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Plate versus intramedullary fixation of two-part and multifragmentary displaced midshaft clavicle fractures – a long-term analysis

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KEYWORDS

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ABSTRACT

Introduction: Surgical fixation of displaced midshaft clavicle fractures is predominantly achieved with intramedullary (IM) or plate fixation. Both techniques have potential pitfalls: plate fixation involves greater periosteal stripping and protuberance of the implant, whereas IM fixation may be associated with implant-related complications, such as migration or skin irritation, which may lead to further surgery for implant removal.
The aim of this study was to compare these two methods in simple (Robinson 2b.1) and multifragmentary (Robinson 2b.2) displaced midshaft clavicle fractures.
Methods: A total of 133 consecutive patients who underwent surgical fixation for a displaced midshaft clavicle fracture with either IM fixation using a 2.5-mm Kirschner wire or plate fixation using an 8-hole Dynamic Compression Plate (DCP) were retrospectively reviewed. Follow-up was a minimum of 1 year. The patients were allocated into two injury groups: displaced simple 2-part fractures (64 IM vs. 16 DCP) and displaced multifragmentary fractures (27 IM vs. 26 DCP). The major observed outcome measures were: infection rate, non-union rate, reoperation rate and postoperative range of motion (ROM).
Results: Rates of non-union for displaced 2-part fractures were 2/64 (3.13%) with IM fixation and 0/16 (0.00%) with plate fixation ($p = 0.477$). For displaced multifragmentary fractures, rates of non-union were 2/27 (7.41%) with IM fixation and 0/26 (0.00%) with plate fixation ($p = 0.161$). No significant difference was observed between the two fixation modalities in patient-reported time to regain ROM on the injured side for displaced 2-part fractures ($p = 0.129$) and displaced multifragmentary fractures ($p = 0.070$). Deep infection rate was zero ($p = 1.000$) overall in the study, and reoperation rate for IM and plate fixation, respectively, was 3.13% and 6.25% in the Robinson 2b.1 group ($p = 0.559$) and 7.41% and 7.69% in the Robinson 2b.2 group ($p = 0.969$).
Conclusion: IM fixation of displaced midshaft clavicle fractures (Robinson 2b.1) has an equivalent non-union rate to plate fixation and similarly low complication and reoperation rates. For displaced midshaft multifragmentary clavicle fractures (Robinson 2b.2), the higher non-union rates observed with IM fixation leads us to recommend consideration of plate fixation for Robinson 2b.2 fractures.

Introduction

Non-operative treatment of displaced midshaft clavicle fractures (DMCF) was traditionally de rigueur; however, in recent times, management has shifted to surgical intervention, namely ORIF utilising plate fixation, or intramedullary (IM) fixation. Non-operative treatment has been shown to result in higher levels of non-union and worse functional outcomes in certain fracture types [1,2].

The thin soft tissue envelope surrounding the clavicle poses challenges to surgical fixation, and the lack of soft tissue overlying the clavicle and its anatomical position contribute to common postoperative complaints from patients relating to scar discomfort and appearance and postoperative metal-work irritation [3–5]. These factors may prompt subsequent metal-work removal, which can result in an increased rate of refracture [6]. The close proximity of the clavicle to the neurovascular bundle supplying the upper limb necessitates a meticulous surgical approach and careful drilling and screw placement [7]. Neurological compromise can range from mild hypoesthesia due to incision placement to brachial plexus compromise, whereas errantly placed cortical screws may cause critical limb ischaemia [8–11]. Plate fixation has also been shown to be more expensive than IM fixation

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despite the common need for a second procedure with the latter modality [12].

IM clavicle fixation may have the benefit of preserving the periosteal blood-supply through the avoidance of soft tissue stripping; however, postoperative removal of some IM devices is offered as standard to prevent migration of the IM device [13,14]. Migration of IM devices into the neck, thorax and spine has been documented in the immediate and late postoperative periods [15,16].

The aim of this study was to compare the objective surgical and subjective patient-reported functional outcomes of plate and IM fixation with Kirschner wires (K-wires) of DMCF.

Studies comparing the outcomes of IM fixation versus plate fixation have focused on the use of devices such as Rockwood pins, Hagie pins and titanium elastic nails (TENs) [17–24]. However, the majority of these studies compared IM fixation with conservative treatment or low contact dynamic compression plates (LCDCP) or reconstruction plates [13,18,21,22,25,26]. All such surgical modalities are more financially burdensome than K-wire or DCP fixation.

This study presents long-term follow-up data on surgical and functional outcomes and related complications of plate and K-wire IM fixation of simple (Robinson 2b.1) and multifragmentary displaced (Robinson 2b.2) midshaft clavicle fractures [27].

Patients and methods

Ethical approval

All the patients consented to their inclusion in this study and ethical approval in accordance with the Helsinki declaration was obtained from the ethical committees at the General Hospital Karlovac, Croatia and University Hospital Centre "Sisters of Mercy", Croatia.

Patients

Between 2000 and 2012, 235 consecutive patients were hospitalised and treated for traumatic unilateral DMCF at the study centres, General Hospital Karlovac, Croatia and University Hospital Centre "Sisters of Mercy", Croatia.

From 2010 onwards at the study institutions, plate fixation was utilised more frequently than IM fixation because of reports in contemporary literature of K-wire migration and related complications with the latter modality.

Thirty-nine patients were treated non-operatively and were excluded from this study.

A total of 196 patients received surgical treatment with IM or plate fixation. All procedures were performed by experienced upper limb trauma surgeons. The indication for surgery was one or more of the following criteria: completely displaced fracture fragments, shortening of greater than 2 cm, associated neurovascular injury, open fractures and threatened skin. Patients with bilateral clavicle fractures were excluded from the study. A total of 63 patients were excluded from analysis because of incomplete follow-up data or they were aged under 16 years at the time of surgical treatment. This left a study group of 133 patients (Table 1) with different mechanisms of injury (Table 2).

Study patients were divided into those with displaced 2-part or multifragmentary (3-part or 4-part) midshaft clavicle fragments as defined by Robinson (type 2b.1 and 2b.2 respectively) [27]. A total of 80 patients sustained a 2b.1 fracture; 64 of these patients underwent IM fixation and 16 underwent plate fixation (Figure 1). A total of 53 patients sustained a 2b.2 fracture; 27 of these patients underwent IM fixation and 26 underwent plate fixation (Figure 1). There were more injured males than females in all treatment groups (male:female ratio was at least 3:1 in all groups) (Table 1).

Study protocol

Patients were followed up by one of two experienced upper limb trauma surgeons for a 1-year period after undergoing IM or plate fixation of the clavicle fracture: follow-up was at 3, 6 and 8 weeks, then 3, 6 and 12 months postoperatively. Plain film anteroposterior (AP) radiographs were obtained at 3, 6, 8 and 12 weeks postoperatively. Radiographs were assessed for the presence of union and clavicle length was recorded. Union was defined as radiographic evidence of re-establishment of cortex continuity.

Surgical technique

All patients received 2 grams Cefazolin at anaesthetic induction for both IM and plate fixation. Patients underwent surgery in a beach chair position.

Table 1
Table showing demographic distribution of the four treatment groups.

	Displaced 2-part fractures (n = 80)			Displaced multifragmentary fractures (n = 53)		
	IM fixation (n = 64)	Plate fixation (n = 16)	Significance	IM fixation (n = 27)	Plate fixation (n = 26)	Significance
Male:Female ratio	4:1	3:1	p = 0.018	8:1	4:1	p = 0.579
Average age (range) in years	32.2 (18–69)	40.8 (18–75)	p < 0.001	37.0 (16–80)	20.0 (18–69)	p = 0.068
Dominant arm injured	17 (26.6%)	5 (31.3%)	p < 0.001	11 (40.7%)	11 (42.3%)	p = 0.849
Neurovascular compromise	4 (6.25%)	2 (12.50%)	p = 0.399	0 (0.00%)	0 (0.00%)	p = 1.000
Open injury	2 (3.13%)	0 (0.00%)	p = 0.477	0 (0.00%)	2 (7.69%)	p = 0.146

Table 2
Mechanisms of injury in each group treated operatively.

	Displaced 2-part fractures (n = 80)		Displaced multifragmentary fractures (n = 53)	
Mechanism of injury	IM fixation (n = 64)	Plate fixation (n = 16)	IM fixation (n = 27)	Plate fixation (n = 26)
Fall from bike/motorbike	24 (37.50%)	11 (68.75%)	10 (37.04%)	16 (61.54%)
Road traffic accident	13 (20.31%)	3 (18.75%)	3 (11.11%)	7 (26.92%)
Fall on the same level	11 (17.19%)	2 (12.50%)	9 (33.33%)	0 (0.00%)
Direct impact to clavicle	4 (6.25%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Sporting injury	6 (9.38%)	0 (0.00%)	5 (18.52%)	2 (7.69%)
Other mechanism	6 (9.38%)	0 (0.00%)	0 (0.00%)	1 (3.85%)