CLINICAL ARTICLE

Arthroscopic Management of Glenoid and Greater Tuberosity Bipolar Fractures

Qing Zhang, MM, Ming Xiang, MD, Yi-ping Li, MM, Jin-song Yang, MM

Department of Upper Limb, Sichuan Provincial Orthpaedics Hospital, Chengdu, China

Objective: To report the clinical and radiological outcomes of arthroscopically assisted surgery for combination of glenoid and greater tuberosity fractures after traumatic shoulder dislocation.

Methods: From December 2013 to December 2018, patients with concomitant fracture of the greater tuberosity and glenoid who underwent arthroscopically assisted surgery were retrospectively reviewed. Fifteen patients were included. Preoperative computed tomography (CT) scans with 3D reconstruction were performed to evaluate the fracture configuration and associated fractures. All patients underwent arthroscopically assisted surgery under general anesthesia with brachial plexus anesthesia in the lateral position. Under the arthroscopic approach, a comprehensive inspection of the joints was firstly conducted to examine the injury of bones and other tissues. With arthroscopy support, closed reduction and internal fixation of both fractures were performed with suture anchors, with or without additional cannulated screws. At the same time, other injuries were also repaired under the arthroscope. Patients were followed up (6 weeks, 8 weeks, 3 months, 6 months, 1 year after surgery) regularly for at least 1 year. At the follow-up, clinical outcomes (Constant score, ASES score, range of motion, and VAS score) and radiological outcomes were analyzed.

Results: Of the 15 patients, there are seven cases of men, eight cases of women; aged 22–66 years, with an average age of 48 years; left shoulder for five cases, 10 cases of the right shoulder. The injury mechanisms were: a simple fall (n = 9), an epileptic seizure (n = 1), a high fall injury (n = 2), and a traffic accident (n = 3). Of the 15 cases of glenoid fracture, 11 cases were type Ia and four cases were type II according to the Ideberg Classification System. The mean size of the glenoid fracture fragment was 28.4% (range, 8.7%–47.2%). According to the Mutch classification system, the fractures of the greater tuberosity were divided into: five cases of avulsion, one case of compression, and nine cases of split. Average time of follow-up was 38.2 months (range, 12–70 months), and one case was lost to follow-up. With fractures healing well, almost all patients had a good joint function. At the final follow-up, mean anterior flexion was 157°; mean external rotation was 40°; mean internal rotation was T_{11} level; the mean Constant–Murley score was 94.6 points (range, 70–100 points); the mean ASES score was 94.6 points (range, 79–100 points); and the mean VAS score was 0.4 points (range, 0–2 points). No recurrent instability or re-dislocation occurred. No patient had revision surgery.

Conclusion: Arthroscopic management of glenoid and greater tuberosity bipolar fractures was useful and effective with minimal injury, and it achieved satisfactory clinical and radiological outcomes at a mean follow-up time of more than 3 years.

Key words: Arthroscopy; Glenoid fracture; Greater tuberosity fracture; Shoulder; Surgical treatment

Introduction

With an overall incidence rate between 24 and 56 per 100000 person-years, the glenohumeral joint is reported to be the joint most prone to dislocation of all joints[1, 2]. Depending on the mechanism and severity of injury, a range of fractures, such as greater tuberosity fracture, coracoid fracture, and glenoid fracture, will occur[3]. Fractures of the anterior glenoid rim (5%–56%) and Hill–Sachs lesions

Address for correspondence Ming Xiang, MD, Department of Upper Limb, Sichuan Provincial Orthpaedics Hospital, Chengdu, Sichuan, China 610041. Tel: 15928080830; Fax: 02887029563; Email: josceph_xm@sina.com

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(65%–71%) are reported to be the most common pathologies[4, 5]. Displaced glenoid rim fractures can cause incongruity of the glenoid fossa, which will lead to shoulder instability as well as degenerative disease of the joint[6]. It is widely accepted that isolated glenoid fracture with a large fragment, or displacement more than 10 mm, or associated instability, should be operatively treated[7].

Approximately 30% of shoulder dislocations are reported to be associated with isolated fracture of the greater tuberosity[8]. Most isolated greater tuberosity fractures are minimally or non-displaced and can be successfully treated non-surgically[9]. A significant proportion of displaced greater tuberosity fractures should be surgically treated in case of tuberosity migration, which may compromise shoulder function. It is widely accepted that surgery should be performed if the displacement >5 mm, or even >3 mm in active patients involved in overhead activities. Most greater tuberosity fractures are associated with rotator cuff tears[10].

Concomitant fracture of glenoid and greater tuberosity after acute shoulder dislocation is a rare event. Only a few cases of this injury pattern have been reported in the literatures, and their specific therapy in the literatures is mostly described as isolated cases. Glenoid fracture combined with displaced greater tuberosity fracture after shoulder anterior dislocation should be surgically treated to avoid malunion, instability, and secondary arthritis. Several treatment options have been reported to manage these articular fractures until now, including conservative treatment, open reduction and internal fixation, and arthroscopic fixation. Considering the scarcity of this injury pattern, only a few case reports or case series[3, 6, 11–13] could be found. Up to now, there is no consensus on which treatment option is preferable.

Open reduction and internal fixation for both glenoid and tuberosity fractures have been reported in some cases. However, the extensive dissection required to expose fracture fragments, especially for glenoid fractures, may result in postoperative stiffness. As arthroscopic techniques improve, the indications for arthroscopic treatment of articular fractures become broader. Many articles have reported arthroscopically assisted fixation techniques for glenoid fractures or greater tuberosity fractures. For anterior glenoid rim fractures, fixation of arthroscopically assisted techniques with suture anchors placing at the glenoid rim augmentation passed around or through the fragment have been described[14]. A double row technique and a suture bridge technique were reported to increase the primary stability of arthroscopic fixation[15], and they achieved excellent results. For greater tuberosity fractures, the arthroscopically assisted surgery has also been described mainly with suture anchor fixation or screw fixation[16], and the technique for arthroscopic internal reduction and fixation of greater tuberosity fractures using suture-bridge technique has also been described[17]. Under arthroscopic procedure, we can easily evaluate the displacement of fractures and stability of the rotator cuff. To our knowledge, there is no case series of this injury pattern that was reported to be treated by arthroscopic technique.

We retrospectively collected data on patients of this injury pattern who were treated surgically. This study presented a series of 15 cases with concomitant fracture of the greater tuberosity and glenoid after traumatic anterior shoulder dislocation, and introduced the treatment of this injury in detail. In this report, all patients underwent arthroscopically assisted surgery for both the glenoid fracture and greater tuberosity fracture with suture anchors, with or without additional screws. Few reports have reported that both fractures were repaired using arthroscopic techniques.

The purpose of the present study was: (i) to describe this injury pattern of cause, classification, associated injuries; (ii) to report arthroscopic management of this injury pattern; and (iii) to determine the clinical and radiological outcomes of this injury pattern with a mean follow-up time of more than 3 years. We hypothesized that arthroscopic management of glenoid and greater tuberosity bipolar fractures could provide rigid fixation of the fractures with low rates of complications, achieving satisfactory clinical and radiologic outcomes.

Methods

Patients and Materials

From December 2013 to December 2018, 15 cases with concomitant fracture of the greater tuberosity and glenoid were retrospectively reviewed. All patients underwent arthroscopically assisted surgery.

This study was a retrospective study, and was approved by the ethics committee of the local hospital.

Inclusion Criteria

The patients were eligible for inclusion in this study if they: (i) had a history of acute shoulder anterior dislocation with concomitant fractures of the greater tuberosity and glenoid; (ii) underwent shoulder arthroscopically assisted surgery for both the glenoid and greater tuberosity fracture in our institution; (iii) had a follow-up time over 1 year; and (iv) were retrospectively recruited.

Exclusion Criteria

The patients were excluded from this study if they: (i) had non-surgical treatment; (ii) treated with open reduction and internal fixation; (iii) either the glenoid fracture or the greater tuberosity fracture had not been fixed.

A total of 15 patients met the inclusion criteria in our hospital. Preoperative shoulder underwent anteroposterior and supraspinatus outlet views. For further evaluation of the fracture configuration and associated fractures, computed tomography (CT) scans, with three-dimensional (3D) reconstruction was also performed preoperatively in all patients (Fig. 1A–C). The displacement of the fragments was measured on CT scans (Fig. 2A–C).

Fig. 1 A 47-year-old female of this injury pattern. (A) Primary X-ray showing combination of glenoid and greater tuberosity fractures with traumatic shoulder dislocation. (B) Pre-operative coronal 2D CT image showing displacement of the glenoid and greater tuberosity fracture fragments. (C) Pre-operative 3D CT scan of the patient with marked displacement of the glenoid fracture fragment.

Surgical Technique

Anesthesia and Position

All patients underwent arthroscopically assisted surgery under general anesthesia with brachial plexus anesthesia. The patient was placed in the lateral position with the affected shoulder joint tracted at 40° abduction and 20° anterior flexion.

Establishing Portals

At first, the posterior portal was established to perform an intra-articular examination of the fractures and associated injuries. Anterior portals, antero-superior portal, and anterolateral portal were successively established *via* the outside-in technique. Hematoma of the fractures were debrided with a shaver, after that the fracture configuration and fracture margin were confirmed (Fig. 3A, D).

Fixation of Glenoid Fractures

In general, the glenoid fracture was fixed prior to the greater tuberosity fracture. Usually, three or four suture anchors were introduced to the scapula to fix the glenoid fracture if the fracture fragment was not too big. Three suture anchors were placed into the anterior-inferior rim of the glenoid surface, with anchors at 5, 4, and 3 o'clock respectively. A suture anchor was often introduced medially from the fracture through the neck of the scapula. Then, a suture hook loaded with a polydioxanone (PDS) was passed through the inferior glenohumeral ligament and around fracture fragment (Fig. 3B, C). If the fracture fragment of glenoid was too big to be fixed only with suture anchors, a 3.0- or 4.0-mm cannulated screw would be implanted instead of a suture anchor introduced through the neck of the scapula. The suture lines of the anchors were tensioned before final impaction of the screw to allow a temporary fixation, so that a firm compression of the glenoid fragment between each anchor could be achieved.

Fixation of Greater Tuberosity Fractures

After fixation of the glenoid fracture fragment, the arthroscope was introduced in the subacromial space. With subacromial synovium debrided, the rotator cuff and the fracture pattern were inspected. Two lateral portals, as in rotator cuff surgery, may reveal the extension of the fracture clearly. Then, the arthroscope was introduced in the glenohumeral space. Two suture anchors were often placed at the articular margin of the humeral head, close to the rotator cuff insertions through rotator cuff attached to the greater tuberosity fragments (Fig. 3E). Similar to conventional transtendon repair for rotator cuff tears, PDS was passed through an 18-gauge needle, and then all eight suture lines were retrieved through the rotator cuff. The

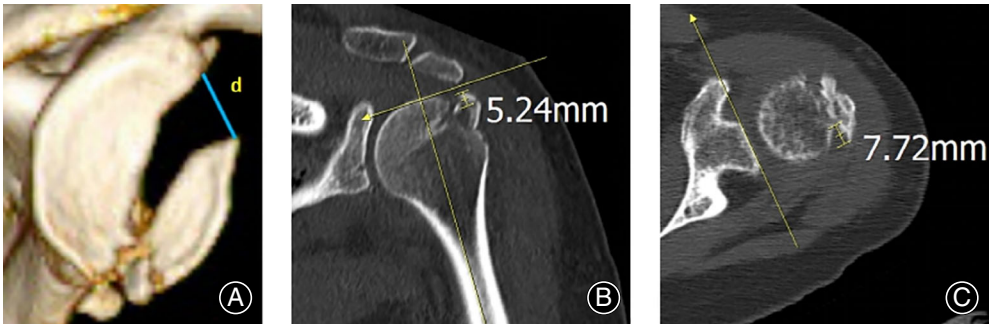

Fig. 2 Method to measure the displacement of fractures. (A) The displacement of glenoid fracture was measured in en face view. (B) Superior or posterior displacement of the fracture fragment of greater tuberosity was measured on coronal CT images. (C) Axial CT scan showed the anterior or posterior displacement of the greater tuberosity fracture.

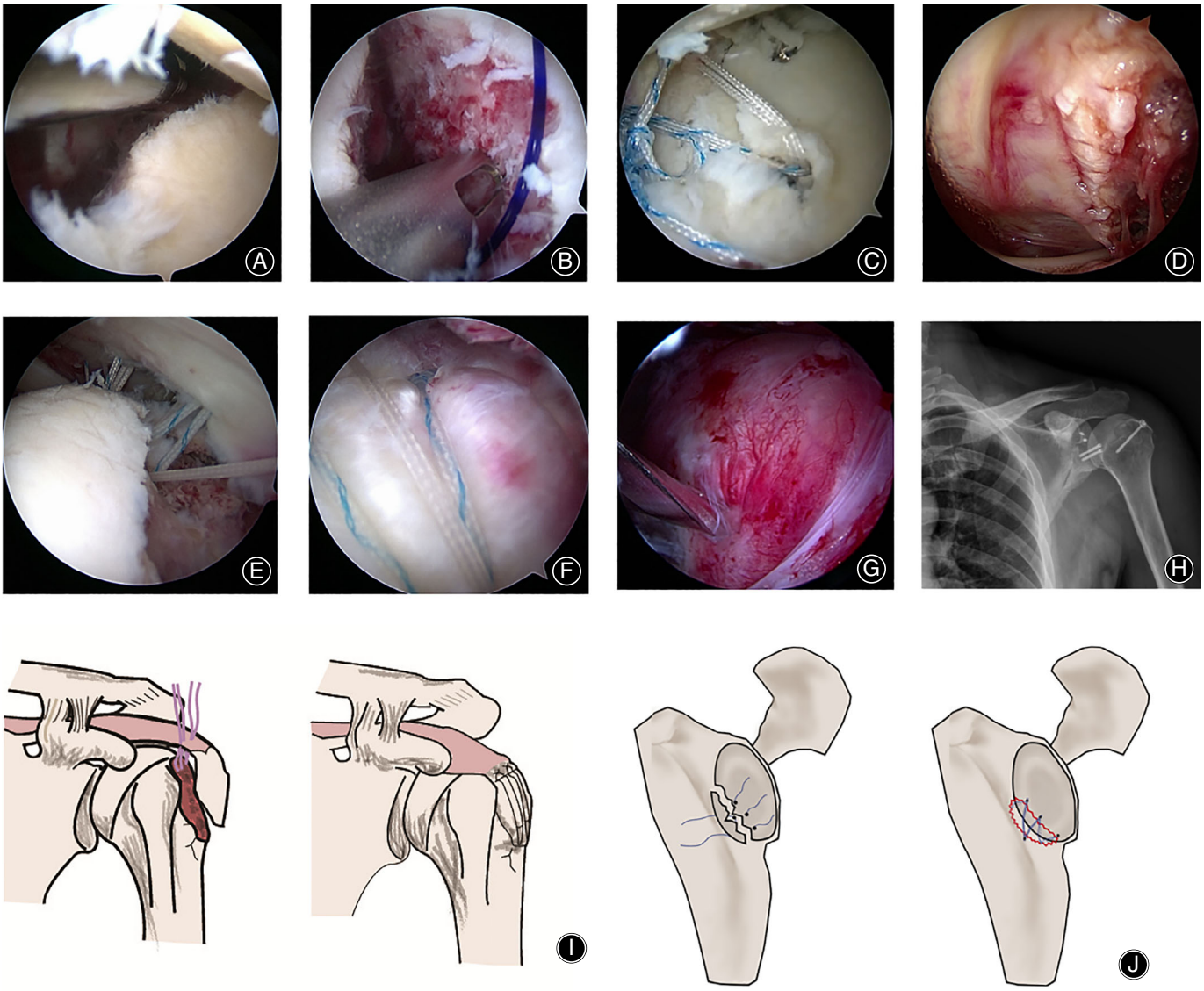

Fig. 3 Main steps of surgery. (A) Arthroscopic photo of displaced glenoid fracture; (B, C) Arthroscopic fixation of the glenoid fracture with 4 suture anchors was performed of which an anchor was inserted in the neck of scapula, another 3 in the articular side of the glenoid. (D) Arthroscopic photo of displaced greater tuberosity fracture with supraspinatus invovled; (E) The site to insert the suture anchors in the medial row; (F) Arthroscopic view of the subacromial space showing the well-reduced fracture fragment; (G,H) Cannulated screws were used when needed. (I,J) Schematic drawings of the arthroscopic repair of the greater tuberosity and glenoid fracture.

greater tuberosity fracture fragment was reduced using the medial row repair and sutures from the medial row were pulled over the fragment. The suture lines were tensioned and secured laterally with knotless anchors placed in the vertical portion of the tuberosity, distal to the fracture (Fig. 3F). Depending on the size of the greater tuberosity fracture fragment, additional 3.0- or 4.0-mm cannulated screws will be inserted (Fig. 3G, H). Lastly, we checked the reduction status of the fractures and screw placement with an intraoperative portable radiograph. Schematic drawings of the arthroscopic suture repair of fractures are shown (Fig. 3I, J).

Postoperative Management

After surgery, the affected shoulder was immobilized in a sling for 8 weeks. On the first postoperative day, elbow, wrist, and finger exercises were allowed. Passive movement exercises of shoulder were allowed 6 weeks after the surgery. Eight weeks after the surgery, active movement excercises

were allowed. Heavy manual work and sports were allowed after 12 weeks.

Standard radiographs in two planes and 3D CT scans were performed for all patients 1 day after surgery to check reduction status (Fig. 4A–C).

Postoperative Evaluations

At every follow-up, the clinical outcomes were measured using the Constant score and the American Society of Shoulder and Elbow Surgery (ASES) shoulder joint score. The Visual Analog Scale (VAS) was used to quantify pain. Range of motion in active and passive anterior flexion, external rotation, and internal rotation was examined. All patients underwent radiographic examination to assess bony union and position of the reduction. Patients were followed up (6 weeks, 8 weeks, 3 months, 6 months, 1 year, 2 years after surgery) regularly in the outpatient clinic.

Visual Analog Scale for Pain

The VAS is the most commonly used questionnaire for quantification of pain. It is a continuous scale comprised of a horizontal or vertical line, usually 10 cm in length. For pain intensity, the scale is most commonly anchored by "no pain" (score of 0) and "pain as bad as it could be" (score of 10). A score of 0 is considered as no pain, 1–3 mild pain, 4–6 moderate pain, and 7–10 severe pain[18].

Constant Score

The Constant score is the most commonly used method for evaluation of rotator cuff tears. The 100-point scoring scale takes into account both subjective and objective measurements: pain (0–15, with 0 being maximal pain and 15 being no pain); activities of daily living (4 × (0–5) = 0–20, 0 worst and 5 best for each item); mobility (4 × (0–10) = 0–40, active, pain- free range of elevation: + 2 points per 30°, where 0 is worst and 10 is best for each item; position of hand: 0 worst to 10 best); and strength (0–25, 1 point per 0.5 kg, maximum 25 points). A total score of 0 is worst and 100 is best function[19].

American Society of Shoulder and Elbow Surgery (ASES) Shoulder Joint Score

The ASES score was developed by the American Shoulder and Elbow Surgeons society, including a patient self-assessment section (patient ASES [pASES]) and a section completed by the examiner (clinical ASES [cASES]). The cASES section includes a physical examination and documentation of range of motion, strength and instability, and demonstration of specific physical signs. No score is derived for this section. The pASES has 11 items that can be used to generate a score. These are divided into two areas: pain (1 item) and function (10 items). The severity of pain is scored by VAS[20].

Result

Follow-Up

Fifteen patients were included in this case series. Of the 15 patients, there were seven cases of men, eight cases of women; aged 22–66 years, with an average age of 48. One case was lost to follow-up, 14 cases had complete follow-up. The 14 patients were followed up for 12–70 months, with an average time of 38.2 months.

General Results

The injury mechanisms were: a simple fall (n = 9), a epileptic seizure (n = 1), a high fall injury (n = 2), and a traffic accident (n = 3). As to the injury side, right side accounted for 10 cases (66.7%) and left side accounted for five cases (33.3%).

Associated Lesions

One case was found to have combined undisplaced fracture of body of scapula, which was treated non-surgically. One case was found to have combined proximal humerus fracture of contralateral side, which was conservatively treated. A type II SLAP lesion was found in one case, for which repair was performed with an anchor. Two cases had associated coracoid fracture, of which the displaced fracture was treated surgically, and the other undisplaced one was treated non-surgically. Three cases had associated partial long head of

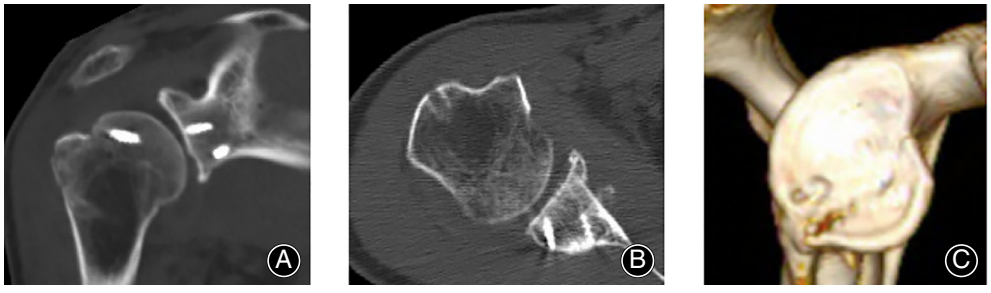

Fig. 4 Post-operative CT scans showing the well-reduced fracture fragment. (A) Post-operative coronal 2D CT image showing the well-reduced fracture fragment of greater tuberosity and glenoid. (B) Post-operative axial 2D CT image showing well-maintained reduction of the fracture fragments. (C) Post-operative 3D CT image of en face view showing reduction of the glenoid fracture.

biceps tendon tear, for which long head of biceps tenodesis was performed. In one case, a subscapularis partial tear was found, which was repaired. Of the 15 patients, 13 patients were found to have articular side partial thickness rotator cuff tears and these tears with greater tuberosity fracture were effectively repaired using arthroscopy.

Clinical Outcomes

Range of Motion
At the last follow-up after the surgery, ROM of the shoulder was: anterior flexion, 157° ± 18.0° (range, 110°–170°); external rotation at the side, 40° ± 8.2° (range, 10°–60°); and internal rotation at the back, T_{11} level (range, L_3–T_6 level) (Fig. 5).

Visual Analog Scale for Pain
The average VAS score was 0.4 ± 0.5 points (range, 0–2 points), indicating that the patients suffered little pain in their daily life. Actually, eight of the 14 patients scored 0, which meant they suffered no pain at all.

Constant Score
At the last follow-up after the surgery, clinical assessment showed that the average Constant score was 94.6 ± 5.5 points (range, 70–100 points).

American Society of Shoulder and Elbow Surgery (ASES) Shoulder Joint Score
At the last follow-up after the surgery, the average ASES score was 94.6 ± 6.5 points (range, 79–100 points).

Radiographic Outcomes

Classification of Fractures
According to the Ideberg Classification System, of the 15 cases of glenoid fractures, 11 cases were type Ia and four cases were type II. The mean size of the glenoid fracture fragment was 28.4% (range, 8.7%–47.2%). According to the Mutch classification system, the fractures of the greater tuberosity were divided into: five cases of avulsion, one case of compression, and nine cases of split.

Preoperative Displacement of Fractures
We evaluated the amount of displacement of the fracture fragments on CT images. The mean preoperative displacement of glenoid was 8.39 mm (range, 3–20 mm). On the preoperative coronal plane of CT scans, the greater tuberosity displaced superiorly in eight cases and inferiorly in seven cases, with a mean displacement of 7.45 mm (range, 3–14 mm). On the axial plane, the greater tuberosity displaced posteriorly in 11 cases, anteriorly in two cases, and not displaced in two cases, with the mean displacement of 6.35 mm (range, 0–10 mm).

Postoperative Displacement of Fractures
On postoperative CT scans, residual displacement of the glenoid fracture fragment was 0.78 mm, and superior or inferior displacement of the greater tuberosity fracture fragment was 0.83 mm, and posterior or anterior displacement of the greater tuberosity fracture fragment was 0.61 mm. Six cases were found to have displacement <3 mm of the greater tuberosity or glenoid fracture after surgery, whose clinical outcomes were still satisfactory. Longer time of follow-up is recommended to evaluate the degeneration status of the joint. Radiological union was obtained in all patients within 8 to 14 weeks after surgery. Radiological results showed consolidation of the glenoid and greater tuberosity fractures (Fig. 6).

Implants Evaluation
Concomitant fractures of the greater tuberosity and glenoid were fixed only by suture anchors in seven cases, and with extra cannulated screws in eight cases. All glenoid fractures underwent anchors fixation, and the mean number of anchors was 3.1 (range, 1–4 anchors). Ten cases of greater tuberosity fractures underwent anchors fixation, and the mean number of anchors was two (range, 1–4 anchors).

Fig. 5 A 22-year-old female with concomitant glenoid and greater tuberosity bipolar fractures. (A-C) range of motion (ROM) of right shoulder at 15 months after surgery.

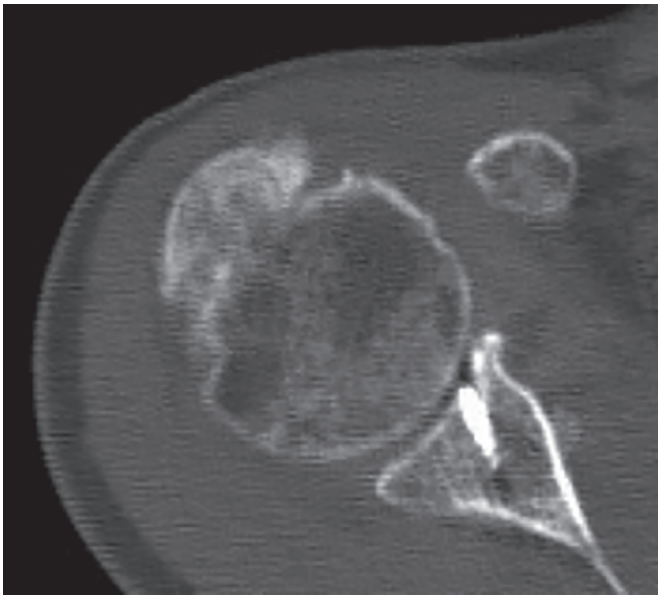

Fig. 6 A patient with concomitant fractures of the greater tuberosity and glenoid. 2 months after surgery, follow-up CT scan showed good healing status of the fractures.

Three cases of glenoid fractures underwent cannulated screw fixation, and the mean number of cannulated screws was 1.3 (range, 1–2 screws). Eight cases of greater tuberosity fractures underwent cannulated screws fixation, and the mean number of cannulated screws was 2.1 (range, 1–3 screws). No implant problems such as protrusion, malposition, migration, and pulling out were found in any case.

Complications

All incisions healed well, and no infections, nerve injuries, or fractures occurred. No patient reported re-dislocation or severe shoulder instability. No patient had revision surgery.

Discussion

Treatment Options

We present the clinical and radiological outcomes of a series of 15 patients with concomitant fracture of the greater tuberosity and glenoid rim after acute traumatic anterior shoulder dislocation. Only a few reports with this rare injury pattern have been published until now. The first case was reported in 2001[11] which was treated non-surgically. Pujol described the case of the first patient to be treated by arthroscopic technique with bioabsorbable suture anchors[12]. Yee-Suk Kim[13] presented a case where the fracture was repaired using arthroscopic techniques and cannulated screws for the first time. Jehan presented a case which was[6] managed with open reduction and internal fixation using two surgical approaches. Plachel[3] described a series of six cases with concomitant fracture of the glenoid rim, greater tuberosity and coracoid process, for which glenoid fixation was performed on all six patients, greater tuberosity fixation on four patients, and coracoid process fixation on three patients with open reduction and internal fixation or arthroscopic procedure, respectively. Revision surgery was performed in two patients due to loss of reduction. In a prospective, observational cohort study of 538 consecutive patients with a first-time anterior dislocation of the shoulder, 11 (2%) cases with concomitant glenoid and greater tuberosity fractures were described, which were conservatively treated in the first 6 weeks[21]. Seven of the 11 cases showed re-dislocaction and were treated with subsequent open reduction and internal fixation. In contrast to these data, no patient reported re-dislocation or severe shoulder instability in our group.

The management of glenoid and greater tuberosity bipolar fractures can be challenging. Several treatment options have been reported to manage these articular fractures, including conservative treatment, open reduction and internal fixation, percutaneous screw fixation, and arthroscopic fixation. In the past, glenoid rim fracture has been mostly treated non-surgically. Nowadays, conservative treatment may not be chosen for these displaced articular fractures due to malunion and instability which may result in osteoarthritis. In general, decisions about conservative or surgical treatment depend on such factors as the number of dislocations, the size of the fragment, the age of the patient, general health, and individual needs. However, in all cases, the glenoid rim fixation should be considered to prevent shoulder instability. All of our patients underwent surgical treatment to ensure long-term joint stability and prevent secondary osteoarthritis.

Open surgery requires an extensive approach, for both fractures, with the risk of more damage to the soft tissues. Especially, it will be extremely difficult to expose the glenoid fracture fragment without damage to the subscapularis. In Jehan's[6] case, two approaches were used to deal with the fractures. In this report, deltopectoral approach was used to fix glenoid fracture and McKenzie's approach was used to fix the greater tuberosity fracture. Besides, the coracoid was osteotomized for better exposure of the glenoid. This is further damaging to soft tissues and may contribute to joint stiffness.

Arthroscopically Assited Technique for This Pattern of Injury

As compared with open reduction and internal fixation, arthroscopy benefits from a low complication rate, tissue injury, and exposure to radiation[16]. Arthroscopy is also a useful diagnostic tool to avoid underestimating associated injuries. The arthroscopic technique allows close inspection and management of concomitant intra-articular pathology, as well as confirmation of anatomic reduction. Furthermore, the arthroscopic technique avoids the morbidity and complexity of an open deltopectoral incision with subscapularis detachment or splitting. In particular, with arthroscopy assisted technique, no subscapularis peel was needed for

exposure when dealing with glenoid fracture, which is less damaging to the subscapularis.

The mean follow-up period in our series was 38.2 months (range, 12–70 months). The mean Constant–Murley Score was 94.6 points (range, 70–100 points); the mean ASES score was 94.6 points (range, 79–100 points); and the mean VAS score was 0.4 points (range, 0–2 points). In this report,we have proven that utilizing suture anchors with or without additional screws for a reduction and fixation of the glenoid and greater tuberosity fracture in an all-arthroscopic fashion is an effective technique.The advantages of arthroscopic reduction of both glenoid fractures and greater tuberosity fractures as compared with open surgery are direct fracture visualization, simultaneous management of labral pathology or cuff injury, and reduced risks of infection and neurovascular injury[12]. However, the arthroscopic technique may take more time during surgery and is skill-demanding.

Method of Fixation

The method of fixation depended on the size of the fracture fragment. For small fracture fragments, suture anchor fixation is proven to be secure enough for bone healing in our report, because the fragments are often attached to the labrum or rotator cuff. It is particularly suitable for comminuted fractures in which the cannulated screw fixation is difficult. Nevertheless, in our view, for large fracture fragments extra cannulated screws are recommended for better fixation. Cannulated screw allows firm compressive fixation of the fragments. This decision should only be made after assessing the size and quality of fracture fragment in consideration of imaging and intraoperative view, as the imaging sometimes cannot precisely predict the degree of comminution. However, before insertion of cannulated screws, indirect reduction with suture anchor fixation may be needed because the manipulation of a large fragment is not straightforward under arthroscopic procedure.

The question then arises, which one of these two fractures should be fixed first? Generally, the glenoid fracture was first to be fixed and then the greater tuberosity fracture. This depended on whether the exposure of inferior-anterior glenoid rim needed excessive tissue retraction and manipulation. If the glenoid fracture was fixed secondly, it will be much harder to expose the glenoid fracture, and there was risk of losing reduction of the greater tuberosity fracture fixation.

Limitations of the Study

This is a retrospective study, which has its inherent limitations. Besides, the sample size is relatively small and follow-up periods are relatively short. In fact, considering the scarcity of the injury pattern, this article presents the largest number with longest follow-up of glenoid and greater tuberosity bipolar fractures treated by arthroscopically assisted technique.

Conclusion

Arthroscopically assisted technique in the treatment of glenoid and greater tuberosity bipolar fractures was useful and effective in reduction and fixation of fractures with minimal injury. It achieved satisfactory clinical and radiological outcomes at an average follow-up period of over 3 years.

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