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ORIGINAL STUDY

Arthroscopic treatment of greater tuberosity fractures : retrospective review of clinical and radiological outcomes

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The purpose of this retrospective study was to analyze the clinical and radiological outcomes and discuss the value of arthroscopic suture bridge technique in patients with isolated greater tuberosity fractures. Between October 2009 and July 2014, 37 patients with greater tuberosity fractures were analyzed. Thirteen of these patients were treated with arthroscopic reduction and fixation. Analysis of the clinical outcome was performed by comparing final range of motion, UCLA and Constant score. Radiological outcome was analyzed with time for union. Postoperative results were analyzed by range of motion, UCLA and constant score. Each figure resulted as: UCLA from 27 to 35 (average: 29); range of motion in forward flexion from 160° to 180° (average: 173°); Constant score from 69 to 100 (average: 73). Using arthroscopic treatment with a suture-bridge technique can be a useful method in terms of clinical and functional outcomes and be considered as a viable alternative to conventional open techniques.

Keywords : Greater tuberosity fracture; suture bridge technique.

INTRODUCTION

Isolated greater tuberosity (GT) fractures of the humerus which account for approximately 17% to 21% of all proximal humeral fractures. They are less common compared to three- or four-part fractures, and they can result in long term shoulder pain or dysfunctions *(1)*. These isolated GT avulsion fracture often takes place from impaction, avulsion, or shearing injury *(1)*. Mutch et al. have described a morphological classification for greater tuberosity fracture into three different types: avulsion, split and depression. The distribution of avulsion, split and depression type fractures was 39%, 41%, and 20%, respectively *(6)*. Treatment options for these fractures are generally with non-operative conservative treatment, open reduction and internal fixation, and arthroscopic fixation. Nondisplaced and minimally displaced (less than 3 mm) GT fractures could be treated non-operatively, and generally have good results *(4,9)*. Surgical treatment is recommended for fractures with greater than 5 mm of displacement in general population or greater than 3 mm of displacement in a more active patients *(4)*. Neer and Bigliani et. al. reported that fractures greater than 1cm displacement, surgical fixation and open reduction is required *(7)*. Bhatia et

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al. reported that they used open with suture anchor technique for treating GT avulsion fracture and came up with favorable long term outcomes *(2)*. However, with recent advancements in arthroscopic technique, arthroscopic fixation for GT avulsion fractures using several fixation techniques have been developed and appeared to be a feasible and attractive challenge. Ji et al. reported good results with an arthroscopic double-row suture anchor fixation technique in patients with GT avulsion fractures *(5)*.

Determining the methods of treatment of GT avulsion fractures are often challenging for an orthopaedic surgeon and the results of surgical treatment is controversial. The purpose of this study was to conduct a retrospective study on patients with GT avulsion fracture treated with arthroscopic fixation using suture-bridge technique and analyze the clinical and radiological outcomes.

METHODS

Study subjects

From November 2009 to July 2014, 37 patients visited our department with isolated GT fractures. 16 patients were treated non-operatively while 8 patients were treated with open reduction and fixation and 13 patients were treated with arthroscopic fixation using suture bridge technique. The study group included 10 female and 3 male patients with a mean age of 59.87 (range: 40 to 81 years) and were followed for 30 months (range, 1-56 months) postoperatively. The mechanisms of injury were slip downs (n = 11), fall from height (n = 1) and motor vehicle accident (n = 1). The average time from injury to operation was 6.3 days. One of the patients showed dislocation, whereas 2 patients showed rotator cuff tears found at arthroscopic examination. In our study, 6 patients were avulsion type fractures and 7 patients were splint type fractures. The classification and diagnosis of greater tuberosity fractures are mainly based on standard plane radiographs (Fig. 1A). However, radiographs do not always provide accurate information regarding the pattern of the fracture. In these cases, a 3D computed tomography (3D CT) or magnetic resonance imaging (MRI) could be an useful tool in verifying the pattern, size of the fragment and the degree of displacement, or associated rotator cuff tear (Fig 1B). During follow-up, radiographs were used to assess fracture union at 2 weeks, 4 weeks, 2 months, 3months, 4 months, 6 months and final follow-up. At the final follow-up visit, all patients were evaluated with a visual

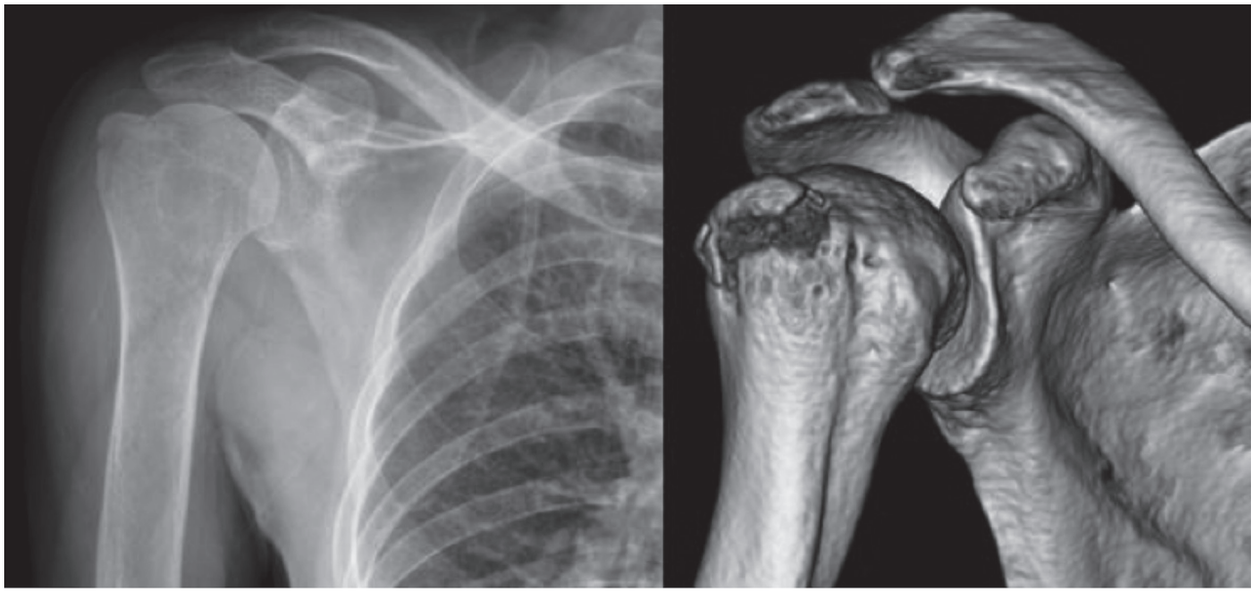

Fig. 1. — (A) Simple radiologic evaluation of GT avulsion fracture. (B) 3D CT scan of GT avulsion fracture

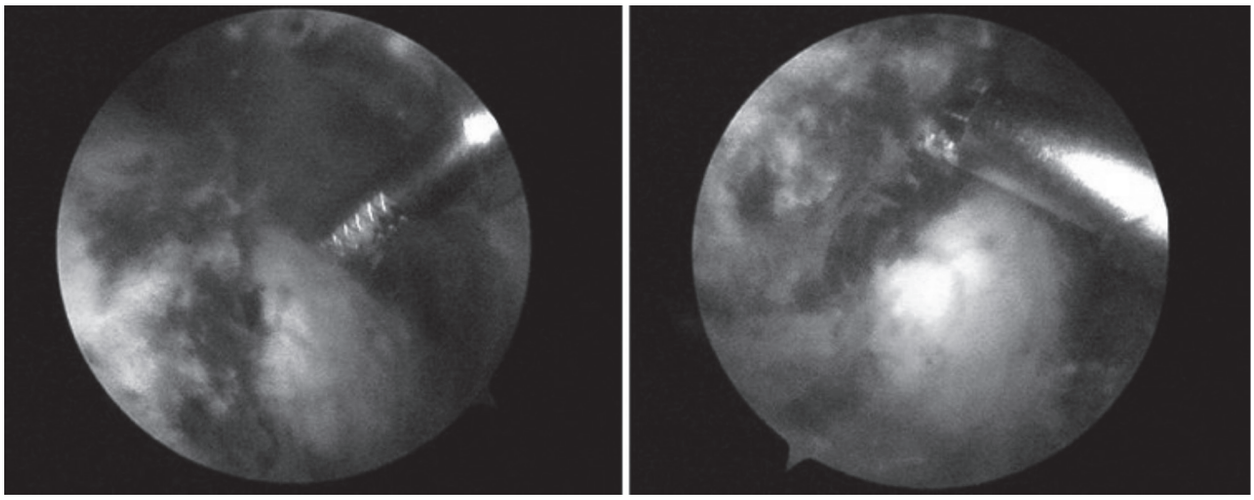

Fig. 2. — (A) (B) Debridement was performed on the undersurface of the fracture fragment

analog scale (VAS); constant score; the University of California, Los Angeles (UCLA) rating scale and thorough physical examination. The UCLA score of 34 to 35 points was considered excellent, 28 to 33 points was good, 21 to 27 points was fair, and 0 to 20 points was poor.

Arthroscopic surgical procedure

Under general anesthesia, the patient was placed in a beach-chair position followed by skin preparation and draping. We use the shoulder portals commonly used for arthroscopic repair of the rotator cuff tear. Posterior portal was positioned 1cm medial and 2 cm inferior to the posterolateral tip of the acromion. Anterior portal was positioned somewhat laterally to midpoint between anterolateral tip of the acromion and the coracoid process. Through the posterior portal, blunted tip obturator was inserted followed by penetrating deeper and verifying intra-articular location and structures. After inserting the arthroscope through a posterior portal, complete intra-articular examination was performed. During examination, the greater tuberosity fracture was confirmed at the supraspinatus tendon insertion site and size, location and degree of displacement was verified. Debridement was performed on the fracture surface (Fig. 2A, B) and two bio-absorbable structure anchors (Bio-Corkscrew FT; AR-192, Arthrex) were fixed at the prepared undersurface of greater tuberosity (Fig. 3A). Sometimes, the fracture site was covered by a hematoma, making it difficult to assess the exact margin of the fragment. In these cases we used the C-arm to assess the fracture margin accurately. Two fiber-wire strands fixed to the anchor were manipulated to pull the intact portion of tendon outward using a suture hook and a bird beak (Fig. 3B). Attempts to reduce the fragment was supported by pulling on the rotator cuff with a grasper followed by PushLock anchors (3.5mm Bio-Pushlock; AR 1926B, Arthrex) to fix the two stands of the anchor as a suture-bridge technique (Fig. 4A). At this time, when a rotator cuff tear was present, it was repaired with a single bundle technique. Reduction of the fragment could be seen from both the bursal and the articular surface (Fig. 4B). A schema of the suture bridge technique is shown in Fig 5. Portal sites were closed properly followed by aseptic dressing.

Postoperative treatment

After the surgery, the shoulder was supported using an abduction brace (K-sling: Eugene medical, Seoul, Korea) and patient-controlled anesthesia was used for postoperative pain management. On the second postoperative day, pendulum exercise and passive elbow ROM exercise were initiated. Two weeks later, continuous passive motion (CPM) exercises were permitted. After discharge, the patients were encouraged to visit the outpatient department for continuous passive motion exercise.

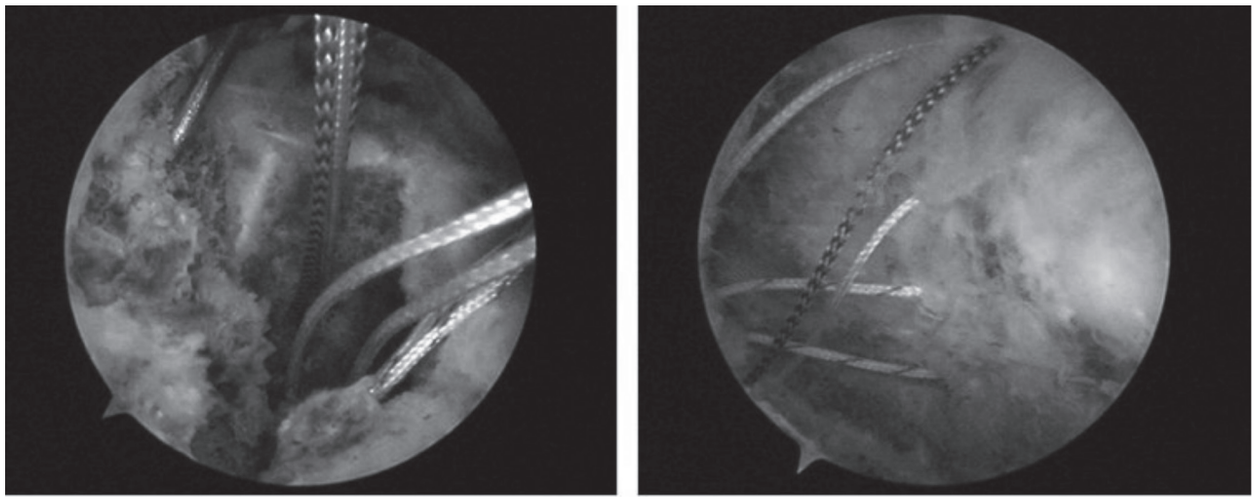

Fig. 3.— (A) Two bio-absorbable suture anchors are fixed to the prepared under surface of fracture site. (B) The suture anchors penetrate the rotator cuff inside-out

Evaluation method

During the follow-ups, standard radiographs were used to evaluate the degree of union. Shoulder function was assessed by using constant score, the University of California, Los Angeles (UCLA) rating scale and thorough physical examination. In this system, subjective and objective clinical data were included with a maximum score of 100 points. Pain (15 points), activities of daily living (20 points), ROM of the shoulders (40 points), and muscle power (25 points) were evaluated *(3)*.

Statistical analysis

We analyzed the average value of UCLA, constant score, and postoperative ROM. Statistical analysis was performed with SPSS version 12 software.

RESULTS

Thirteen patients underwent arthroscopic greater tuberosity fixation. The average operation time was 89.2 minutes. No intraoperative complication such as anchor pullout in the osteoporotic bone occurred.

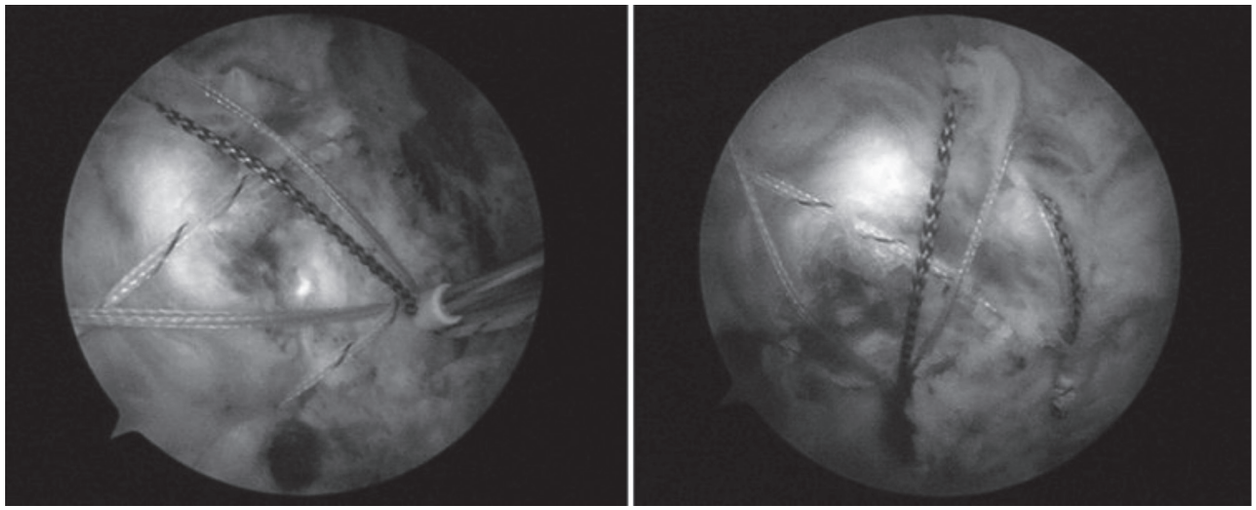

Fig. 4. — (A) Two stands of the anchor were fixed by the push-lock suture using Suture-bridge technique. (B) Arthroscopic finding showed good fixation

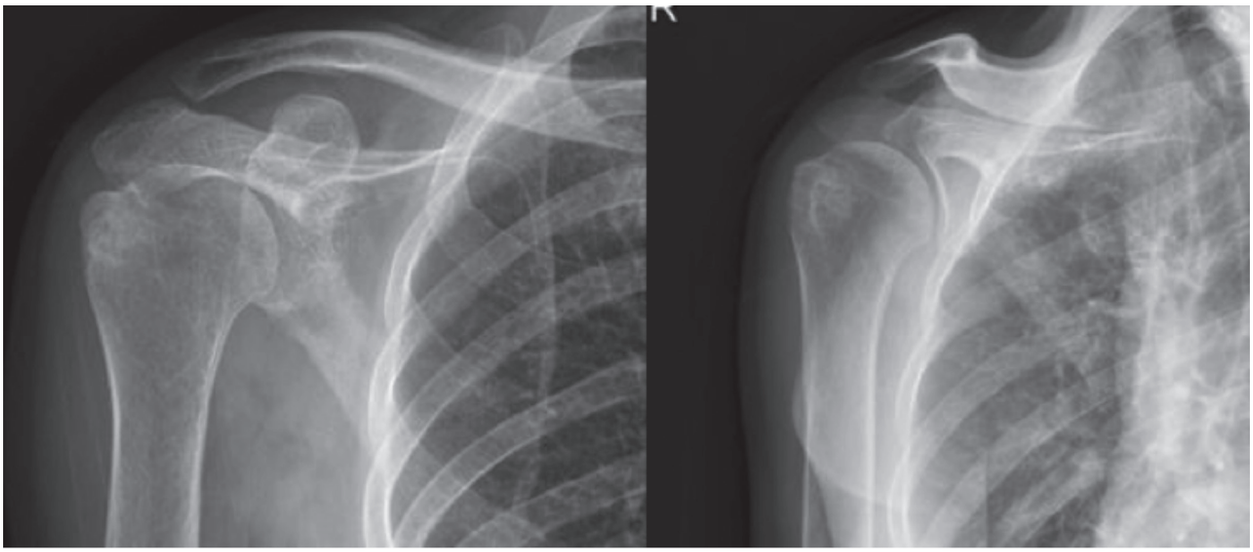

Fig. 5. — A simple radiologic examination showed a good reduction of the greater tuberosity fracture postoperatively

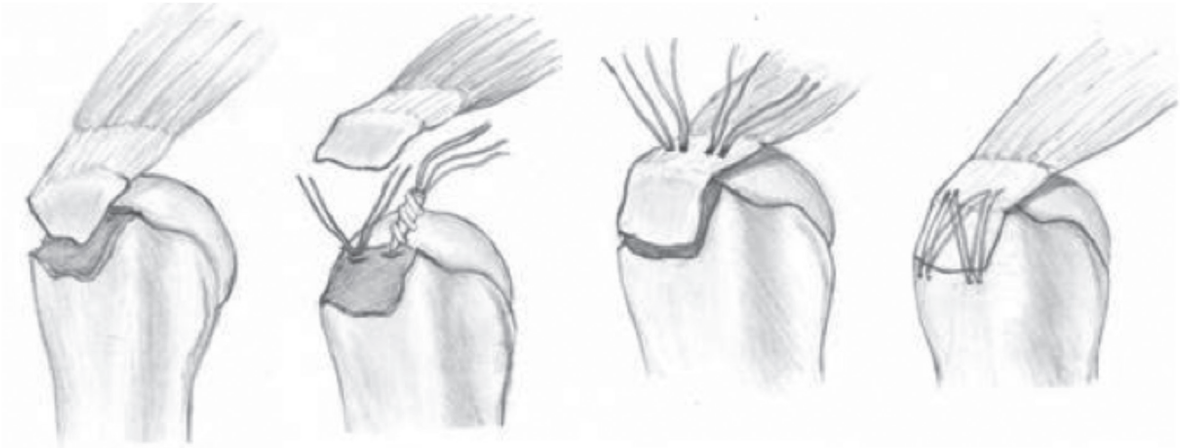

Fig. 6 .— Suture-bridge technique methods. (A) GT avulsion fracture. (B) Two bio-absorbable suture anchors placed on the articular margin of the humeral head. (C) Sutures passed through the intact rotator cuff attached to the GT fragments (D) After all sutures were passed through the rotator cuff, two stands of the anchor were fixed by push-lock suture using Suture-bridge technique

There were no complications related to the surgery such as nerve injury, infection or complications of wound healing. The follow-up radiologic evaluation showed that bony union was achieved within 11 to 24 weeks in all cases. There was no heterotopic bone formation or anchor pullout in all cases. During follow-up, no patients complained about postoperative frozen shoulder.

Magnetic resonance imaging (MRI) and arthroscopic finding showed concomitant pathologies, such as rotator cuff tears or traumatic SLAP. Rotator cuff repair were performed in 5 patients. One of the patients with biceps lesion, tenotomy of biceps tendon was performed. Except these patients biceps tendon was preserved in all cases. The presence of rotator cuff injury did not affect the postoperative bone union, function and range of motion (ROM).

All patients had a low VAS score at final follow up which was 2.18 (range, 0-4). The mean postoperative UCLA was 29 (range, 27-35), constant score was 73 (range, 69-100), and postoperative

forward flexion 173.0 (range, 160-180). According to the UCLA score, there were 2 excellent results, 10 good results and 1 poor result.

DISCUSSION

Recently, arthroscopic fixations of isolated greater tuberosity avulsion fractures are being reported using several different fixation techniques. Determining a method of treatment of GT avulsion fracture is often challenging for an orthopedic surgeon. Several fixation methods have been introduced for GT avulsion fractures. The options for the treatment could be conservative treatment, open reduction and internal fixation, and arthroscopic fixation. Platzer et al. reported that patients who had undergone open reduction and fixation had better results in terms of shoulder function and radiographic results than those who had undergone conservative treatment *(8)*. Recently, arthroscopic fixations using several fixation techniques have been developed and have produced promising results as we are reporting a good result using a similar technique for arthroscopic reduction and fixation with suture bridges technique in an aspect of clinical and functional outcomes.

We believe that using the arthroscopic techniques to fracture management allow a viable alternative to conventional open techniques. Open reduction of greater tuberosity fractures has the advantage of direct visualization and accurate reduction of the fracture fragment. However, the risk of injury of axillary nerve and cosmetic problem exist. Therefore a patient with GT avulsion fracture accompanied by rotator cuff tear, an arthroscopic surgery using a suture-bridge technique could be a viable alternative to the conventional open methods. Ji et al. reported good results with an arthroscopic double-row suture anchor fixation technique in patients with comminuted, displaced GT avulsion fractures *(5)*. Arthroscopic technique has several advantages. First, this technique allows us to simultaneously address and treat accompanying pathologies such as rotator cuff tears in fracture patients. Secondly, shorter hospital days due to prompt recovery from pain allows for early rehabilitation, effectively reducing the incidence of frozen shoulders. Thirdly, it has the merits of cosmetic aspect due to small skin incision. Fourthly, implant removal surgery is not required once bone union is achieved. However, there are several disadvantages. Visualization of the fracture site can be limited by the hematoma that

Table I. — Patient demographics

	Gender	Age (yr)	Follow up (months)	Constant score	UCLA	Union period (weeks)	FF (°)	VAS	combine lesion
1	M	53	72	69	28	12	160	2	RCT
2	F	62	54	83	31	17	180	2	No lesion
3	F	43	5	73	29	13	160	3	Dislocation
4	F	81	1	77	28	15	160	2	Dislocation
5	F	63	40	92	33	12	175	0	No lesion
6	F	79	47	78	28	15	180	3	RCT
7	F	68	9	90	29	24	180	2	No lesion
8	F	57	50	91	33	20	180	2	Dislocation
9	M	46	32	92	30	24	180	4	No lesion
10	F	42	56	100	35	11	180	0	RCT
11	F	65	36	83	31	12	175	2	RCT
12	F	73	16	81	27	24	160	0	RCT
13	M	55	12	93	35	15	180	0	No lesion

Abbreviations: FF, forward flexion; ABD, abduction; IR, internal rotation; RCT, rotator cuff tear

follows the fracture fragment or soft tissue swelling. Inexperienced in shoulder arthroscopy can prolong the operation time. Therefore, comparing with open reduction and internal fixation of a fracture of the greater tuberosity, the arthroscopic fixation can be technically demanding. However, above mentioned limitations can be overcome through repetitive experience resolving technical difficulties.

This study had several limitations. The number of patients was quite small to adequately evaluate the result of arthroscopic treatment using a suture-bridge technique. Patients with open reduction and internal fixation was lacking, making the results impossible comparing the clinical and functional outcomes. However, these limitations can be overcome through randomized controlled study afterward and the long-term follow-up results are still needed.

CONCLUSION

Various surgical techniques and fixation methods are available in treating patient with isolated greater tuberosity avulsion fractures. Using arthroscopic fixation treatment with a suture-bridge technique can be a useful method in terms of clinical and radiological outcomes and be considered as a viable alternative to conventional open techniques.

DECLARATION

IRB: The study submitted has been reviewed by IRB, after reviewing submitted IRB protocol and other related materials, the participated IRB members upon "Approval" of the research.

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