Comparison of Clinical Results of Surgical Treatment for Unstable Distal Clavicle Fractures by Transacromial Pins With and Without Tension Band Wire

Yu-Chuan Tsuei[1,2], Man-Kuan Au[1], William Chu[1,2]*

[1]Department of Orthopedics, Cheng Hsin Rehabilitation Medical Center, and [2]Institute of Biomedical Engineering, National Yang-Ming University School of Medicine, Taipei, Taiwan, R.O.C.

Background: An unstable distal clavicle fracture (Neer type II) is an indication that surgical intervention is required. Numerous treatment options have been introduced, but there is no gold standard.

Methods: We report on our experience of 29 consecutive cases, between 2002 and 2008, of acute unstable distal clavicle fracture (Neer type II) and operative treatment using transacromial pins with tension band wire, and compare the use of this treatment with that of traditional transacromial Kirschner wire fixation. All patients were given postoperative radiological and clinical evaluations at 4, 8 and 12 weeks, and then the final clinical outcome, based on the University of California at Los Angeles shoulder rating, was recorded.

Results: The fractures in both groups were clinically united at a mean follow-up of 8.62 weeks (range, 6–20 weeks). Six of the 14 patients (43%) with traditional transacromial Kirschner wire fixation suffered from pin migration and discomfort of skin erosion, 3 had residual displacement, and 1 had a recurrent fracture. In contrast, only 1 patient (7%) in the tension band wire group had residual displacement and pin migration causing skin tenting, and this was made comfortable by pin removal. The complication rate and the University of California at Los Angeles shoulder rating were significantly different between the 2 groups.

Conclusion: Transacromial pins with tension band wire provide superior fixation for a type 2 fracture of the distal clavicle, compared with traditional transacromial Kirschner wire fixation. [*J Chin Med Assoc* 2010;73(12):638–643]

Key Words: clavicle fracture, distal clavicle fracture, lateral clavicle fracture, tension band wire, transacromial K-wire fixation

Introduction

Fractures of the clavicle are common due to the bone's subcutaneous position, and they account for approximately 10% of all bone fractures.[1,2] Clavicle fractures are categorized into proximal, midshaft, and distal fractures. Although distal clavicle fractures represent only 15–28% of cases,[3] they constitute 30–45% cases of nonunion.[1–5] Therefore, many investigators have addressed surgical interventions for displaced distal clavicle fractures.[6–9]

Many different surgical procedures have been developed for fixation of the distal clavicle fracture since Neer[4] first recommended the use of transacromial Kirschner wires (K-wires). Ballmer and Gerber[10] used a Bosworth screw for coracoclavicular fixation. Goldberg et al[11] developed the Dacron tape loop for coracoclavicular stabilization, with direct suture fixation of the fracture site. Many investigators have recently reported satisfactory results when using the clavicular hook plate.[12,13] Although there are many types of operative procedures, almost all of the previous reports presented small case series without comparisons, and none of them has resulted in a gold-standard treatment.

This report describes satisfactory results obtained from a surgical procedure using transacromial pins

*Correspondence to: Dr William Chu, Department of Orthopedics, Cheng Hsin Rehabilitation Medical Center, 45, Cheng Hsin Street, Taipei 112, Taiwan, R.O.C.
E-mail: William@bme.ym.edu.tw • Received: April 13, 2010 • Accepted: July 15, 2010

with additional tension band wire (TBW) for unstable distal clavicle fractures, and compares it with the results of traditional transacromial K-wire fixation (TKW).

Methods

This study performed a retrospective search for all fractures of the distal clavicle treated in Cheng Hsin Rehabilitation Medical Center from 2002 to 2008. The exclusion criteria were situations in which conservative treatments or surgery, other than TKW or TBW, had been used, and where transacromial pinning was considered impossible intraoperatively (1 case was managed with coracoclavicular wiring and 2 were managed with an extra-articular Knowles pin). With the patients' informed consent, 30 were treated in a randomized fashion with either of the 2 methods; of these, 29 were finally included, due to the loss of 1 patient during follow-up. The patients were divided into 2 groups according to operative procedure, of which 14 were treated with TKW and 15 were treated with TBW. Follow-up was scheduled at 4, 8 and 12 weeks postoperatively if there was no specific condition. All medical records and radiographic examinations were retrospectively reviewed for clinical results and evaluation of fracture union. Follow-up was performed on an outpatient basis using a questionnaire, based on the University of California at Los Angeles (UCLA) shoulder rating, to assess the subjective satisfaction with the range of motion and daily activities, and a radiographic examination for the objective evaluation of bone union. Union time was defined as the period required to achieve clinical union, i.e. when callus formation was noted radiographically, and there was complete freedom from fracture-related symptoms.

The 2-sample t test and χ^2 test were used for continuous and discrete variables, respectively, in statistical analyses in the study.

Operative technique

TKW group

The traditional TKW method, as described by Neer,[4] was performed. However, the postoperative rehabilitation protocol was modified from Neer's study. All patients received arm sling protection postoperatively for 4 weeks, with only a passive range of motion exercises permitted. If clinical union of the fracture was noted at the first, 4 week, postoperative visit, the K-wires were removed with local anesthesia 6 weeks postoperatively. Until that time, active exercise was forbidden. After removal of the K-wires, the patients were allowed to return to work and engage in their previous activities if bone union was confirmed by radiographic examination.[4,14]

TBW group

TBW operations were performed under general anesthesia with the patient in the beach-chair position. An incision was made from the proximal end of the fracture site extending to the acromion laterally along the axis of the clavicle. The fracture site and lateral end of the acromion were exposed directly and gently to spare the acromioclavicular joint. The upwardly displaced proximal clavicle was reduced with an elevator or towel clip, and 2 2.0-mm Steinmann pins were carefully applied with a power drill from the acromion posterolaterally to the proximal clavicle anteromedially. If the fracture had been reduced and fixed correctly with these 2 Steinmann pins, the fracture site should be stable within the anatomic alignment. The TBW technique was then applied above the fractured clavicle across the acromioclavicular joint after predrilling of the proximal clavicle (Figure 1). Finally, the Steinmann pins were bent beneath the soft tissue and the skin was closed in layers after irrigation.

Arm sling immobilization was used immediately in the operating room. Pendulant activity in the arm sling was encouraged from the first postoperative day. Arm

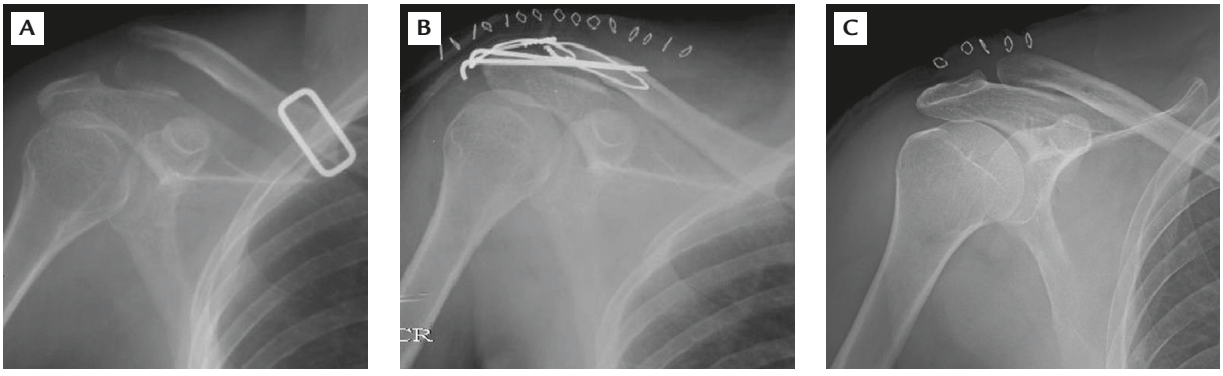

Figure 1. A 23-year-old female: (A) with an unstable fracture of the right distal clavicle; (B) treated with transacromial Steinmann pins and tension band wire; (C) good bone union after removal of the implants.

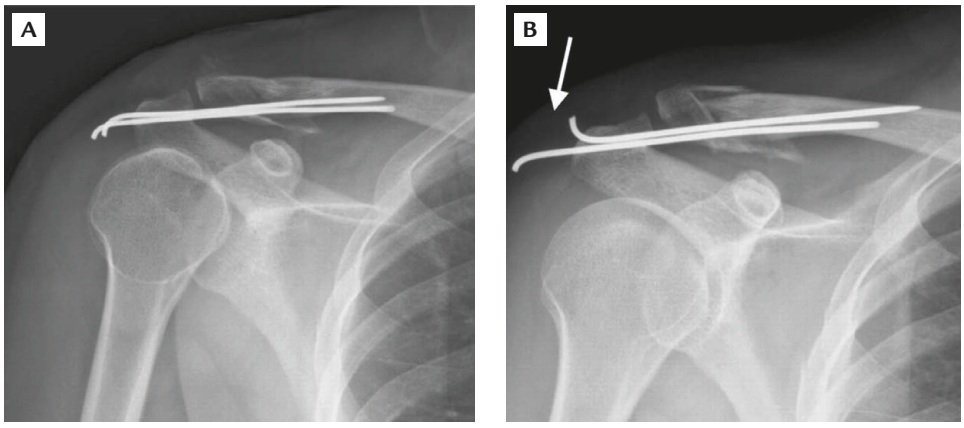

Figure 2. A 26-year-old male with fracture of the right distal clavicle: (A) underwent transacromial K-wire fixation; (B) pin migration was noted (arrow) 2 weeks postoperatively.

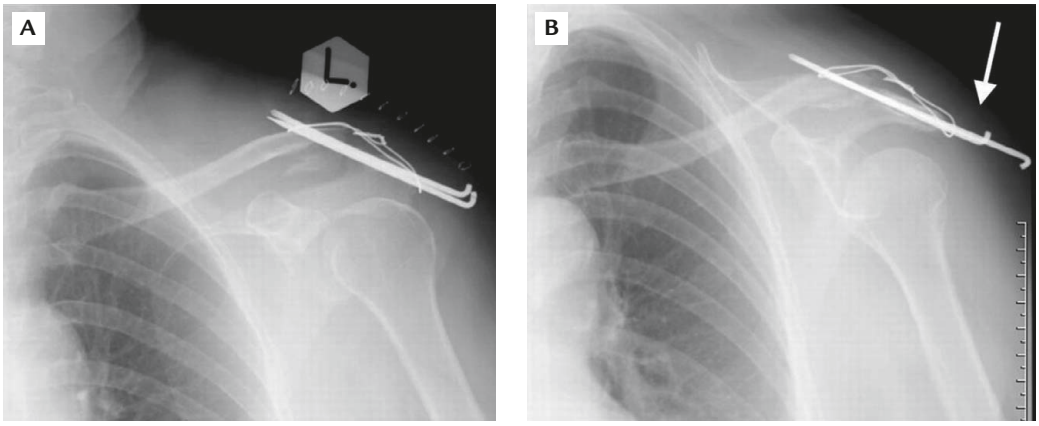

Figure 3. A 57-year-old female with fracture of the left distal clavicle: (A) received tension band wire; (B) pin migration was noted (arrow) 3 months postoperatively.

elevation up to 90 degrees was allowed immediately if pain was relieved. A full range of motion, including active overhead activity, was allowed 7 days postoperatively. After radiographic confirmation of bone healing, removal of the implants was suggested 3 months postoperatively.

Results

When the TKW and TBW groups were combined, all fractures were united clinically at a mean of 8.62 weeks (range, 6–20 weeks) postoperatively (TKW group, 8.93 weeks; TBW group, 8.33 weeks). Six of the 14 patients (43%) in the TKW group suffered from discomfort caused by skin erosion due to pin migration (Figure 2), with residual displacement noted in 3 of them. One case suffered from a minor falling trauma, causing a recurrent fracture 11 months postoperatively. The fracture line extended along the proximal pin tract. The case with the recurrent fracture was treated with revision surgery using a compression plate. For patients with pin migration and skin erosion, pin removal was performed as early as 3 weeks postoperatively in the TKW group in consideration of the patient's discomfort and the risk of infection. However, another patient in the TKW group who suffered from persistent pain without signs of clinical union had the pins removed as late as 20 weeks after the fracture site stabilized. Only 1 patient (7%) in the TBW group had pin migration causing skin tenting at 3 months postoperatively (Figure 3), and this was made comfortable by pin removal. One patient in the TBW group had residual minimal displacement without functional deficit or discomfort complaints. There were no severe complications such as deep infection, neurovascular injury, or pin migration causing vital organ injury, in either group.

The mean UCLA shoulder rating at the final follow-up was 31.4 (range, 20–35) in the TKW group and 33.8 (range, 30–35) in the TBW group ($p=0.021$). The mean follow-up time was 45 months (range, 10–85 months). The complication rate was significantly

Table 1. Characteristics and results of the 2 groups*

	TKW group	TBW group	*p*
Number of patients	14	15	
Sex (male:female)	9:5	11:4	0.325
Age (yr)	39.2 ± 14.96 (23–56)	39.3 ± 14.12 (21–61)	0.886
Arm (right:left)	5:9	7:8	0.316
Operation time (min)	77.5 ± 15.78 (45–105)	85 ± 13.50 (60–105)	0.886
Union time (wk)	8.93 ± 3.60 (6–20)	8.33 ± 1.50 (6–10)	0.273
UCLA rating score	31.4 ± 4.33 (20–35)	33.8 ± 1.74 (30–35)	0.021
All complications	6 pin migrations Combined with: 3 residual displacement & 1 recurrent fracture	1 pin migration Combined with: 1 residual displacement	0.005

**Data are presented as n or mean ± standard deviation (range). TKW = transacromial K-wire fixation; TBW = tension band wire; UCLA = University of California at Los Angeles.*

higher in the TKW group than in the TKW group ($p = 0.005$). The characteristics of the 2 groups and results are listed in Table 1.

Discussion

Distal clavicle fracture with disruption of the coracoclavicular ligament from the medial clavicular fragment resulting in upward displacement of the medial fragment (Neer type II) does not readily heal without surgical intervention. Neer,[1] Edwards et al[3] and Nordqvist et al[5] all reported high rates of nonunion or delayed union (67–75%) in Neer type II distal clavicle fractures with conservative treatment. Many surgical methods have been introduced for distal clavicle fractures, including TKW,[4] transacromial screw/Knowles pin fixation,[14,15] plate fixation,[12,13,16,17] and coracoclavicular stabilization for indirect reduction with wiring, tape looping, reconstruction, or screws.[10,11,18–20] All of these methods provide an acceptable union rate (80–100%) after surgery, but there are various reasons why there is still no gold-standard treatment. Our rationale for the present study was the need to determine the optimal surgical technique for treating distal clavicle fractures in terms of which is the easiest, the most reproducible and reliable, and has the lowest major complication rate of the various case series. TKW fixation has the advantage of being easy to perform with simple hardware. However, it also has the disadvantages of pin migration and low fixation, which causes skin irritation and even central migration, with vital organ injuries, resulting from the loss of reduction, in some cases.[21] Because of concern about the loss of reduction and pin migration, the full range of motion is always forbidden before the removal of the implants. After bone union and removal of implants, which were scheduled at 6–12 weeks postoperatively, we found that shoulder stiffness had developed in some cases when the rehabilitation program started, resulting in a poor UCLA shoulder rating. The UCLA shoulder rating varied widely, from 20 to 35 in the TKW group, where the mean ULCA rating was significantly lower than that of the TBW group.

Transacromial screw fixation, such as those methods which use the Association for the Study of the Problems of Internal Fixation (AO/ASIF) malleolar screws and the Knowles pin, has shown good stability and a clinical union time as short as 6.8 weeks.[14,15,22] However, acceptable stability requires the use of large-diameter screws (4.5-mm AO/ASIF screw or 3.8-mm Knowles pin) for fixation. Cases of an extremely distal fracture or with comminution can make the application of such screws very difficult extra-articularly. On the other hand, if the threaded screw is fixed through the acromioclavicular joint, concerns remain about acromioclavicular joint destruction and bone erosion.[14]

Coracoclavicular fixation/stabilization is a surgical procedure with a high technical demand that sometimes causes major complications such as coracoid fractures or screw loosening. Moreover, both extensive soft tissue dissection and the long operation time are disadvantages of this procedure, and a failure rate as high as 32% has been reported.[18,23,24]

Hook-plate fixation usually results in a bulking mass with skin irritation and an increased infection risk. Other problems include rotator cuff damage, subacromion impingement, plate migration up to the acromion causing osteolysis, and fracture of the acromion.[12,17]

The use of TBW as a treatment for distal clavicle fracture or acromioclavicular dislocation was introduced to provide better stability than TKW fixation alone.[25]

Kao et al[26] introduced a surgical technique with K-wires and TBW extra-articularly with good results, but this method might not be suitable for fractures with higher degrees of comminution.[26]

Many surgeons in other institutions perform the traditional Neer's method using TKW fixation and an open retrograde technique or under fluoroscopy because of the ease of application and acceptable results.[27] Flinkkila et al[28] showed similar functional results for the use of K-wires and clavicular hook-plate fixation, with a high pin-migration rate (in 13 of 22 cases) of K-wire fixation and with occasional skin protrusion, erosion, and even superficial infection and loss of reduction resulting in the suggested use of the hook plate.[28] However, the functional performance and union rate can be as high with simple K-wires as with a costly hook plate, with the only concern being minor complications of pin migration. A simple operation procedure based on K-wire fixation with a lower complication rate may be an ideal treatment method for unstable distal clavicle fractures. Our comparison of case series between TBW and Neer's TKW fixation procedure has shown that TBW provides better results and a more rapid recovery of range of motion, a lower complication rate, and a shorter recovery period.

There are no biomechanical experimental reports about unstable distal clavicle fractures. However, in a biomechanical study, Kiefer et al[25] reported a better stabilizing effect of the TBW, when compared with the various implants, including the Bosworth screw and hook plate used on torn acromioclavicular joints. We hypothesize that an unstable distal clavicle fracture (Neer type 2) is similar to acromioclavicular dislocation. However, the advantage for treating distal clavicle fracture is that fracture union is more predictable if reduction and stability are both maintained adequately despite what implant is applied. We chose a simple implant rather than a costly hook plate. Many studies have applied a TBW technique for treating distal clavicle fracture sporadically without specified analysis.[21,26,28] Our clinical report achieved 100% union rate in a mean time of 8.33 weeks, with a satisfactory function outcome of UCLA shoulder rating of 33.8 points in the TBW group, which is comparable with other previous surgical technique reports; although in the present study, we felt that the case number was not large enough.

In conclusion, we have presented a simple and easy method using a transacromial Steinmann pin, with TBW for fixation of unstable distal clavicle fractures, which we consider has greater stability and a lower complication rate than traditional TKW fixation. However, further research is needed involving larger case numbers and more detailed biomechanics when using TBW in this area since it is not traditionally considered to be a tension site.

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