G8 Combining Radiographically Observed Craniofacial and Tooth Developmental Age Predictors

Parul Khare, MSc, KU Leuven, Kapucynenvoer 7, Leuven B3000, BELGIUM; Guy Willems, PhD, Katholieke Universiteit Leuven, School of Dentistry, Kapucijnenvoer 7, Leuven B-3000, BELGIUM; Steffen Fieuws, PhD, Kapucijnenvoer 7, Leuven B3000, BELGIUM; and Patrick W. Thevissen, PhD, KU Leuven, Dendermondsesteenweg 483, Sint-Amandsberg, Oost Vlaanderen B-9040, BELGIUM*

After attending this presentation, attendees will be aware of the fact that multiple craniofacial variables registered on panoramic and cephalometric radiographs are potentially providing age-related information in children and subadults.

This presentation will impact the forensic science community by enlightening the rationale that age related information from different craniofacial variables added to dental age-related information does not contribute to improving the age estimation performances based only on dental information.

Human age estimation is an important component of protocols for the identification of unknown individuals, and it is an essential component for estimating the age of living individuals who lack age documentation so that they can obtain legal, administrative, and social rights and benefits. Dental and skeletal parameters have been combined to potentially improve age estimation performance. The current study assesses age-related craniofacial variables registered on Panoramic (PAN) and Cephalometric (CEPH) radiographs because they are easy to obtain in dental practices. Therefore, radiologically registered skeletal age-related information could be obtained during forensic age estimation analysis without the need to consult a general radiologist. The goal of this study was to identify craniofacial age-related variables registered on PAN and CEPH radiographs, and to combine the craniofacial age-related information with that based on PAN radiographs.

A total of 360 PAN and CEPH radiographs were collected, which included images taken at the same times from the same subjects with age ranges between 5 years and 23 years. The images were categorized with respect to age group (one-year intervals) and gender; ten radiographs (five PAN, five CEPH) per gender and per age group were selected for analysis. Twenty craniofacial variables were evaluated. For CEPH analysis, seven linear measures between landmarks, one differential value, and six sella turcica specifications were registered. For PAN analysis, six linear measures between landmarks were registered and the lower left mandibular permanent teeth were developmentally staged according to the method of Demirjian et al.[1] The development of all third molars present was staged according to the method of Köhler et al.[2] All radiographs were imported in Adobe® Photoshop® CS6 for digital analysis and data collection. First, an age-prediction model was developed using the approach of Fieuws et al, which was based on the 11 ordinal tooth scores (seven Demirjan scores and four Köhler scores).[3] Ten-fold cross-validation was performed to establish age predictions. The Root-Mean-Square Error (RMSE) was calculated based on these ordinal scores. Second, the continuous craniofacial measurements were evaluated to determine if they contribute information to age prediction. Separate regression models were computed for PAN and CEPH radiographs, with the difference between real ages and predicted ages (based on ordinal tooth scores) used as dependent variables. A backward selection procedure, Aikake Information Criterion (AIC), was implemented (p=0.157) for model selection. A principal component analysis was performed as an alternative method to process the large number of craniofacial measurements, and the Principal Component Scores (PCS) (the required number to explain 80% of the variability) were used as independent variables in the regression models. The RMSEs were calculated using these craniofacial measurement models.

The RMSE of age estimation based on ordinal dental scores was 1.75 years. The RMSEs of age estimation based on PCS values were 1.72 years, 1.72 years, and 1.71 years for PAN, CEPH, and PAN+CEPH radiographs, respectively. The RMSEs of age estimation based on the ordinal dental scores with the PCS values added were 1.71 years, 1.78 years, and 1.83 years for PAN, CEPH, and PAN+CEPH radiographs, respectively. The error increase after adding information reflected the effect of overfitting, and this increase was significant even for the combination of PAN+CEPH information. Therefore, the addition of craniofacial information derived from PAN and CEPH radiographs resulted in approximately similar age estimations as those obtained from using information from dental variables alone. These results indicate that the addition of craniofacial information derived from PAN and/or CEPH radiographs did not significantly improve age prediction. In summary, forensic age estimations of children and subadults do not require additional information obtained from craniofacial age predictors derived from PAN and/or CEPH radiographs when dental age predictors are accessible.

Reference(s):

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*Presenting Author