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Do dentine and cortical bone thickness covary in humans? The influence of age and sex assessed in a modern sample and the condition of Neandertals

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Differences in tooth dentine and cortical bone thickness and distribution have been independently reported between modern humans and Neandertals, with the latter typically displaying greater volumes of radicular dentine and thickened long bones [1-3]. The functional hypothesis, i.e., the adaptation to more severe loads, is often put forward to explain these differences. However, few research has combined the study of dentine and cortical bone to ultimately explore the possibility of a related role played by genetic, epigenetic, and environmental factors on the morphogenesis and development of these mineralised tissues. Indeed, dentine and cortical bone share similarities in their embryological origin and development, which is regulated by several common genes, hormones and signalling pathways. The aims of this study were to quantify dentine and cortical bone thickness in a sample of immature and adult modern humans in order to identify their possible covariation and to evaluate to what extent aging and sex influence their developmental patterns. Finally, we compared our results with the signal from some immature and adult composite Neandertal representatives. The canine and distal extremity of the radius were selected as they have been proposed to be under less biomechanical constraints than other teeth and long bone elements. Absolute volumetric variables and 3D relative indices expressing tissue proportions were measured on a microCT record of maxillary canines (UCs) and distal radii in a sample of 11 immature individuals of unknown sex (aged from circa 9 to 19 years) and of 18 adults (8 males and 10 females) selected *ad hoc* from French medieval cemeteries. The composite immature Neandertal is represented by the association of the D24 deciduous UC canine from Krapina (MIS 5e, Croatia) and the radius from the Roc-de-Marsal 1 specimen (MIS 4, France); the adult Neandertal individual results from the association of six UCs from Krapina (D36, D37, D56, D76, D139, D146) and the UC Vindija 12.5 from Vindija (MIS 4-3, Croatia) with the radii from the partial skeletons Regourdou 1 (MIS 5c-4, France) and Spy 6 (MIS 3, Belgium). We quantified the 3D Relative Dentine Thickness (3D RDT), a measure similar to the classic 3D Relative Enamel Thickness [4] adapted here to the dentine and pulp components and the 3D Relative Cortical Thickness (3D RCT [5]; similarly adapted to the cortical bone and medullary cavity components). 3D RDT was computed between 60% (apical) and 90% (subocclusal) of the total root length for volumes portions representing 10% of the root length and for the crown dentine. 3D RCT was calculated for 10% portions between 20 (distal) and 50% of the biomechanical length of the radius. In both the extant human sample and the composite Neandertals, the whole results indicate covariation between dentine and cortical bone among the immatures, while this signal is not detected in

the adults. Among the extant adults, males show the highest correlation between the mid-root dentine and the most distal part (20-30%) of radius, whereas in female this occurs between the crown dentine and again the most distal part of radius. The Krapina/Roc-de-Marsal composite immature Neandertal has relative and absolute proportions of coronal dentine and cortical bone that fall outside the extant human range, whereas the mature Neandertal chimeras do not differ in these proportions from our reference sample. At least in part, this could reflect ontogenetic differences between the two taxa. Despite the limited number of specimens considered in this study, the differences recorded in both extant humans and Neandertals in the pattern of dentine-cortical bone covariation between immatures and adults confirm the need for clarifying the role distinctly played by genetic/metabolic and environmental/culturally-related factors on the evolution of mineralised tissues in extinct hominins.

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