Introduction: Although there is great variability among those afflicted with osteoporosis and the factors that cause it, there is a universality to this disorder. That is, although the rate and magnitude of bone loss may differ between individuals and between skeletal sites, everyone decreases their mean bone mass as a function of age. This loss, manifested by cortical thinning, is most attributable to increased resorption depth in the area of the endosteum.1 A previous study on cortical resorption and age in the femur revealed that, as a function of age, there is greatly increased porosity and size of resorption spaces in the subendosteal region of bone. Therefore, endosteal resorption, as a result of enlarging spaces, eventually reduces the width of the cortex of bone.2 Our laboratory has shown a similar pattern of bone loss within the distal radius, with endosteal preservation until the later decades of life.3 While bone loss is universal among individuals and skeletal sites, previous studies have shown site specific variation of bone loss within the femur. A study on age related changes in the femur found that the medial-lateral diameter increased more than the anterior-posterior diameter and the anterior region experienced greater endosteal resorption and periosteal apposition than the posterior region.4 These site specific differences have been attributed to various strain environments within the bone. Other studies have shown that certain site specific differences in femoral bone loss reflect an increased risk of fracture.5,6 Along with hip fractures, Colles’ wrist fractures are also a manifestation of osteoporosis. Yet, no studies have looked at site specific bone loss of the distal radius. The aim of this study was to examine bone loss, as a function of age, at the anterior, posterior, radial, and ulnar quadrants of the radial cross sections.

Methods: Twenty-four radii were harvested from 13 female and 11 male cadavers (mean age = 76; range 43-96). Radii were manually stripped of soft tissues then measured with calipers to obtain radial length. Cross sections of the radial shaft (2 mm thick) were then made using a diamond-coated wafering saw (Southbay Inc., San Clemente CA, USA) at a distance that was 30% of the radial length from the distal tip of the styloid. The cross sections were cleaned in acetone baths for one week then air-brushed to remove dehydrated marrow. The sections were fixed in polymethylacrylate and further sectioned and polished to 200 µm. These sections were then surface-stained with toluidine blue and imaged using a Digital camera. Prior to analysis, the anterior, posterior, radial, and ulnar quadrants were marked with reference to the distal radii they were cut from. Using Adobe Photoshop, each image was grayscaled for Scion Image analysis. Using Scion Image, five sites per quadrant were analyzed for presence of the original endosteum, intracortical resorption, and thickness of the intact cortex corrected for size.

Results: Analysis of the 24 cross sections revealed that the frequency with which the original endosteum was present (as either part of the intact cortex or as a thin layer) and the thickness of the intact cortex both decreased with age in a significant manner (correlation coefficients = 0.426 and 0.487, respectively). The frequency with which intracortical resorption was present was found to significantly increase as a function of age (correlation coefficient = 0.673). When these parameters were examined based on their location around the circumference of the cross section, site specific variations were noted. When the frequency with which the original endosteum was present was regressed with age for the anterior, posterior, radial, and ulnar quadrants, the anterior and posterior quadrants were the only sites that revealed a significant decrease with age (p = 0.047 and 0.042, respectively). While each quadrant showed an age-related decrease in cortical thickness (corrected for size), the ulnar quadrant was the only site that did not show a statistically significant decrease (p = 0.109) (Figure 1). Additionally, when the mean cortical thicknesses of each quadrant were compared to each other in a paired samples test, there was a statistically significant difference between the cortical thickness of the radial and ulnar quadrants (P = 0.025). No other paired quadrant comparisons showed a significant difference in cortical thicknesses.

Discussion: Our findings reveal that the radius does in fact exhibit site specific variations in parameters related to bone loss. Previous studies have not only shown site specific variations in femoral neck cross sections, but they have shown that such variations differ between those with and without hip fracture history.5,6 Among hip fracture cases, femoral cortical bone loss was found to occur primarily along the inferoanterior to superoposterior axis. This is significant because it is this axis that bears the greatest strain during a fall.7 Similarly, our study revealed a significant age-related decrease in the frequency with which the original endosteum was present at the anterior and posterior sites of the radius. This is the primary axis along which Colles’ fractures occur during a fall on the outstretched hand. This is significant because such site specific variations have not previously been established for the radius despite this bone’s propensity for osteoporotic fractures. Additionally, our study showed that the ulnar side of the radius was the only site that did not significantly decrease its cortical thickness with age. Also, the cortical thickness between the radial and ulnar side were significantly different from each other. The significance of this finding may lie in the variation in anatomy of the forearm. Ulnar variance describes the bone geometry of the forearm as the difference between radial and ulnar bone heights. Previous studies have shown significant positive correlations between ulnar variance and age in normal wrists.8 Our findings on the cortical thickness of the ulnar side and its difference from the radial side are in accordance with the referenced study since an increasing positive ulnar variance leads to a shift in axial load toward the ulna bone.9

Figure 1: Linear Regression of Radial and Ulnar Side Intact Cortical Thickness as a Function of Age.


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