**Relationship Between Material and Mechanical Properties of Osteophytes and Non-osteoophytic Cortical Bone: A Preliminary Study**

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**Introduction:** Several studies have associated the development of spinal osteophytes with disc degeneration [1-4]. Others have characterized them as adaptive bone remodeling in response to unusual stress/strain. No recent study examined the microstructure and mechanical properties of osteophytes. In this present study, we aimed at addressing the mechanical and material characteristics of osteophytes. Two specific mechanical tests were utilized: micro-hardness and three-point bending [5, 6].

**Methods:** Lumbar osteophytes were harvested from eight different cadavers. For the micro-hardness test, the size of the specimen was not an issue so therefore very small samples were taken from each specimen for both the hardness test and to evaluate the material properties. However, non-osteoophytic vertical beams (length: 18-24mm; width: 3-5mm; height: 2-3mm) were taken from the anterolateral cortex of the vertebrae and used for three-point bending. Radiological density was obtained with a Faxitron X-rayTM machine. After resin embedding and polishing, the hardness measurements were obtained by performing micro-indentations on embedded tissue using a Vickers diamond micro-indenter. A 10gf preset load was applied to the bone specimens for 15s. Five indentations were made on each specimen. A three-point bending was used as a means of investigating the mechanical properties of the osteophytes. The samples were tested using an Instron Machine (Model 556) with a span of 14mm and bent to deformation. The samples were chemically de-fatted with ethanol 100% for 24 hours and air dried for 48 hours at room temperature. Then, the trabecular material density (Dmat) was measured based on the Archimedes’ Principles using an electronic microbalance (Mettler-Toledo). The samples were dried at room temperature for 48 hours, weighted, and burnt in a furnace at 700 °C for 6 hours for ash density determination. Global differences in mechanical shear strength and structural properties between the anatomical regions were investigated using SPSS Statistics 17.0 and Microsoft Excel. One-way analysis of variance (ANOVA) and Tukey Tukey post-hoc test were used to assess the statistical significant differences among the means of the groups. Linear regression and the Pearson’s coefficient correlation (R²) were used to determine the correlations among the variables.

**Results:** The osteophytes had an average of 27.99 HV (hardness value), while the sample of cortical bone had a HV of 45.94. Overall, a 39% decrease was observed in the HV value of cortical bone to osteophytic bone. Additionally, there was no correlation between the relative hardness of the osteophytes and the material density (Dmat) but there was a positive correlation with the radiological areal/ optical density (Dopt) and ash density.

The maximum load to failure for osteophytic and non-osteophytic specimens was 64 and 4 Newtons (N), respectively.
Discussion: Previous studies have described the material density (Dmat) of cortical bone at a range of 1.40-2.0g/cm³. Our data showed the Dmat range for the osteophytes (both vertical beams and hardness samples) between 1.18 and 1.70g/cm³. Based on these findings, one can assume that cortical bone tissues are slightly denser than osteophytes. Furthermore, similar to bone, osteophytes do undergo different stages of development [4]. Therefore, to account for the wide range of Dmat values, it can be assumed that the osteophytes used in this study were all in different stages of their development. The non-osteophytic vertebral cortical beams were osteoporotic leading to a wide margin in bending strength compared to osteophytes. Furthermore, no microindentation data were collected for the former specimens. We are preparing vertebral cortical samples from more cadavers that will be tested for microindentation.

Significance: Vertebral osteophytes have higher load carrying capacity than vertebral cortical bone. However, diaphyseal cortical bone present a more mature and organized microstructure which leads to higher mechanical strength than osteophytes.
Figure 2. Load carrying capacity for spinal osteophyte and spinal cortical bone.

Figure 3. Images of cortical bone and osteophyte obtained from the microhardness machine (top). Undecalcified histological images of bone from osteophyte and cortical bone (bottom). Note the disorganized structure of the osteons observed in the vertebral osteophyte (right) compared with the regular ones from the femoral diaphyseal cortical bone (left).

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