G16 The Influence of Lower Third Molar Segmentations on Automated Tooth Development Staging Using a Convolutional Neural Network Approach

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Learning Overview: After attending this presentation, attendees will understand how segmenting the lower third molar on panoramic radiographs affects automated stage allocation performance for age estimation.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by providing insight into the consecutive steps needed in an automated age estimation procedure based on third molar development. In particular, the choice of an optimal tooth segmentation technique will be discussed.

Introduction: In an automated age estimation method based on third molar development, an automated developmental stage allocation technique can be integrated. De Tobel et al. established a pilot set up for such an automated technique, based on panoramic radiographs.[1] First, they manually selected a rectangular Region Of Interest (ROI) around the lower left third molar. Second, deep learning was used to further process the ROIs with a Convolutional Neural Network (CNN).[2] The network investigated a way to automatically allocate stages to the third molars. However, the used ROI contained information of surrounding anatomical structures (e.g., periodontal ligament, bony structures, inferior alveolar nerve canal). It can be assumed that segmenting only third molar information will reduce noise from these structures and will ameliorate the automated stage allocation performances.

Goal: To establish and validate an automated staging technique for third molar development after rough and full segmentation on panoramic radiographs.

Materials and Methods: Two human observers staged each lower left third molar in consensus, according to a modified Demirjian staging technique (ten stages).[3] A third observer acted as a referee in case of disagreement between the first observers. Per stage and per sex, 20 radiographs were included, and their stage classification acted as the gold standard. The images were imported in Adobe® Photoshop® CC 2018 and segmented using built-in tools. Three types of segmentation were processed: Box segmentation (B, similar to De Tobel et al., Rough tooth Segmentation (RS), and Full tooth Segmentation (FS).[1] CNN DenseNet201 from Keras API with TensorFlow backend was used for automated stage allocation in the three types of segmented images.[4] The automated staging was compared with the gold standard staging in general and per stage. Stage allocation performance was evaluated using a five-fold cross-validation between the automated and the gold standard stages, using 80% of the images for training and 20% for testing.

Results: The FS technique had the best overall results with 61% of correctly allocated stages, a mean absolute difference in stage allocation of 0.53 stages and a mean linear weighted kappa of 0.84. Per stage and for all segmentation types, the final root stages were the most difficult to distinguish from each other. The five-fold cross-tabulation indicated that misallocated stages were mostly neighboring stages.

Conclusion: Segmenting the third molar from the panoramic radiographs increased the overall stage allocation performance. The FS is advised to be integrated in an automated dental age estimation process.

Reference(s):

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Forensic Odontology, Automated Dental Age Estimation, Automated Tooth Development Staging