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Evaluation of Isolated Greater Tuberosity Fractures Based on Morphological Classification - A Retrospective Analysis

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Abstract: *Approximately 3% of upper limb fractures occur in the proximal humerus1 and the injury affects both younger and older populations. Need and AO classification however could not incorporate technical implications of surgery, its prognostic outcome. A morphological classification developed by Dutch et al addressed prognostic or technical implications of the variable morphology found in these fractures. In the present study, the perspective of early investigation and to provide the basis for the evaluation and management of these injuries. Furthermore, the morphological classification, evaluation, treatment, and results are reviewed in the context of the current approach to the management of isolated greater tuberosity fractures. Morphological classification of isolated greater tuberosity fractures may serve as an adjunct to the Neer and AO classifications with no additional cost or radiation exposure for implementation. Isolated greater tuberosity fractures can be managed conservatlvey managed only when minimally displaced and significant displacement over 5 mm needs surgical intrervention.*

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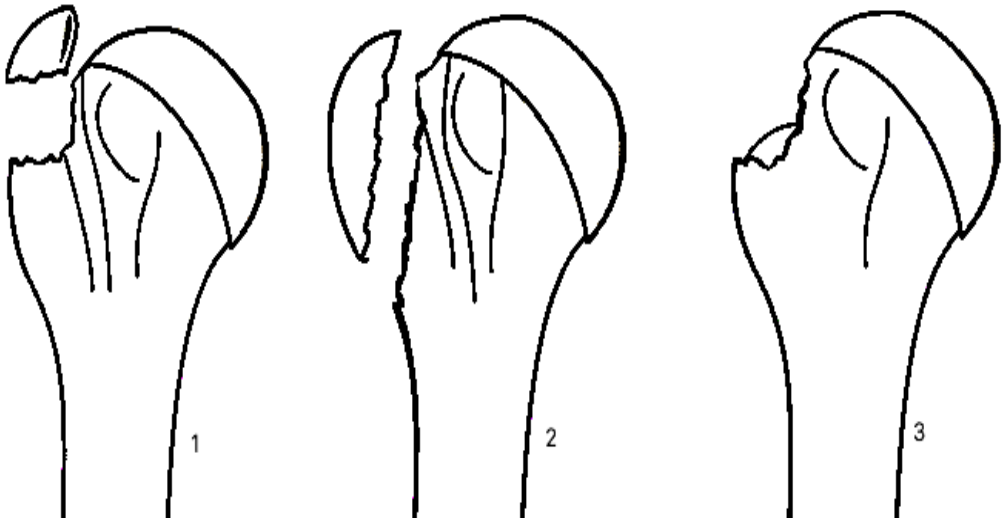
I. Introduction

Approximately 3% of upper limb fractures occur in the proximal humerus1 and the injury affects both younger and older populations. Isolated injuries of the greater tuberosity (GT), the site of insertion of supraspinatus and infraspinatus, represent approximately 20% of proximal humerus injuries. They are often associated with anterior glenohumeral dislocation or can result from an impaction injury, also called a shear injury, against the lower surface of the acromion or superior glenoid. [3] Despite being a well recognized clinical entity, the diagnosis of a greater tuberosity fracture is fairly commonly missed, ignored, or trivialized. This can result in an unacceptable treatment outcome. Perhaps it is the uncommon nature of this injury that leads to these problems, as many orthopaedic surgeons have only limited personal clinical experience with these injuries, and other health care providers may not be sufficiently aware of the significance of these injuries. Adequate understanding of these injuries is imperative. With the ageing of our population and associated osteoporosis, these injuries may become more common and will require appropriate care.

In order to guide treatment, several systems of classification have been proposed, of which the most popular are those of Neer [4,5] and the AO foundation. [6] Neer originally classified greater tuberosity fractures as two-part if they were displaced more than 1 cm but fragments displaced more than 5 mm superiorly are usually now considered suitable for surgical treatment. [7,8] The AO classification added an additional category of displaced fractures associated with glenohumeral dislocations. [9] Both of these classifications address only one type of GT fracture, namely a large fragment with a vertical fracture line, and while the recommendation for surgical fixation of superior displacement is apparently valid, it does not adequately deal with the prognostic or technical implications of the variable morphology found in these fractures. Fragment size, shape and orientation may reflect different mechanisms and velocity of injury. Additionally, the technical aspects of GT fragment fixation are affected by fracture morphology. GT fractures caused by avulsion was described by Bhatia [10] and Fahmy [11]. Additionally, a GT fracture by impaction was described by Davies [12] and Kaspar [13] as a very lateral Hill–Sachs type lesion that was found outside the articular surface of the humeral head.

Mutch et al [14] proposed a valid morphological classification addressing the above scenarios. Morphologically, greater tuberosity fractures can be classified in to three 1. An avulsion fracture involves small frag- ments of bone with a horizontal fracture line. The mechanism would be similar to that which causes a rotator cuff tear. 2. A split fracture generally involves a large fragment with a vertical fracture line. This is likely caused by impaction on the anterior surface of glenoid during dislocation or subluxation of the shoulder.3. A depressed fracture involves a fragment that is displaced inferiorly. This is probably due to impaction beneath the inferior surface of the glenoid when the humerus is dislocated in this direction or beneath the inferior surface of the acro- mion during extreme abduction. [Fig 1}

This retrospective review aims to study the perspective of early investigation and to provide the basis for the evaluation and management of these injuries. Furthermore, the morphological classification, evaluation, treatment, and results are reviewed in the context of the current approach to the management of isolated greater tuberosity fractures.



II. Methodology

64 patients with isolated fractures of the greater tuberosity of the humerus were treated at our department over a 5 year period (2012–2017). Mean age of the study group is 42 (26–85) years with 51 isolated greater tuberosity fractures of the proximal humerus could be re-examined a mean Figure 1 : 1) Avulsion fracture 2) Vertical Split fracture 3) Depressed fracture of 2.3 (0.7–4.5) years after treatment. The remaining 13 patients were lost to follow up. The mechanisms of injury were either falling from a height or falling on stairs (n = 21), vehicle trauma or motorcycle accidents (n = 23), recreational accidents (n = 3), or sporting trauma (n = 4). There was no open fracture. The right proximal humerus had been affected more often (n = 36) than the left (n = 15). Patients were evaluated retrospectively at out patient follow up, as they come for follow up review. Complaints, radiological X-ray, outcome assessment by DASH Score were documented at follow up. Mean time for follow up, radiological evaluation, clinical outcome were all analysed. Neer`s sign was examined in patients complaining with impingement symptoms. Pre-operative standard plain radiographs with true glenoid anteroposterior (AP) and trans-scapular lateral view (Y-view) of the shoulder were retrospectively evaluated. If available, complementary to standard plain radiographs (axillary views), CT scans, or MRI scans were interpreted. The extent of fragment dislocation was measured in mediolateral and craniocaudal direction. Post operative follow up imaging was done in the same format, and interpreted. The degree of fragment dislocation was classified (undisplaced to minor: ≤ 5 mm; moderate: 6–10 mm; major: > 10 mm) and calculated as the distance between the upper surface of the humeral head and the upper margin of the displaced main fragment, or the distance between the outer surface of the humeral head and the outer margin of the displaced main fragment, respectively. Anterior and cranial displacements are given as positive values, and posterior and caudal displacements as negative values.

III. Results

Of the 51 patients included in the study, 38% (n=19) of the cases were avulsion injuries, 49% (n=25) were vertical split and 13% (n=7) were depressed injuries. 38 patients with initial displacement >10 mm were operated predominantly by cannulated cancellous screws with washer [Single screw in 7 cases, 4 cases with TBW - CC screw or k wires and 2 screws with or without washer in 21 cases,]. Of the operated isolated greater tuberosity fractures (n=32), 31% (n=10) of the operated cases were avulsion injuries, and 69% (n=22) were vertical split and none were depressed injuries. Fractures in patients over 60 years were displaced significantly more often (36% vs 23%) in patients aged 60 years or younger (p = 0.002). Glenohumeral dislocation was present in 19/51 (38%) of cases overall but occurred twice as often in depression (46%) than in avulsion (21%) or split (25%) type fractures and this was statistically significant (p = 0.009). Depression type fractures were rarely displaced and needed surgical fixation of greater tuberosity, hence conservatively managed. Four cases of depressed fracture were operated later for recurrent dislocation of shoulder (n=3) and one case was operated for rotator cuff repair.

Of the 19 cases treated conservatively, 09 had displacement < 5mm, 04 had displacement 5-10 mm and 6 cases had displacement over 10 mm. Displaced fragments (n=11), less than 7 mm (range 3-7mm) which were treated conservatively in our study group had excellent result outcome as assessed by DASH score. Among the 8 fractures displaced more than 7mm, 2 displaced fragments of range 7-10mm had moderate outcome as assessed by DASH criteria. Among the 6 patients, with displacement over 10mm, 3 had moderate outcome and 3 patients had moderate outcome as assessed by DASH criteria. Among the operated cases (n= 32), vertically split fractures (n=22), 17 had excellent outcome and 5 had moderate outcome and none had poor outcome. Of the 10 avulsion injuries, 7 had excellent outcome and 3 had moderate outcome.

Fig 2 : Pre op X ray of allusion injury fixed with TBW with cc screw and ss wire.

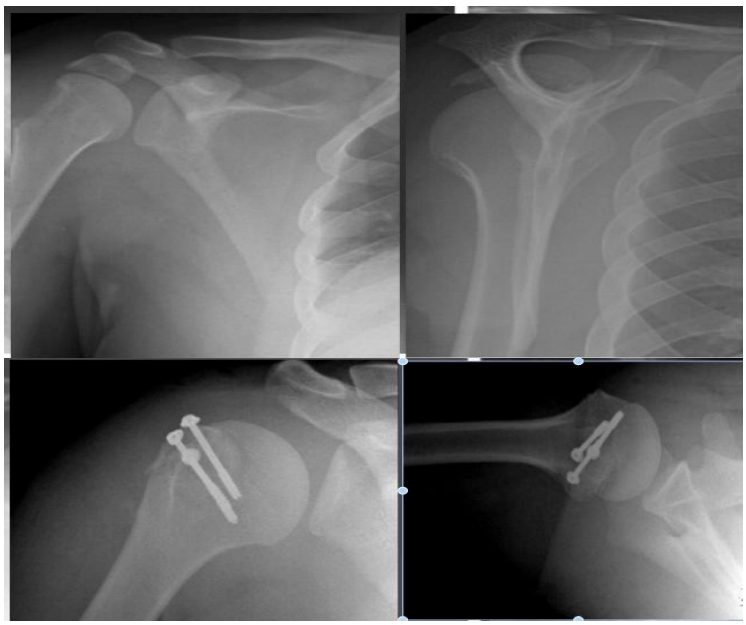


Fig 3 : pre-op X ray of split fracture treated with cc screws

IV. Discussion

The morphology of GT fractures has important implications in terms of mechanism of injury. For the depression type fracture in particular, multiple radiographs were available showing the GT depressed beneath the glenoid rim in the dislocated position. This mechanism through impaction is circumstantially supported by the significantly greater number of glenohumeral dislocations in the depression compared to the avulsion and split fracture types. However, patients with a glenohumeral dislocation that spontaneously reduces may not show any evidence of the dislocation on initial presentation. This is a source of bias and may underestimate the overall incidence of glenohumeral dislocations in our series. Fracture morphology significantly influences the technical aspects of surgical management as well. For example, a GT fracture with a large fragment (split type) can be fixed with a compression system such as a plate and screw, but this would almost certainly fail if there was a small horizontal fragment (avulsion type). In such a situation a tension band fixation may be more appropriate. Avulsion type fractures involve a small fragment of bone and the fracture line is horizontal. Barhs et al, [15] the mechanism is probably similar to rotator cuff tears with the tendon avulsing a fragment of bone rather than causing a cuff tear. Because the fragment is small and the rotator cuff is intact, it is ideally fixed with suture anchors or ethibond. However a cc screw with washer buttressing the fragment with intact cuff to it has also been effective in our small series.

The amount of fragment displacement of isolated greater tuberosity fractures that warrants surgical intervention has been discussed since the early 1970s [4]. Posterosuperior displacement of the greater tuberosity of more than 5 mm from the anatomic position can result in malunion and impingement of the shoulder due to an altered rotator cuff insertion site influencing the motion in the glenohumeral joint (15). The recommendation of Neer [4] to treat displacements of the tuberosity of less than 1 cm non-operatively has been revised, and in the current literature it is recommended that surgical fixation be used for fractures with more than 5 mm of displacement in the general population or more than 3 mm of displacement in active patients with frequent overhead activity [16,17]. Three distinct fracture morphologies described avulsion, split, and depression, have practical implications in terms of pathophysiology and surgical fixation technique However, larger, prospective studies are needed to improve our understanding of the precise mechanism of these types of fractures as well as their clinical, surgical and prognostic implications.

V. Conclusion

Morphological classification of isolated greater tuberosity fractures may serve as an adjunct to the Neer and AO classifications with no additional cost or radiation exposure for implementation. Isolated greater tuberosity fractures can be managed conservatlvey managed only when minimally displaced and significant displacement over 5 mm needs surgical intrervention.

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