Comparing Neanderthal and Modern Human Long Bone Loading History from Cross-Sectional Geometry

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Comparing Neanderthal and modern human long bone loading history from cross-sectional geometry

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Abstract:
We evaluate here efforts to compare archaic and modern human limb loading from long bone cross sectional. Recent studies find that cross sectional properties (I, J, Z) calculated from second moments of area (SMA) are similar in Neanderthals and early modern humans when adjusted for body mass and limb length, but differ in cross-sectional shape (e.g., I_x/I_y). These results suggest the two taxa had similar magnitudes but different patterns of locomotor loading. Such interpretations, however, assume that long bones are deformed like long, straight beams in pure bening, with neutral axes (NA) that run through the cross-sectional area centroids. We test this assumption experimentally using exercised sheep with rosette strain gauges mounted at three locations around the midshaft of the tibia and metatarsal. Calculation of normal strain distributions at the midshaft indicate that the NA does not run through the area centroid, largely because of the combined effects of bending and compression. In addition, orientation of the centroidal axes around which maximum SMAs (I_{max}) are calculated are unrelated to the planes in which the bines bend. Because SMAs are fourth-power functions, cross-sectional properties that assume the NA runs through the area centroid yield substantial errors in magnitude (up to 100%) compared to cross-sectional properties calculated around experimentally-determined NAs. The polar moment of area, J, is least subject to error. Applying these analyses to the hominoid fossil record indicates that SMAs neither support nor refute the hypothesis that Neanderthals and early modern humans had different magnitudes or patterns of loading.