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ORIGINAL ARTICLE

Clinical outcomes of minimally invasive open reduction and internal fixation by screw and washer for displaced greater tuberosity fracture of the humerus

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Background: The purpose of this study was to investigate clinical and radiologic outcomes of open reduction and internal fixation with a screw and washer for a displaced greater tuberosity fracture of the proximal humerus through a small incision.

Methods: We retrospectively reviewed 29 patients who underwent open reduction and internal fixation with a screw and washer for a greater tuberosity fracture of the proximal humerus. After surgery, the patients were immobilized in a brace for 4 weeks. To determine clinical outcomes, we evaluated a visual analog scale pain score; the Subjective Shoulder Value; the University of California, Los Angeles shoulder score; the American Shoulder and Elbow Surgeons score; and active range of motion.

Results: All patients achieved bone union within 3 months after surgery. At the 2-year follow-up, the mean visual analog scale pain score was 1.1 ± 1.1; Subjective Shoulder Value, 93.4 ± 5.3; University of California, Los Angeles shoulder score, 31.2 ± 2.7; and American Shoulder and Elbow Surgeons score, 92.6 ± 6.7. Mean active forward flexion, external rotation, and internal rotation were 144° ± 16°, 33° ± 11°, and 13.3 ± 1.7, respectively. Postoperatively, 9 patients (31%) had stiffness and pain refractory to conservative treatment and underwent arthroscopic release.

Conclusion: Although minimal open reduction and screw and washer fixation resulted in bone union in all cases, the incidence of postoperative stiffness was relatively high in patients with displaced greater tuberosity fractures because of prolonged immobilization after surgery.

Level of evidence: Level IV; Case Series; Treatment Study

Keywords: Greater tuberosity fracture; open reduction; screw and washer; minimally invasive; immobilization; postoperative stiffness

Our institutional review board approved the study (4-2017-0515), and the requirement for informed consent was waived.

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Greater tuberosity (GT) fractures account for approximately 20% of all fractures that occur in the proximal humerus,[8,11] and most proximal humeral fractures, including GT fractures, are generally known to have good clinical outcomes with conservative treatment.[7,22]

The GT provides an anatomic footprint for rotator cuff insertion and allows external rotation of the shoulder. Thus, when a fractured fragment of the GT displaces posterosuperiorly from its original anatomic position, it can lead to alterations in shoulder biomechanics that result in impingement or limitation in range of motion (ROM) in the shoulder joint.[22] Generally, the surgical indication for a proximal humeral fracture is defined as displacement of more than 1 cm or a greater than 45° angulation of the fracture fragment. However, for GT fractures, the indication decreases to displacement of 5 mm or more. Recently, some authors have suggested that the indication should include an even smaller displacement of 3 mm.[21,23]

Currently, most surgeons use open reduction–internal fixation (ORIF) with plate or arthroscopic reduction and fixation of the displaced GT.[6,9,15] Compared with open surgery, arthroscopic reduction with fixation, albeit a technically challenging procedure, provides an opportunity to evaluate intra-articular lesions.[2,17] On the other hand, ORIF is more familiar and enables accurate reduction and strong fixation under direct visualization. In addition, ORIF is effective when there is a concomitant fracture such as that of the humeral neck.[6,7,24] Although we could argue that internal fixation with a plate is a good option even without a concomitant surgical neck fracture, the screw fixation of the GT through a small incision might be sufficient to obtain bone union and a satisfactory outcome. However, there are few examples in the literature pertaining to minimally invasive surgery for GT fractures.[4,23]

The purpose of this study was to investigate clinical and radiologic outcomes of ORIF with a screw and washer for a displaced GT fracture of the proximal humerus through a small incision. We hypothesized that, considering a metaphyseal fracture with a wide contact area, bone healing might be obtained in all cases. However, we are aware that the rate of postoperative stiffness could be high because of 4 weeks of immobilization after surgery and the inability to immediately exercise.

Materials and methods

Study population

The indication for surgery was displacement of the GT of 5 mm or more as observed on either radiography or computed tomography (CT). The fracture pattern was assessed according to the classification system of Mutch et al.[18] Our study included the split and avulsion types and excluded the depression type that was treated by conservative means. If severe comminution was present on the lateral wall of the GT, other surgical options were considered because internal fixation with a screw and washer was not feasible. Between May 2009 and March 2015, 35 patients underwent ORIF with a screw and washer for displaced GT fractures of the proximal humerus by a single surgeon in our institute. The exclusion criteria were (1) patients who were not available for the 2-year minimum follow-up after surgery, (2) patients with a history of surgery on the affected shoulder, or (3) patients with any concomitant proximal humeral fractures including humeral neck fractures. A total of 29 patients were included in the study.

Functional and radiologic assessment

The visual analog scale for pain assessment; the Subjective Shoulder Value; the American Shoulder and Elbow Surgeons score; the University of California, Los Angeles shoulder score; and active ROM were evaluated for the functional assessment. Active ROM was measured based on forward flexion in the scapular plane, external rotation with the arm at the side, and internal rotation. Internal rotation was estimated by determining the highest spinal segment that the patient could reach with his or her thumb. For ease of statistical analysis, spinal segments were converted into numbers: segments T1 through T12 were designated as 1 through 12, segments L1 through L5 were designated as 13 through 17, and the sacrum was designated as 18.[12,13,19] An independent examiner assessed the pain scale, shoulder functional scores, and active ROM.

For the radiologic evaluation, a true anteroposterior view and 3-dimensional CT scan of the shoulder were obtained prior to the operation. Fragment size and displacement were measured by the longest fracture line observed on coronal and axial views on CT. The split type had a mean fragment height and width of 33 ± 6 mm (range, 24-41 mm) and 19 ± 5 mm (range, 15-33 mm), respectively, with mean displacement of 7 ± 2 mm (range, 6-14 mm), whereas the avulsion type had a mean fragment height and width of 22 ± 4 mm (range, 19-31 mm) and 19 ± 4 mm (range, 15-25 mm), respectively, with mean displacement of 19 ± 9 mm (range, 7-30 mm). After surgery, true anteroposterior views (neutral, 20° of external rotation, and axillary) were taken at 2 weeks, 6 weeks, 3 months, 6 months, 1 year, and 2 years.

Operative procedures

The operation was performed with the patient under general anesthesia in a 20° beach-chair position. A single longitudinal skin incision of approximately 3 cm in length was made from the anterior one-fourth of the acromion (Fig. 1), and subsequent dissection was performed. To avoid injury to the axillary nerve, the shoulder was abducted to reduce deltoid tension while retracting the muscle. After reduction under fluoroscopic guidance, temporary fixation was performed with guide pins. Through these guide pins, two or three 4.0-mm cannulated screws with washers were inserted, depending on the size and location of the fragments (Fig. 2).

Postoperative rehabilitation and implant removal

The arm was immobilized with a brace for 4 weeks in a neutral position to prevent internal rotation (Fig. 3). After 4 weeks, passive ROM exercises including table sliding and stretching exercises, in addition to forward flexion in the supine position, were encouraged (preferably performed during or after a hot bath or shower). After 8 weeks, postoperative stiffness was assessed during ROM