

Arthroscopic Treatment of Symptomatic Shoulders with Minimally Displaced Greater Tuberosity Fracture

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— Abstract —

Twenty-three patients with chronic shoulder pain beyond 6 months after the fracture of the greater tuberosity underwent arthroscopic treatment and were retrospectively assessed after an average of 29 months (range, 22 to 40 months). There were 18 men and 5 women with the average age of 39 years (range, 24 to 61 years). Fourteen were isolated fractures and nine were related to acute anterior instability episode. The average displacement of the fracture was 2.3mm (range, 0 to 4mm) on the anteroposterior view of the plane radiographs. At the time of arthroscopy, all patients had partial thickness rotator cuff tears in the articular surface. The cuff tears were located on the tuberosity fracture area and were an Ellman's grade I to II in depth. With the arthroscopic debridement or repair of the tear depending on the condition of the tear itself, as well as the subacromial decompression, the UCLA score revealed good to excellent results in 20 and fair in 3 patients. Nineteen of the patients had returned to the previous level of activities. The patient with a higher activity demand revealed a lower level of activity return ($p=0.034$). The partial thickness rotator cuff tear should be considered in patients with chronic shoulder pain after the minimally displaced fracture of the greater tuberosity, and arthroscopic debridement or repair is an appropriate procedure.

Key Words : Shoulder, Greater tuberosity fracture, Partial thickness rotator cuff tear, Arthroscopy

Fracture of the greater tuberosity can occur as a result of acute glenohumeral dislocation or as an isolated fracture due to a direct injury on the shoulder. If the fracture is reduced to the anatomic position, the healing is usually not problematic. Although Neer¹⁾ recommended open reduction of the fracture if the greater tuberosity had more than 1cm of displacement, unsatisfactory results were reported in several studies²⁻⁴⁾. Recently Bigliani et al⁵⁾ reported that the displacement of the

greater tuberosity of more than 5mm should be reduced surgically to the anatomical position. The rationale for open reduction of the greater tuberosity fracture is to prevent the nonoutlet impingement of the greater tuberosity beneath the acromion. A fracture with a displacement of less than 5mm can be treated conservatively. Park et al⁶⁾ suggested operative treatment if the fragments are displaced more than 5mm in active patients, and more than 3mm in athletes and heavy laborers with over-

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head activity. However, patients with a minimally displaced greater tuberosity fracture may have prolonged shoulder pain regardless of conservative treatment. Current arthroscopic technique improved our understanding of the pathologic lesions of the various shoulder problems. To our knowledge, there is no published report on the greater tuberosity fracture with a minimal displacement in terms of the cause of pain, pathologic lesion and results of the treatment. The purpose of this study is to describe arthroscopic findings, and the results of arthroscopic treatment in patients with chronic shoulder pain after the minimally displaced fracture of the greater tuberosity.

MATERIALS and METHODS

Twenty-three shoulders in 23 patients with chronic shoulder pain after the greater tuberosity fracture were included in this study. The patients who had the Neer's 2-part fracture, a greater tuberosity fracture with a more than 5mm of displacement, a combined fracture in another area in the shoulder girdle, or a history of previous shoulder pain or surgery were excluded from this study. There were 18 men and 5 women with an average age of 39(range, 24 to 61 years). Sixteen patients had the fracture in the dominant arm. Nine of the patients had a history of an acute instability episode in the involved shoulder(instability group). In these patients, two had acute shoulder dislocations, which were reduced by other persons, and the other 7 had an acute subluxation, which were reduced spontaneously. Fourteen of the patients had a direct trauma on the shoulder and an isolated fracture on the greater tuberosity

(isolated fracture group). The mechanism of injury included a direct fall on the shoulder from a significant height, and an impact against a hard object during sports. Of 9 patients in the instability group, six were males and 3 were females with an average age of 51(range, 42 to 61 years). Of the 14 patients in the isolated fracture group, there were 12 males and 2 females with an average age of 32(range, 24 to 48 years). Ten of the patients were involved in athletic activity on a regular basis. Six were on a nonregular basis. Seven of the patients were not involved in any athletic activity.

The anteroposterior, axillary, and lateral view in the scapular plan were obtained. Plane radiographs revealed a minimal to non-displaced fracture of the greater tuberosity in 19 patients. The average displacement was 2.3mm(range, 0 to 4mm) on the anteroposterior view. All measurements were carried out on the PACS(Picture Archiving Communication System, GE, Munich, Germany. Pixels: 1024×1024) monitor which calculated the length automatically to two decimal points. Nine of the patients had a large single fracture and ten had a multiple number of small shell fragments(Fig. 1). In 4 of the patients, no fragment was identified in the plane radiographs. An arch view showed a flat acromion in thirteen patients, a curved acromion in nine patients, and a hooked acromion on one patient. The acromioclavicular joint was normal in all but two patients who had small osteophytes formation undersurface of the acromioclavicular joint.

MR-arthrography was conducted in all patients. All patients demonstrated a greater tuberosity fracture in the MRI. A

T2-weighted oblique coronal image showed linear increment of the MR signal in the fracture area of the greater tuberosity (Fig. 2). In 4 patients who did not have a greater tuberosity fracture in the plane radiographs and were initially considered to have rotator cuff injury, however, the resulting MRI revealed a concealed fracture of the greater tuberosity. Partial thickness rotator cuff tears were suspected only in 3 patients, and tendinopathy of the rotator cuff was detected in 6 patients. The other 14 patients were regarded as having an intact rotator cuff. Discrete Bankart lesions were identified in 5 shoulders in the instability group. The other 4 in the instability group had an intact anterior capsulolabral structure in the MR-arthrogram. However, those 4 patients revealed a small Bankart lesion during arthroscopic examination, in which the anteroinferior labrum had a small detachment without displacement to the medial surface of the glenoid neck. In the isolated fracture group, no Bankart lesion was identified in the MR-arthrogram.

Fifteen of the patients were referred from other hospitals and 8 were treated in our hospital from the initial time of injury. All patients were initially given conservative treatment including nonsteroidal anti-inflammatory medication, and sling immobilization for 3 weeks. After 3 weeks, the regular rehabilitation program was initiated such as physiotherapy modality, rotator cuff strengthening exercise, and range of motion exercise. All patients had persistent pain in the involved shoulders 4 to 9 months after conservative treatment. Eighteen of the patients had shoulder pain since the traumatic episode, while five patients experi-

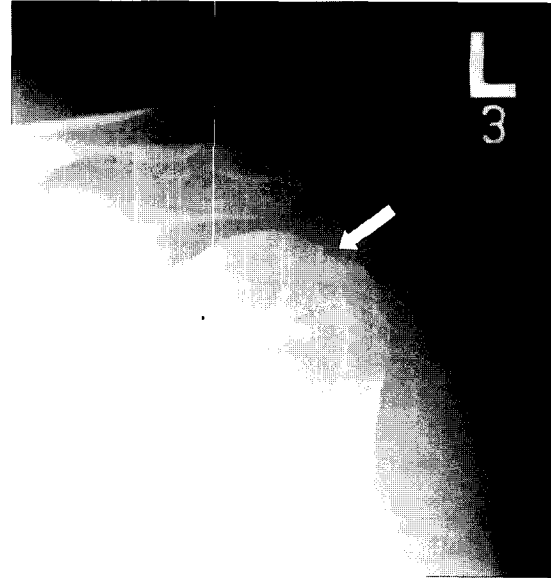


Fig. 1. An anteroposterior view of the left shoulder. A small nondisplaced fragment was noted (arrow).

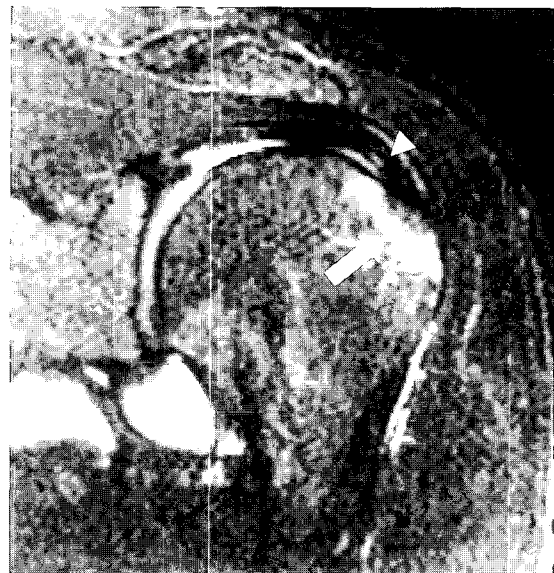


Fig. 2. A MRI of the left shoulder. A T2-weighted oblique coronal image showing linear increment of the signal intensity in the greater tuberosity indicating fracture (arrow). No fragment was identified in the plane radiographs. This patient was initially considered to have a rotator cuff injury, however a MRI revealed a concealed fracture of the greater tuberosity and intact rotator cuff (arrowhead).

enced recurring pain in the involved shoulder at an average of 5 months(range 4 to 9 months) after the initial injury. All patients experienced shoulder pain during overhead activity. Thirteen of the patients experienced significant pain at rest which was aggravated during the night time disturbing comfortable sleep. Neer's impingement sign was positive in 16 patients and the subacromial injection of lidocaine significantly relieved the pain in 14 patients. Examination under general anesthesia revealed stable shoulders in all patients in the isolated fracture group and 6 patients in the instability group. Only 3 out of the 9 patients in the instability group demonstrated a grade II anterior translation. Twelve of the patients had limited shoulder motion in forward elevation, external rotation, and internal rotation. These limitations of motion were improved under general anesthesia during arthroscopic examination. However, five patients demonstrated fixed motion limitation, which did not improved in the examination under general anesthesia. These patients with fixed motion limitation were considered to have a secondary frozen shoulder owing to the partial thickness rotator cuff tears and subjected to manipulation under general anesthesia.

After failure of conservative treatment for 4 to 6 months after the initial trauma, an arthroscopic evaluation and treatments were carried out by one author(S-H Kim). All patients had partial thickness rotator cuff tear on the articular surface and received arthroscopic treatment. After an average of 29 months(range, 22 to 40 months), the results were evaluated according to the UCLA shoulder rating and functional return to the prior activity or job.

Return to the previous job or level of athletic activity was evaluated using four grades. Grade 0 represented no limitation of athletic activities and a complete return to the prior job. Grade I was mild limitation in athletic activities and return to the prior job. Grade II was rated when the patient had moderate to severe limitation of their athletic activities or moderate limitation to the job even though the patient continued prior job or sports activities. Grade III represented complete inability to return to prior athletic activities or previous job. Grade 0 and I were classified as favorable returns, while grade II and III were classified as unfavorable returns.

The UCLA rating was compared between the preoperative and follow-up scores using the Mann-Whitney *U* test. Spearman's rank correlation coefficient was measured to evaluate the contributing factors to the final results. Nonparametric test of Kruskal-Wallis was used to evaluate the difference in return to activity in different groups of sports activity. The SPSS program(SPSS, Chicago, Illinois) was used for all analysis, with the statistical significance level set at $p=0.05$.

RESULTS

1. Arthroscopic Findings

All patients underwent arthroscopic examinations on an average of 8 months (range, 4 to 16 months) after the initial trauma. A consistent finding during arthroscopic examination was a partial thickness rotator cuff tear on the articular surface. All tears were confined within the fracture area in the insertion of the supraspinatus tendon. The tear was a rim-vent tear extending from the antero-



Fig. 3. An arthroscopic view of the left shoulder viewing from posterior portal. A partial thickness rotator cuff tear on the articular surface in the area of the greater tuberosity fracture was noted(arrow). B: Biceps tendon. H: Humeral head.

posterior direction(Fig. 3). The partial thickness tears were classified using Ellman's grading system. Ellman's grade I tears have a depth of less than 3mm, which is less than one-fourth of the thickness of the cuff. Grade II tears are less than 6mm in thickness, which is less than one-half of the cuff thickness. Grade III tears involve more than one-half of the cuff thickness⁷⁾. There were an Ellman's grade I in seventeen patients and grade II in six patients. All patients had an intact rotator cuff on the bursal surface except four patients who demonstrated mild softening of the bursal surface of the supraspinatus tendon upon palpation with the probe. The fragment of the fracture could be palpable inside of the rotator cuff tendon in these four patients. The subacromial bursa had minimal to mild inflammatory change and coracoacromial ligament had

mild to moderate fraying at the insertion area under the anterior acromion(Fig. 5). All but three patients had smooth surfaces in the anterior acromion without significant sized osteophytes. The three patients who had osteophytes on the anterior acromion denied any shoulder symptom prior to the index trauma. Eleven of the patients had a Bankart lesion, which occurred in 9 patients in the instability group and 2 patients in the isolated fracture group. The Bankart lesion was a small anteroinferior labral tear confined to the anteroinferior labrum. Three out of 11 Bankart lesions were complete separations of the labrum from the glenoid margin, while the other 9 lesions were superficial cracks or incomplete tears of the anteroinferior labrum without separation from the glenoid.

2. Surgical Treatment

In 5 patients with a limitation of shoulder motion under general anesthesia, gentle manipulation was performed before arthroscopic treatment and a full range of motion was achieved with the manipulation. Arthroscopic capsular release was not performed for all patients. Capsular tearing were found in the shoulders of all patients who were manipulated prior to arthroscopy.

Under general anesthesia, all arthroscopic procedures were carried out in the lateral decubitus position with the torso tilted 30 degrees posteriorly. Arthroscopic debridement of the partial thickness cuff tear on the articular surface was performed in all Ellman grade I tears and three of the Ellman grade II tears which had a severely frayed margin of the tear. In another three patients with Ellman's

grade II tears with a healthy flap, arthroscopic repair of the torn flap with the No-2 nonabsorbable suture was performed. Three Bankart lesions with a complete separation of the labrum were repaired using the suture anchor technique with FASTak(Arthrex, Naples, FL) or mini-Revo screws(Linvatec, Largo, FL) and No-2 nonabsorbable suture materials. The other 9 small Bankart lesions were not repaired since the labral tears were of insignificant size and depth, and the shoulders were stable under general anesthesia. Arthroscopic subacromial decompression was performed in all patients. Coracoacromial ligaments were divided from the anterior edge of the acromion in all patients. However in 10 of the patients, aged 40 or younger, the division of the coracoacromial ligament was limited to the lateral half of the ligament in order to preserve the passive stabilizing effect of the coracoacromial ligament.

3. Postoperative Treatment

Postoperatively, the shoulder was supported using an arm sling with a pillow spacer(K-Sling, Eugene Medical, Seoul, Korea). The patients' pain were controlled with the aid of PCA(patient controlled Anesthesia). From the day after the operation, pendulum exercise and continuous passive motion exercise were initiated. From the third day, passive elevation using rope and pulley, and cuff strengthening exercise with the arm at the side were integrated. A more vigorous strengthening exercise and active elevation was encouraged when severe shoulder pain decreased. The patients stayed at the hospital for an average of 3.6 days(range, 2 to 5 days). After discharge from the hospital, the patients were encourage to use the

home therapy kit(STK, BREG, Inc., Vista, CA) for the shoulder exercise. Overhead sports activity was allowed from 6 to 10 months after surgery.

4. Follow-up Results

At the average of 29 months(range, 22 to 40 months), the UCLA score significantly improved from 13(range, 7 to 20) preoperatively to 32 points(range, 25 to 35) postoperatively($p=0.001$). Twenty of the patients had good to excellent results and 3 patients had fair results. There were no poor results. In regard to returning to the prior activity or job, fourteen had a grade 0 return, and five grade I returns. Overall 82.6% of the patients had a satisfactory return to the prior level of activity or job. Four patients resulted in grade II return to the prior activity. The Average UCLA score was 31(range, 25 to 35) in the instability group and 33(range, 26 to 35) in the isolated fracture group. No further recurrent instability occurred in the instability group. The UCLA score and level of activity return were not related to the age of the patients, the type of anterior acromion, size of fracture, magnitude of displacement, Ellman grade of rotator cuff tear, and preoperative range of motion. There was no difference in the UCLA score and level of activity return between the patients with an isolated greater tuberosity fracture and those with an acute instability episode($p=0.41$). We could not evaluate the effect of rotator cuff repair owing to the limitation of the number of the patients. Spearman's rank correlation coefficient showed that the level of activity return was related to the activity demand of the patients($r=0.628$). Nonparametric test of Kruskal-Wallis demonstrated that a group of 8 patients with overhead

sports activity achieved lower grade of return compared to the 7 patients without athletic activity ($p=0.034$). There were no major complications related to the surgery.

DISCUSSION

Greater tuberosity fracture can occur in conjunction with anterior dislocation of the shoulder⁹. The incidence of greater tuberosity fracture has been reported to occur in approximately 15 to 30% of anterior shoulder dislocations⁸⁻¹⁰. Such cases are more common in older patients than in younger patients, and usually does not progress to recurrent instability¹¹. Isolated greater tuberosity fractures account for fewer than 2% of operatively treated proximal humeral fractures¹². The fragments are usually retracted posteriorly and superiorly, and closed reduction is often difficult. If the fracture is not properly reduced, a malunion can occur that will block glenohumeral motion². In general, nonoperative treatment is recommended in both cases if the fracture remained less than 5mm of displacement. However, to our knowledge, there is no published report that nonoperative treatment is sufficient for all patients with a minimal or nondisplaced greater tuberosity fracture without any consequence. In our study, all patients had a minimal or nondisplaced greater tuberosity fracture and the patients received prolonged rehabilitation resulting in the failure of nonoperative treatment. All patients had a partial thickness rotator cuff tear on the articular surface. Fifty-two percents of the patients had significant limitation of shoulder motion. We believe the cause of late pain and limited motion in shoulders

with minimally displaced greater tuberosity fracture is due to these partial thickness rotator cuff tears on the articular surface. Although we do not know what percentage of patients with minimally displaced greater tuberosity fractures had partial thickness rotator cuff tear, we believe that the failure of conservative treatment in patients with minimal or nondisplaced greater tuberosity fractures are attributable to these undersurface partial thickness rotator cuff tear, and in part to the secondary frozen shoulder. Although the rotator cuff tear in the displaced greater tuberosity fracture with the anterior dislocation of the shoulder had been described, these were longitudinal cuff tears at the rotator interval between the supraspinatus and subscapularis tendon⁴. In our patients, the rotator cuff tear was of partial thickness on the articular surface adjacent to the bony insertion. The rotator cuff lesion was confined within the region of the fracture and was a rim rent tear rather than longitudinal.

In one radiologic report on the fractures of the greater tuberosity presenting as rotator cuff abnormality, MRI demonstrated one partial thickness rotator cuff tear in 6 shoulders¹³. Three patients had a normal rotator cuff and two had evidence of tendinopathy with the supraspinatus tendon. None of the patients had full thickness rotator cuff tears and none of 6 patients went on to arthroscopy. In our study, out of 23 patients, the preoperative detection of partial thickness rotator cuff tear in the MR-arthrography was only possible in 3 patients. Six patients were diagnosed as having tendinopathy and the other 14 as having a normal rotator cuff.

We believe that the low detection rate of partial rotator cuff tear in our patients is due in part to the small rim-vent tear adjacent to the insertion area and in part to the signal overlap of the MRI with the increased signal of the greater tuberosity fracture. MR-arthrography has low sensitivity in the detection of partial thickness rotator cuff tear in the articular surface, which occurs in conjunction with a minimally displaced fracture of the greater tuberosity.

Arthroscopic examination and treatment provides satisfactory outcomes in the majority of the patients. The pre-existing acute anterior instability episode did not influence the final results. Twenty of the 23 patients achieved satisfactory results on the UCLA scale and 19 patients returned to their prior activity. The grade of functional return correlated to the physical demand of the individual patients. Those who participate in overhead activity showed a comparably inferior return level of activity.

In summary, partial thickness rotator cuff tear on the articular surface should be considered in patients with minimally displaced greater tuberosity fractures if they have persistent pain beyond 6 months after the injury. Arthroscopic debridement or repair of the tear, and subacromial decompression are necessary in order to achieve a satisfactory result in these patients.

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— 국문초록 —

상완골 대결절의 미세전위골절의 관절경적치료

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상완골의 대결절 골절 후, 6개월 이상 지속되는 만성견관절 동통을 호소하는 총 23명의 환자에 대해 관절경적 치료를 시행하였고 평균 29개월(22~40개월) 후에 후향적 평가를 시행하였다. 환자군의 연령은 24세에서 61세까지로 평균 39세였으며 남자가 18례 여자가 5례였다. 이중 14례는 단독골절 이었고 9례는 급성전방 불안정성과 연관이 있었다. 단순방사선 전후방 사진상에서 골절의 평균 전이는 2.3mm(0~4mm)였다. 관절경을 시행하였을 때 모든 환자에게 관절면 쪽으로 회전근개의 부분 파열이 있었고, 그 깊이는 Ellman I도에서 II도였다. 관절경적 견봉하 감압술과 함께, 파열된 정도에 따라 관절경적 변연 절제술 또는 봉합술을 시행한 후 UCLA 점수로 평가했을 때 20례에서 우수(good) 또는 매우 우수(excellent), 3례에서는 양호(fair)를 나타냈다. 19례에서는 수상 이전 활동으로 복귀하였고, 많은 활동량을 가졌던 환자에서는 활동복귀 정도가 낮았다($p=0.034$). 미세하게 전이된 대결절 골절 후에 만성견관절 동통을 호소하는 환자에서는 반드시 회전근개의 부분 파열을 고려해야 하며 이때 관절경적 변연 절제술 또는 봉합술이 적절한 치료법이다.

색인단어 : 견관절, 대결절 골절, 회전근개 부분 파열, 관절경