INTRODUCTION:
Rotator cuff disease is a common disorder in the aging adult population. Most studies of rotator cuff tears have focused primarily on the soft tissue component of the bone-tendon interface, while very few studies have investigated bone mineral density of the greater tuberosity in the setting of rotator cuff tears [1,2]. Although previous studies of bone quality of the greater tuberosity have focused on issues of implant fixation, we hypothesize that osseous changes in the greater tuberosity may play a role in the development of rotator cuff disease. The purpose of this study was to compare the bone mineral density of the greater tuberosity in normal subjects with that of subjects with impingement syndrome and rotator cuff tears in order to better understand the association between osseous changes and the development of rotator cuff disease.

MATERIALS AND METHODS:
The bone mineral density of the greater tuberosity was determined for three age-matched study groups: normal asymptomatic shoulders (CON, n=39), rotator cuff disease without full-thickness tears (impingement syndrome) (IMP, n=39), and full-thickness rotator cuff tears (RCT, n=39). Subjects for all three groups were males between 40 and 70 years of age.

The control group consisted of subjects who presented to our clinic for evaluation of knee disorders, with no history of shoulder pain, shoulder surgery or systemic inflammatory disease. These subjects underwent shoulder ultrasound performed by a fellowship-trained musculoskeletal radiologist to confirm the absence of a partial or full-thickness tear of the rotator cuff.

The impingement group (pre-tear disease) consisted of subjects with impingement syndrome and no evidence of full-thickness rotator cuff tears, as confirmed by MRI, ultrasound, or surgical findings. The RCT group consisted of subjects with known full-thickness attritional rotator cuff tears of the shoulder.

For all patients, digital antero-posterior shoulder radiographs were obtained. Using NIH Image Software, the bone mineral density was determined for the greater tuberosity (GT), the greater tuberosity cortex (GTc), the greater tuberosity subcortex (GTsc), and the cancellous region of the humeral head (HH). An analog grading scale from 0 to 1 was used for each radiograph with 0 representing air, and 1 the average of the medial and lateral proximal diaphysis of the humerus.

A power analysis based on published data employing the same imaging technique [1] revealed that 39 subjects in each group would be necessary to detect a 10% difference in bone density between groups with 80% power and a Type I error of 0.05. A one-way ANOVA with a Bonferroni post hoc test was used for comparisons between experimental groups. Significance was defined as p≤0.05. Data is presented as average ± standard deviation.

RESULTS:
Fifty-two subjects were enrolled as controls. Thirteen (25%) were excluded due to the presence of either a full-thickness (n=6) or partial-thickness (n=7) tear of the rotator cuff on screening ultrasound. The bone mineral density for the GT was found to be significantly higher for the normal controls compared to both impingement and cuff tear subjects (Table 1). No differences were found between the two groups of patients with known rotator cuff disease. These differences were similar for the GTc and GTsc outcome measures. No differences between groups were found for HH bone mineral density.

Although age-matching was attempted, it was found that the average age for the impingement group (50.3yrs ± 6.4yrs) was significantly lower than the control group (55.0yrs ± 8.0yrs) and RCT group (54.1yrs ± 7.6yrs). However, a linear regression using a univariate analysis of variance revealed that age did not have an effect on any of the measures of bone density.

Table 1: Age and relative bone densities for groups of normal controls (CON), impingement syndrome (IMP), and full-thickness rotator cuff tear (RCT). Significant difference (p<0.05) compared to CON indicated by bold; Significance between IMP and RCT indicated by cursive.

<table>
<thead>
<tr>
<th>Age (yrs)</th>
<th>CON</th>
<th>IMP</th>
<th>RCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>GT</td>
<td>0.63±0.08</td>
<td>0.54±0.19</td>
<td>0.51±0.20</td>
</tr>
<tr>
<td>GTc</td>
<td>0.64±0.09</td>
<td>0.55±0.20</td>
<td>0.51±0.21</td>
</tr>
<tr>
<td>GTsc</td>
<td>0.63±0.08</td>
<td>0.54±0.20</td>
<td>0.51±0.21</td>
</tr>
<tr>
<td>HH</td>
<td>0.78±0.05</td>
<td>0.77±0.12</td>
<td>0.75±0.12</td>
</tr>
</tbody>
</table>

DISCUSSION:
We have demonstrated that bone mineral changes in the greater tuberosity are present in shoulders with cuff disease both with and without full-thickness tears. This suggests that osseous changes in the greater tuberosity do not only occur in the setting of cuff tears and this may help us better understand the development of rotator cuff disease. Although there is no evidence that bony changes play a role in the etiology of cuff disease the maintenance of bone mineral density in the proximal humerus might be studied as a preventative measure against the development rotator cuff disease. The absence of focal demineralization within the humeral head for any of the rotator cuff disease groups suggests that disuse osteopenia is not likely an explanation for the reduction in greater tuberosity bone mineral density.

REFERENCES:

ACKNOWLEDGEMENTS:
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