

Elastic stable intramedullary nailing of midclavicular fractures in adults

32 patients followed for 1–5 years

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Background Osteosynthesis of clavicular fractures is sometimes indicated. Since plate fixation may lead to complications, we have used elastic stable intramedullary nailing and report our experience of midclavicular fractures in 32 adults.

Patients and methods From 2000 to 2005, we treated 32 adults (26 men), median age 40 (19–66) years, by intramedullary nailing with a titanium elastic nail (TEN). All patients were re-examined after median 27 (12–59) months.

Results Nonunion was not observed. 20 clavicles healed without shortening, 12 clavicles healed with shortening of more than 5 mm. Migration of the TEN in 8 patients required secondary shortening of the nail in 5 of them. Nail breakage after fracture healing was observed twice. The nails were removed in 29 patients after a median of 6 (1.3–15) months postoperatively. No patient sustained a re-fracture after TEN removal. The mean Constant score was 95 (SD 1.9) points and the mean DASH score was 5 (SD 2.3) points.

Interpretation Intramedullary stabilization of midclavicular fractures with a titanium elastic nail is a minimally invasive technique with good cosmetic and functional results. Intramedullary fixation can be seen as an alternative to plate fixation and nonoperative treatment.

Hill et al. (1997) and Robinson et al. (2004) reported that nonoperative treatment of midclavic-

ular fractures leads to subjectively, clinically, and radiographically unsatisfactory results in 10–30% of patients. Indications, as reported in the literature, for open reduction and internal plate fixation of fresh midclavicular fractures are: (1) a markedly displaced fracture; (2) an open fracture or imminent skin perforation; (3) presence of fractures of the lower extremities also or multiple injuries, and (4) neurovascular injury caused by the clavicular fracture (Hill et al. 1997, Chu et al. 2002, Rüedi and Murphy 2003). Plate fixation may, however, be followed by complications (Böstman et al. 1997, Shen et al. 1999).

We report our experience with the use of elastic stable intramedullary nailing for treatment of midclavicular fractures in adults.

Patients and methods

From May 2000 through May 2005, we treated 32 adults (26 men) with a median age of 40 (19–66) years and with midclavicular fractures, by intramedullary nailing with a titanium elastic nail (TEN) (Clinical House GmbH, Bochum, Germany). 30 patients had simple fractures (2 fragments), 1 patient a fracture with 3 fragments, and 1 patient had a fracture with 4 fragments. No patient had bilateral fractures. In 10 patients, the clavicular fracture was an isolated injury. 15 patients had additional injuries such as long-bone and rib frac-

tures, chest injuries or spinal injuries. 7 patients had life-threatening injuries with an average ISS of 41 (25–59).

9 patients underwent an operation upon explicit request, due to a marked fracture displacement. In 3 patients we expected imminent skin perforation, as displacement had increased radiographically after 1 week. 4 patients with additional fractures of the lower extremity and 1 patient with a temporary paraplegia were treated operatively in order to enable them to use crutches. In 1 patient, a “floating shoulder” was stabilized. 7 patients with severe chest trauma underwent surgery to stabilize the chest wall; 7 polytraumatized patients were operated to facilitate the recovery period. The dominant extremity was affected in 17 patients. None of the patients had a history of previous shoulder dysfunction or pain.

The operations were performed median 2 (1–28) days after trauma. 20 patients were operated on within 3 days of the accident. 6 patients were treated within 4 weeks of nonoperative treatment because we did not see the expected incipient callus formation.

Closed reduction was successful in 16 patients, after which 1 nail (2.5, 3 or 3.5 mm in diameter) was inserted via a stab incision over the medial end of the clavicle. In 16 cases, an accessory incision had to be made above the fracture. We used a vertical incision running across the bone, parallel to Langer’s lines. Surgery more than a couple of days after trauma always required an additional incision, as soft callus tissue became interpositioned and prevented closed reduction.

The nails were removed from all patients after an average of 6 (1.25–15) months. Local anaesthesia was sufficient in 23 patients.

Patients were followed for an average of 27 (12–59) months. At latest follow-up after nail removal, patients were examined physically and radiographically and questioned about the subjective outcome, along with their overall level of satisfaction including cosmetic results (good = 1, fair = 2, poor = 3).

The functional outcome was assessed by the Constant and Murley shoulder score (1987) (range 0–100 points; best = 100). Usage of the upper extremity was evaluated by the DASH score (Disability of the Arm, Shoulder, and Hand question-

naire: range 0–100 points; best = 0) (MacDermid et al. 2000).

Results

All fractures healed. No re-fractures occurred after nail removal. 20/32 fractures healed without shortening. 6 patients healed with 5–10 mm of shortening and 6 patients had more than 10 mm of shortening. The 3-fragment fracture healed with 5 mm of shortening and the 4-fragment fracture healed with 30 mm of shortening. Further neurovascular impairment or pulmonary injuries were not observed.

Superficial skin infection developed in 1 patient, but early removal of the nail was not necessary. Medial nail migration in 7 patients and lateral migration in 1 patient, after iatrogenic perforation of the lateral cortex, required secondary shortening of the nail in 5 patients because of local pain and skin irritation. It was performed under local anesthesia. Breakage of the nail was observed twice. Because the fracture had healed, the lateral part of the nail was left in situ. These patients did not complain of any discomfort. 8 patients had keloid scars.

The mean overall level of patient satisfaction was 1.3 (1–3). 18 patients reported the same status before and after the fracture. 2 patients reported occasional weather-dependent shoulder pain. The mean Constant score was 95 (SD 1.9) points and the mean DASH score was 5 (SD 2.3) points.

Discussion

The technique of elastic stable intramedullary nailing of midclavicular fractures is based on the operative principle described by Ligier et al. (1988) for femoral shaft fractures in children.

In our study, all fractures healed and the overall level of patient satisfaction was high. Shoulder function was good, and was similar to the results reported after the use of Knowles pins (Chu et al. 2002) or conservative treatment (Oroko et al. 1999).

12 midclavicular fractures healed with shortening, but with no functional consequences.

Nordquist and Petersson (1994), Nowak et al.

(2005), and Oroko et al. (1999) found the same and could not demonstrate any relationship between clavicular shortening and shoulder function. Shortening is the result of inadequate cortical contact of the nail in the midshaft, especially in multiply-fragmented fractures.

Towards the end of the study, the finding of medial migration combined with skin irritation led us to change the bone entry from the center of the medial clavicle to the lower bone edge. If the nail migrates a few mm, skin is not affected. Furthermore, the nail should be advanced laterally by hand. A hammer should not be used, as we perforated the lateral cortex on one occasion.

Nail breakage, which occurred in 2 patients, had no functional consequences. Both patients were men and the TEN diameters were 2.5 and 3 mm, respectively. These were probably too thin, although Slongo (2005) has suggested a nail diameter of between 33% and 40% of the diameter of the medullar space. As the middle third of the clavicle is subjected to considerable tension, bending and torsional forces, we believe that the diameter of the nail should not be less than half of that of the medullar cavity, as quick pain relief may result in premature use of the arm.

Intramedullary fixation of midclavicular fractures with a titanium elastic nail is a safe, minimally invasive surgical technique and has been standard procedure at our hospital for 6 years. It produces good cosmetic and functional results, and can be seen as an alternative to plate fixation or nonoperative treatment.

Contributions of authors

MM: evaluation of data, postoperative management, writing of manuscript. CB: performance of operations, writing of manuscript. AF: performance of operations. NS: examina-

tion of the patients and evaluation of data. CR: performance of operations, senior author. MM and CB contributed equally to this paper.

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