Early Midterm Clinical Efficacy of Mini-Plate Fixation of Rockwood Type II Fracture of the Lateral Clavicle

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Abstract: This study aims to investigate mini-plate fixation of Rockwood Type II fracture of the lateral clavicle and its early midterm clinical efficacy. A retrospective analysis was conducted on 15 patients with Rockwood Type II fracture of the lateral clavicle who were treated with mini-plate fixation from July 2010 to April 2012, and the early midterm clinical results of the treatment were observed. All cases were followed up for 3 months to 21 months. All fractures were healed, and mean healing time was 8.6 weeks. No case presented infection of incisional wound, fracture displacement, and other complications. The mean constant score during postoperative follow-up visit was 92.56 ± 3.31 points. For the treatment of Rockwood Type II fracture of the lateral clavicle, the mini-plate fixation has advantages such as easy operation and reliable fixation as well as a satisfactory early midterm clinical efficacy.
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1. Introduction

Clavicle fracture is a common fracture around the shoulder girdle and can be classified into three types: medial, lateral, and internal 1/3. Among these types, a fracture of the lateral clavicle 1/3 accounts for approximately 0.6% of all human fractures. Rockwood Type II fracture is the most common fracture of the lateral clavicle 1/3. For a distal clavicle fracture with mild displacement, a conservative treatment is usually conducted. Although braces have resulted in more complications (Suso et al., 1994), neck wrist brace has clear clinical efficacy (Nordqvist et al., 1993; Robinson and Caims, 2004). For most clavicle fractures, conservative treatment can have satisfactory treatment efficacy. Treating a distal clavicle fracture is remarkably difficult because ligaments and acromioclavicular joints are involved. In clinical reports, the 8-shaped tension band fixation that employs Kirschner steel wire, Bosworth operation, and clavicular hook are common treatments for a distal clavicle fracture. However, these methods involve various complications that limit their applications to a certain extent. In this study, we apply the mini-plate fixation to the treatment of Rockwood Type II fracture of the lateral clavicle and use the absorbable suture to repair the coracoclavicular ligaments. The operation does not involve the acromioclavicular joint. As a result, the early midterm clinical efficacy is satisfactory.

2. Materials and Methods

2.1 General data

A total of 15 patients with Rockwood Type II fracture of the lateral clavicle 1/3 were treated from July 2010 to April 2012 in our department. Nine of the patients were males and six were females. Eight patients had fractures on the left side and seven had fractures on the right side. The average age was 35.7 years (the age range of all patients was 20 years to 63 years). With regard to the injuries, 5 cases were caused by traffic accidents and 10 cases were caused by a fall. Based on Rockwood typing, 4 patients had Type IIA and 11 patients had Type IIB fractures (see Fig. 1). The time from injury to operation ranged from 2 days to 16 days, and the mean time was 6.3 days. Clinical manifestations included obvious local painful swelling on the shoulder, abductor lift function limitation of the affected upper arm and tuberositas, and tenderness at the acromioclavicular joint. A number of patients were also sensitive to bone rubbing. According to the degree of injury, X-ray films, and CT indication, all patients had a Rockwood Type II fracture. This study was conducted in accordance with the declaration of Helsinki. This study was conducted with approval from the Ethics Committee of Jiangsu province Kunshan city the second people's hospital. Written informed consent was obtained from all participants.

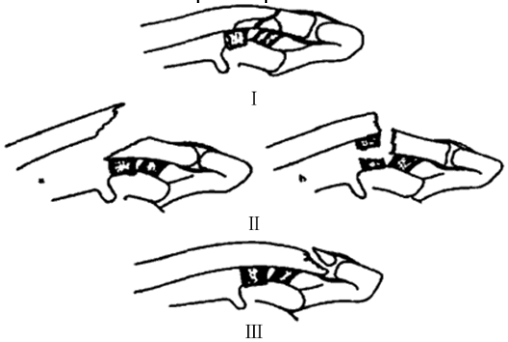

Figure1. Rockwood typing schematic diagram for fracture of lateral clavicle 1/3

2.2 Methods

Before operation, block anesthesia of the cervical plexus and the brachial plexus was administered. Patients were placed in a supine position with the affected shoulder raised by using pads. With the fracture end as the center, an arc incision of approximately 5 cm to 6 cm was cut along the clavicle to expose the deltoid and trapezius fascia. On the long axis of the clavicle, the fascia was cut to expose the fracture end. The cut was conducted carefully to maintain acromioclavicular joint integrity during operation. In addition, the anterior deltoid was appropriately lifted to adequately expose the coracoid base to determine the coracoclavicular ligament integrity and to clean the fracture end. 1 # absorbable tendon suture was used to repair broken conoid ligaments (not knotted temporarily). Fracture blocks were restored subsequently. Based on the fracture block size, two miniature phalanx bone plates provided by Chuangsheng Co. were implanted in the clavicle fracture ends (one at the anterior end and another at the upper end) and were fixed with screws with suitable lengths. After fracture stabilization, the repaired ligaments were knotted onto the upper steel plate to maintain a tension-free or relatively small-tension status (see Fig. 2). On the second postoperative day, a passive functional exercise of the shoulder joint was initiated. On the second postoperative week, an active functional exercise of the shoulder joint was started. When the X-ray examination results showed obvious signs of fracture healing, an exercise to strengthen the shoulder joint was started.

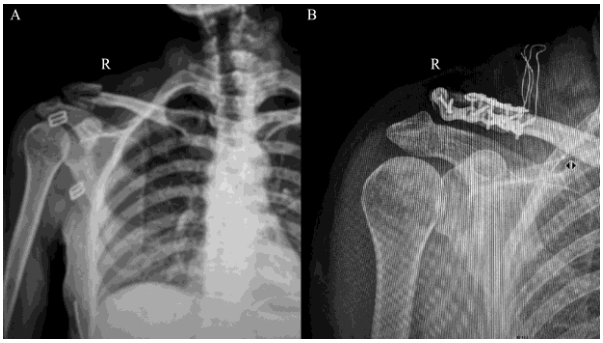

Figure2. Preoperative and postoperative X-ray films. (A) Preoperative X-ray film; (B) Postoperative X-ray film

2.3 Efficacy criteria

Visual analogue scale (VAS) from 0 to 10 points was used. 0 represented no pain and 10 represented intense pain. After treatment, a decrease by over 3 points in VAS was considered to be effective. Constant–Murley score (Constant and Murley, 1987) was employed in the postoperative evaluation of the shoulder joint function.

2.4 Statistical analysis

Statistical software SPSS15.0 was used in the analysis. Rank sum test or t-test was conducted to compare various groups of measurement data, and the data were expressed as $\overline{X} \pm s$. Chi-square test was used to enumerate the data. Inspection level was set at Q = 0.05. If P value was less than 0.05, a significant difference could be observed.

3. Results

The mean postoperative follow-up time was 11.8 months (3 months to 21 months). All fractures were healed, and the mean healing time was 8.6 weeks (6 weeks to 16 weeks). No internal fixation presented loss, deformation, and breakage. Postoperative fracture displacement did not recur. Delayed union, disunion, or malunion of fractures did not occur. No case presented malformation on the chest and shoulder or pain and dysfunction of the shoulder joint. According to the VAS, the mean preoperative score was 8.49 ± 0.13 points, and the mean postoperative score was 2.27 ± 0.36 points. For these scores, a significant difference (P < 0.01) was observed. Constant–Murley score was 92.56 ± 3.31 points (76 points to 100 points). No case presented incisional wound infection, fracture displacement, and other complications.

4. Discussion

Clavicle fracture is common and its incidence rate accounts for approximately 5.98% of systemic fractures. Distal clavicle fracture affects the lateral clavicle 1/3, and its incidence rate accounts for 10% to 15% of all clavicle fractures (Ritchie and McCarty, 2004). Based on Rockwood typing, a fracture of the lateral clavicle 1/3 can be classified into three types (see Fig. 1). Type I is a mild fracture displacement that occurs among ligaments. Type II is a moderate fracture displacement from the internal ligaments to the coracoclavicular ligaments. This type can be classified further into two subtypes: IIA (conoid ligament and trapezoid ligament attachment) and IIB (conoid ligament breakage and trapezoid ligament attachment). Type III is an articular surface fracture. For Rockwood Types I and III fractures, a conservative treatment is commonly conducted. In a Type II fracture complicated by coracoclavicular ligament breakage, the coracoclavicular ligaments suffer from partial or complete breakage and fracture displacement, which affect fracture healing and result in a higher nonunion rate. Previous studies confirmed that nonunion rate via conservative treatment was 22% to 44% (Rokito et al., 2002-2003). At the time of this study, open reduction and fixation were the preferred methods to restore acromioclavicular joint anatomy relationship and to reconstruct joint stability. These methods are crucial for

acromioclavicular joint restoration to normalize activity function, prevent pain, and prevent traumatic arthritis after injury. Yang Yi (2002) performed targeted simple external fixations on 20 patients with clavicle fractures. Among them, 17 cases presented malunion. Although the shoulder joint function was not obviously affected, the appearance was affected. Numerous treatment methods are available for this type of fracture. However, certain indications are confusing such as non-rare complications (Aggarwal, 2005). The traditional method involves Kirschner wire fixation. However, this method has disadvantages such as acromioclavicular joint activity limitation and occurrence of traumatic arthritis at a later stage. Moreover, Kirschner wire displacement, as well as loosening and fracture redisplacement, easily occurs after surgery. For Kirschner wire tension band fixation, shoulder joint activity causes tension band wire relaxation, Kirschner shedding, wire tract infection, and even internal fixation failure. Conducting a triangular bandage fixation is required after the operation, which causes muscle and joint spasticity (Kiefer et al., 1986; Hessmann et al., 1996; Flinkkila et al., 2002). Distal clavicle resection is another method. However, Eskola et al. (1996) argued that the distal clavicle (Type II) fracture was accompanied by coracoclavicular ligament breakage, and the simple distal clavicle resection was inadequate to address deformation and stabilization issues; thus, long-term efficacy was not ideal. In recent years, the clavicular hook plate has been used widely in the treatment of distal clavicle fractures (Kashii et al., 2006). Most scholars concur that using a clavicular hook plate for the treatment of distal clavicle fracture has advantages such as simple operation, firm fixation, and low re-dislocation rate. However, complications tend to occur after the clavicular hook plate application. Studies (Flinkkila et al., 2006; Kashii et al., 2006) demonstrated that the incidence rate of various complications generated by the clavicular hook plate could reach 14%. Ikuta et al. (1999) followed up 47 cases of acromioclavicular joint dislocation and distal clavicle fracture that received the clavicular hook plate treatment and found that several patients experienced postoperative shoulder pains. After the steel plate was removed, the shoulder pain symptoms eased or disappeared. Muramatsu et al. (2007) stated that the design of the existing clavicular hook plate was unreasonable, and approximately 77% of patients had to undergo intraoperative adjustment of the clavicular hook plate. The Bosworth operation is also proposed by a number of scholars. The coracoclavicular screw fixation used in this method requires stronger internal fixation. Ensuring the integrity of the coracoid upper clavicle is necessary for bicortical fixation. Otherwise, the fixation strength is significantly reduced. Therefore, the clinical application of the Bosworth operation is limited to a certain extent. In the Bosworth operation, the internal fixation is conducted by using a compression screw between the clavicle and the coracoid, and the coracoclavicular ligaments are not exposed for repair. The screw impedes the synchronous rotation of the scapula and the clavicle (Pavlik et al., 2001). For the cases included in this study, the mini-plate fixation is used to treat Type II fractures of the lateral clavicle. This treatment has several advantages such as small operation incision, convenient operation, reliable fixation, and clear efficacy. This treatment can also prevent broken needles, screw withdrawals, non-firm fixation, shoulder pain, and other complications. In the treatment of distal Type II clavicle fracture, different opinions are considered for the treatment of coracoclavicular ligaments. Most scholars advocate that while the fracture is being fixed, coracoclavicular ligaments should be repaired and reconstructed (Wang and Gu, 2007). By contrast, other scholars think that repairing or reconstructing coracoclavicular ligaments is not necessary (Klein et al., 2010). We argue that internal fixation only serves as a fixation material and can create a tension-free condition for ligament healing. Finally, after the internal fixation is removed, the acromioclavicular joint stability of the ligaments is maintained. Thus, coracoclavicular ligaments are repaired immediately. Most of the lateral clavicle fractures discussed in this study were classified as Type IIB. The Type IIA cases were typically complicated by partial injury of coracoclavicular ligaments. We used the absorbable tendon suture to stitch the fracture end. However, the suture was temporarily not knotted to avoid tearing the fracture end because the residual end was usually torn into irregular beams after an injury. After the mini-plate fracture block was fixed and rendered tension-free, the suture was knotted. Thus, the fracture end repair for all patients was satisfactory. We conclude that for lateral clavicle fractures accompanied by coracoclavicular ligament injury and that do not involve the acromioclavicular joint, mini-plate fixation can effectively reduce the fracture and stabilize the fracture end to achieve fracture healing. Combined with postoperative rehabilitation exercise, the shoulder joint function can be restored to its previous movement level. The treatment method proposed in this study has significant advantages such as short operation time and few postoperative complications. Therefore, this proposed treatment is worthy of promotion and clinical application.

Conflict of interest: None.

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