

## Case Report

# Isolated avulsion fractures of lesser tuberosity humerus: a case report and review of the literature

Gen-Bin Wu<sup>1</sup>, Shu-Qing Wang<sup>1</sup>, Si-Wan Wen<sup>2</sup>, Guang-Rong Yu<sup>1</sup>

<sup>1</sup>Department of Orthopedics, Tongji Hospital of Tongji University, Shanghai 200065, China; <sup>2</sup>Department of Cardiology, Tongji Hospital of Tongji University, Shanghai 200065, China

Received January 11, 2014; Accepted February 18, 2014; Epub March 15, 2014; Published March 30, 2014

**Abstract:** In this case, a 31 year-old female was diagnosed of isolated fractures of lesser tuberosity humerus. The patient could take early functional training of shoulder joint two days after operation. Although isolated fractures of lesser tuberosity humerus are rare, when pain of anterior shoulder joint after trauma, doctors should consider isolated fractures of lesser tuberosity humerus. As for the therapy methods, they should be chosen according to time length after injury. Most of the patients had no obvious residual functional disability after treatments.

**Keywords:** Isolated fractures, lesser tuberosity humerus, functional training

### Case report

A 31 year-old female was hospitalized for falling onto her left forearm and elbow with a result of left shoulder ache and limitation of motion for four days. Physical examination showed swollen of left upper limb, mild limitation of shoulder joint movement, pain of active and passive movements, increasing pain during supination and adduction, no marked deformities or ecchymoma, good blood circulation, sensation and motion of left acral. The X-ray photo (**Figure 1**) showed overlap images of lesser tuberosity humerus and humeral head, continuous bone cortex, swollen soft tissue of left arm. CT (**Figure 2**) showed avulsion fracture of left lesser tuberosity humerus, normal joint position, no widening or narrowing of joint space.

There are big fracture fragment and obvious displacement in this patient. So operators took oblique deltoid incision outside of coracoid, pulled down the subscapularis and reduced under direct vision. Guide wires were first used, and then three 4 mm cannulated screws were placed (**Figure 3**). There was no longer fractures or displacement when passive movements of shoulder joint during operation. Patient could take early functional training of shoulder joint two days after operation.

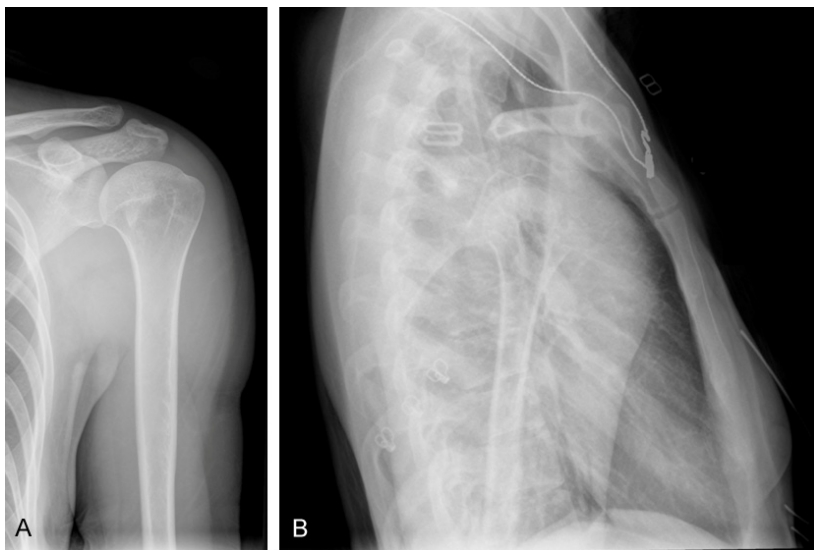
### Discussion

The first reported isolated fracture of lesser tuberosity humerus was fracture of lesser tuberosity humerus together with fracture of proximal humerus on the same side of a 17-year-old younger, reported by Hartigan et al. in 1985 [1]. Avulsion fracture of lesser tuberosity humerus often classified with Neer V type fracture and occurs concurrently with dislocation of the posterior shoulder joint and fracture of the proximal humerus. Isolated fractures of the lesser tuberosity humerus (Neer I type) are extremely rare, occurring in only 0.46 persons per 100,000. It's reported that rate of missed diagnosis of fractures of lesser tuberosity humerus is highest for its low incidence, among different kinds of proximal humerus fractures. Imaging test should be taken at first visit to doctors, if isolated fracture of lesser tuberosity humerus is considered. There is always no typical imaging or only a sliver of bone in the region of the lesser tuberosity [1], because of the overlaps of bones' imaging in X-ray. There is even no abnormalities during arthroscopy [2]. So it is always old fracture (>50%) when found.

### Mechanism of injury

Isolated fracture of lesser tuberosity humerus could be divided in two to categories according

## Isolated fractures of lesser tuberosity humerus



**Figure 1.** X-ray of humerus. The X-ray showed overlap images of lesser tuberosity humerus and humeral head, continuous bone cortex, swollen soft tissue of left arm. A: Anteroposterior position; B: Transthoracic position.

to violence which leading to injury: direct violence and indirect violence. The mechanism of injury is a traumatic event or repetitive stress to the subscapularis tendon attachment with the arm abducted and externally rotated [3]. High-risk people of fractures of lesser tuberosity humerus are athletes and skeletally immature adolescents with high daily activity. Patients usually had active history with anterior arm over shoulder, like falling down from a height, a backward violent fall, being thrown down during a Japanese wrestling match, motorcycle crash. The mechanism of the lesser tuberosity fracture in this patient was 90° of abduction with external rotation during an evasive movement. When the arm is in 90° of abduction, the muscle is relaxed [1]. While, a forced external rotation of the shoulder at 60 degrees of abduction might lead to fracture [4]. Or patients fell onto the forearm or elbow from a standing-height, with external rotation and abduction of shoulder and excessive tension of subscapularis, which finally leads to avulsion fracture of lesser tuberosity humerus [5]. Mechanism that repetitive contraction of subscapularis caused fatigue fractures of lesser tuberosity humerus was seldom reported. Also a few authors reported isolated fractures of lesser tuberosity humerus caused by forced extension and internal rotation of shoulder joint (i.e. back-reach position) [6]. To the most serious, shoulder joint might partially or totally dislocated [3]. The frac-

ture developed into fatigue fractures of lesser tuberosity humerus at late stage: formation of callus, endochondral ossification of the fracture hematoma, avulsed glenohumeral capsule attaching to the posterior aspect of the exostosis, predisposing the shoulder to instability and disuse atrophy of muscle [7].

### *Clinical manifestation*

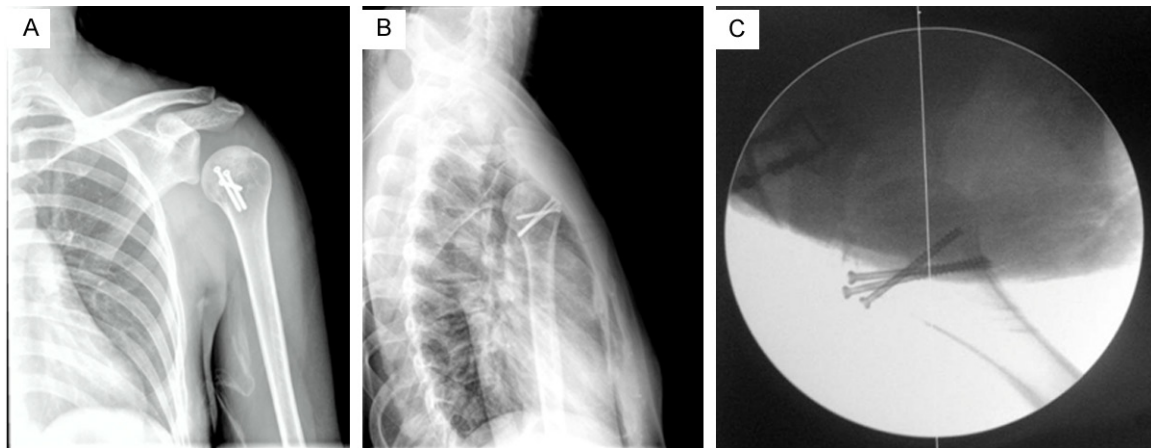
Mild or no limitation of shoulder joint movement, pain during adduction of upper limb, tenderness of anterior of upper limb are the often manifestation of patients. There is no de-

formities or ecchymoma of shoulder joint at the acute stage of fracture. No typical sign of disability of internal rotation and adduction can be found for extensive tenderness of shoulder joint and moving pain. Fractures with few or without displacement are hard to be diagnosed via anteroposterior chest and proximal humeral chest X-ray films [4], while they should be diagnosed through CT or CT three dimensional reconstruction, which is the main reason for missed diagnosis. Most of the patients had typical clinical manifestation: excessive pain with active external rotation of upper limb (extremely external rotation of fatigue fracture patients), tenderness of anterior of shoulder joint, decrease of myodynamia of medial muscle group in manual muscle testing when 45 degree of external rotation. Unlike acute phased patient, fatigue fracture patients had no pain but only dysfunction of shoulder joint several years after injury. They had disability of active internal rotation of shoulder joint, decrease of myodynamia of subscapularis, and sometime increase of myodynamia of extortor. The imaging test showed obvious callus, ossification of cartilaginous and ossification of hematoma. Teixeira RP reported two cases. There is no obvious abnormalities after injury with 10-hour-long activity everyday. Pain of anterior of shoulder joint occurred after 72 hours after injury, which aggravated with active and passive movement. These patients had

## Isolated fractures of lesser tuberosity humerus



**Figure 2.** CT scans of humerus. Different levels of CT scans (A, B) showed avulsion fracture of left lesser tuberosity humerus, normal joint position, no widening or narrowing of joint space.



**Figure 3.** X-ray of humerus during and after surgery. Guide wires were first used, then three 4 mm cannulated screws were placed. (A) Anteroposterior position; (B) Transthoracic position. There was no longer fractures or displacement when passive movements of shoulder joint during operation (C).

tenderness of lesser tuberosity humerus and positive subscapularis test. The proximal humeral chest X-ray showed isolated lesser tuberosity humerus.

### *Treatment*

When disability of adduction and internal rotation of shoulder joint occurred after trauma, fractures of lesser tuberosity humerus should be taken in account. CT scan could be helpful for diagnosis. There is still controversy in treatment: operate or not to operate, which can kind of operation should be chosen? The most common treating methods used in clinic included forearm straps, arthroscopy internal fixation, open reduction and internal fixation, and percutaneous closed reduction and internal fixation

[5]. The operator should choose different operation according to the type of fractures.

Conservative treatment was suitable for isolated fractures of lesser tuberosity humerus without or with few displacements. Forearm straps were used for six to eight weeks [4, 5]. Patients should take appropriate functional training after remove of straps. Most of them would have good prognosis. When displaced avulsion fractures of lesser tuberosity humerus occurred, they should be treated via operation in order to release pain of shoulder joint and regain range of motion.

Operations used in clinical included anchor suture fixation and cancellous bone screw fixation. It has been our experience that the ana-

## Isolated fractures of lesser tuberosity humerus

tomic footprint of the lesser tuberosity is cancellous and often lacks the cortical shell needed for small-diameter suture anchors. In these situations, the surgeon should be prepared to use larger threaded suture anchors or to utilize transosseous suture repair techniques. Finally, care must be taken during the transosseous repair so as not to injure the biceps tendon. If utilizing transosseous sutures, the sutures typically enter medial to the bicipital groove and are tied over an osseous bridge lateral to the biceps [8]. Garrigues GE et al. [2] preferred a lasso technique using suture anchors and sutures to loop over and hold down the fragment to internal fixation using screws or sutures through drill holes in the tuberosity after a large amount of follow-up. Shoulder joint functions of most patients could recover, even with serious displacement after operation. Range of motion and myodynamia of subscapularis could recover to normal levels after operation.

Arthroscopy is a novel treating method of isolated avulsion fractures of lesser tuberosity humerus so far. Arthroscopy consists of two steps: closed reduction and internal fixation. Patients would have anatomical and functional reduction after operations. Arthroscopy could be used for all displaced isolated fractures of lesser tuberosity humerus.

Open reduction and internal fixation was recommended, only when serious fractures of lesser tuberosity humerus (Neer V type) occurred or fractures occurred associated with dislocation of biceps [9]. The recommendation is because that fractures caused by subscapularis could lead fracture nonunion, coracoid impaction, dislocation of long head of biceps tendon. Patients had good prognosis, with no pain and residual neurologic sequelae, normal myodynamia of internal rotation and adduction, negative shoulder joint lift test and negative in adduction test. Garrigues GE et al. reported that average American Society for Shoulder to Elbow Surgeon Scores of six patients was 97 (range: 88-100), and average Ontario Shoulder Joint Instability index was 94 (range: 84-100) after operation [10].

Some researchers pointed recently that therapy methods for fractures of lesser tuberosity humerus should be chosen according to the time after fracture. Isolated fractures of lesser tuberosity humerus divide into acute and

chronic, according to the time between injury and hospital. Open or closed reduction internal fixation could be used for acute isolated fractures of lesser tuberosity humerus. Patients of fatigue fractures without displacement should first accept conservative treatment, because of the poor conditions of local soft tissue. Patients could have operations when the effects of conservative treatment were bad [11]. Patients of fatigue-displaced fractures should be treated by operations, because of the shoulder joint dysfunction cause by callus. Surgeons should totally remove the callus in operation. When tendon degenerated and atrophied, operators should do muscle transplant using pectoralis major [7]. Ogawa K took a 30-year-long follow-up study for 10 patients. Six of them were acute injuries. Injured times of 4 patients were longer than 6 months. 3 acute injured patients accepted conservative treatment, whose prognosis were good. 3 other acute injured patients accepted operations. Prognosis of two were perfect, one was good. Four chronic patients all took muscle and strength training. Two of them took further operations for bad conservative treatment. They all had good prognosis. So Ogawa K concluded that acute patients are recommended for open reduction and internal fixation, while chronic ones are recommended for conservative treatments, operations is just a salvage for conservative treatments [11].

### Conclusion

Although isolated fractures of lesser tuberosity humerus are rare, when pain of anterior shoulder joint after trauma especially occurred in skeletally immature adolescents, without exact case history and body signs, doctors should consider isolated fractures of lesser tuberosity humerus [7]. Usually, case histories and physician examinations are normal. Only a few cases had typical tenderness of anterior of shoulder joint and positive subscapularis test. Diagnosis could be conformed by shoulder joint internal rotation, external rotation, neutral position, outlet view and sternal chest X-rays and MRI [1]. As for the therapy methods, they should be chosen according to time length after injury. Most of the patients had no obvious residual functional disability after treatments.

### Disclosure of conflict of interest

None.

## Isolated fractures of lesser tuberosity humerus

**Address correspondence to:** Dr. Guang-Rong Yu, Department of Orthopedics, Tongji Hospital of Tongji University, 389 Xincun Road, Shanghai 200065, China. E-mail: guangrongyu\_00@163.com

### References

- [1] Harper DK, Craig JG and van Holsbeeck MT. Apophyseal injuries of the lesser tuberosity in adolescents: a series of five cases. *Emerg Radiol* 2013; 20: 33-37.
- [2] Garrigues GE, Warnick DE and Busch MT. Subscapularis avulsion of the lesser tuberosity in adolescents. *J Pediatr Orthop* 2013; 33: 8-13.
- [3] Teixeira RP, Johnson AR, Higgins BT, Carrino JA and McFarland EG. Fly Fishing-related Lesser Tuberosity Avulsion in an Adolescent. *Orthopedics* 2012; 35: e748-e751.
- [4] Kanso I and Bricout J. Isolated avulsion fracture of the lesser tuberosity of the humerus. Apropos of a case. *Rev Chir Orthop Reparatrice Appar Mot* 1998; 84: 554.
- [5] Gruson KI, Ruchelsman DE and Tejwani NC. Isolated tuberosity fractures of the proximal humerus: current concepts. *Injury* 2008; 39: 284-298.
- [6] Ohzono H, Gotoh M, Mitsui Y, Kanesaki K, Okawa T, Higuchi F and Nagata K. Isolated fracture of the lesser tuberosity of the humerus: a case report. *Kurume Med J* 2011; 58: 131-133.
- [7] Goeminne S and Debeer P. The natural evolution of neglected lesser tuberosity fractures in skeletally immature patients. *J Shoulder Elbow Surg* 2012; 21: e6-e11.
- [8] Vezeridis PS, Bae DS, Kocher MS, Kramer DE, Yen YM and Waters PM. Surgical treatment for avulsion injuries of the humeral lesser tuberosity apophysis in adolescents. *J Bone Joint Surg Am* 2011; 93: 1882-1888.
- [9] Scheibel M, Martinek V and Imhoff AB. Arthroscopic reconstruction of an isolated avulsion fracture of the lesser tuberosity. *Arthroscopy* 2005; 21: 487-494.
- [10] Levine B, Pereira D and Rosen J. Avulsion fractures of the lesser tuberosity of the humerus in adolescents: review of the literature and case report. *J Orthop Trauma* 2005; 19: 349-352.
- [11] Ogawa K and Takahashi M. Long-term outcome of isolated lesser tuberosity fractures of the humerus. *J Trauma* 1997; 42: 955-959.