Locking plate osteosynthesis of clavicle fractures: complication and reoperation rates in one hundred and five consecutive cases

Marie Fridberg · Ilija Ban · Zaid Issa ·
Michael Krashenninnikoff · Anders Troelsen

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Abstract

Purpose Locking plate osteosynthesis has become the preferred method for operative treatment of clavicle fractures. The method offers stable fixation, and would theoretically be associated with a low rate of fracture-related complications and reoperations. However, this remains to be explored in a large cohort, and our purpose was to assess the overall rates of complications and reoperations following locking plate osteosynthesis of mid-shaft clavicle fractures.

Methods We identified all locking plate osteosynthesis of mid-shaft clavicle fractures operated upon in our department from January 2008 to November 2010 ($n=114$). Nine patients did not attend the follow-up at our institution. The study group of 105 fractures (104 patients, 86 males) had a median age of 36 years (14–75 years). Follow-up ranged from 0.5 to 3.5 years. No patients were allowed to load the upper extremity for six weeks. By studying patient files and radiographic material, we assessed complications and reoperations.

Results Overall, there were 31 cases (30 %) of plate removals for discomfort. There were five cases (5 %) of failure of osteosynthesis: two occurred early after approximately six weeks and three late after ten to 13 months postoperatively.

Conclusion The overall rate of failure of osteosynthesis is low (5 %). The burden of plate removals in approximately one third of patients should be included in the preoperative information.

Introduction

Clavicle fractures comprise five to ten percent of all fractures [1]. Approximately 75 % of these fractures are located in the middle third of the clavicle, with the majority of fractures being displaced [1, 2]. Despite the relative high prevalence of clavicle fractures, the optimal treatment of displaced mid-shaft clavicle fractures remains a matter for debate [3]. In 2007, the Canadian Orthopaedic Trauma Society published a randomised controlled trial comparing conservative treatment and plate osteosynthesis for the treatment of displaced mid-shaft clavicle fractures [4]. Based on assessment of functional outcome and the rate of non-union, the study suggested superiority of plate osteosynthesis. The results of the Canadian study resulted in a shift towards performing more surgical treatment of displaced, midshaft clavicle fractures.

The precontoured locking plate is now the preferred choice of implant for surgical treatment of clavicle fractures [1, 5, 6]. The locking plate theoretically offers increased stability of fixation, which again should allow for application of greater forces than conventional reconstruction or dynamic compression plates (DCP) plates. Biomechanical studies investigating the impact of torsional and bending load forces on both locking and DCP supports the concept that improved fixation is achieved when using a locking plate [7, 8]. Clinical studies support advantages of locking plates over more conventional plate types [8–10]. Despite the frequent use of locking plates, little is known about what rates of complications and reoperations to expect following the use of this technique in daily practice [6].

The aim of this study was to investigate the overall rates of reoperations and complications after locking plate osteosynthesis of midshaft clavicle fractures within one year of surgery.

M. Fridberg (✉) · I. Ban · Z. Issa · M. Krashenninnikoff ·
A. Troelsen
Clinical Orthopaedic Research, Department of Orthopaedics,
Hvidovre University Hospital, Copenhagen, Denmark
e-mail: mfridberg@hotmail.com

Material and methods

By studying patient files, surgery records, and preoperative and postoperative X-rays, we identified 114 clavicle fractures (in 113 patients) treated in our department with pre-contoured locking plate osteosynthesis from January 2008 to November 2010. A total of nine patients were lost to follow-up. A total of 105 fractures (in 104 patients, one staged bilateral) was included for further analysis. Patient demographics (age, sex and ASA score) and fracture type, classified by the Edinburgh classification [11] are outlined in Table 1. All patients included had a midshaft clavicle fracture.

Three different pre-contoured locking plates were used (Fig. 1), either superior (Acumed/Biomet ITS Clavícula Plate, Implant Technologie Systeme, Austria) or anterior-superior positioned (Synthes, The 3.5 LCP synthes Modular system, USA). The choice of plate and surgical technique was determined by the surgeon. In our series, 91 patients had a superior positioned plate and 14 patients had an anterior-superior. The 105 operations were performed by 35 different surgeons, mostly at junior resident level, and were supervised by a senior surgeon. Operations were performed with patients positioned in a beach chair or with the patient supine on an operating room table and a sand bag underneath the shoulder on the operated side. The standard surgical procedure of the department was: Incision directly over the clavicle, direct reduction of the fracture, temporary fracture fixation with a clamp, and if possible placing one to two lag screws across the fracture or in intermediary fragments. A stabile osteosynthesis was performed using a pre-contoured locking plate fixed preferentially with three bi-cortical screws on each side of the fracture complex.

The postoperative complications and reoperations were retrospectively assessed from patient records and postoperative radiographs. A complication was defined as an adverse observation (delayed wound healing, superficial infection, reduced range of motion [ROM]) or patient complaint (soft tissue discomfort, pain or reduced strength) that aggravates the

Fig. 1 Osteosynthesis of a mid-shaft clavicle fracture using a pre-contoured locking plate

primary treatment but does not require a secondary operation. A reoperation was defined as any secondary operation related to the primary treatment. Data collection was performed during April and May 2011 and follow-up ranged from 0.5 to 3.5 years.

Statistics

Data that were not normally distributed were presented as median values with ranges, and binominal data were presented as proportions. Statistical analysis was performed using Stata software package (Stata 10.1, College Station, TX, USA).

Results

We found an overall complication rate of 23 % (24/105). The predominant complication was related to decreased level of function, as 20 of the 25 registered complications were either reduced ROM ($n=13$) or reduced strength of the arm ($n=7$). Delayed wound healing was found in three cases and one patient had a superficial infection successfully treated with oral antibiotics.

The overall reoperation rate was 34 % (36/105). The majority of the reoperations were implant removal for discomfort or pain (31/105), accounting for 86 % of reoperations. Failure of osteosynthesis was seen in five of 105 cases (5 %) and accounted for 14 % of all reoperations. Two of the failures were seen within six weeks of primary surgery and the last three failures occurred ten to 13 months after primary surgery, with two of the failures caused by a new trauma.

No perioperative complications were registered and no non-unions or deep infections were registered.

Discussion

There is no previous study investigating a large cohort of patients treated by locking plate osteosynthesis of midshaft

Table 1 Patient demographics

	Total cohort
Total number of fractures	105
Age in years	36 (14–75)
Median (Range)	
Sex (Male/Female)	86 M/19 F
Fracture type	
Edinburgh classification	
2A1: Cortical alignment	1
2B1: Displaced simple or wedge comminuted	91
2B2: Displaced with Isolated or comminuted segmental	13

clavicle fractures, and little information exists about the overall rate of complications and reoperations.

The radiological and clinical indications to perform osteosynthesis of mid-shaft clavicle fractures are still debated, and the suggested technique, choice of plate and position also vary in the literature [5, 7, 8, 10–14]. Despite the widespread use of locking plate osteosynthesis in clavicle fracture treatment, there is little clinical information about outcome and potential benefits of its use. A recent study by Campochiaro et al. [15] on osteosynthesis of midshaft clavicle fractures with a precontoured locking plate suggest that excellent clinical outcome evaluated by Constant and DASH scores can be achieved.

Our report of five percent reoperations due to failure of osteosynthesis is low, as it compares favourably to that reported in the literature [6]. The two early cases of failure of osteosynthesis that we report (after approximately six weeks) indicate that primary solid fixation can be challenging. Soft tissue irritation seems to be the biggest problem related to osteosynthesis despite use of precontoured plates. Nearly one third of the patients (31/105) had the plate removed approximately six months postoperatively. Thus, precontoured locking plates do not seem to reduce local irritation and discomfort compared with other previously used plating techniques [6]. Whether bad positioning, bad anatomical fit of precontoured plates or superficial placement directly beneath the skin causes this irritation is unknown, but the frequency of plate removals should be included in the preoperative information to patients [16].

Decreased level of function (whether related to ROM or strength) seems to be the commonest complication observed after locking plate osteosynthesis. However, it should be acknowledged that decreased function can be anticipated in some patients following a midshaft clavicle fracture, irrespective of the treatment strategy. Our retrospective assessment does not reveal whether the decreased level of function has any impact on overall functional outcome or daily living. A prospective study using patient reported outcome measures to evaluate the patients could reveal this. Surgically related complications, such as delayed wound healing and superficial infection, were rarely encountered. Our findings compare favourably to that reported in previous studies on plate fixation of midshaft clavicle fractures [4, 6, 13, 17, 18].

No previous study has reported what impact surgical experience has on the result of clavicle fracture surgery. Our finding show that the rate of moderate and major complications can be kept low even in a department where a large mixed group of consultants and junior surgeons performed the operations. This could in part be explained by the fact that clavicle fracture patients are mostly young and healthy and

have a great healing potential, and therefore probably would heal despite varying technical quality of osteosynthesis and even if treated conservatively.

Conclusion

This is the first larger cohort study investigating rates of complications and reoperations following locking plate osteosynthesis of midshaft clavicle fractures. The low failure and complication rate indicates that locking plate osteosynthesis is a safe procedure, but almost one third of all patients will undergo implant removal due to soft tissue discomfort, and this should be an important part of the preoperative patient information.

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