

H35 A 3D CBCT Method for Adult Age Estimation Based on Pulp Chamber Narrowing of Central Incisors

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Learning Overview: After attending this presentation, attendees will have a better understanding of the adult age assessment method based on the geometric approximation of dental volumes and its reliability in different age cohorts and adult populations.

Impact Statement: This presentation will impact the forensic science community by providing a reliable age assessment method for those cohorts of adult age for which other methods usually fail or are not applicable.

The deposition of secondary dentin throughout the life of an adult individual causes a progressive narrowing of the volume of the pulp. Previous studies demonstrated a significant correlation between secondary dentin deposition (pulp narrowing) and adult age; Pinchi et al. proposed a new, simple, and non-invasive method based on a geometric approximation of tooth volumes using Cone Beam Computed Tomography (CBCT) with good accuracy, especially for cohorts of age 30-59.^{1,2}

Since recent literature highlights the need to validate experimental methods for adult age assessment and to produce reliable population-specific results for forensic purposes, this study aims to improve the accuracy of the Pinchi et al. method applied to a larger sample.³ The secondary scope of this study is to analyze the influence of inter-operator variability, radiography technique, and other confounding factors on age estimation results.

A total of 500 CBCTs from healthy subjects aged from 18 to 90 years were collected and only the upper left central incisor was chosen to evaluate pulp/tooth volume, the most reliable tooth according to previous review.⁴ Only sound teeth were included in the study. Two experienced forensic odontologists performed blinded measurements of dental volumes: the root, the pulp, and the crown were assimilated to elliptical-based solid cones, and the volume was calculated by taking nine measurements (three linear and six areas) on Digital Imaging and Communications in Medicine (DICOM) images using RadiAnt™ software. The ratio between the Pulp volume and the Hard tissues volume (PHr) was assumed as the significant variable for age estimation in order to reduce errors according to the following formula: $PHr = \frac{V_{pulp}}{V_{ht}} \left[\frac{V_{ht}}{V_{tot} - V_{pulp}} \right]$ (V_{pulp} is the volume of the pulp, V_{ht} is the volume of dental hard tissues, and V_{tot} the total volume of the tooth).

The analysis of the outliers was applied to identify the presence of any anomalous values/families of values. Four different methods (one-class SVM with non-linear kernel (RBF) - covariance estimator - local outlier factor - isolation forest) were used to verify the non-randomness of the results, imposing that the data identified as outliers were 5% of the total. Hierarchical cluster analysis techniques combined with the WARD algorithm for graph construction were then applied to verify the presence of any hidden clusters within the sample.

Preliminary results show high variability, especially in 30–60 year samples, but interesting different linear dynamics of the relationship between tooth volume and age cohorts (<30 years, between 30–60, and >60 years). These results are consistent with the biological trend of dental “aging” for the first two age cohorts (almost absent before 30–35 years, then significant in the 40-50-60 years) but extremely promising in the third age cohort (>60–65 years) in which the other age assessment methods become less reliable because of the plateau in which the aging processes slow down.

References:

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