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ORIGINAL ARTICLE

Titanium Elastic Nail versus plate fixation of displaced midshaft clavicle fractures: A retrospective comparison study

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Abstract This study has two purposes: (1) to compare the clinical results between the Titanium Elastic Nail (TEN) and plate fixation of the displaced midshaft clavicle fracture; and (2) to demonstrate the relationship between length shortening and functional outcome after TEN fixation, especially in the comminuted fracture pattern. A retrospective, case-controlled study was conducted and 55 patients were included in our study: 25 in the TEN fixation group (TEN group) and 30 in the plate fixation group (plate group). All patients were classified into four subgroups: simple fracture in the TEN group (ST; $n = 13$), simple fracture in the plate group (SP; $n = 15$), comminuted fracture in the TEN group (CT; $n = 12$), and comminuted fracture in the plate group (CP; $n = 15$). Wound size was significantly smaller in the TEN group ($p < 0.001$). The injured clavicular length after fracture healing was significantly shorter in the TEN group ($p = 0.036$). There was no significant difference in the mean Constant and DASH scores. Injured clavicle shortening was significantly larger in the CT subgroup ($p = 0.018$). However, there was no statistically significant difference in Constant score and DASH score while comparing the CT subgroup to other subgroups. Although TEN fixation may lead to a higher degree of length shortening after bony union especially in cases of comminuted fracture pattern, no statistically significant difference was observed in objective functional results as

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compared to other subgroups. Therefore, TEN can be used to fix a displaced midshaft clavicle fracture even in cases of comminuted fracture pattern, which overall is an effective and less surgically invasive procedure.

Introduction

Clavicle fractures account for 2.6% of all fractures, and > 80% involve the middle third of the clavicle [1]. Traditionally, conservative treatment has been used to treat displaced midshaft clavicle fractures. However, poor outcomes after conservative treatment for such fractures have been reported recently, resulting in fracture non-union, clavicle length shortening, or marked functional deficits [2–4]. Generally, clavicle length shortening of > 2 cm (no cortical contact between the proximal and distal fragments radiographically) is widely accepted as a criterion for surgical intervention in displaced midshaft clavicle fractures [5,6].

Plate or intramedullary devices are the two implants most commonly used to fix displaced midshaft clavicle fractures. The plate type implant is the most commonly used, although complications reported include wound infection, wound dehiscence, skin irritation or numbness, implant failure, and poor cosmetic results [7–11]. Therefore, intramedullary devices which utilize minimally invasive surgical techniques were developed to treat displaced midshaft clavicle fractures. These have the advantages of preventing plate irritation, decreasing the infection rate, avoiding wound dehiscence, and providing greater cosmetic satisfaction with the results. Intramedullary devices may also preserve the soft tissue envelope, periosteum, and vascular integrity around the fracture region, potentially enhancing fracture site callus formation [12–18]. Application of intramedullary devices seem to have more advantages than plate fixation for treatment of displaced midshaft clavicular fractures [19–21].

The Titanium Elastic Nail (TEN) system (Synthes Holding AG, West Chester, PA, USA) is one type of intramedullary device. TEN had been used with satisfying results to treat displaced midshaft clavicle fractures; advantages include the elastic property of the TEN system, easier insertion, small incision wound, lower infection rate, high union rate, and high satisfaction rate with good functional results [12,22–25]. However, complications related to TEN fixation in midshaft clavicle fractures include medial migration of the nail tip and clavicle length shortening after fracture healing, especially in comminuted fractures due to the telescope effect after TEN fixation [12,25,26].

Few studies have examined the differences between TEN and plate fixation of displaced midshaft clavicle fractures and the functional outcomes associated with clavicle length shortening after TEN fixation [27–29]. To clarify the clinical results between TEN and plate fixation of displaced midshaft clavicle fractures, we introduced a case-controlled study. Our study has two aims: (1) to compare the clinical results of TEN and plate fixation of displaced midshaft clavicle fractures; and (2) to determine the relationship between length shortening and functional outcomes after TEN fixation of midshaft clavicle fractures, especially comminuted fractures. We hypothesized that results for TEN fixation would be as good as those for traditional plate fixation in treating displaced midshaft clavicle fractures, even in patients with comminuted fractures and postoperative shortening.

Materials and methods

A retrospective, case-controlled study was conducted from November 2006 to December 2011 at our institute on patients with displaced midshaft clavicle fractures. Inclusion criteria were: (1) a markedly displaced midshaft clavicle fracture (no cortical contact between the proximal and distal fragments on radiography and/or > 2 cm of shortening) [5,6]; (2) patients being older than 16 years; and (3) patient's ability to provide complete information, sign a consent form, fill out questionnaires, and attend further follow up. Exclusion criteria were presence of any of the following: (1) pathologic fracture; (2) previous clavicle fracture nonunion; or (3) inability to provide complete information, sign a consent form, fill out questionnaires, or attend further follow up. None of the patients had an open fracture or neurovascular-associated injuries. The study protocol was approved by the hospital's Institutional Review Board.

All surgeries were conducted by one experienced surgeon at our institute. Twenty-five patients included in the TEN group were operated on early, from November 2006 to August 2009, and 30 patients in the plate group were operation on later, from September 2009 to December 2011, for the purpose of having a case-controlled comparison group. Patients in the TEN group received TEN fixation, inserted from the sternal end of the clavicle with a 1–2 cm incision wound. Under fluoroscopic assistance, the nail tip was passed through the proximal fragment of the clavicle until it reached the fracture site. The fracture site was reduced with the closed method. If closed reduction was not successful, a small incision was made directly over the fracture site to allow direct visual reduction. The proximal entry end of the nail was cut off near the ventral cortex to prevent skin irritation (Figure 1). In the plate group, the fractured ends of the clavicle were fixed with a 3.5 mm small reconstruction plate or dynamic compression plates applied in either the anterior or superior position, according to the fracture pattern and the shape that best fit the clavicle (Figure 2).

All patients were protected with a sling immediately after the operation. Patients were given instructions in performing early gentle and passive shoulder motion cautiously under sling protection for a period of 4 weeks.