

Displaced isolated greater tuberosity fractures of elder adults treated with plate osteosynthesis

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Abstract

Background: We elucidated the effect of open reduction and internal fixation with locking plate for acute isolated displaced greater tuberosity fractures of humerus in elder adults (aged >60 years).

Methods: From 2009 to 2015, data from 32 patients, aged between 60 and 88 years, who had acute unilaterally displaced greater tuberosity fractures of humerus were collected and evaluated retrospectively. All the fractures were managed with open reduction and internal fixation with locking plate. The follow-up period was 50.8 months on an average (range 22-80 months). Finally, 25 patients were available for final evaluation of radiographic and functional results.

Results: All the 32 fractures had union with the average union time of 14 weeks (range 10-18 weeks) and with no complications. The average of preoperative Visual Analogue Scale (VAS) was 6.2 (range 4-8), ASES was 30.4 (range 13-45), and Constant score was 30.4 (range 20-45). At the last follow-up, the mean VAS was 1.3 (range 0-2.5), the mean ASES score was 90.1 (range 72-100), and the mean Constant score was 90.3 (range 80-100). There were statistically significant differences between preoperative and final follow-up in VAS, ASES, and Constant score. Hundred percent of patients had good or excellent results by Constant score, with excellent results (86-100) in 17 (68%) patients and good result (71-85) in 8 (32%).

Conclusion: In conclusion, open reduction and internal fixation with locking plate is an effective treatment for acute displaced greater tuberosity fractures of humerus in elder adults.

Keywords: Elder; Isolated greater tuberosity fracture; Plate osteosynthesis; Shoulder

1. INTRODUCTION

Isolated displaced greater tuberosity fractures are less common and only account for about 2% of proximal humerus fractures encountered in clinical practice.^{1,2} It typically occurs as a result of impaction, shearing, or avulsion mechanisms.³ Impaction fractures usually occur from a direct fall onto the shoulder or with hyperabduction and compression of the greater tuberosity against the acromion. In contrast, shearing and avulsion fractures can occur in association with glenohumeral dislocation as the tuberosity shears across the glenoid rim or with forceful contraction of the rotator cuff.⁴ The treatment varies according to the fracture displacement, age of patients, bone quality, and preexisting comorbidity. Open reduction with internal fixation is generally suggested to treat displaced fractures in young patients, and conservative treatment is generally recommended for undisplaced or minimally displaced fractures of any age.⁵⁻⁷ The implants for fixation in such fractures include screws and plate.⁸⁻¹⁴ To date, no reports had evaluated the efficacy of open reduction and internal fixation in treatment of displaced greater

tuberosity fracture in the elderly patients. This study aimed to evaluate the clinical and radiographic outcomes of open reduction and internal fixation with locking plate for acute isolated displaced greater tuberosity fractures of humerus in elder adults (aged >60 years).

2. METHODS

Between 2009 and 2015, 32 consecutive elderly patients (aged between 60 and 88 years) of acute unilaterally isolated displaced greater tuberosity fractures of humerus (Fracture type: AO 11-A1; Neer's classification: 2-part)¹⁵ without other associated injury were managed with open reduction and internal fixation in our institute. All fractures were confirmed by using radiographs (AP and lateral views). The surgical approach for open treatment of displaced greater tuberosity fractures through deltopectoral approach allows access to the greater tuberosity without compromising the origin of the deltoid muscle. Nevertheless, the deltopectoral approach does offer limited access to the posterior aspect of the rotator cuff. However, this limitation can be overcome by placing traction sutures into the rotator cuff progressively from the anterior aspect of the supraspinatus tendon to the posterior aspect of the infraspinatus tendon. In addition, a small skin hook can be used to reach behind the humerus and pull the greater tuberosity from a retracted posterior medial position. During the operation, the displaced fragments from the subacromial space were retrieved to reduce anatomically and fixed rigidly by locking plate (Zimmer, Warsaw) by the senior authors (Y.P. Su and F.Y. Chiu).

Thirty-two patients were enrolled in the initial evaluation of this retrospective study. Patients with history of surgery of the same shoulder (two patients), associated shoulder dislocation

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(one patients), the same upper arm fracture due to repeated trauma (one patient), and lost follow up due to various causes (three patients) were excluded in final evaluation. The remaining 25 patients (7 men and 18 women, 14 right and 11 left, mean age of 75 years [range 60-88 years]) were included in the final evaluation. No history of rotator cuff disease, immunological disease, or use of steroid was noted in all these 25 patients. The cause of injury of these 25 patients was falling down. All the operations were performed within 5 days after injury. The patients were allowed to start active and passive range of motion exercise immediately after surgery. The hospitalized days were 3.7 days on average (range 2-5 days), and after discharge, each patient was followed once in every 2 weeks in the first month and once in every month thereafter. Additional visits were arranged if implicated.

Radiographic findings according to AP and lateral views were used to calculate the distance of the displaced fragments. Vertical distance is referred as the distance between the upper surface of the humeral head and the upper margin of the displaced fragment, and horizontal distance is referred as the distance between the outer surface of the humeral head and the outer margin of the displaced main fragment.¹⁰ Anterior and cranial displacements are given as positive values, and posterior and caudal displacements as negative values.

General function of the shoulder and rotator cuff were determined clinically by standard tests, with measurements of motion using a goniometer. Impingement syndrome was diagnosed by history and physical examination using Neer's clinical sign.¹⁶ For the objective assessment, including ASES,¹⁷ constant score¹⁸ and VAS¹⁹ were done at every visit and once in every 6 months after union of the fracture. Each patient had one special chart with detailed records of their personal data, smoking and drinking habits, injury mechanism, type and classification of the fracture,²⁰ body mass index (BMI), ASA class (rating of the American Society of Anesthesiologists), course of the management (including timing of treatment, course of operation, operation time, length of hospital stay, early complication, late complication, and management of complication), condition and course of the fracture healing, radiographic findings, and functional recovery. The follow-up period was 50.8 months on an average (range 22-80 months)

All numeric parameters were analyzed statistically by using *t* test and Mann-Whitney rank sum test; χ^2 test and Fisher's Exact Test were used to analyze categorical data, wherein the *p*-value to be considered statistically significant was set at <0.05 before analysis. To determine whether these tests were appropriately powered, power analysis was also performed with the alpha set at 0.05. Statistical analyses were performed with the SigmaStat software package, version 2.0 (Jandel Corp., San Rafael, CA).

3. RESULTS

For the 25 patients included in the final follow-up, the mean age at the index operation was 75 years (range 60-88 years), the average BMI was 29 (range 26.4-32.3), and the average hospital stay was 3.7 days (range 2-5 days).

Radiographs on the day of injury showed that 17 patients had a greater tuberosity fracture consisting of one fragment, whereas in eight patients the fractured greater tuberosity consisted of two or more fragments. The average vertical and horizontal distances were 4.06 mm (range 0-9) and 0.815 mm (range 10-8), respectively. All lesions healed without a measurable loss of reduction after the surgery and united smoothly with the average union time of 14 weeks (range 10-18 weeks).

The average of preoperative Visual Analogue Scale (VAS) was 6.2 (range 4-8), ASES was 30.4 (range 13-45), and Constant score was 30.4 (range 20-45). At the last follow-up, the mean VAS was 1.3 (range 0-2.5), the mean ASES score was 90.1 (range 72-100), and the mean Constant score was 90.3 (range 80-100). There were statistically significant differences between preoperative and final follow-up in VAS, ASES, and Constant score.

The excellent-and-good rate was 100% according to Constant score with excellent result (86-100) in 17 (68%) patients, good result (71-85) in 8 (32%), moderate (56-70) and poor (0-55) in 0 patients.

There was no shoulder impingement, adhesive capsulitis of the affective shoulder, or other complications occurred (Fig. 1). No hardware removal was needed and done in this series. At the last follow-up, the average range of motion to the affected side of shoulder were as follows: 155° of forward elevation (range 130°-170°), 153.8° of abduction (range 130°-170°), and 36.9° of external rotation (range 25°-60°).

4. DISCUSSION

Traditionally, there were several systems of classification for the greater tuberosity fracture and the most popular one was Neer's classification.²¹ According to Neer's classification, the greater tuberosity was classified as two-part if the fragment is displaced more than 1 cm. Although Neer's values were long used as the standard for clinical decision-making, recent improvement in osteosynthetic techniques have encouraged a trend toward operative treatment. Mildly displaced fractures are now considered as an indication for surgery more commonly than before. Although it is often stated in the literature that 60% to 80% of nondisplaced or mildly displaced fractures can be treated conservatively,⁶ certainly most such fractures are now treated surgically, and the threshold values for a surgical indication are now being set lower than in the past.²⁰ Recently, surgical treatment of isolated greater tuberosity was indicated if displaced fracture was >5 mm.^{22,23}

Multiple surgical techniques have been introduced to fix this type of fracture, including arthroscopic reduction and internal fixation,²⁴ transosseous heavy suture fixation, tension band wire, screws,²⁵ and plate.⁹

Braunstein et al.²⁶ reported that the biomechanical strength of various fixation constructs, tension band wiring, or cancellous screws provided strong fixation for isolated fractures of the greater tuberosity. However, subacromial impingement was resulted from screws with washers. The larger the implant the greater is the chance of impingement.²⁷⁻²⁹ Besides, screw washer constructs may cause failure through the fracture line, or a stress riser 1 to 2 cm above the cephalad-most screw, resulting in bone cutouts in older, osteoporotic patients.²⁶

Transosseous sutures are another choice to be used for isolated proximal humerus fractures. This allows fragment fixation between the tendon and bone junction, reduces the effect of hardware irritation, and generally does not necessitate removal. However, the procedure depends on the size and comminution of the tuberosity fragment.²²

Dimakopoulos et al.²⁷ evaluated the long-term follow-up studies and the results showed satisfactory clinical and radiographic outcomes with transosseous sutures. In their series, all 165 patients with a proximal humeral fracture were treated with transosseous suture fixation. Bony union occurred within 4 months in all patients except the two patients with 3-part fractures, and 155 patients had excellent or very good fracture reduction. At the final evaluation, the mean Constant Score was 91 points, the mean Constant Score as a percentage of the score for the unaffected shoulder, unadjusted for age and gender, was 94%.

Schoffl et al.⁹ treated the patients with displaced fractures of the greater tuberosity in a study of 10 patients (age mean 45.6 years, range 29-68). The patients underwent open reduction and internal fixation using "Bamberg" plate hand-made from a calcaneus plate. All fractures healed smoothly without complication. There was no secondary loss of reduction occurred. The mean Constant score was 94.2 (range 91-98), at least 6 months follow up showed the excellent functional results in all cases.

Flatow et al.¹⁴ performed a study of 12 patients who underwent ORIF of a 2-part displaced fracture of the greater tuberosity of the proximal part of the humerus. The results showed half

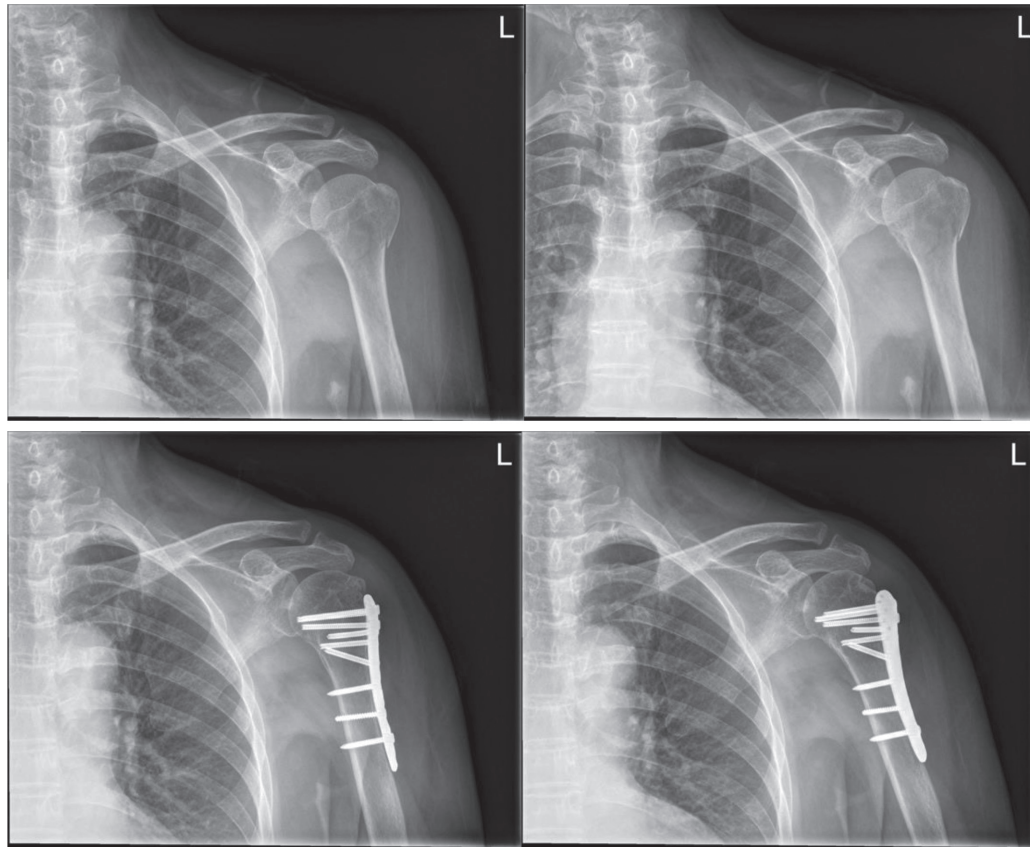


Fig. 1 Case presentation representing a 66-year-old male patient with left proximal humerus, isolated greater tuberosity fracture. A, B, Internal and external rotation view of the shoulder radiographs at the time of his surgery. C, D, Radiographs of the shoulder at the time of final follow-up.

the patients had an excellent outcome, and the other half had a good outcome with active elevation averaging 170° .

Besides, Ji et al.¹¹ stated in a series of 16 patients with isolated displaced proximal humerus fractures treated with arthroscopic fixation, mean postoperative American Shoulder and Elbow Surgeons (ASES) score was 88 and mean forward elevation was 148.7° at the last follow-up.

This study investigated the effect of open reduction and internal fixation with locking plate for acute displaced fractures of greater tuberosity of proximal humerus in elder adults. We treated the patients using locking plate for fixation. For the elderly patients with osteoporotic bone, locking plate could provide rigid fixation and prevent implant failure. In our study, all the fractures achieved anatomical reduction and united smoothly with no complications. The patients got good-to-excellent functional results, compared to those reports in young patients.^{9,30,31}

Some of the limitations of this study are its retrospective nature and small number of patients, and thus, some bias of evaluation could not be avoided completely. Another limitation is that there is no comparable treatment group in our study. We knew patients who suffered from greater tuberosity fracture had much pain to perform or limit their daily activities, so they had to undergo early rehabilitation program immediately after surgery to prevent further stiff shoulder. Our results were evident and helpful for the surgeons' reference. In conclusion, open reduction and internal fixation with locking plate is an effective treatment for acute displaced greater tuberosity fractures of humerus in elder adults, with early and better functional recovery.

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