### Introduction:
Studies using dual-energy x-ray absorptiometry (DXA) have shown that relatively modest increases in bone mineral density (BMD) caused by treatment with alendronate result in large decreases in fracture risk [1]. Because BMD only accounts for approximately 70 percent of bone strength, other aspects of bone, including trabecular bone micro-architecture, are thought to be important in determining overall bone quality [2]. In this study we analyzed trabecular bone micro-architecture in the proximal femora of postmenopausal women using high-resolution parallel magnetic resonance imaging (MRI). Correlation coefficients were calculated to determine whether relationships existed between MRI-based micro-architectural parameters and DXA-based T-scores. The results of this study will provide baseline values for an ongoing longitudinal study of the effects of alendronate on trabecular bone micro-architecture.

### Materials and Methods:
Fifty-three postmenopausal women classified as osteopenic (T-score -1.1 to -2.5) based on BMD measurements at the spine and hip were recruited for a longitudinal study comparing the effects of alendronate and placebo on trabecular bone micro-architecture. High resolution MR images of the left hip were acquired in 37 of the study participants (mean age = 55 years; range = 48 to 61 years). Consistent limb and surface coil placement were achieved using a foot alignment device and coil holding belt. Images of the proximal femoral trochanter were obtained on a 3-Tesla GE Signa system. Parallel imaging was employed using a four-element, dual-phased array coil and a multi-acquisition bSSFP (fully-balanced steady-state free precession) sequence. Using this imaging protocol, a total of 74 coronal slices with a thickness of 1 mm and an in-plane resolution of 234 μm were obtained in a scan time of 11 to 12 minutes. A region of interest was manually defined in the volume of trabecular bone contained between the epiphysis and the cortex of the greater trochanter, and ten slices of each image were analyzed using in-house software. Mean bone volume fraction (BV/TV), apparent trabecular thickness (Tb.Th), apparent trabecular number (Tb.N), and apparent trabecular separation (Tb.Sp) were computed for each set of analyzed slices. The same 37 subjects were imaged with DXA (32 subjects on a Hologic QDR 4500 system; 5 subjects on a GE Healthcare Lunar Prodigy system) to obtain the T-score of the trochanter region for comparison with MRI-based parameters. The Pearson correlation coefficient between the DXA-based trochanteric T-score and each of the four micro-architectural parameters was determined, and correlations were considered significant for p < 0.05.

### Results:
Mean bone micro-architectural parameters and DXA T-scores are provided below (Table 1). Significant (p < 0.02) correlations with trochanteric T-score were detected for Tb.N (positively correlated) and Tb.Sp (negatively correlated) and the relationship between T-score and BV/TV approached significance (p = 0.054).

### Table 1.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean (±SD)</th>
<th>Standard Deviation</th>
<th>Correlation with T-Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>BV/TV</td>
<td>0.354</td>
<td>0.256</td>
<td>-0.32</td>
</tr>
<tr>
<td>Tb.N (mm)</td>
<td>0.123</td>
<td>0.181</td>
<td>0.04</td>
</tr>
<tr>
<td>Tb.Sp (mm)</td>
<td>0.137</td>
<td>0.181</td>
<td>-0.32</td>
</tr>
<tr>
<td>Tb.Th (mm)</td>
<td>0.137</td>
<td>0.181</td>
<td>-0.32</td>
</tr>
<tr>
<td>Trab T-Score</td>
<td>0.04</td>
<td>0.06</td>
<td>-0.32</td>
</tr>
</tbody>
</table>

### Discussion:
The results of this study suggest that Tb.N and Tb.Sp are related to DXA-based T-scores in the greater trochanter. It was expected that BV/TV would likely demonstrate a relatively strong correlation with T-score, but the relationship was just outside the range of statistical significance. Follow-up imaging at the 12-month time point is currently being performed and will offer the opportunity to determine whether longitudinal changes in DXA T-scores and MRI-based micro-architecture differ between postmenopausal women treated with alendronate and those treated with placebo. The longitudinal study will also help to determine whether micro-architectural changes with alendronate treatment contribute to the clinical observation that relatively small increases in BMD coincide with large decreases in fracture risk.

Trochanteric micro-architecture in this cohort of postmenopausal women was similar to that measured in a smaller sample (n = 6) of young, healthy males using scanning and analysis protocols identical to those used in this study [3]. Although no significant differences were present, the values of BV/TV, Tb.N, and Tb.Th were all slightly higher in postmenopausal women. This unexpected result may be explained by differences in thickness of overlying soft tissue and changes in relative amounts of hematopoietic and fatty bone marrow that occur with age. These differences in soft tissue thickness and marrow can affect the signal obtained in the trochanteric region by the surface coils.

Using the imaging and analysis methods presented above, relatively low signal and the heterogeneous mix of hematopoietic and fatty bone marrow also preclude a meaningful analysis of trabecular bone micro-architecture in the femoral neck, which is likely a more relevant site for evaluating factors related to fracture risk. However, because the greater trochanter is often the site of impact in a fall to the side, the trabecular bone micro-architecture in this region is an important component of the biomechanical environment of the proximal femur in the event of a fall.

### References:

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