Original article – Works of SFA

Does bone density of the greater tuberosity change in patients over 70?

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ARTICLE INFO

Article history:
Accepted 20 November 2013

Keywords:
Osteoporosis
Rotator cuff tear
Bone density
Greater tuberosity
CT scan

ABSTRACT

Introduction: There are no published studies on bone density of the greater tuberosity of the humerus, which could influence the stability of reinsertion by suture anchors. The goal of our study was to determine the influence of age, gender and the type of tear on the quality of bone in the greater tuberosity.

Methodology: Ninety-eight patients over the age of 60 were included, 41 without a rotator cuff tear and 57 with an isolated stage 1 or 2 supraspinatus tear and fatty infiltration (FI) ≤ 2. The areas of measurement included cancellous bone located under the cortex of the greater tuberosity. Measurements were obtained either across from the tear or from the middle facet with greater tuberosity if the cuff was not torn. We measured average, maximum and minimum bone density and the standard deviation (SD) in each region with Osirix software.

Results: The two groups were similar for age (73), investigated side and mean densities (0.282 g/cm² vs 0.210 g/cm²). Age over 70 was a predictive factor for osteoporosis of the greater tuberosity whether or not a rotator cuff tear was present (P < 0.0001). There was less trabecular bone in women with cuff tears (P = 0.009). Stage 2 cuff retraction was predictive of osteoporosis of the greater tuberosity (P = 0.0001).

Conclusion: This is the first study in the literature to evaluate bone density of the greater tuberosity in relation to the presence or not of a rotator cuff tear in an elderly population. Female gender, age over 70 and stage 2 cuff retraction are factors responsible for osteoporosis of the greater tuberosity of the humeral head. The osteoporosis is not severe, and normally the quality of bone of the greater tuberosity should not limit stability of suture anchors.

Level of evidence: 3.

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1. Introduction

Besides the capacity to heal, an obvious question in the management of rotator cuff tears in elderly subjects is the stability of suture anchors in potentially osteoporotic bone. Imaging often shows a “bone defect or cyst” under the cortex of the greater tuberosity (Fig. 1) across from the tear, strongly suggesting that there is a risk of instability of the suture anchor, whether it is impacted or screwed, large or small. It therefore seemed important to evaluate whether the “weak link” in this type of repair was the quality of the bone for suture anchor stability, rather than the tendon itself.

Our working hypothesis was that significant changes that occur in the quality of bone of the greater tuberosity after the age of 70 could be worsened by rotator cuff injuries. The goal of this study was to determine the influence of age, gender and the type of tear on the quality of greater tuberosity bone. We evaluated the quality of the subcortical trabecular bone of the greater tuberosity by defining regions of interest or measurements that could be used and reproduced in daily clinical practice.

2. Methodology

2.1. Patients

This retrospective study included 98 patients whose files were obtained from the Picture Archiving and Communication System (PACS) of the Strasbourg University Hospital (CHU de Strasbourg); 41 patients without rotator cuff tears (group 1), who were the control group, and 57 patients with a tear (group 2). The main inclusion criterion was age over 60 (to compare patients who were older and younger than 70). The tear was limited to the supraspinatus in

Please cite this article in press as: Clavert P, et al. Does bone density of the greater tuberosity change in patients over 70? Orthop Traumatol Surg Res (2013), http://dx.doi.org/10.1016/j.otsr.2013.11.009

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1877-0568/ – see front matter © 2013 Published by Elsevier Masson SAS.
http://dx.doi.org/10.1016/j.otsr.2013.11.009

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patients presenting with a rotator cuff tear, with cuff retraction to zone 2 at most and fatty infiltration ≤ 2. The following information was obtained for each patient: age and gender, the side examined and when appropriate, the type of tear and its characteristics (retraction and fatty infiltration) [1,2].

2.2. Measurements

All original images for each patient were transferred to OsiriX software (OsiriX software v 4.1.2, 32 bit). A study protocol was developed for the greater tuberosity based on previously published and validated protocols on the use of CT scan as a method for analyzing bone density [3–5]. An identical and common region of interest (ROI = 1956 pixel²) was defined for all files (Fig. 2). With the help of the software, all CT scan images were scaled 1:1 so that the surface being studied was not different from one patient to the other. We defined the axis of the humerus from original CT scan images for reconstruction of frontal-oblique views. The region of measurement always involved cancellous bone located under the cortex of the middle facet and along the greater tuberosity. Measurements were obtained across from the tear, if present.

Slices were contiguous and we obtained 3 measurements per patient, each obtained from a slice that was separated from the preceding and next slices by 3 slices, to obtain a mean assessment of the region that was as representative as possible. The different measurements were performed during the same session for all cases.

This study did not determine bone density by g/cm², but the density of absorption of an X-ray beam in a specific region expressed in Hounsfield Units (HU) [5]. We obtained the mean, maximum and minimum (depth of trabecular rarefaction) absorption and standard deviation (SD) for each region.

2.3. Statistical analysis

Statistics were calculated using Xlistat 2007 software (Addinsoft, Paris, France). The distribution of the two groups was not normal with the Kolmogorov–Smirnov test, thus, we used non-parametric tests to compare the results of each group and to compare the groups among themselves.

P < 0.05 was considered to be significant.

3. Results

Both groups were comparable for mean age (group 1: 72.7 and group 2: 72.9 years old), side explored and mean Hounsfield density of the greater tuberosity (81.86 vs 73.02). Group 2 (cuff tear) included slightly more women than group 1 (gender ratio W/M 0.58 in group 1 vs 1.19 in group 2).

3.1. Influence of age

Age was not found to be a predictive factor of osteoporosis of the greater tuberosity in the overall series (P = 0.27), either for mean, maximum or minimum bone density. On the other hand, when the population was divided into two groups: age 60–69 on one hand, and ≥ 70 on the other hand, age was found to be a predictive factor of osteoporosis of the greater tuberosity whether or not a cuff tear was present (P < 0.001).

3.2. Influence of gender

Gender was not a predictive factor of osteoporosis of the greater tuberosity in an intact cuff (P = 0.27). On the other hand, we found trabecular rarefaction in women with cuff tears. The minimum density in this group was significantly lower than that in the group of women without tears (P = 0.009).
3.3. Influence of supraspinatus tears

Although the presence of a tear was not the cause of osteoporosis of the greater tuberosity \((P=0.127)\), this statement must be qualified in relation to the characteristics of the tear. Retraction to zone 2 was a predictive factor of osteoporosis of the greater tuberosity (bone density in zone 1 retraction vs zone 2 retraction \(-P=0.0001\)).

4. Discussion

It is well known and generally accepted that the area of maximum resistance of the proximal humerus is located at the inter-tubercular groove [6], while data for the rest of the epiphysis are either less precise or concern the humeral head rather than the tuberosities. The populations studied in the literature are different from those in the present study (a population that is often young with an indication for internal fixation) [7]. Therefore, this is the first study to specifically evaluate bone density of the greater tuberosity in relation to the presence or not of a rotator cuff tear in an elderly population with a possible indication for surgical cuff repair.

Osteoporosis is the most frequently diagnosed metabolic disease in industrialized countries, and is known to be a major cause of morbidity and incapacity in the elderly population [8]. The main predisposing factors are female gender, advanced age and menopause (chemical or natural). Although there is a correlation between bone density of the proximal humerus and the age of the patient [7,9], it is important to note that this correlation only becomes statistically significant at the age of 70. Female gender is not highly predictive of osteoporosis of the greater tuberosity. This study only confirms that there is a reduction in the ossification of trabecular bone in women. Reduction in bone density and deterioration of the bone micro-architecture of the greater tuberosity is a factor influencing fractures as well as poor stability of suture anchors [10,11]. One must be careful for the quality of the cancellous bone of the greater tuberosity in case of rotator cuff tears that are retracted to zone 2 or more. These tears may be older and the quality of bone is highly dependent upon the stresses it undergoes. [12]. Because the stresses of the rotator cuff do not penetrate deeply into the cancellous bone of the greater tuberosity [13], the presence of a tendon tear is going to rapidly affect mineralization of the subcortical bone across from this tear.

Because our protocol has been validated and has been shown to be reproducible according to the literature [3], it can be used in daily clinical practice to obtain objective, measurable information, rather than basing decisions on an impression of changes in the light and contrast of a CT scan machine. Analysis of bone density of the greater tuberosity by the radiologist could therefore become an element in the decisional criteria to help the surgeon decide on surgical repair or conservative treatment in patients over the age of 70 with slightly retracted rotator cuff tears without fatty degeneration.

5. Conclusion

This study shows that female gender, age over 70, and stage 2 or greater cuff retraction are factors correlated with osteoporosis of the greater tuberosity.

On the other hand, the osteoporosis is not deep, and the changes are not as severe as suggested in our working hypothesis. These changes in bone density are not an absolute contraindication to rotator cuff repair surgery in patients over 70.

Disclosure of interest

The main author of this article (PC) is a consultant for Mitek. PH is a consultant for Arthrex.

References