MANAGEMENT OF MID-SHAFT CLAVICLE FRACTURE WITH TITANIUM ELASTIC NAIL

Abstract:

Background: Elastic, stable intramedullary nailing (ESIN) with titanium nails is a promising minimally invasive treatment for displaced midclavicular fractures, which may be an alternative to plate fixation (ORIF) or even nonoperative treatment. We describe the surgical technique and outcome in 27 patients.

Methods: The nail was inserted at the medial inferior end of the clavicle in 24 patients and in the acromial end in 3 patients. An open fracture reduction via an additional small incision was necessary in 17 patients and closed manoeuvre was successful in 10. Implant removal was performed in 6 patients.

Results: The functional status of 27 patients after 13 months reached 6.8 (0–43) points on the DASH score. The fracture healed in correct anatomical axis in 23 of 27 patients, 1 cases ended in a nonunion. Implant migration of the nail occurred in 1 patients, who required early implant removal. Repeated nailing was necessary in 1 patient who had secondary dislocation after early nail removal.

Interpretation: Flexible intramedullary nailing, a minimally invasive technique for stabilization of displaced midshaft clavicle fractures, has minor risks and complications.

Key-words: Mid– shaft, clavicle fracture, TENS
Introduction

Treatment of dislocated midshaft clavicle fractures is still controversial.\textsuperscript{1,2} In most cases, nonoperative treatment is favored and leads to a good result.\textsuperscript{3} Regarding displaced midshaft fracture types, the rate of nonunion is up to 15%\textsuperscript{4} and a high rate of sequelae in almost half of the patients, even after 9 years, has been reported.\textsuperscript{5} Thus, operative treatment should be considered in fractures with marked shortening or gross dislocation of the clavicle. However, surgical procedures using plate fixation have shown major complications such as hematoma, infections, implant failures and nonunion.\textsuperscript{6-9}

We analyzed the results of a new minimally invasive procedure based on the use of elastic, stable intramedullary titanium nails.

Material and methods

From January 2015 to September 2015, we operated 27 patients (22 men) with midshaft clavicle fractures using elastic titanium nails. The mean age of the patients was 38 (15–74) years. Inclusion criteria were displaced fractures with a displacement of more than shaft width, shortening by over 2 cm, angulations of over 30\degree, open fractures, or threat of skin perforations at fracture ends. 5 patients who developed progressive displacement under closed treatment had later nail fixation.

Operative Technique

The patient lies supine on a radiolucent table with free range of motion of the arm. A small incision of 1–1.5 cm is made under the sternal end of the clavicle. In 27 cases, a medial entry point was selected and a lateral-dorsal entry point was chosen in only 7 patients with shorter lateral fragments. The anterior inferior edge of the cortex is opened after soft tissue dissection with an awl or a drill bit. A flexible titanium nail with an average thickness of 2.5–3.5 mm is mounted on a Jacob's chuck, and is inserted forward in the medullary canal manually. The selection of the nail is determined according to the diaphyseal diameter.

The small and flattened tip serves for adjustment of the nail and prevents perforation through the cortex. The original curvature of the nail tip should be straightened slightly, however, in order to facilitate better gliding in the small medullary canal. With image intensification, the implant is advanced to the fracture site. When the tip reaches the fracture, reduction is performed manually or percutaneously by means of a reduction clamp, inserting the nail into the lateral fracture fragment. If this does not succeed, the tip of the nail is introduced under direct view after performing a second small (2–3-cm) skin incision directly over the fracture site. The sparingly exposed soft tissue, which is sometimes interposed, should be closed and fixed with few fascia and periosteal sutures over the fracture after reduction. The nail is then advanced manually or gently tapped with a hammer until it is just medial to the AC joint. At the transition to the acromional end of the clavicle, the tip of the nail is likely to perforate the curved thin dorsal cortex; thus, accurate maneuvering of the tip is necessary under image intensifier control. After reaching the end position, the nail is cut close to the entry point in order to minimize soft tissue irritation, at the same time leaving sufficient surface for extraction later.

For postoperative pain control, a sling is given for a few days. Active movements of the shoulder (over 90\degree abduction or flexion) should be limited for 6 weeks, since increasing rotational loads on the clavicle may result in proximal migration of the nail, especially in comminuted fractures. The operations were performed by 8 different surgeons. The average operation time was 53 (10–130) min. In 42 cases of closed reduction, the operation took 32 (10–75) min. An open fracture reduction was needed in 53 cases, with an average operation time of 63 (25–130) min. Excluding the 5 multiply-injured patients, the length of stay in hospital with isolated clavicle fractures was 3 (1–6) days.

Implant removal is recommended after radiographic fracture consolidation, after 10 weeks at the earliest and not later than 12 months. The implant can be removed easily with strong extraction forceps, under local or general anaesthesia depending on the patient’s desire.

Follow-up

27 patients were evaluated after mean 13 (6–28) months. Outcome was assessed by the standardized subjective DASH score: 0 (best) to 100 (worst).\textsuperscript{10} In addition, shoulder function was measured with the self evaluated Constant score (maximum 100 points).\textsuperscript{11} Subjective data were evaluated with reference to the cosmetic outcome (malunion, asymmetry, scar formation). In the first post-surgical radiographs in two planes, the implant position (correct, miss, perforation) and the quality
of reduction (anatomical reduction, dislocation until or over shaft width) were evaluated. In the later follow-up after 6–12 weeks and also as after implant removal, the nail position (correct, dislocation, hardware removal), bone healing (nonunion, proper or hypertrophic callus) and the alignment of the clavicle (axial deviation ≤ 30°, axial deviation < 30°, fracture dislocation over shaft width or shortening) were evaluated.

Results

The mean DASH score in the 27 patients was 6.9 (0–43) points. On average, inability to work lasted 3 weeks. 24 of the 27 patients were content with the cosmetic outcome and only 2 patients complained of irritation or scar formation at the medial entry point.

In 2 cases, the protruding end of the nail at the medial side caused irritation. In 2 patients, the nail missed the medullary canal of the lateral fragment. 1 patient underwent a second operation to reintroduce the nail; the other refused a further operation and the fracture healed with a slight malunion.

Fracture healing occurred in correct alignment in 23 of 27 patients. 3 patients healed with angulations of over 30° and 1 had a dislocation of more than a shaft width. Shortening of more than 1 cm was found in 2 patients. This was due to intraoperative bone excision in 1 patient and overlapping bone consolidation after premature nail extraction in the other. In 1 patient a nonunion persisted. An atrophic nonunion was seen in a 42-year-old smoker with the nail in situ for 9 months; however, she remained clinically asymptomatic.

Discussion

Clavicle fractures with displacement of more than 1 cm or comminution leads to inferior results if treated nonoperatively. A prospective randomized study showed 12 nonunions in 35 displaced clavicle fractures treated nonoperatively. Wick et al. and Lazarides and Zafiropoulos found that complete displacement or shortening of the fracture is a predisposing factor for nonunion and they thus advocated surgery in such cases. In cases with open clavicle fractures, threat of skin perforation by fracture ends, complete displacement or neurovascular compromise, open reduction and internal fixation is indicated.

Due to the high complication rate with plate fixation, such as soft tissue infection, implant failure, nonunion, and poor cosmetic appearance of the incision, it is advisable to use intramedullary nails. Elastic stable intramedullary nailing (ESIN) through a titanium nail with increased bending rigidity is a new concept. In contrast to Knowles pinning, predrilling of the intramedullary canal is not necessary.

We evaluated 27 patients using these intramedullary titanium nails at an average follow-up time of 13 months. Only 1 patient showed a nonunion, and 2 other patients had a malunion. These numbers are clearly superior to the complication rate reported by Bostman et al. when using a plate fixation.

We advocate this minimally invasive method as a reliable technique for the treatment of displaced midclavicular fractures without bone contact.

Conclusion

Elastic stable intramedullary nailing is a good alternative to plate fixation for displaced clavicular fractures. Risks and complications are markedly reduced as compared to plate fixation. Results are comparable to plate fixation and are much better than conservative treatment. It can be successfully used for dislocated mid shaft clavicular fractures.

References

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10. DASH score The Institute for Work & Health are the copyright owners of the DASH and QuickDASH Outcome Measures (http://www.dash.iwh.on.ca/)