INTRODUCTION: Existing research suggests a relationship between increased bone density and osteoarthritis (OA). Both cartilage degeneration and changes in subchondral bone density have been examined as possible precipitators of OA with neither yet established as the single initiating factor. Previous study of bony architectural changes and its correlation to severity of cartilage degeneration at the knee and ankle revealed no relationship between the two at the ankle, while a significant correlation was found at the knee. The purpose of this study was to examine apparent bone density in human proximal tibias to determine if density varies as a function of early cartilage degeneration.

METHODS: Seventeen matched sets of knee and ankle bones provided by the Gift of Hope Organ and Tissue Donor Network, were utilized in this study, which had institutional IRB approval. No donor had a history of clinical OA or any metabolic disease. Severity of cartilage degeneration at the tibia and talus was established based on the following scale: grade 0= smooth, glassy cartilage; grade 1= superficial fibrillation/shallow pits with absence of fissuring; grade 2= deep fibrillation and fissuring; grade 3= extensive fibrillation and fissuring with erosion of <30% of the cartilage surface down to subchondral bone; grade 4= erosion of >30% of cartilage surface down to subchondral bone. In all matched sets, tali had a grade of zero. Matched sets included twelve males and five females, with four grade 0 (ages 46-71), five grade 1 (ages 49-75), and eight grade 2 (ages 46-71). Tibiae and tali were imaged using quantitative computed tomography (QCT) (Imatron EBT) with a five column phantom (Mindwaves) containing known amounts of K$_2$HPO$_4$ in water for calibration. Five contiguous slices were selected, yielding a volume of bone 7.5mm thick for density analysis. For each tibia, slices were selected around the intercondylar eminences to allow for inclusion of the weight-bearing areas of the bone. Each slice was divided into six regions of interest, three proximal and three distal (Fig 1). For each talus, slices were selected around the midpoint of the talar body with one region of interest defined on each slice. Each region of interest was analyzed for volume and apparent density (Bioquant Nova Prime Software). Apparent density for each tibial region of interest was normalized by dividing by the apparent density of its matched talus. Data were analyzed with analysis of variance and t-tests.

RESULTS: Although an ~ 25% increase in mean apparent bone density of the proximal medial condyle was observed in tibiae with cartilage scores of grade 1 compared to grade 0, this increase was not statistically significant (p=0.079, Fig 2). When unnormalized data were used in the analysis, however, the results were significant (p=0.043). This trend was not observed in proximal central (intercondylar) or lateral regions. Distally, a similar trend of increased apparent density was observed medially, but was less pronounced (~10%). The mean apparent densities of lateral and central regions were significantly lower than the medial regions both proximally and distally (p<0.001).

DISCUSSION: Results suggest a possible correlation between increased apparent bone density of the medial tibial condyle and mild/early cartilage degeneration. However, a power analysis indicates a sample size of 26 would be needed. The appearance of this increase medially but not laterally, corresponds to the greater prevalence of medial knee OA, and supports the suggestion that a relationship exists between bone density and OA. No tibiae of grades 3 or 4 were evaluated in the present study, although one would expect to find increased bone density with tibiae of these grades. In our study, the increase from grade 0 to grade 1, the lack of increase from grade 1 to 2 suggests bone density may play a role in early and late stages of disease progression, but not in this intermediate period.

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