

Surgical Management of Isolated Greater Tuberosity Fractures of the Proximal Humerus

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KEYWORDS

- Proximal humerus fracture • Greater tuberosity fracture • Rotator cuff
- Open reduction and internal fixation • Glenohumeral dislocation • Arthroscopic internal fixation

KEY POINTS

- Because the greater tuberosity is the insertion site of the posterior superior rotator cuff, fractures can have a substantial impact on functional outcome.
- Although the greater tuberosity is commonly involved in proximal humerus fractures, isolated fractures are not and can be inadvertently trivialized.
- Thorough patient evaluation including adequate imaging is required to make an appropriate treatment decision.
- In most cases surgical management is considered when there is displacement of 5 mm or greater.
- Although reduction of displaced greater tuberosity fractures has traditionally been performed with open techniques, arthroscopic techniques are now available.
- The most reliable techniques of fixation of the greater tuberosity incorporate the rotator cuff tendon bone junction rather than direct bone-to-bone fixation.

INTRODUCTION

Although proximal humerus fractures account for approximately 5% of all fractures and many involve the tuberosities, isolated greater tuberosity fractures are less common and only account for about 2% of proximal humerus fractures.¹⁻³ The intimate association of the rotator cuff with the tuberosities has a substantial impact on the management and outcome of these injuries. In addition, age-related factors such as activity level and bone quality play a role in the treatment of

greater tuberosity fractures. The appropriate management of these fractures is predicated on having a clear understanding of the relevant anatomy, fracture characteristics, associated injuries, and patient factors. This article focuses on current principles of surgical management of isolated greater tuberosity fractures.

ANATOMY

The greater tuberosity is an apophyseal structure of the proximal humerus. Ossification of the

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greater tuberosity occurs during the second and third years of life. On average, the superior aspect of the greater tuberosity is 6 to 8 mm inferior to the most superior aspect of the articular surface of the humeral head⁴ and is composed of 3 facets: superior, middle, and inferior.⁵ Recent anatomic studies show that the rotator cuff tendon insertions on the greater tuberosity are more complex than earlier descriptions (Fig. 1).⁵⁻⁷ An earlier anatomic study found that the supraspinatus tendon inserts on the superior facet and the superior half of the middle facet, whereas the infraspinatus tendon inserts on the entire middle facet, covering a portion of the supraspinatus tendon.⁵ A more recent anatomic study by Mochizuki and colleagues⁶ describes a different relationship in which the supraspinatus insertion is localized to the anteromedial aspect of the highest impression of the superior facet and the infraspinatus insertion is localized to the anterolateral aspect of the highest impression of the superior facet and all of the middle facet. The soft tissue attachments of the rotator cuff affect the direction and amount of displacement of the fractured greater tuberosity. The force vectors of the supraspinatus and upper aspect of the infraspinatus result in superior displacement, whereas the lower infraspinatus and teres minor cause posterior displacement. Understanding this anatomy helps to guide both the evaluation of injuries and the operative management of displaced fractures.

The vascularity of the greater tuberosity, as well as the humeral head articular segment, derives from an anastomosis of vessels from the posterior humeral circumflex vessels and the ascending branch of the anterior humeral circumflex artery (arcuate artery), and to a lesser degree by the rotator cuff tendons and joint capsule.^{8,9} Hettrich and

colleagues⁹ performed a quantitative assessment of the blood supply to the humeral head and found that, overall, the posterior humeral circumflex artery contributes more to the blood supply (64%) than the anterior humeral circumflex artery (36%), including the area containing the greater tuberosity. Isolated fractures of the greater tuberosity have not proved to compromise blood flow to the humeral head.¹⁰

Proximal humerus fractures, including isolated greater tuberosity fractures, are commonly associated with neurologic injury. The axillary nerve, a branch of the posterior cord of the brachial plexus, passes inferior to the subscapularis muscle and through the quadrilateral space before dividing into anterior and posterior branches, which provide innervation to the deltoid and teres minor muscles respectively, as well as sensory innervation to the lateral aspect of the upper arm and shoulder. The axillary nerve is thus tethered anteriorly and posteriorly and subject to traction injury, especially with glenohumeral dislocation. The suprascapular nerve passing through suprascapular notch and around the scapular spine at the spinoglenoid notch provides innervation to the supraspinatus and infraspinatus muscles. Both of these important peripheral nerves, as well as the more proximal aspects of the brachial plexus, are susceptible to traumatic and iatrogenic injury.

FRACTURE CLASSIFICATION

Codman's¹¹ early observation that fracture patterns involving the proximal humerus fractures often occurred along the physeal scars of the proximal humerus formed the basis for Neer's¹⁰ 4-part classification system. The humeral shaft,

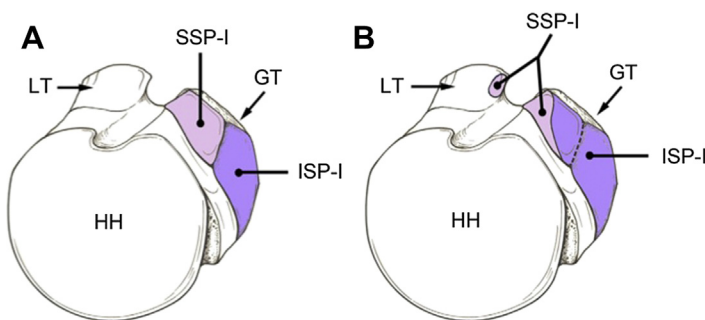


Fig. 1. The insertion of the rotator cuff tendons onto the greater tuberosity. (A) The generally accepted concept of the anatomy of the humeral insertions. The supraspinatus is shown to insert into the highest impression, and the infraspinatus into the middle impression of the greater tuberosity. (B) The findings of the present study. The insertion area of the infraspinatus occupies about half of the highest and all of the middle impression of the greater tuberosity. The insertion area of the

supraspinatus is located at the anteromedial region of the highest impression and is sometimes located at the superior-most area on the lesser tuberosity. GT, greater tuberosity; HH, humeral head; ISP-I, insertion area of the infraspinatus; LT, lesser tuberosity; SSP-I, insertion area of the supraspinatus. (From Mochituki T, Sugaya H, Uomizu M, et al. Humeral insertion of the supraspinatus and infraspinatus. *J Bone Joint Surg Am* 2008;90:962-9; Figs. 6A and B; with permission.)

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