traumatol., 12 (4): 185-92, 2011.
- 15- FRIGG A., RILLMANN P., PERREN T., et al.: Intramedullary nailing of clavicular midshaft fractures with titanium elastic nail: Problems and complications. Am. J. Sports Med., 37 (2): 537-9, 2009.
- 16- HARTMANN F., HESSMANN M.H., GERCEK E. nd ROMMENS P.M.: Elastic intramedullary nailing of midclavicular fractures. Acta. Chir. Belg., 108 (4): 428-32, 2008.
- 17- KETTLER M., SCHIEKER M., BRAUNSTEIN V., et al.: Flexible intramedullary nailing for stabilization of displaced midshaft clavicle fractures. Acta. Orthopaedica, 78 (3): 424-429, 2007.
- 18- KEIHAN SHOKOUH H., NASIR NADERI, et al.: Treatment of Midshaft Clavicular Fractures With Elastic Titanium Nails. J. Trauma Mon. August, 19 (3): e15623, 2014.

تثبيت الكسور المتباعدة لمنتصف عظمة الترقوة باستخدام المسامير النخاعى المرن

كسور عظمة الترقوة تكون من ٢.٦٪ من جميع كسور الجسم. الأكثر شيوعاً هي كسور منتصف عظمة الترقوة وتمثل ٨٠٪ من الكسور. غالباً ما تعالج كسور منتصف عظمة الترقوة الغير مزاحة تحفظياً، في حالة وجود اختلال بالأعصاب والأوعية المجاورة أو احتمالية ثقب الجلد أو عدم التحام كسور الترقوة والكسور شديدة الإزاحة من مؤشرات التثبيت الجراحى.

وكان الهدف من هذه الرسالة هو تقييم نتائج علاج الكسور المزاحة للثلث الأوسط لعظمة الترقوة باستخدام مسامير نخاعية مرنة مستقرة عبر الجلد. وتضمنت هذه الرسالة عشرين مريضاً يعانون من كسور مزاحة بالثلث الأوسط لعظمة الترقوة. وتراوح عمر المرضى من ١٨-٦٥ سنة. وتم عمل (الرد المفتوح) فى ٦ حالات (٣٠٪) بعد فشل (الرد المغلق) بدون فتح. وقت اللحام كان يتراوح ما بين ٨-١٢ أسبوع بإستثناء حالة واحدة لم تلتحم.

تم متابعة المرضى لمدة حوالى ستة أشهر وتم التقييم وفقاً لمؤشر كونسنتت ومورالى للكتف. وكانت النتيجة النهائية لمؤشر كونسنتت 89.70 ± 13.55 . فقد كانت النتائج ممتازة فى ١٤ من المرضى (٧٠٪)، جيدة فى ٤ حالات (٢٠٪)، مقبولة لمريض واحد (٥٪)، وضعيفة فى مريض واحد (٥٪). وقد وجدت علاقة ذات دلالة إحصائية بين النتائج النهائية والعمر والأمراض المصاحبة. وفيما يتعلق بالمضاعفات، عانى مريض واحد (٥٪) من عدوى الشق الجراحى وعانى اثنان من المرضى (١٠٪) من تهيج البشرة بسبب الطرف الأيسى للمسمار النخاعى. بينما عانى اثنان من المرضى (١٠٪) ترحيل خارجى خلفى للمسمار النخاعى. وعانى مريض واحد (٥٪) من عدم الإتحام.