

Occult fractures of the greater tuberosity of the humerus

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Abstract We studied the highest reported number of patients with occult fracture of the greater tuberosity of the humerus and we analysed why fracture was not diagnosed, shoulder function and prevalence of eventually associated rotator cuff tear (RCT). Twenty-four patients with a missed fracture of the greater tuberosity underwent MR study for a suspect RCT. We evaluated shoulder function and self-assessed comfort with the Constant score (CS) and Simple Shoulder Test (SST). Nine patients showed evidence of cuff tendinosis, 11 of partial (p) RCT (2: subscapularis; 6: supraspinatus and 3: supraspinatus and infraspinatus). All patients with pRCT were older than 40. Initially, the mean CS and SST were 54% and 5/12; at follow-up, values increased to 36% and 5 points. MR should be performed in patients apparently negative for fracture but with painful shoulders and decreased ROM. Of our patients, 45.8% had pRCT; nevertheless function recovery was verified in 16 weeks.

Résumé Nous avons étudié un grand nombre de patients qui présentaient une fracture inapparente du trochiter et nous avons analysé pourquoi cette fracture n'avait pas été diagnostiquée, quelle était ensuite la fonction de l'épaule et éventuellement de la coiffe des rotateurs. 24 patients avec une fracture passée inaperçue du trochiter ont été étudiés par IRM. Nous avons analysé la fonction de l'épaule avec le score de Constant et le test SST. 9 patients montraient à l'évidence des lésions de la coiffe et 11 avaient des lésions partielles (2 sous

scapulaires, 6 sus-épineuses et 3 sus et sous épineuses). Tous les patients avec une lésion partielle de la coiffe étaient âgés de moins de 40 ans. Le score initial de Constant et le SST était de 54% et 5/12. Au suivi, cette valeur a augmenté de 36% et de 5 points. une exploration par résonance magnétique doit être réalisée chez les patients qui apparemment n'ont pas de lésions traumatiques de l'épaule mais dont l'épaule reste douloureuse et pour lesquels il existe une diminution de la mobilité. 45,8% de nos patients présente une rupture partielle de la coiffe, cependant ils ont récupéré une bonne fonction en 16 semaines.

Introduction

It is well known that fracture of the greater tuberosity of the humerus occurs as the result of two different mechanisms of trauma. It can be the consequence of a direct impaction, as might occur in a fall on the shoulder or with hyper-abduction and impaction of the greater tuberosity against the superior glenoid or acromion, or due to avulsion injuries that habitually occur in association with anterior shoulder dislocation. In this case, fracture probably occurs as the consequence of the impact of the greater tuberosity against the glenoid or traction exercised by the rotator cuff.

X-ray examination provides an easy diagnosis in case of a displaced fracture; however, it may be missed or ignored if it is undisplaced and the radiographic series does not include an AP view with the arm in external rotation.

Mason et al. [3] referred to a series of 12 patients with persistent weakened abduction and external rotation, initially considered negative for humerus fracture, and for which diagnosis was made only after a MR exam performed for suspected rotator cuff abnormality. Authors attributed the initial mistake to the fact that external rotation

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may be limited for the shoulder pain and therefore fractures may not be visible in radiographs carried out in internal or neutral rotation or because the X-ray beam is not tangential to the curved surface of the proximal humerus. Likewise, Reinus and Hatem [7] referred to six patients who were clinically misdiagnosed as having rotator cuff injury, and consequently sent for MR examination, after which X-ray films were erroneously interpreted as negative. In a MR study [11], radiographically occult fractures of the greater tuberosity were found in 9 (38%) of 24 patients with clinically suspected traumatic tears of the rotator cuff. Finally, Patten et al. [6] support the fact that if the greater tuberosity is not displaced, radiographs may not show the fracture, regardless of the number and angle of the views obtained.

On the basis of information arising from the literature, it is supposed that many fractures of the greater tuberosity remain undiagnosed. Nevertheless, information regarding the clinical condition of these patients is only partially known. Zanetti et al. [11] followed nine patients and observed that shoulder pain persisted for a mean time of 14 weeks. No further detailed clinical information can be deduced from this or other articles.

Furthermore, the actual prevalence of rotator cuff tear associated with an occult fracture of the greater tuberosity is not clear. In fact, Reinus et al. [7] observed that only one of six patients (16%) had a partial thickness tear; Patten et al. [6] reported definite rotator cuff tears in 4 of their 24 patients (17%) with confirmed fracture (only 10 of them with initially misdiagnosed fractures), while Zanetti et al. [11] referred to a high incidence of supraspinatus and

subscapularis lesions, but with the available data no other information could be obtained.

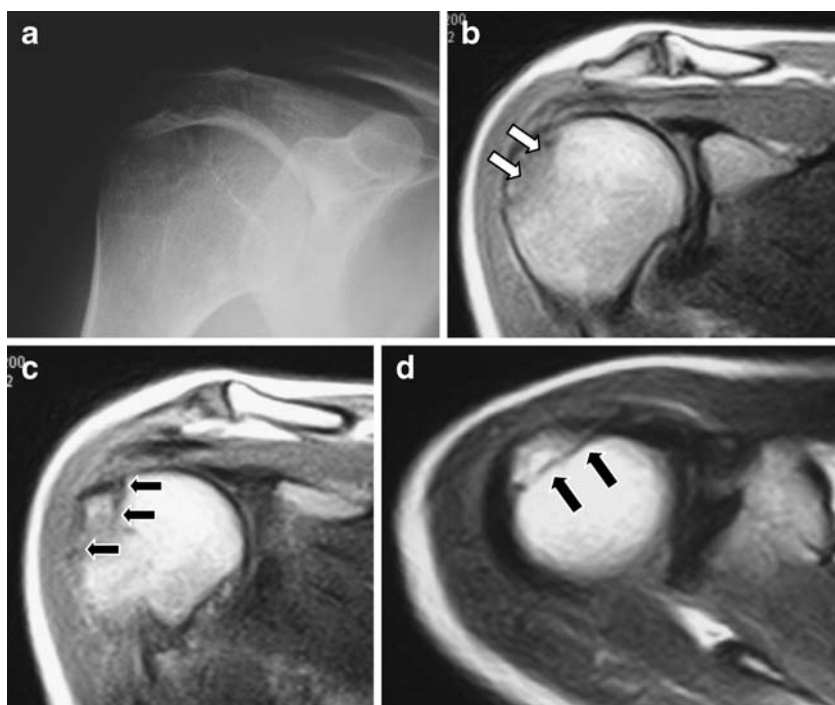
We have performed a study on the highest reported number of patients for whom, initially, a diagnosis of shoulder contusion, with a suspicion of rotator cuff lesion, was formulated and who later obtained a correct diagnosis after a clinical evaluation and X-ray and MR examinations.

Our aim is to clarify the clinical condition, rotator cuff tear prevalence and reasons why fracture was not diagnosed in patients with occult fracture of the greater tuberosity of the humerus.

Materials and methods

From 2003 to 2006, we clinically evaluated 24 patients with a undisplaced and initially missed fracture of the greater tuberosity of the humerus diagnosed by MR performed for a suspected traumatic rotator cuff tear. The study group consisted of 15 males and 9 females with a mean age of 46 (22–65 years). All patients came from our Emergency Department and all indicated that, before trauma, the injured shoulder had always been painless. After trauma, all patients presented with weakened abduction and external rotation of the humerus. Initial plain radiographs of the injured shoulder consisted of at least three views (AP in internal and external rotation; axillary or transcapular view). The radiograms were interpreted by the referring physicians as showing no evidence of fracture (Fig. 1a). Therefore, all patients were treated conservatively

Fig. 1 A 44-year-old-woman with acute right shoulder pain after hyperabduction injury to shoulder, 14 days before MR imaging. **a** Initial AP view radiograph was interpreted as normal. **b–d** Oblique coronal T1-weighted spin echo. MR shows an abnormal signal (oedema) (white arrows)(b) and a fracture line (black arrows)(c) in the greater tuberosity region. Supraspinatus tendon has abnormal signal, consisting of a partial thickness tear. Undisplaced greater tuberosity fracture (arrows) is also visible on axial T1-weighted spin echo (black arrows)(d)



except one for whom immobilisation for 1 week was recommended. The average time elapsed from the injury to our first evaluation was 18 days (3 to 28 days). In eight cases MR exam was recommended immediately after trauma, in the remaining 16 cases in our department at the first examination. The standard sequences included oblique coronal T1-weighted spin-echo images and axial multiplanar gradient-echo images supplemented with oblique coronal proton density-weighted and T2-weighted spin-echo images or oblique coronal and sagittal fat-suppressed T2-weighted images (STIR). All studies were interpreted by a musculoskeletal radiologist and by one of us (SG). The diagnosis of fracture was made if T1- or T2-weighted images showed a crescentic or oblique line of decreased signal intensity extending from the trabecular to the cortical bone (Fig. 1b–d). T2-weighted images showed that medullary bone surrounding the area of low signal intensity had increased signal intensity that was interpreted as oedema [9]. When clearly identified, fractures were classified according to Neer's method [5]. Acromion-humeral distance and cuff condition were also evaluated. In all cases the examination was performed within 4 weeks after injury. Shoulder functional assessment was performed using Constant and Murley's method [1]. Self-assessed comfort and function were documented with use of the Simple Shoulder Test.

After the MR examination provided a diagnosis, a retrospective study on radiograms that had been made in the Emergency Department was also performed.

All patients were encouraged to rehabilitate the involved shoulder 21–28 days after trauma. All cases were clinically followed for 1 year (18 cases) or more (6 cases).

Results

Fracture was best seen on the T1-weighted spin-echo sequences in the oblique coronal plane, while subacromial soft tissue and bone oedema were more evident on the T2-weighted and STIR images. All patients but one had minimal or no displacement of the fracture fragment. In the only patient whose fracture was interpreted as displaced, the fragment had migrated 5 mm laterally and posteriorly.

All fractures were classified as Neer's one part fractures; therefore conservative treatment was instituted. Of the 24 patients, 9 showed evidence of tendinosis of the posterosuperior cuff, 2 and 9 of the subscapularis and supraspinatus partial tears (bursal side), respectively. Of the latter nine patients, three had findings indicating infraspinatus partial tear, in addition. None of the patients had evidence of full-thickness rotator cuff tear. Finally, the rotator cuff of four patients was judged as normal. The average shortest

distance between the humerus and the antero-inferior margin of the acromion was $10 \text{ mm} \pm 2$ in the 11 cases with partial cuff tear and $11 \text{ mm} \pm 3$ in the remaining 13 ($P > 0.5$). All patients with partial tears were older than 40 (range 41–65 years; average 51 years).

During our first evaluation, the mean Constant score was 54% (range 38 to 68). The number of positive answers to the Simple Shoulder Test was 5/12 (range 2–10/12).

The retrospective review of the radiograms performed in the Emergency Department revealed (with awareness of the final diagnoses) subtle fractures of the greater tuberosity in 18 patients. We suppose that cause for misdiagnosis was poor quality of the radiograms (four cases) and suboptimal positioning of AP external rotation exams (three cases). No evidence of fracture was retrospectively found in six patients.

Two patients with partial tear of the bursal side of the supraspinatus and a restricted acromion-humeral space (8 mm) underwent arthroscopic subacromial decompression and cuff debridement 2 months after trauma. Both resulted in being completely asymptomatic 18 and 22 weeks respectively after the operation (Constant score 86% and 88%).

In conservatively treated patients, shoulder pain and decreased ROM persisted for a mean time of 16 weeks (range: 3–30 weeks). At the final follow-up, Constant Score percentage and Simple Shoulder Test points were, respectively, 90% (78 to 96) and 10 (8 to 12).

Discussion

Our cohort of 24 patients with misdiagnosed fracture of the greater tuberosity is the highest of those mentioned in the literature. Whoever presents with weakened abduction and external rotation after shoulder trauma should be considered as a potential patient with fractured, fracture/dislocation of the cuff injury. In the vast majority of the cases, X-ray trauma series settle any doubts. Lack of diagnosis always has been attributed either to the poor quality of radiograms or lack of the external rotation view or lack of clinical experience. In our series, poor of images performed in patients with nondisplaced fracture and suboptimal positioning of AP external rotation examinations represents the cause that most frequently interfered with a correct diagnosis. MR examination (T1-/T2-weighted spin-echo images and fat-suppressed T2-weighted images), successively carried out for persisting symptoms, revealed the fracture in all cases. Therefore, MR examination should be performed in all patients with painful shoulder and decreased range of motion despite negative fracture findings. Clinical evidence was available in all our patients. In fact, low values of the Constant score and Simple Shoulder Test

(54% and 5 points, respectively) indicate an objective decrease in shoulder function and a subjective symptoms hindering daily activities. This disability and discomfort increased during time elapsed between injury and diagnosis of fracture if the involved shoulder was not immobilised. Furthermore, in our experience, a Constant value lower than 60% cannot be attributed to a simple contusive trauma.

Published data indicates that 16%–82% [3, 7] of the misdiagnosed fractures of the greater tuberosity are, as a matter of fact, clearly visible on radiograms performed in the Emergency Department. In our series the retrospective review of the radiograms showed a subtle fracture in 18 patients (75%). This figure looks excessively mortifying for colleagues who initially excluded fracture; although, we believe that the high rate depends on our awareness of the final diagnosis and, perhaps, to our particular experience in this field.

Prevalence of rotator cuff tear associated with occult fractures of the greater tuberosity is still a reason for discussion. Although available information is poor, it is believed that one sixth [6, 7] of these patients has a tendinous lesion. In our series, 11 patients (46%) had partial tears of the anterior or postero-superior cuff. In only three cases (12.5%) were two tendons involved (supraspinatus and infraspinatus). All of the patients with partial tears were older than 40 years (41 to 65 years). This information elucidates the role of trauma, responsible for the fracture, in the genesis of the cuff tear. In fact, Sher et al. [8], studying abnormal findings on MR images on asymptomatic subjects, report that the frequency of full-thickness and partial-thickness tears increased significantly with age and that of the 25 individuals who were 40 to 60 years old, 1 (4%) had a full-thickness and 6 (24%) had a partial-thickness tear. However, this study was carried out more than 10 years ago; therefore it is possible that the reported rates are underestimated because of the low potency of the MR machine. Again, Milgrom et al. [4], using ultrasound, observed that prevalence of partial- or full-thickness tears increased markedly after 50 years of age: these were present in over 50% of dominant shoulders in the seventh decade and in 80% of subjects over 80 years of age. Finally, Fukuda [2], in a cadaveric study, observed that 7% and 13% of the examined shoulders had, respectively, a full-thickness or a partial cuff tear. Our rates seem to be more in tune with Zanetti et al.'s results [11]; in fact they believe that a high percentage of patients with occult fractures of the greater tuberosity sustain supraspinatus and subscapularis lesions. Because acromion-humeral distance among patients with and without partial cuff tear was similar, it is

plausible that cuff damage may be attributed to intrinsic factors or to the trauma. However, we believe that further studies are needed to better understand if tendinous symptoms caused by trauma may be responsible for a transitory cuff insertion derangement that may be erroneously interpreted as a partial tear.

There is only one paper referring to the symptom evolution in patients with misdiagnosed fracture of the greater tuberosity [11]. We have observed that shoulder pain and a decrease in function persist for an average period of 16 weeks. This time is just a little more than that previously reported. At the final follow-up, Constant score percentage and Simple Shoulder Test value are the same as that habitually registered in asymptomatic subjects with an age similar to our studied cohort [10]. This means that healing of nondisplaced fracture is easily achievable and that bursal partial tear will be, or could remain, asymptomatic after fracture healing. Therefore, we recommend patients to be submitted to arthroscopic cuff debridement or cuff repair only if pain and shoulder function persist after 5 months.

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