CALCIFIED FIBROCARTILAGE ON THE HUMAN FEMORAL NECK

**Introduction:**
Femoral neck fractures are a significant cause of morbidity and mortality in the elderly. Recent investigations have identified a hypermineralized tissue on the neck of the femur that increases in fractional area with age in both males and females\(^1\). The origin of this tissue is unknown. The tissue is found on the periosteal surface, and contains a large number of cracks. These cracks are most likely processing artifacts, but suggest that the tissue is more prone to fracture. It has been hypothesized that the tissue is correlated with tendon and ligament insertion sites\(^2\). Tendon and ligaments attach via four zones: 1) collagen, 2) fibrocartilage, 3) calcified fibrocartilage, 4) bone\(^1\). The purpose of this study is to determine if the hypermineralized tissue in previous investigations is calcified fibrocartilage from tendon and ligament insertions, and to determine how the quantity of this tissue varies along the superior region of the neck of the femur.

**Materials and Methods:**
Seven femurs were obtained from Caucasian females (4) and males (3). Since the hypermineralized tissue has been reported to be more prevalent in elderly specimens, donors had a mean age of 62 ± 3. The specimens were embedded in methylmethacrylate. A 3mm coronal section, corrected for anteversion, was taken from the midsection of each neck. The embedded specimens were initially examined using back scattered electron (BSE) imaging. The length of the neck was divided into 6 equal regions and a 100X image taken at the middle of each region. Region 1 was defined as the region closest to the greater trochanter, and region 6 was defined as the region closest to the head of the femur. A grid was placed over each image and a semi-automated point counting technique was used to measure the fractional area of void space (porosity), hypermineralized tissue and cortical bone, where the sum of all three phases was considered to be the total area. The above methods used matched previously reported techniques\(^2\). Following BSE imaging, the sections were stained with Modified Giemsa and viewed under a light microscope at a similar magnification. The same regions that were imaged with BSE were viewed to determine if the hypermineralized tissue was located at a tendon or ligament insertion, and if it had a similar morphological appearance as the calcified fibrocartilage of the insertion. Data followed a skewed non-normal distribution; therefore the nonparametric Kruskal-Wallis test was used for statistical analysis with region as the influencing factor.

**Results:**
No statistically significant difference (p>0.14) was observed among the six different regions in terms of percent area of porosity and cortical bone (Table 1). The percent of hypermineralized tissue ranged from zero to 31.4 percent, and there was a tendency for differences among the six regions (p = 0.07).

The light microscopy results found that the areas that contained hypermineralized tissue corresponded to the calcified fibrocartilage zone of the insertion site (Figure 1). The hypermineralized region had similar lacunar morphology as the calcified fibrocartilage. It was also possible to match morphological features, such as pore pattern and structure, in the BSE images with equivalent areas in the light microscope images to determine the location of the hypermineralized tissue (Figure 1). Regions of the neck that did not contain calcified fibrocartilage had a layer of connective tissue that resembled the periosteum found on the diaphysis. The osteogenic capability of the areas with the apparent periosteum was not known.

**Discussion:**
The hypermineralized tissue previously observed on the neck of the femur appears to be a calcified fibrocartilage associated with a tendon or ligament insertion. There are no reported muscle insertions on the neck of the femur, but the ones observed in the present study are most likely from muscles inserting onto the trochanteric fossa and capsular insertions. A large variability exists in the relative amount of calcified fibrocartilage observed on the neck of the femur, with some specimens having more than 20% of the examined area composed of calcified fibrocartilage, rather than cortical bone.

**Table 1. Regional differences at the neck of the femur. (mean ± SE)**

<table>
<thead>
<tr>
<th>Region</th>
<th>Porosity (%)</th>
<th>Hyp. (%)</th>
<th>Ct. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>22.1 ± 9.03</td>
<td>3.3 ± 2.1</td>
<td>74.5 ± 9.7</td>
</tr>
<tr>
<td>2</td>
<td>20.4 ± 7.0</td>
<td>4.8 ± 2.0</td>
<td>74.8 ± 8.0</td>
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<tr>
<td>3</td>
<td>24.5 ± 10.7</td>
<td>10.4 ± 4.3</td>
<td>65.2 ± 9.8</td>
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<tr>
<td>4</td>
<td>9.5 ± 3.8</td>
<td>1.5 ± 1.7</td>
<td>88.9 ± 3.6</td>
</tr>
<tr>
<td>5</td>
<td>6.9 ± 3.6</td>
<td>7.1 ± 2.8</td>
<td>86.0 ± 4.1</td>
</tr>
<tr>
<td>6</td>
<td>8.6 ± 5.3</td>
<td>4.1 ± 3.6</td>
<td>87.3 ± 5.6</td>
</tr>
</tbody>
</table>

**Acknowledgments:**
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**References:**
1) Boyce TM, Bloebaum RD: Bone 14:1769-778, 1993

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**Figure 1. BSE Photomicrograph (left) and light microscopy (right) of the same region on the superior neck of a human femur. CF = calcified fibrocartilage**