



G7 Validating Tooth Development Staging Techniques Based on the Prediction of the Mature Root Lengths

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After attending this presentation, attendees will be aware of an established standard used to verify the correct classification of tooth development stages based on the prediction of the mature root length(s).

This presentation will impact the forensic science community by proving that tooth development staging techniques based on the prediction of the mature root length(s) at the moment the observed tooth is still in development has disadvantages for use in forensic age estimation investigations.

Several staging techniques were established to classify tooth development. Most of these techniques used prediction of the final root length as a reference to classify the proportionally relative stage of observed root development. For example, the technique of Köhler et al. defines the developmental stage "Root ½" as teeth with a root length equal to or longer than half of the predicted final root length and shorter than the proportional root length of the next developmental stage, which is designated as "Root ¾" and is 75% of the predicted final root length.¹ Predicting the final (mature) root length while the observed tooth is still undergoing development is a meticulous and observer-dependent (biased) task. The current study was undertaken to evaluate the validity of staging techniques based on prediction of mature root length(s).

This retrospective study collected 119 series of digital dental panoramic radiographs from the dental clinic files of the Katholieke Universiteit Leuven (KUL), Belgium, and included 63 female and 56 male subjects. Development of the second molars was evaluated for all radiographs. Each series included at least two panoramic radiographs registered from the same subject at different times. The chronologically last-registered radiograph contained mature second molars. All second molars were evaluated and staged by eight observers according to the method of Köhler et al.¹ The ratio between the second molar root lengths measured in the last-registered radiograph and in each previously registered radiograph was calculated for each subject. The degree of root length development corresponding to each Köhler stage is defined as follows: root ¼ developed, Stage 5; root ½ developed, Stage 6; root ¾ developed, Stage 7; and root fully developed, Stage 8-10. Therefore, the calculated range of second molar root length ratios that confirm correct Köhler staging are as follows: range=0.25 to <0.50, Stage 5; range=0.5 to <0.75, Stage 6; range=0.75 to <1, Stage 7; ratio=1 (i.e., no range), Stage 8-10. The calculated ratios and registered Köhler stages were independently verified for each second molar position and for each of the eight observers. Köhler staging bias was evaluated by considering that if Köhler staging was not biased, the expected mean ratio at each stage should be as follows: ratio=0.375, Stage 5; ratio=0.625, Stage 6; ratio=0.875, Stage 7; ratio=1, Stage 8-10.

Perfect differentiation between consecutive registered Köhler stages was not detected for every second molar root length and every observer. Verification of the calculated ratios and registered Köhler stages revealed that all observers generally classified the developing tooth as a more advanced stage than the correct stage, except for Stage 5. Therefore, significant observer bias was detected for all Köhler stages except for Stage 5, which did not have significant observer bias.

Longitudinal collection of subjects with panoramic radiographs containing developing second molars and fully developed, mature second molars provided exact information regarding the final root length(s) of the evaluated molars. This study developed a standard for correct tooth development staging based on prediction of final root length. The study identified significant discrepancies in observer evaluations and classifications of consecutive tooth stages. Therefore, this study proposes that staging techniques for developing teeth that are based on predictions of mature root lengths should only be performed after adequate observer training and calibration. The present study provided a useful tool that can be used for observer training and calibration.

Reference(s):

1. Köhler S., Schmelzle R.L., Püschel K. Development of wisdom teeth as a criterion of age determination. *Ann Anat.* 1994. 176: 339-345.

Dental Age Estimation, Tooth Development Staging, Tooth Maturation