

UNIVERSITI TEKNOLOGI MARA

**MICRO-COMPUTED
TOMOGRAPHIC
CHARACTERISATION OF ROOT
DENTIN TRANSLUCENCY IN
DIFFERENT AGE SCALES OF
AGING INDIVIDUALS**

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ABSTRACT

Dental age estimation is an important niche in forensic odontology in cases of human identification. As dental hard tissues are resistant to degradation, they act as excellent age indicators for dental age estimation. Root dentin translucency is known to be strongly correlated with dental age and has been chosen as the sole parameter in multiple dental age estimation studies. Current dental age estimation studies based on root dentin translucency are focused on the length and area of translucency which, in some instances, require destructive tooth sectioning. As forensic odontology requires teeth to be preserved for legal and investigative purposes, destructive methods such as tooth sectioning are unfavourable. Micro-computed tomography (micro-CT) is a non-destructive, high-resolution imaging technique that allows for the development of accurate three-dimensional models and the acquisition of quantitative data. This study aims: (i) to develop and propose a method to 3-dimensionally visualise and quantify volumetric root dentin translucency (vRDT) via micro-CT, (ii) to determine vRDT of different age groups in the Malaysian Malay population based on micro-CT grey value, (iii) to determine the volumetric pulp chamber to whole tooth (vPCWT) of different age groups in the Malaysian Malay population via micro-CT, and (iv) to formulate novel dental age estimation formulas based on vRDT and vPCWT. 144 single-rooted male and female mandibular premolars of known chronological age from the Malay population were scanned using micro-CT scanner (XSlicer SMX-6000, Shimadzu). The X-ray source was operated at a voltage of 160 kV and a current of 100 μ A, whilst analyses were performed using the open-source software FIJI/ImageJ. Results show that the micro-CT-generated grey-scale values are capable of visualising the distinctive butterfly-shaped pattern seen in physiological sclerotic dentin sections that represents the visual root dentin translucency effect, as well as generating distinctive grey values for dentin, enamel and the pulp chamber. Via the collection of adult premolars of known age, general population and sex specific dental age estimation models were constructed based on the calculated ratio of root dentin translucency to root (rRDTR) and ratio of pulp chamber to whole tooth without enamel (rPCWT). Regression analyses using the generated data showed positive correlation when compared against known chronological age. The rRDTR parameter alone (males, $R^2 = 0.69$; females, $R^2 = 0.667$; mixed sex, $R^2 = 0.676$), had a comparable accuracy to that of rPCWT parameter alone (males, $R^2 = 0.715$; females, $R^2 = 0.72$; mixed sex, $R^2 = 0.701$). A combination of rRDTR and rPCWT generated an improved dental age estimation accuracy (males, $R^2 = 0.787$; females, $R^2 = 0.823$; mixed sex, $R^2 = 0.797$). Though this novel method is in its infancy, it opens the avenue for future accurate non-destructive dental age estimation studies. Further work is needed to improve on dental hard tissue visualisation and chronological age correlation across different populations.

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CHAPTER 1

INTRODUCTION

1.1 Research Background

Dental age estimation (DAE) plays a crucial role in forensic odontology and bioanthropology, serving purposes such as medico-legal human identification and disaster victim identification (Altunsoy et al., 2015). Teeth are considered the most reliable indicators of age in both living individuals and cadavers, as their development is less influenced by environmental, nutritional, and genetic factors compared to other body structures. Furthermore, dental hard tissues are highly durable, remaining unchanged for thousands of years and exhibiting remarkable resistance to decay owing to their high inorganic content (Asami et al., 2019; Panchbhai, 2011).

A variety of tooth characteristics have been used as age estimation indicators. In juveniles, dental age can be estimated via either tooth eruption or tooth formation by examining the mouth and estimating the age according to the teeth that are present or absent (AlQahtani, 2012; Demirjian et al., 1973). In adults however, dental age is estimated via regressive changes, or age-related changes, to the adult dentition (Verma et al., 2019). Gustafson et al. (1950) was the first to propose tooth histological characteristics for dental age estimation in adults based on age-related changes in adult dentition (Gustafson, 1950). Gustafson considered 6 parameters for age estimation namely, attrition, secondary dentin apposition, periodontitis, cementum apposition, root resorption, and root dentin transparency. Since then, most histological dental age estimation methods are modifications of Gustafson's parameters.

Traditional methods of analysing tooth histological properties involved tooth sectioning. This method is not preferred in forensic odontology as it damages and deforms crucial evidence in medico-legal cases. In addition, traditional methods of measurement rely heavily on handheld operator-dependent equipment such as vernier callipers to measure tooth morphometrics. These methods are commonly associated with a large range of standard deviation as they are susceptible to human and experimental errors. Furthermore, in the case of measuring root dentin translucency (RDT) in sectioned tooth extracted tooth, due to the dried and opaque conditions of the tooth, it increases the risk of committing experimental and judgement errors.