G3 Dental Age Estimation: Combining Radiographic Information of Two Dental and Four Skeletal Predictors in Children

Akiko Kumagai, Remi Vardervaerenlaan 1, Bus 0403, Leuven 3000, BELGIUM; Guy Willems, PhD, Katholieke Universiteit Leuven, School of Dentistry, Kapucijnenvoer 7, Leuven B-3000, BELGIUM; Ademir Franco, MSc, Katholieke Universiteit Leuven, Kapucijnenvoer 7, Block A, Leuven 3000, BELGIUM; Steffen Fieuws, PhD, Kapucijnenvoer 35, Leuven B3000, BELGIUM; and Patrick W. Thevissen, PhD, KULeuven, Dendermondsesteenweg 483, Sint-Amandsberg, Oost-Vlaanderen B-9040, BELGIUM*

After attending this presentation, attendees will be updated on the current scientific trends in research involving age estimation in children. Additionally, attendees will benefit from learning that the combination of radiographic dental and skeletal age predictors results in more accurate age estimates. Finally, attendees will be acquainted with the specific added value each skeletal age predictor provides when combined with the dental age predictor.

This presentation will impact the forensic science community by indicating the best practices in age estimation procedures involving children. In particular, it will reveal that multivariate analysis of combined dental and skeletal age predictors contributes to more accurate age estimates. Additionally, the optimal balance between the most accurate age estimate and minimal radiation dose will be proposed for application in forensic age estimation practices.

In children and adolescents, the age estimation process is based primarily on radiographically observed development of either the teeth or the skeleton, or both.[1-4] Combining several age estimation parameters for more accurate age prediction appears to be the general consensus[5]. In order to obtain more accurate age estimates in a safe manner, dental and skeletal developmental parameters should be combined with a minimal use of radiation (in some jurisdictions, there may be issues with exposing individuals to radiation for a non-diagnostic, non-therapeutic purpose such as age assessment). The goal of this study was to validate age prediction methods that combine dental development of the permanent teeth and third molars with the skeletal development of cervical vertebra, hand-wrist bones, and craniofacial bones.

Panoramic radiographs, lateral cephalometric radiographs, frontal cephalometric radiographs, and left hand-wrist radiographs were collected from 256 female (n=135) and male (n=121) Japanese subjects between 4 and 20 years of age. The set of four radiographs of the sampled subjects were all made the same day. On the panoramic radiographs, the development of the permanent left mandibular teeth were staged according to the technique of Demirjian et al., and the available third molars were staged according to the technique of Köhler et al.[2,6] The skeletal development of the hand-wrist bones from the left hand-wrist radiographs and the third cervical vertebra from the lateral cephalometric radiographs were staged according to the techniques of Greulich et al. and Hassel et al., respectively.[3,7] On the frontal cephalometric radiographs, the cranial width and the mandibular angle width were measured and recorded. The age estimation procedure was sex-specific and based on the application of Bayes' rule to a multivariate continuation ratio model for the distribution of the scores.[8] The correlation between variables was calculated. The age estimate performances were quantified for mean error, mean absolute error, and Root Mean Squared Error (RMSE). The Wilcoxon signed rank test was used to compare the error and absolute error between models containing different variables as age predictors.

Strong correlations were found between chronological age and hand-wrist development (females: correlation coefficient (Rho)=0.89, p<0.0001, males: Rho=0.84, p<0.0001), mandibular angle width (females: Rho=0.68, p<0.0001, males: Rho=0.62, p<0.0001), or third cervical vertebra (females: Rho=0.77, p<0.0001, males: Rho=0.82, p<0.0001). Combining all parameters was the most accurate technique for age estimation in children (RMSE: 1.14 years in females, 1.19 years in males; mean error: -0.04 years in females, -0.04 years in males; mean absolute error: 0.91 years in females, 0.95 years in males). The best performing single combination was the dental parameters combined with the hand-wrist parameter (RMSE: 1.19 years in females, 1.22 years in males; mean error: -0.06 years in females, -0.06 years in males; mean absolute error: 0.94 years in females, 0.98 years in males).

This study proved that combining dental and skeletal age predictors enhances accuracy of the age estimates. Combining the dental and hand-wrist development variables resulted in more accurate age estimates. The images could be obtained with minimal ionizing exposures.

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