

ORIGINAL ARTICLE

DISPLACED FRACTURES OF GREATER TUBEROSITY OF HUMERUS: OUTCOMES AND COMPLICATIONS AFTER OPEN REDUCTION AND INTERNAL FIXATION

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ABSTRACT:

Background: Humerus fractures account for 5% to 8% of total fractures. Non-union and delayed union of Greater Tuberosity (GT) fractures though uncommon but presents a challenge to the orthopedic surgeons. Substantial disagreement surrounds ideal treatment of such neglected fractures. This article evaluates the outcomes of open reduction and internal fixation (ORIF) of displaced GT fractures. **Methods:** Results of surgical intervention in 15 patients with displaced non union of GT fractures were evaluated. Range of Motion, muscle forces, Visual Analogue Scale (VAS) and Activities of Daily Living (ADL) Score were all recorded preoperatively and after 30 months of follow up post-surgery. The results obtained were compared with that of the undamaged shoulder. **Results:** Patients undergoing surgical intervention were followed up for 24.5 months on an average. All fractures healed satisfactorily. Anatomic reduction could be achieved only in 8 cases with no reports of necrosis or infection. Range of motions and muscle forces were found to have increased significantly [Mean Forward Flexion: 58.22 to 149.6(ROM), Mean Internal Rotation: 2.8 to 4.4(muscle force), Mean External Rotation: 4.4 to 4.7(muscle force)] ($p < 0.0001$). VAS and ADL scores also improved significantly postoperatively (Mean VAS: 6.8 to 1.1, Mean ADL: 6.2 to 28.3) ($p < 0.0001$). **Conclusion:** Even for displaced fractures of the Greater Tuberosity, open reduction and internal fixation has satisfactory functional outcomes, despite non-anatomical reduction of the fracture.

Keywords: Delayed union, Greater tuberosity, Humerus fractures, Reduction

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INTRODUCTION

Fractures of the proximal part of the humerus remain one of the most common orthopedic injuries, predominantly in the aged. Humerus fractures comprise of 5% to 8% of all fractures. Non-unions of these fractures are usually uncommon, but when they happen, they portray a huge challenge to the orthopedician¹. The indications for its immediate surgical reconstruction include fracture which is displaced more than 5 mm for general population or 3 mm in case of athletes or patients performing frequent occupational or recreational activities.² Nonunion and malunion are of the most frequent complications after proximal humerus fractures. Pain in such cases is a key component of patient satisfaction.³ The incidence of non-union or delayed union is increasing in the present scenario due to growth in rate of sports and road accidents and prevalence of osteoporosis.⁴ It usually occurs when non-surgical treatment fails, medical status is poor and more specifically in developing countries where medical care

services are not easily accessible.⁵ These type of delayed unions are usually debilitating; though only in younger or physically active patients.

The distorting forces of the attached cuff muscles stretch the tuberosity to retract posterolaterally; the articular surfaces however remain unaffected. The posterior displacement produces a bony block to external rotation, while superior displacement may block abduction and lead to subacromial impingement. Tuberosity malposition can also produce cuff dysfunction, attrition, and tears.⁶

Such patients are usually more prone to osteoporosis, poor physiologic state, medical comorbidities and drug treatment, heavy smoking, and alcohol abuse.⁷ Complete disruption of the periosteal sleeve may lead to mechanical instability, and soft tissue interposition of periosteum, muscle, and the tendinous portion of the long head of biceps and may inhibit callus formation⁸.

The most common complaints are pain, stiffness and loss of shoulder function. The pain is usually severe, debilitating, and aggravated through shoulder motions.

CT scan is indicated to confirm the nonunion, the degree of separation and the feasibility of reduction and fixation of the fracture. In extreme cases of severe tuberosity mal-union or a displaced non-union, humeral head arthroplasty or reverse shoulder arthroplasty may be indicated but there is a high rate of complications associated with these procedures⁹.

Treatment is usually considered controversial. Displaced fractures often require surgery, and management can be challenging because of poor bone quality. Substantial discrepancy surrounds ideal treatment of mal-union of GT fractures, including hemiarthroplasty (HA), reverse total shoulder arthroplasty (RTSA) and open reduction internal fixation (ORIF)².

Also there is a challenge to the outcomes of delayed surgical treatment due to poor proximal humerus bone repair and absence of appropriate evaluation of fixation of neglected fractures. Limited evidence is available to guide surgeons in the management of these complications. Cost and benefits of surgical repair is still a major issue of controversy. Thus, this retrospective comparative study was planned up to evaluate the results of delayed ORIF of displaced GT fractures.

MATERIALS AND METHODS

Patients reporting with displaced GT fractures to Hospital during 2010 to 2015 were included for the present study. A total of 15 patients with GT fractures having more than 1 cm displacement, approved by CT scan, were included. These patients visited a minimal of 8 months after the injury happened.

Exclusion criteria included those with concomitant injuries in each of shoulders like fracture – dislocation, bilateral humeral fractures, and those with previous full thickness rotator cuff tears (exposed during surgery), patients who did not accept to receive surgical treatment or were lost to follow up.

All patients were examined with special attention to neuromuscular status of the injured shoulder. Other data including age, sex, side of involved shoulder and interval between trauma to surgery were recorded. Preoperative range of motion (ROM) of both shoulders in forward flexion, external and internal rotation and muscle forces in abduction, external and internal rotations were determined. An anteroposterior, true lateral scapular view and lateral axillary view X-rays and a three-dimensional CT scan of the affected shoulder were obtained to confirm the deficit and the defect. The study was approved by the ethical committee and written consent was obtained from the patients.

Shoulder abduction brace with 40- 60 degrees of abduction and 20-30 degrees of external rotation was

prescribed post surgically for a period of 6 weeks after the required procedure was carried out. Active ROM exercise was started after a period of 8 weeks and strengthening exercise after 12 weeks. The patients were educated to implement these exercises at home for at least 4 hours in a day, whereas physiotherapy was prescribed at physiotherapy center.

Follow up visits of all patients were scheduled at 3, 6 and 10, 14 weeks for the first 4 months. Subsequently, patients visited every 4 months for the first year and then every 6 months in the second year, and annually then. X-rays of the affected shoulder were obtained immediately after surgery and 3 and 6 weeks postoperatively to determine any displacement of the fractured fragment. After 3 month postoperatively, the patients were examined to assess and record shoulder ROM in forward flexion, external rotation with arm at side, and internal rotation were assessed and recorded. At the 6th month visit and also for the next follow up visits for the next two years, muscle forces were also recorded into the examination. Data including age, gender, side of injury, interval between injuries to surgery and functional results were recorded. Before and after operative treatment, researchers evaluated function of both damaged and undamaged shoulders by physical examination, reviewing medical records and the prepared questionnaires included Visual Analogue Scale (VAS) and Activities of Daily Living (ADL) Score.

ROMs in internal rotations were recorded as the highest spinus process where the thumb reached. If the thumb could not reach to the spine, thigh or buttock were considered as references. Statistical software SPSS version 20.0 (SPSS Inc., Chicago, IL) was used. p <0.05 was considered to be statistically significant.

RESULTS

Patients were followed up clinically for at least 24 months after surgery (ranging from 24 to 31 months, with mean of 24.3 months). The mean ROM in forward flexion of the involved shoulders was 149.6° [Table 1]. All ROMs of the involved shoulders increased significantly (p < 0.001), but were less than the other normal side. The mean muscle forces of the involved shoulders in abduction and external rotation were 4.60 and 4.40 (out of 5), respectively [Table 2] (p<0.001).

This increase in muscle force and range of motion was observed in internal rotation forces also. All scores including VAS and ADL score of the involved shoulders were improved significantly but were not as good as the other normal side (p <0.05).

Table 1: Range of Motions (mean value) of involved and uninvolved shoulders

ROM	Affected side- Pre- op	Affected side- last FU	Unaffected side	p-value
Forward Flexion	58.22	149.6	176	<0.001
External rotation	-5.2	28.3	43.2	<0.001
Internal rotation	3.2	9.3	13.8	<0.001

Table 2: Muscle force (mean value) of involved and uninvolved shoulders (out of 5)

ROM	Affected side- Pre-op	Affected side- last FU	Unaffected side	p-value
Abduction force	3.8	4.6	4.8	<0.001
External rotation	2.8	4.4	4.9	<0.001
Internal rotation	4.4	4.7	4.8	<0.001

DISCUSSION

Recent studies have reported controversy surrounding the benefits of delayed treatment of nonunion greater tuberosity fractures by reverse total shoulder arthroplasty (RTSA) or open reduction internal fixation (ORIF). The acquisitions levied on these procedures are that they are technically demanding and frequently associated with a relatively high rate of complications.^{2,6}

There are few studies discussing delayed treatments of greater tuberosity fractures and not enough evidence was found in the scientific literature to help surgeons to decide whether late surgery can attain acceptable consequences or not. Lu et al. treated 39 proximal humerus fractures including isolated GT fractures with ORIF after a delay of 21-120 days from the initial injury⁵. ROM were improved except for internal rotation and all of the evaluated scores including visual analogue scale (VAS), Constant-Murley score, University of California Los Angeles (UCLA) scoring system score and Simple Shoulder Test (SST) score demonstrated great reconstruction.

All cases in the present study had isolated nonunion of GT fracture and treated much later. Regardless of this latency, the result of the present study appears acceptable. This may be attributable to adequate exposure of the fracture site and release of the fractured fragment, stable fixation and effective post-operative rehabilitation.

There are a few reports of the results of treatment of malunion or non-union associated with greater tuberosity fractures, which have reported considerable pain relief and functional enhancement but associated with prolonged recovery times. Beredjikian et al. treated 39 patients for malunion of a fracture of the proximal humerus. Results were satisfactory for 27 patients (69%) and unsatisfactory for the remaining 12 (31%). They suggested that in cases of malunion of the fracture of the proximal humerus, both osseous and soft-tissue abnormalities are the cause of pain and stiffness. Hence, they stated that surgical treatment of these patients is fruitful only if all osseous and soft-tissue abnormalities are amended during surgery.

Displaced GT fractures cause pain and impingement to acromion, thereby restricting ROM and inducing some degrees of stiffness. These issues can be resolved eventually by an effective surgery. As it is seen that three out of four rotator cuff tendons attach to GT, hence rotator cuff forces decrease in cases of displaced

GT fractures. These can be increased by fixation of the fracture fragment as anatomically as much as possible.⁶

The postoperative rehabilitation practices and daily home exercises advised in this study play a significant role in these results. The patients were educated precisely exercise at home for at least 4 hours in a day, and prescribed physiotherapy two sessions weekly until the progression of ROMs and forces reached to a plateau. Mean Visual Analogue Scale for pain (VAS) decreased significantly from 6.8 (out of 10) preoperatively to 1.1 postoperatively. This diminution reveals that pain, which is a major complaint in shoulder disease, had improved. Pain may be due to numerous causes such as impingement and muscle weakness that would mainly have been resolved with this surgery.

Decreased ROM, pain and muscle forces can affect Activity Daily Living (ADL) score. ADL score of the involved shoulder increases from 6.2 preoperatively to 28.3 post-operatively. Such a significant increase is significant and means improvement of the function of the operated shoulders.

CONCLUSION: Thus, it can be concluded that with regards to appropriate outcomes and significant results of data analysis, ORIF of displaced greater tuberosity fractures associated with a post-operative management as suggested by the present study, can result in acceptable functional consequences without perceptible difficulties. Plausible non-anatomical reductions do not influence the results significantly.

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