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3D enamel thickness in Neandertal and modern human permanent incisors

Laura Buti[1], Adeline Le Cabec[2], Noemi Dipino[3], Jean-Jacques Hublin[2], Stefano Benazzi[1,2], Robin N.M. Feeney[4]

1 - Department of Cultural Heritage, University of Bologna, Ravenna, Italy · 2 - Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany · 3 - University of Ferrara, Ferrara, Italy · 4 - UCD School of Medicine, Health Sciences Centre, University College, Dublin, Ireland

The study of enamel thickness distribution in living and extinct hominoids for taxonomic, dietary and phylogenetic purposes has concentrated on the permanent teeth, particularly postcanines, benefiting from novel 3D methodologies [1]. Growing attention on the anterior dentition [2] has fostered the application of a recent protocol [3] to investigate the 3D enamel thickness in Neandertal (NEA) and modern human (MH) unworn to variously worn upper and lower permanent incisors. This research aims to: 1) provide new data to discriminate between the two groups and 2) to explore enamel thickness distribution in NEA and MH incisors. MicroCT data of 88 upper (UI1=48; UI2=41) and 120 lower (LI1=54; LI2=n=64) permanent incisors from Neandertals (upper=38; lower=35), Upper Paleolithic (UPMH, upper=8; lower=13) and recent modern humans (RMH, upper=37; lower=80) at different wear stages (1 to 5 according to [4]) were segmented in Avizo 7 to reconstruct 3D digital models of the teeth. The cervical line was digitized on each 3D model in Geomagic Design X to separate the crown from the root. Volumes of enamel and of crown dentine, and the enamel-dentine junction (EDJ) surface were measured to compute 3D Average Enamel Thickness (AET) and 3D Relative Enamel Thickness (RET) indices.

Permutation tests for 3D AET values do not differ between NEA and MH (=UPMH+RMH) for all four incisor positions. Among lower incisors, mean values for 3D RET in LI1 significantly differ between the two groups for worn teeth at wear stages 4 and 5 (both $p<0.05$). For LI2, NEA and MH show significantly different 3D RET values at wear stages 1-2, 3 and 5 (all $p<0.05$).

By contrast, the upper central incisors do not differ in 3D RET values between the two groups at wear stages 3 and 4 ($p=0.13$; $p=0.34$, respectively). Due to the different sample assemblages for wear stages 1-2 and 5, statistical comparisons were not possible. The lateral upper incisors do not show significant difference between 3D RET values at wear stages 1-2 and 4 ($p=0.17$; $p=0.3$, respectively). The limited sample size for wear stages 3 and 5 only allow for a qualitative investigation, which revealed the same non discriminant result. Our preliminary results suggest that 3D RET could successfully discriminate between NEA and MH lower incisors, including worn teeth. However, while worn LI1 can be used for discrimination, due to the small sample size of unworn LI1 caution is needed when using this incisor position. The consistent findings of LI2 allow us to consider this tooth position the most effective of the four to discriminate between NEA and MH, ranging from unworn to moderately worn teeth. In comparison, both upper incisors positions do not discriminate between the two groups. Interestingly for unworn UI2, the sample is consistent for the permutation test yet 3D RET do not discriminate between NEA and MH ($p=0.1669$). In most of the tooth positions, NEA show statistically greater values for both enamel and dentine volumes, with MH showing greater variability among the single values.

We can propose that for some reasons to be determined, even though the amount of enamel and dentine volumes are generally greater in NEA, upper and lower incisors follow different configurations which results in different 3D RET discrimination. A better understanding of the enamel distribution in the incisor teeth will provide insight to better explain the results of 3D RET, as will further investigation to determine if incisor dental tissues scale with allometry. Notwithstanding, as worn teeth are more frequently found in the fossil record [5], the discriminant power of 3D RET for lower incisors may be considered as a useful tool for taxonomical purposes.

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