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Sexual Dimorphism of the Human Permanent Mandibular Canine.

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Sexual Dimorphism of the HUMAN PERMANENT MANDIBULAR CANINE

TISSUE PROPORTIONS

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INTRODUCTION

Accurate sex estimation is one of the most important steps for the reconstruction of the biological profile of an individual both in a forensic and a paleoanthropological context. Due to their durability, teeth have increasingly been used in post-mortem identification procedures, especially when other elements are not available. Several researchers have corroborated that dental tissue proportions from permanent dentition have also differ significantly between males and females [1-5]. Among the different tooth classes, canines show the highest degree of dimorphism [3][6]. The aim of this study is to quantify the sexual dimorphism of madibular canines tissue proportions from high-resolution micro-CT images in Spanish sample of known sex.

CONCLUSIONS

Our results support the hypothesis that sexual dimorphism of dental tissue proportions are due to the male's greater amount of dentine, and that sex differences in enamel do not make a large contribution to overall tooth size dimorphism [1][5][7]. Even though it is unclear which is the exact mechanism by which the sexual hormones influence on dental tissues formation, there are a great number of evidences that support that hormones affect not only in the dentine original formation, but also in its subsequent deposition along the individual's life [2][8][9]. 3D measurements have end up being more appropriate to evaluate tissue proportions since it counteracts the effect of dimensional loss in classic 2D estimations, maximizing the biological information that can be obtained from teeth [5][10][11].

METHODS

Sample

The analytical sample consisted of a total of 22 mandibular permanent canines of known sex and age at death from the exhumation of two Spanish cemeteries from the Anthropological Collection of Escuela de Medicina Legal de Madrid.

Micro-CT image acquisition and image processing

The teeth were scanned by X-ray microtomography (microCT). The following image processing was carried out using the Amira 6.0.0 software (Visage Imaging, Inc.). Each virtual record was reoriented to obtain crown buccolingual sections employing the method of Benazzi et al. (2014)[12] and crown reconstruction was carried out following the methodology described and validated by Saunders et al. in 2007[4]. 3D reconstructions were generated after the segmentation process.

Dental tissue measurements

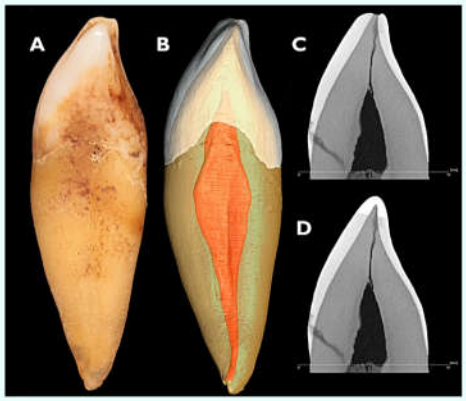
We recorded the variables described by Martin (1983)[10] from the cross sections in order to develop the 2D tissue proportions analysis. The three-dimensional metrics from the crown were measured following the protocols of Olejniczak et al (2008)[13] and Feeney et al (2010)[5]. To the whole tooth 3D measurements, the variables described by Bayle et al (2009)[14] and Zanolli et al (2013) [15] were considered. We also recorded the root volumes following the protocols describe by Le Cabec et al (2012, 2013)[16][17]. T-Student test statistical analyses were then performed to compare the male and female means. This statistical evaluation was supplemented by means of a Principal Components analysis to provide additional information about of inter-sexual variability.

RESULTS

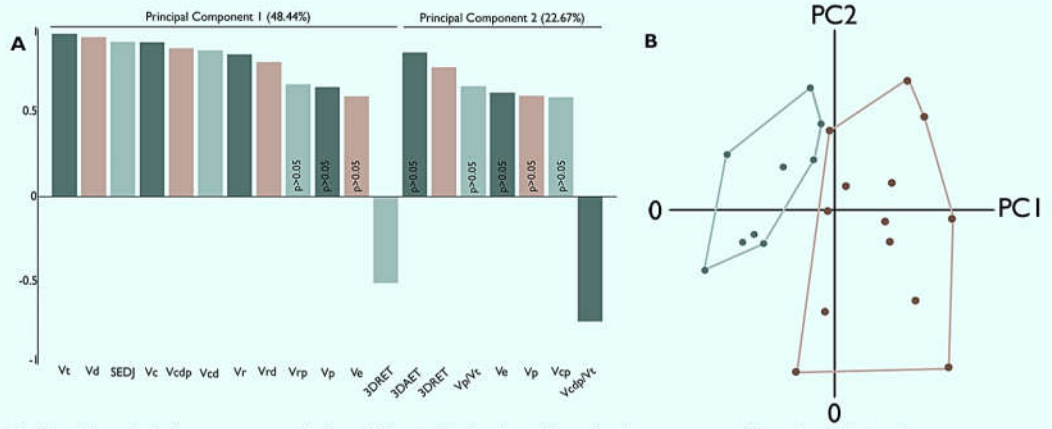
- All the variables and rates considered in this study are described in detail in the Supplementary Information.
- Males canines have significantly greater mean dimensions, which have 35.19% more volume than female canines (Vt males: 552.93±70.37mm3; Vt females: 408.99±57.84mm3).
- The lower canines of both sexes possess equivalent amounts of enamel (Ve), though males have significantly more amount of dentine (Vcdp, Vcd, Vrd, Vd) even when tooth size is controlled (Vcdp/Vt).
- In the same way, EDJ dimensions (length and surface) are significantly greater in males, probably because of the bigger dentine volume.

Principal Component Analysis PCA

When we considered only the 2D variables from the crown there was a clear overlapping between both groups, which only differed along the the first component. When we added a dimension, the overlapping substantially decreased. But only when we considered the coronal and the whole tooth 3D measurements, the PCA allowed us for clearly discriminating males from females.



Tissue segmentation and cross-sections obtaining
(A) Mesial surface of the Individual UCM_20 lower left canine. **(B)** After scanning, dental tissues (enamel, dentine and pulp) were semi-automatically segmented. **(C)** The virtual cross-sections were obtaining following the method of Benazzi et al. (2014)[12], and the crown reconstruction was out applying the Saunders et al. in 2007[4] methodology **(D)**.



Results of the principal components analysis carried out with the three-dimensional measurements from the whole tooth.
(A) Correlation coefficients between variables and canonical axes. Only the variables which have a coefficient higher than 0.5 are represented. We indicate in the graphic which variables are not significantly different between both groups when we employ T-Student test. **(B)** PC1 plotted against PC2. Brown circles: masculine individuals; green circles: feminine individuals. We could differentiate both sexes mainly due to the PC1, being females located at the negative quadrant and males more dispersed, but mainly in the positive one. The variables are described in the Supplementary Information.

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SUPPLEMENTARY INFORMATION
For more information about references, variables description and authors use the QR code

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