



Complications associated with operative fixation of acute midshaft clavicle fractures



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ABSTRACT

Introduction: The aim of this study was to review the complication rate and profile associated with surgical fixation of acute midshaft clavicle fracture in a large cohort of patients treated in a level I trauma centre.

Patients and methods: We identified all patients who underwent surgical treatment of acute midshaft clavicle fracture between 2002 and 2010. The study group consisted of 138 fractures (134 patients) and included 107 men (78%) and 31 women (22%); the median age of 35 years (interquartile range (IQR) 24–45). The most common mechanism of injury was a road traffic accident (78%). Sixty percent ($n = 83$) had an injury severity score of ≥ 15 indicating major trauma. The most common fracture type (75%) was simple or wedge comminuted (2B1) according to the Edinburgh classification. The median interval between the injury and operation was 3 days (IQR 1–6). Plate fixation was performed in 110 fractures (80%) and intramedullary fixation was performed in 28 fractures (20%). There were 85 men and 25 women in the plate fixation group with median age of 35 years (IQR 25–45) There were 22 men and six women in the intramedullary fixation group with median age of 31 years (IQR 24–42 years). Statistical analysis was performed using independent sample t test, Mann Whitney test, and Chi square test. Significant P -value was < 0.05 .

Results: The overall incidence of complication was 14.5% ($n = 20$). The overall nonunion rate was 6%. Postoperative wound infection occurred in 3.6% of cases. The incidence of complication associated with plate fixation was 10% (11 of 110 cases) compared to 32% associated with intramedullary fixation (nine of 28 cases; $P = 0.003$). Thirty-five percent of complications were related to inadequate surgical technique and were potentially avoidable. Symptomatic hardware requiring removal occurred in 23% ($n = 31$) of patients. Symptomatic metalware was more frequent after plate fixation compared to intramedullary fixation (26% vs 7%, $P = 0.03$).

Conclusions: Intramedullary fixation of midshaft clavicle fracture is associated with a higher incidence of complications. Plate fixation is associated with a higher rate of symptomatic metalware requiring removal compared to intramedullary fixation. Approximately one in three complications may be avoided by attention to adequate surgical technique.

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Introduction

Midshaft clavicle fractures account for approximately 70–80% of all clavicle fractures [1]. Traditionally clavicle fractures have been managed nonoperatively, influenced by early literature suggesting a very low nonunion rate of $< 1\%$ [2,3]. This finding has been questioned by more recent studies showing a nonunion

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rate for nonoperative treatment up to 15% and unsatisfactory clinical results in 23–31% [4–6].

Plate fixation and intramedullary fixation are the most commonly used techniques in the operative treatment of clavicle fractures. Both methods are associated with potential complications [7–9]. Very few studies are available with a focus on complications associated with surgical fixation of midshaft clavicle fractures [10–16]. Bostman et al. reported a 23% complication rate associated with plate fixation of acute midclavicular fractures including deep infection, plate breakage, nonunion, and refracture following removal of plate [11]. In a retrospective review, Grassi et al. found that adverse events such as infection, refracture, and nonunion occurred in 35% of patients undergoing intramedullary fixation of midclavicular fracture [16]. Strauss et al. reported a 50% incidence of postoperative complications associated with Hagie pin fixation of midshaft clavicle fractures and concluded that it should not be used as a fixation device [12]. In a retrospective study of 105 midshaft clavicle fractures treated with plate fixation, Fridberg et al. reported reduced range of movement and strength of arm being the predominant complication (19%) [10].

The purpose of this study was to evaluate the complication profile associated with operative fixation of acute midshaft clavicle fractures, comparing intramedullary fixation with plate fixation in an Australian major trauma centre.

Material and methods

This retrospective study was conducted in a single-level I trauma centre and was approved by the Human Research Ethics Committee (HREC; project number 242/10). All patients who underwent surgical fixation of acute midshaft clavicle fracture between 2002 and 2010 were identified using the prospective Victorian Orthopaedic Trauma Outcome Registry (VOTOR) database [17]. Patients were included if they underwent surgical fixation of a midshaft clavicle fracture, ≥ 16 years of age, and were followed up until union was documented. The indications for surgical fixation of midshaft clavicle fractures included shortening > 2 cm, marked displacement, multi-trauma injury pattern, associated ipsilateral upper limb fracture, open fractures, floating shoulder, associated neurovascular injury, and skin tenting. Delayed fixation (> 28 days from injury date) [18], periprosthetic fractures, and patients with follow-up of < 6 weeks were excluded. Clavicle, anteroposterior, and oblique (25° caudal X-rays) were reviewed and the fractures were classified according to the Edinburgh classification system [1].

Complications were identified by review of the medical records and operation notes. A complication was defined as any adverse event in the treatment episode as a direct consequence of orthopaedic intervention [19]. Fracture union was defined as lack of tenderness on palpation over the fracture site and evidence of bridging callus on radiographs. Implant failure was defined as plate breakage or loosening [13]. Nonunion was defined as lack of radiographic consolidation with clinical symptoms (pain and/or fracture motion) after 6 months [20]. Two orthopaedic consultants reviewed the complications.

Surgical technique was not standardized and multiple operating surgeons contributed to this retrospective study. Intramedullary fixation involved cannulated screw placement utilizing a mini-open approach centred over the fracture site. The intramedullary implants used were 4 mm or 6.5 mm ACE screws (15%; Depuy Synthes, MA, USA), ASNIS screws (1%; Stryker, NJ, USA), and 4.5 mm or 6.5 mm Herbert differential pitched screws (5%; Zimmer, Warsaw, IN, US). Plate fixation was performed using Depuy-Synthes 3.5 mm Locking compression plate (LCP) clavicle plates (6%), limited contact dynamic compression plate (LC-DCP; 23%), dynamic compression plate (DCP; 4%), 3.5 mm pelvic

reconstruction plates (41%), and the precontoured Acumed clavicle plates (5%; Acumed, Hillsboro, OR, USA). The plate was applied to the superior surface in all cases.

All patients had their arm in a sling postoperatively and rehabilitation protocols varied according to stability of fixation and the preference of the surgeon performing the surgery. Patients were followed up in a fracture clinic at 2 and 6 weeks with repeat radiographs. Follow-up continued until clinical and/or radiologic union was documented. In cases of multi trauma, the follow-up was influenced by the need to monitor other associated fractures.

A total of 209 patients with a clavicle fracture underwent surgical fixation of their clavicle fracture between 2002 and 2010. Of these, 40 patients sustained lateral third fractures, four medial third, and five non-acute midshaft clavicle fractures. In total, 160 patients had an acute midshaft fracture. Three cases were excluded from the study: two sustained peri-prosthetic fracture and one patient died due to severe brain injury. A total of 23 patients were lost to follow-up and four patients sustained bilateral fractures.

This study focuses on the remaining 138 fractures in 134 patients. Table 1 outlines patients' characteristics. The demographic and injury patterns of the studied patients did not differ from those who were lost to follow-up. There were two open fractures: one neurologic injury (paraesthesia along the lateral antebrachial cutaneous nerve distribution) and one fracture with skin tenting. Twenty patients had floating shoulders. Sixty percent ($n = 83$) of fractures were associated with an injury severity score of ≥ 15 , thereby indicating major trauma [21]. Forty-seven percent of patients ($n = 63$) required intensive care unit (ICU) admission with a median length stay of 6 days (interquartile range (IQR): 4–14 days). The overall hospital length of stay of all patients was 8.6 days (IQR: 2.75–16). The median length of stay was statistically longer in the major trauma group (12 vs. 1.8 days, $p < 0.001$)

Statistical analysis

Statistical analysis was performed with the Statistical Package for the Social Sciences (SPSS) software (version 14; SPSS, Chicago, IL, USA). Simple descriptive and frequency analysis was performed on multiple variables. Shapiro–Wilk and Kolmogorov–Smirnov

Table 1
Patient demographics and injury information.

Age	35 (IQR 24–45)
Gender	
Male	107 (78%)
Female	31 (22%)
Fracture side	
Right	74 (54%)
Left	64 (46%)
Fracture classification	
2B2	8%
2B1	75%
2A2	4%
2A1	4%
Other	9%
Mechanism	
RTA ^a	107 (78%)
Bicycle accident	15 (11%)
Sports injury	9 (6%)
Fall > 3 m	3 (2%)
Fall	4 (3%)
ISS	20 (IQR 7–29)
Interval between injury and operation	3 (IQR 1–6)

Injury severity score.

^a Road traffic accident.

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