

## Dental age estimation using radiographs: an unsettling conflict between ethical principles and scientific evidence

The need for age estimation arises from two main circumstances: first, poor birth registration practices, and second, falsified reporting of age. Although world nations have taken efforts to register births, the United Nations Children's Fund (UNICEF) reports that more than one quarter of the global population of children under the age of 5 have never been registered.<sup>1</sup> There is a global increase in cross-border migrations, particularly in the United States. In the first half of fiscal year 2019, around 780,000 people were denied entry while trying to cross the border compared to 521,000 in the entire fiscal year 2018.<sup>2</sup> Unaccompanied alien children (UAC) alone represent around 10% of total people seeking asylum.<sup>2</sup> Age becomes disputed when a subject cannot provide an authentic document to prove their age. The falsification of age is mostly noted when a subject claims his or her age to be lower than their true chronologic age to claim the benefits that are commonly reserved for juveniles. The 18-year-old threshold is of particular importance since this age differentiates a juvenile from an adult.

A strong correlation exists between physical growth and chronologic age ascertained from different biologic indicators. Amongst these indicators, age estimated from dental tissues has shown to be more accurate, as these tissues are subjected to the least modification from environmental or nutritional changes. Several methods of dental age estimation have been developed, but radiologic methods have been shown to be the least invasive, and provide accurate, reliable estimates of age. Panoramic radiography provides an opportunity to evaluate the developing dentition in a single tomographic image. Based on this imaging technique, several investigators have reported standards on dental development for different ethnic groups. Particularly at the 18-year-old threshold, the standards have been reported mainly based on the crown and root development,<sup>3</sup> root pulp volume,<sup>4</sup> and periodontal ligament visibility.<sup>5</sup> These methods have been tested for diagnostic accuracy through validity and reliability assessments.

Although the scientific literature has clearly favored dental age estimation as a reliable method to estimate age, several concerns have been raised for this procedure, including that it is inaccurate and unethical.<sup>6</sup> The concerns regarding the ethical

aspect of age estimation stem from accuracy of the estimated age due to variability in the rate of dental development, subsequent statistical approaches to determine the age, and exposure of radiation for the purpose of dental age estimation. The most vital part of an age estimation method is the quality and accuracy of the reference data that are used for estimating the age of an individual. Many population-specific dental reference standards have been published in recent years that could narrow the population variability in dental development. This is available for major ethnic populations including white people,<sup>4</sup> Chinese,<sup>3</sup> Africans,<sup>7</sup> and many more. In addition, newer statistical methods allow calculation of the probability of a person "above" or "below" a specific age threshold within specific levels of certainty. Based on a large data of white subjects, Lucas et al<sup>4</sup> showed that a subject who exhibits complete root development of mandibular third molar combined with stage C or stage D of root pulp volume (RPV-C, RPV-D)<sup>4</sup> and periodontal ligament visibility (PLV-C, PLV-D),<sup>5</sup> is indisputably above the 18-year threshold.

The use of radiographs is an integral part of the process of dental age estimation. It is noteworthy that ionizing radiation exposures, even at very low levels, carry some risk. However, an estimated 50% (3.10 mSv) of global annual effective dose (6.20 mSv) are from natural background radiation while the remaining 50% (3.10 mSv) are from other sources including diagnostic medical radiology.<sup>8</sup> About half of the human-made radiation exposure comes from computed tomography (CT) scanning.<sup>8</sup> Dental radiography accounts for approximately 2.5% of the effective doses received from all medical radiography and fluoroscopy combined.<sup>8</sup> The radiation doses in dentistry are minimal and should not be a matter of concern. In addition, a variety of measures are in place to minimize the radiation dose received by patients, including the use of appropriate selection criteria, minimizing re-exposures, appropriate technique, and the use of digital detectors instead of film.<sup>8</sup>

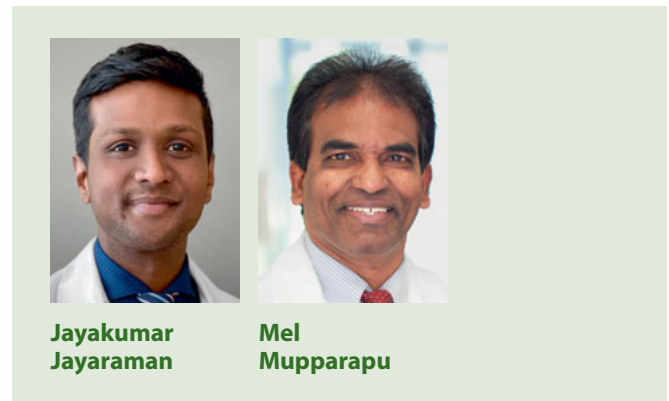
Many countries in the world, including the US, have experienced a rapid increase in the demand for forensic age estimates of unaccompanied alien children. Estimation of the exact date of birth is practically impossible and, to date, no method has



been able to achieve this. Age estimation using dental radiographs alone has been extensively analyzed and, based on the best scientific evidence to date, it has shown to be fairly accurate and reliable. Best efforts must be taken to safeguard the rights of children and age estimation must always be used as a last resort when all efforts to ascertain an individual's age fail. The risk of exposure to very low levels of ionizing radiation must be balanced with the benefit of an individual and, perhaps, the society as a whole. Only trained advocates should be allowed to interview and examine the children to elicit information and determine age. When radiographs are exposed, the exposure must be kept to a minimum and the resulting image must be interpreted by a trained and calibrated dental professional and reviewed by a second trained professional. The report must clearly mention the method of assessment employed, and statistical analysis must be presented along with margin of error. As advocates of children, we have a great role to protect their rights, and any procedure should be conducted in accordance with codes of principles put forth by the medical and dental fraternities. Issues with cross-border migration will not end, and the demand for age estimation will continue to rise. It is time to stop false propagations on age estimation methods and have a fresh look at the empirical evidence. ■■

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