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TRAUMA SURGERY

Outcome of arthroscopy-assisted treatment for distal clavicle fractures

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Abstract

Hypothesis The purpose of the present study was described as the arthroscopically assisted procedure that uses a synthetic conoid ligament reconstruction using Zip Tight (Zimmer biomet, Warsaw, USA) and fracture-site fixation with K-wire. Our hypothesis was that this technique provided a satisfactory functional outcome with minimum complication.

Methods 45 patients underwent operation to treat fractures of the distal clavicle between January 2014 and May 2017. The inclusion criteria were as follows: (1) there is an episode of trauma and it is the first fracture (2) distal clavicle fracture of Neer type IIb with dislocation in image findings. The exclusion criteria were as follows: (1) Neer type I, IIa and III of distal clavicle fracture (2) existing injury of rotator cuff, biceps tendon and labral during the arthroscopic procedure. Based on these criteria, 23 patients were included in this study. Clinical outcome assessments were performed using 1-year postoperative Quick DASH score, Constant–Murley score, ASES score. Radiological outcome consisted of antero-posterior and axillary radiographs.

Results Mean clinical outcomes were as follows: Quick DASH score was 3.8 ± 2.8, ASES score was 92.3 ± 3.2 and Constant–Murley score was 94.1 ± 3.0. It was a highly satisfactory result in all of the score at 1-year follow-up. All patients had achieved radiographic union at a minimum 1-year follow-up. There were no cases of nonunion or osteolysis.

Conclusions This study demonstrated that the arthroscopy-assisted treatment using Zip Tight and K-wire provided a satisfactory functional outcome with minimum complication with Neer type IIb fractures of the distal clavicle.

Level of evidence IV, Case series, Treatment study.

Keywords Distal clavicle fracture · Arthroscopy-assisted treatment · Neer type IIb fracture · Coracoclavicular ligament

Introduction

The fracture of the distal clavicle is only 10–15% of all clavicle fractures [1, 2]. Clinical outcome may also decrease when conservative treatment is selected for distal clavicle fracture since the risk of producing a nonunion after conservative treatment is as high as 20–44% [3, 4, 5]. Neer classified distal clavicle fractures into three types from the location of the coracoclavicular (CC) ligaments and the distal fragment [6]. Type II fractures are medial to the ligament attachment. Craig and Rockwood subclassified Type II fractures in type IIa and IIb fractures [7]. In type IIa fractures, both conoid and trapezoid ligaments are attached to the lateral fragment. In type IIb fractures, the trapezoid ligament is intact whereas the conoid ligament is detached from proximal fragment. Therefore, type IIb fractures are unstable and it tends to cause risk of nonunion compared to other type of distal clavicle fractures. Several surgical techniques for type IIb fractures have been reported, but there is still no consensus. Surgical treatments for fracture of the distal clavicle have direct fixation using internal fixation materials such as clavicular hook plate, clavicular distal plate and TBW, and indirect fixation to stabilize the CCL. Direct fixation can be rigidly fixed to fracture, but the hook plate may cause pain by the risk of the erosion of the acromion and osteoarthritis of the acromioclavicular (AC) joints. The distal plate will not have rigid fixation if the size of the distal fragment is small or if the location of fracture is too distant. In contrast, indirect fixation aimed at stabilizing CC ligaments has been often fixed with screws, sutures and K-wires. Recently, arthroscopic surgery for AC joint dislocation has

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been reported [8, 9, 10], and there are some reports applying it to the clavicle distal fracture [11, 12, 13, 14, 15].

The arthroscopy-assisted treatment in this study uses Zip Tight (Zimmer biomet) to stabilize between the CC joints, and Kirschner wire (K-wire) to fix the AC joint and the fracture. The purpose of the present study is to describe the clinical and radiological evaluation of this treatment for Neer type IIb distal clavicle fractures.

The hypothesis is that this technique will have fewer complications, higher bone union rate, and is sufficient treatment requiring no further surgery.

Materials and methods

45 patients underwent operation to treat fractures of the distal clavicle between January 2014 and May 2017 at Toho University Ohashi Medical Center. The inclusion criteria were as follows: (1) there is an episode of trauma and it is the first fracture (2) distal clavicle fracture of Neer type IIb with dislocation in image findings (3) patients who underwent arthroscopically assisted fixation using Zip Tight and K-wire.

The exclusion criteria were as follows: (1) Neer type I, type IIa and type III of distal clavicle fracture (2) existing injury of rotator cuff, biceps tendon and labral during the arthroscopic procedure. Based on these criteria, 23 patients were included in this study.

This study was approved by the Ethics Committee of Toho University Ohashi medical Center (No. H17088).

Clinical and radiological evaluation

Clinical outcome assessments were performed using 1-year postoperative QuickDASH score [16], Constant–Murley score [17], American Shoulder and Elbow Society (ASES) score [18].

Radiological outcome consisted of antero-posterior and axillary radiographs. Fractures were assessed for radiographic union or nonunion. Furthermore, the failure or postoperative complication was assessed, including infection, nonunion, implant breakage or loosening, and erosion or osteoarthritis of the AC joint. Radiological follow-up was performed at 1 week, 4 weeks, 3 months, 6 months, 9 months, and 1 year postoperatively.

Statistical analysis

No statistical analysis was necessary to compare outcome data. The calculations of outcome data were performed using SPSS (version 24.0; IBM Corp., Armonk, NY, USA).

All statistical analyses were performed using SPSS (version 24.0; IBM Corp., Armonk, NY, USA). Results are expressed as the mean ± standard deviation (SD).

Surgical technique

The surgical procedure was performed by one same senior orthopaedic surgeon.

The patient was positioned in the beach chair position under general anesthesia. First, after inserting the arthroscopy from the posterior portal, the anterior working portal was created. Diagnostic arthroscopy was performed to check for injury of rotator cuff, biceps tendon and labral. Subscapularis bursa was resected from lateral to medial along the superior of the subscaplaris tendon to expose the inferior of the coracoid process using a radiofrequency ablator.

Next, a 2–3 cm-skin incision was made on the fracture of distal clavicle, and the fracture was reduced. After reduction, a 2-mm K-wire was inserted from acromion as temporary fixation. Using arthroscopic view and fluoroscopy, a 2.4-mm guide wire was passed through the clavicle and the coracoid process using anterior cruciate ligament outside-in guide (Fig. 1). A 3.5-mm cannulated drill was passed over the guide wire until it exited from the inferior aspect of the coracoid. The ZipTight system (Zimmer biomet) was then inserted, and the button was flipped under the surface of the coracoid process. Finally, reduction and fixation could be performed (Fig. 2). K-wire was implanted subcutaneously.

K-wire was removed under the local anesthesia at 8–12 weeks postoperatively, when the union of fracture was recognized.

Postoperative rehabilitation protocol

Patients were fixed with a sling immediately after surgery. Range of motion training for pendulum and passive exercises was started from the day after surgery. The sling was removed at 4 weeks and active range of motion was started. Patients were instructed to avoid lifting, carrying, pushing and pulling with a strong force on the operated side until 8 weeks after the operation. Since K-wire exists through the AC joint, sports or major efforts should be avoided for 8–12 weeks. A return to sports and heavy labor were allowed in the condition of full ROM at 4–5 months after the operation.

Results

Clinical evaluation

The mean age at the time of surgery was 34.3 years (± 9.5 years). Mean follow-up was 18.6 months

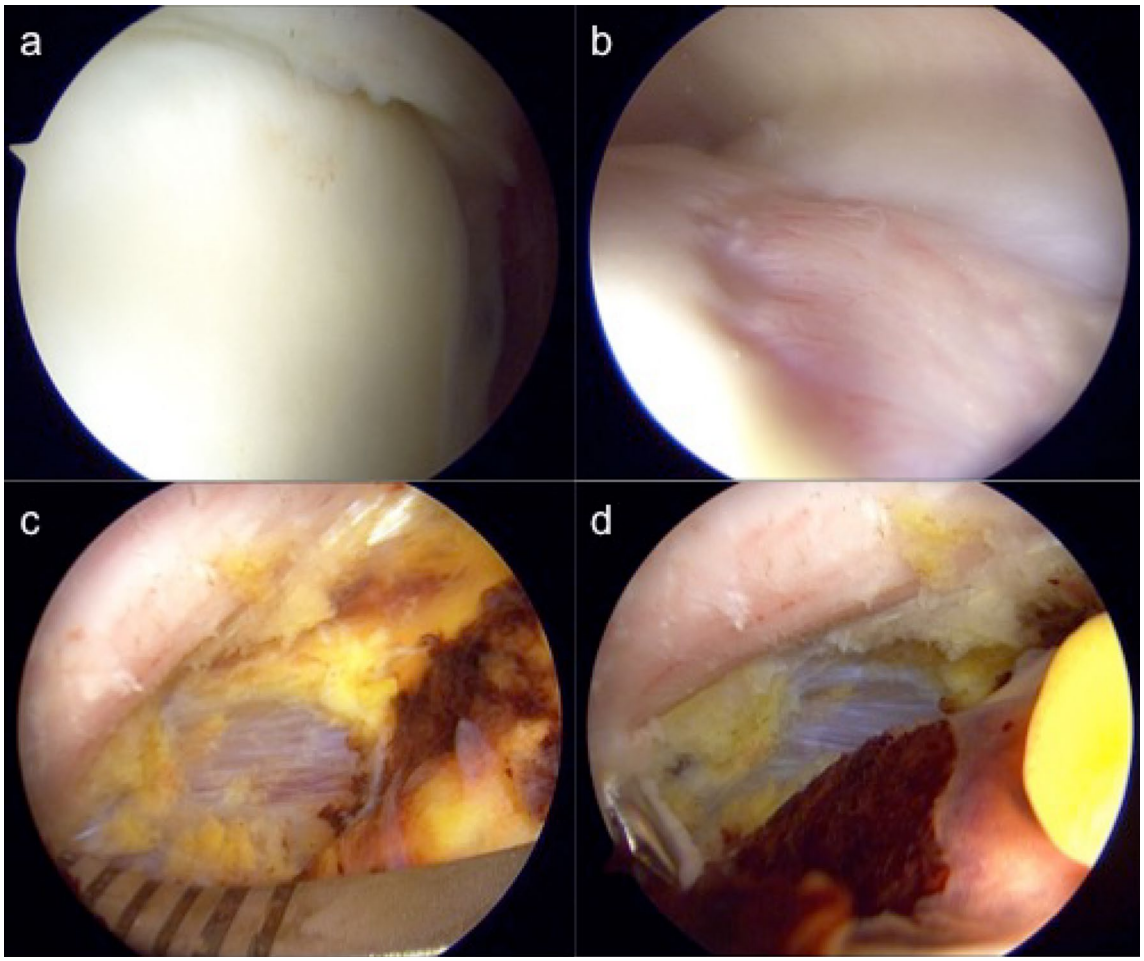

Fig. 1 Arthroscopic view of a right shoulder. **a**, **b** A grenoid side was checked from posterior portal. There was no SLAP lesion and rotator cuff tear. **c**, **d** The synovial tissue anterior to the rotator interval is resected with the radio frequency to identify the base of the coracoid. The ACL guide introduced through the anterior portal. A 2.4 mm guide wire drilled from the clavicle to the inferior aspect of the coracoid process

(± 3.6 months). Mean clinical outcomes are described in Table 1. Highly satisfactory result was shown in all of the score at 1-year follow-up. In the physical examination at the final follow-up, no contracture of the shoulder joint or tenderness of the AC joint was observed. In all cases, the horizontal adduction test was negative.

Radiological evaluation

All patients had achieved radiographic union at a minimum 1-year follow-up. There were no cases of nonunion or osteolysis.

During the follow-up period, there were no patients of re-operation, infection, implant breakages or loosening, or erosion or osteoarthritis of the AC joint.

Discussion

The most important finding of this study was that arthroscopy-assisted treatment for distal clavicle fractures of Neer type IIb achieved sufficient outcomes at 1-year follow-up. Clinical outcomes including patient satisfaction were high. Radiographic nonunion, implant breakage and postoperative complication had not occurred. Our hypothesis that this technique will have fewer complications, higher bone union rate, and is sufficient treatment requiring no further surgery is confirmed. Typically, distal clavicle fractures of Neer type IIb were treated surgically with direct osteosynthesis. Oh et al. reported 105 patients received coracoclavicular stabilization, 162 hook plate, 42 intramedullary fixation, 16 interfragmentary fixation and 40 K-wire

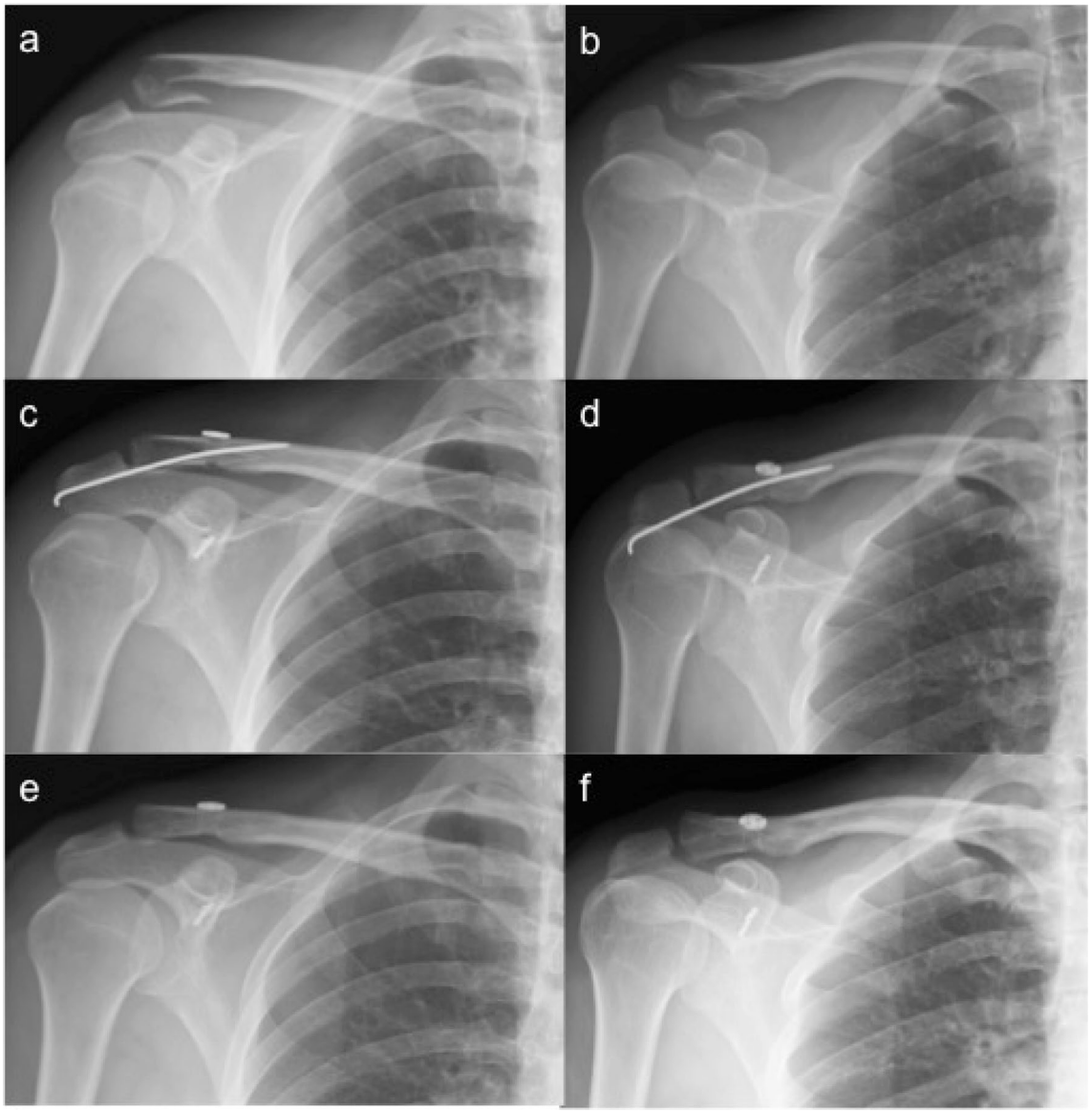

Fig. 2 Preoperative antero-posterior (**a**) and 30° upshot (**b**) radiographic examples show a displaced Neer type IIb distal clavicular fracture. Postoperative antero-posterior (**c**) and 30° upshot (**d**) radiographic examples show satisfactory reduction. Postoperative radiographs at 1-year postoperatively (**e**, **f**) show bony union and nonimplant breakage

Table 1 Clinical outcomes

Scoring system	Score
Quick DASH	3.8 ± 2.8
ASES	92.3 ± 3.2
Constant–Murley	94.1 ± 3.0

plus tension band wiring in a systematic review of 425 cases (60 treated conservatively and 365 surgically) [19]. The overall nonunion and complication rates in open techniques were 1.6 and 22.2%, respectively. In this study, the osteoarthritis or erosion of AC joint had not occurred. In hook plate fixation, complications like subacromial impingement, rotator cuff tear, acromion fractures, and acromial osteolysis were increased [20, 21]. On the other hand, the clavicular distal plate had less complications such as acromial osteolysis and ACJ arthrosis than hook plate [22]. The distal plate may not provide good fixation depending on the size of the distal fragment and the area of fracture. This technique in current study does not depend on the size of distal bone fragments. In addition, since this method assisted arthroscopy, it is possible to check the lesion such as rotator cuff and SLAP in the joint. Several papers have reported good clinical results with fixation of fractures of suspension devise only [11–15]. However, since it was reported that AC ligament injury

was associated with clavicle distal fracture and AC joint dislocation had occurred, AC joint was fixed and stabilized using K-wire in this study [23]. Loriaut et al. reported that one case of nonunion occurred due to implant failure in arthroscopic treatment using a double button device for Neer typeIIb fractures [11]. If the suspension device used is only one, there is a high risk of re-dislocation of the fracture when implant failure occurs. Therefore, K-wire used in this study plays the role of assisting the fixing of the fracture.

In direct fixation using plate, second surgery is sometimes necessary, but it is also one of merit that second surgery for plate removal is unnecessary in this method. Moreover, medical cost can be reduced since wire is removed under local anesthesia without hospitalization in 8–12 weeks after surgery. What is important in this technique is accurate reduction and K-wire fixation. It is important to reduce the risk of re-dislocation by first performing sufficient reduction and inserting K-wire in the correct position, then augmenting and reconstructing the CC ligament.

This study, however, has some limitations. Since there is no control group, there is no statistical analysis done. In addition, since the number of cases is small, definite conclusion has not been reached.

Conclusion

This study described that the clinical and radiological evaluation of this treatment for type IIb distal clavicle fractures achieved sufficient outcomes at 1-year follow-up. The arthroscopy-assisted treatment using Zip Tight and K-wire is a sufficient surgery without complications for Neer type IIb distal clavicle fractures.

Compliance with ethical standards

Conflict of interest The authors report that they have no conflicts of interest in the authorship and publication of this article.

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