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Treatment of unstable distal clavicle fractures using two suture anchors and suture tension bands

Sang-Jin Shin *, Kwon Jae Roh, Jong Oh Kim, Hoon-Sang Sohn

Department of Orthopaedic Surgery, Ewha Womans University, School of Medicine, 911-1, Mok-Dong, Yangcheon-Ku, 158-710 Seoul, Republic of Korea

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ABSTRACT

Objective: The study presents a surgical technique using two suture anchors combined with two non-absorbable suture tension bands and the clinical and radiological results obtained in patients with acute distal clavicle fractures associated with coracoclavicular ligaments disruption.

Materials and methods: Nineteen patients with distal clavicle fractures were included with a mean follow-up of 25 months. All patients had type IIb fractures according to the Neer classification. Coracoclavicular ligaments were reconstructed using two suture anchors to maintain distal clavicle in an anatomical position, and supplementary interfragmentary fixation was performed using two non-absorbable suture tension bands in figure-of-eight configurations. Functional outcomes were assessed at final follow-up visits using the Constant score.

Results: The numbers of lateral fragments averaged 1.4. Seventeen patients maintained the same vertical coracoclavicular distance between both shoulders. However, in two patients, the coracoclavicular distance of the injured shoulder increased by 50% compared with that of the contralateral shoulder. Fracture union was obtained in 18 patients at a mean 4.8 months postoperatively. One patient had symptomatic nonunion until 9 months postoperatively, and subsequently, distal clavicle resection was performed. Two patients showed delayed union and achieved fracture union at 9 and 10 months postoperatively, respectively. Clavicular erosion was found in two patients. The lateral fragment of one patient united in an upward angulated position caused by over-tightening of the medial clavicle. The average Constant score improved to 94.

Conclusion: Coracoclavicular reconstruction using two suture anchors and supplementary interfragmentary fixation using two non-absorbable suture tension bands for acute distal clavicle fracture are reliable techniques for restoring stability in patients with acute distal clavicle fracture.

Surgical treatment is often recommended for the management of displaced fractures in the distal third of the clavicle caused by a high rate of nonunion following conservative treatment.[7,21] Edwards et al.[7] demonstrated a 30% rate of nonunion after non-operative management. Moreover, an additional healing period of greater than 6 weeks has been reported to be required for non-operative treatments.[23] These morbidities are attributable in part to fracture displacements caused by opposing forces acting on the fragments. The trapezius muscle, attached to the medial fragment, displaces the medial clavicle superiorly and the weight of the arm draws the lateral fragment inferiorly, which results in major displacement and nonunion. In addition, the severity of associated ligamentous disruption, especially of the coracoclavicular (CC) ligaments, also contributes to nonunion.[12] Distal clavicle fractures are also classified according to the injuries of CC ligaments because the conoid and trapezoid ligaments are important structures for the fracture-healing process.[20] Biomechanical investigations have confirmed that the CC ligaments primarily restrain vertical translation.[6,10] Furthermore, if CC ligament disruptions are left untreated, the fracture fragments may be unstable and the risk of nonunion increased. Therefore, the surgical treatment for distal clavicle fracture should be considered to include reconstruction of disrupted CC ligaments to stabilise the clavicle from superior migration and to provide an environment conducive with fracture union.

Although numerous surgical methods have been proposed, no consensus has been reached yet regarding the optimal surgical treatment for displaced distal clavicle fractures. Various fixation techniques have been used, including wires, screws, tape or a plate.[3,4,13,14,17] The majority of the surgical methods described have produced favourable clinical outcomes; however, complications and morbidities appear almost inevitable. More recently, the use of a suture anchor was described for the treatment of complete

* Corresponding author. Tel.: +82 2 2650 5010; fax: +82 2 2642 0349.
E-mail address: sjshin622@ewha.ac.kr (S.-J. Shin).

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acromioclavicular (AC) joint dislocation.[5,24] Suture anchors offer the advantages of ease of use and improved pullout strength, and reduce the risk of neurovascular injury when passing the suture material underneath the coracoid process. Therefore, the authors devised a surgical technique using suture anchors to obtain fracture stability and eliminate the considerable risks of complications posed by the hardware.

The purpose of this study was to present a surgical technique using two suture anchors combined with two non-absorbable suture tension bands and the clinical and radiological results obtained in patients with acute distal clavicle fractures associated with CC ligaments disruption.

Materials and methods

Nineteen patients with acute distal clavicle fractures were treated with the devised technique using two suture anchors and suture tension bands. All patients had type IIb fractures according to the Neer classification.[20] There were 5 women and 14 men of mean age 43.4 years (range, 17–70 years). The dominant shoulder was involved in 12 patients. All patients underwent surgery within 3 weeks of injury, with a mean time from injury to operation of 7.1 days (range, 1–21 days). Two of the 19 patients had associated injuries including one fracture of both forearm bones and one lateral malleolar fracture, respectively. Fractures were caused by a fall from height in seven patients, motor vehicle accidents in six, bicycle accidents in five and sports injuries in one.

Distal clavicle fracture was diagnosed based on clinical and radiological assessments. Clinical diagnoses were based on the presence of a painful and palpable step off in distal clavicle areas concerned after the traumatic episode. Preoperative radiological evaluations included antero-posterior (AP) and axillary views of both shoulders. Computed tomography (CT) was taken in all patients preoperatively to identify comminution and the accurate position of fracture fragments. Maintenance of reduction was determined by measuring the vertical distance between the upper border of the coracoid process and the inferior cortex of the clavicle (CC distance) in preoperative and postoperative standard radiographs. CC distance of the injured shoulder was compared with that of the contralateral shoulder. Radiographs were taken with shoulders fixed in the same position to avoid the influences of projection changes that may have affected interpretations of the outcome.

The average follow-up period was 25.9 months (range, 24–40 months). Functional outcomes were assessed at final follow-up visits using Constant score and times required before returning to work. Radiological evaluations, which included both shoulder AP and axillary views, were routinely performed at 3 weeks postoperatively and every 3 months thereafter until union was observed. Shoulder antero-posterior (AP) radiographs in a standing position with patients holding a 4 kg weight in each hand (both shoulder stress view) were available for all patients at 6-month postoperative visits. All shoulders were supported in a sling for 3 weeks postoperatively to avoid excessive downward traction. An active range of motion exercises of the elbows, wrists and hands were started at the first day postoperatively. Passive- and active-assisted shoulder exercises were initiated from 3 weeks postoperatively and a strengthening exercise program at 6 weeks postoperatively. Heavy use of the affected arms and contact sports were not allowed for 3 months following the procedure. The paired Student's t-test in SPSS (version 16.0, Chicago, IL, USA) was used for statistical analysis.

Surgical techniques

The patient was placed in the beach-chair position, with the affected shoulder draped free at the lateral edge of the table. A vertical skin incision was made from 2 cm medial to the AC joint toward the lateral aspect of the coracoid process. The deltotrapezoidal fascia was split in the coronal plane and the deltoid muscle was released from the anterior edge of the distal one-third of the clavicle. Some of the deltoid and trapezius attachments to the clavicle were found to have been stripped as a result of injury. Subsequently, the AC joint, the distal one-third of the clavicle and the base of the coracoid process were exposed. The medial clavicle usually requires about 4 cm of exposure from the fracture edge. The base of the coracoid can be palpated without entirely exposing the CC interval area.

After exposing the fracture site, two suture anchors with doubly loaded sutures were placed on the base of the coracoid process. A 3.7-mm bioabsorbable suture anchor (Arthrex, Naples, FL, USA), preloaded with two strands of 2/0 Fiberwire sutures, was then inserted into the antero-lateral portion of the base of the coracoid process, where the trapezoid ligament is attached. The other suture anchor was placed on the postero-medial portion of the coracoid process, where the origin of the conoid ligament lies. The stabilities of these two suture anchors were checked by pulling on the sutures. Two clavicular holes, which were related to postero-medial anchor, were drilled side by side in the mid-portion of the clavicle about 2 cm from the medial edge of the fracture using a 1.6-mm Kirschner wire. The horizontal distance between these two clavicular holes was about 1 cm; the holes were usually placed on the conoid tubercle and at points directly above the postero-medial suture anchor, so as to allow the clavicle to be pulled vertically down, thereby preventing superior displacements of medial fragments of the clavicle. Two suture strands of the postero-medial suture anchor were passed together through one clavicular hole, and the other two suture strands of the same anchor were passed through the neighbouring hole using the looped wire made of a 26-gauge wire. After the looped wire is passed from superior to inferior clavicular holes, the end of the wire is extracted through the CC interval and the two suture strands of the suture anchor are passed through the looped wire, which was then pulled back through the clavicular holes. Therefore, the suture strands of the postero-medial suture anchor were oriented in the same direction as that of the conoid ligament. The passing procedure was repeated whenever suture strands were passed through the clavicular holes.

With the fracture fragments held temporarily in the reduced position, additional two clavicular holes were drilled for the antero-lateral anchor at the respective centres of the abutting ends of the medial and lateral fracture fragments. These clavicular holes were placed far enough from each fracture edge (about 1 cm) to prevent the risk of fracture propagation. The horizontal distance between these two clavicular holes was about 1.5–2 cm, but changed depending on the length of the lateral fragment. The same suture-strand-passing procedure described above was performed, this time across the fracture line. Later, four clavicular holes were drilled using a 2.0-mm Kirschner wire for making suture tension bands to reinforce the reduction. First, two parallel clavicular holes were drilled in the medial clavicle, anterior and posterior to the line connecting the middle two of the four drill holes placed for the anchor strands. An additional two drill holes were placed in the lateral fragment, likewise anterior and posterior, beyond the lateral-most hole already in place. Thereafter, two strands of 5/0 Fiberwire sutures (Arthrex, Naples, FL, USA) were passed together through the four newly created clavicular holes in a figure-of-eight configuration. The pairs of suture strands of anchors were then tied over the superior surface of the clavicle, starting from the medial suture strand pair through to the lateral suture strand pair. During the tying process, the distal clavicle was fixed in an anatomic position. After confirming that the distal clavicle was in the reduced position, two strands of 5/0 Fiberwire sutures were tied in the figure-of-eight configuration (Fig. 1). Distal clavicle resection