

# Age Estimation by Different Techniques of Dentin Translucency: A Literature Overview

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## Abstract

**Background:** Human Dentition presents as the most durable and resilient part of the skeletal system in the body subjected to wide range of physiological changes with increase in age such as attrition, cemental apposition. Among several functional changes dental root translucency is often considered to be more reliable parameter for estimation.

**Methodology:** The literature search for articles written in the English language in PubMed, MEDLINE, Embase and Google Scholar database by using MeSH terms “Dentin Translucency”, “Age Estimation”, “Forensic Method” “Dentin in Forensics”, “Digital Method of Age Estimation”, “Dentin Age estimation” was retrieved. The present evaluation is to provide a broad literature review on “Dentin translucency” as a tool in age estimation with emphasis on the most substantial method obtainable for identification.

**Observations:** It was observed both traditional and digital method are significant and reliable for identification of age by root dentin translucency. The custom built software program is commercially available and extensively used image editing software program. Moreover, digital method is easy to use, precise and less time consuming. Considering these benefits, the present study recommends the use of digital method to assess root dentin translucency for age estimation.

**Conclusion:** Though conventional sectioning of teeth with observation using caliper or under microscope was gold standard, due to advancement in technology and more precise results digital method could possibly serve as more reliable where estimation of age plays a vital role in identification process in the field of forensics.

**Keywords:** *Dentin Translucency, Forensic science, Image software, precise age, Physiological Method.*

## Introduction

Age assessment by dental examination is one of the most reliable method of chronological age estimation used for criminal or illegal responsibilities, judicial punishment, medical, employment, execution of minority

and anthropological purposes<sup>[1,2]</sup>. Eruption of teeth, tipping, later or horizontal movement through maxilla or mandible, mechanical or physiological attrition, periodontal disease, secondary dentine or cemental apposition, root resorption, dentin translucency and changes in color are substantial features that increases or changes with age. Physical or morphological, histological, physiological, radiological, chemical method were developed to evaluate dental age<sup>[3]</sup>.

Once dental growth in association with or without skeletal growth is complete, developmental stages could not be used for age estimation instead the indicators such as attrition, loss of periodontal attachment, coronary secondary dentin formation, resorption of

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root, transparency of root undergo changes through life are being used<sup>[4]</sup>. These Morphological or Physical method are based on assessment of ex-vivo teeth for age estimation in younger as well as adult population. The samples of the extracted tooth can be sectioned or unsectioned and observed with the eye or with microscope<sup>[5]</sup>.

Gustafson<sup>[6]</sup>, Solheim<sup>[7]</sup>, Bang and Ramm<sup>[8]</sup>, Lamendin et al<sup>[20]</sup> supported the assessment of dentin translucency at the tooth root as a reliable morphological parameter for age estimation by using calipers. Tomes, the first investigator described the translucent dentin as the affinity of root dentine to appear transparent in the transmitted light in dense section from the apex upwards as a result of the merging of the dentinal tubules<sup>[21, 22]</sup>. Conversely, numerous attempts were made to measure translucency using computer-based customized software<sup>[14]</sup>. The present evaluation is to provide a broad literature review on “Dentin translucency” as a tool in age estimation with emphasis on the most substantial method obtainable for identification.

## Methodology

The literature search for articles written in the English language in PubMed, MEDLINE, Embase and Google Scholar database by using MeSH terms “Dentin Translucency”, “Age Estimation”, “Forensic Method” “Dentin in Forensics”, “Digital Method of Age Estimation”, “Dentin Age estimation” was retrieved. The present evaluation is to provide a broad literature review on “Dentin translucency” as a tool in age estimation with emphasis on the most substantial method obtainable for identification.

**Review of Literature: Bang and Ramm in 1970** presented a simple and accurate method for age estimation by **sectioning of the teeth** based on the measurement of the apical translucent zone length using incisors and cuspids. The zone length was measured buccally from the cemento-enamel junction to the root apex. It was concluded

$\text{Age} = \text{B0} + (\text{B1 X}) + (\text{B2 X}^2)$  formulae is used for <9mm translucent zone and if translucent zones > 9 mm age is estimated by using  $\text{Age} = \text{B0} + (\text{B1 X})$  (where X stands for Translucent zones) formulae. The teeth were sectioned. In this study transparent root dentin zone was measured halfway between the pulp chamber and the root margin where the translucency is nearly horizontal<sup>[8]</sup>.

**Nicolas et al in 1993** evaluated the image analysis systems for **digital** root dentin translucency. The study showed measurements obtained by Computer based translucency in compared to the conventional caliper method prove to be the reliable precise method for age estimation<sup>[9]</sup>.

**Thomas et al in 1994** investigated the apical translucent dentine distribution among 49 vital and 55 non-vital teeth by using **sectioned teeth**. Freshly extracted teeth were sectioned longitudinally in the buccolingual plane to a thickness of 150µm. Sections were photographed in polarized light at a standard magnification. Black-and-white prints of translucent apical dentine under standard magnification obtained were plotted using an Apple II digitizer. Regression analysis performed by using formulae derived as

$L\% = I/L \times 100$ ,  $A\% = S/D \times 100$  where L= length, A- area, S= area of translucent dentine and D= area of root dentine. The study concluded increased in apical translucency present in non-vital teeth when related with vital teeth at any specified age<sup>[10]</sup>.

**Amariti et al in 1999** suggested different techniques for determining the age of a subject by means of the analysis of **microscopic and macroscopic** structural modifications of the tooth with ageing. Determination of age was performed by using regression formulae of

$\text{Age} = \text{RST} \times 5.3 - 2.28$  by ratio of dentinal sclerotic (RST) or tubule thickness,  $\text{Age} = \text{Secondary dentin} \times 0.20 + 20.35$  by deposition of secondary dentine ratio,  $\text{Age} = \text{Cemental apposition} \times 9.19 + 6.74$  by using cemental apposition ratio. The study stressed that dense sclerosis or dentinal tubule thickness provides more precise results for estimation of age than secondary dentine and cementum thickness<sup>[11]</sup>.

**Valenzuela et al in 2002** presents three multiple regression models for age estimation from fresh extracted teeth. Model I for **manual morphologic analysis** using dentin color, attrition and cementum apposition, Model II for **computer morphologic analysis** using pulp and translucency width and area, Model III including **both manual and computer** morphologic analyses by attrition, color and translucency width. The study recommended image analysis of root dentin translucency width on freshly extracted teeth as a significant method for estimation of age<sup>[12]</sup>.

**Singh et al in 2013** used a simple digital method

on 50 extracted permanent teeth **sectioned to 250 µm** to measure root dentin translucency and compared digital measurements to conventionally obtained dentinal translucency measurements. Assessment was made by using the formulas as

**Age = 32.3103 + (2.9452 x translucency length)** by conventional method and **Age = 32.0417 + (2.8151 x translucency length)** by digital method. Application of these method revealed a similar reliability of both the method to assess age to within ±5 years of the actual determined age<sup>[13]</sup>.

**Acharya in 2014** proposed a new digital method with the help of commercially accessible computer hardware and software. Root dentin translucency area and length were measured on 100 **sections of 250 µm thickness**. Regression formulae derived using translucency length and area measurements showed

**Age = 29.91 + (7.45 x ATL) + (-0.44 x (ATL x ATL))** by average translucency length, **Age = 28.61 + (5.50 x MTL) + (-0.24 x (MTL x MTL))** by maximum translucency length and **Age = 31.75 + (2.97 x TA) + (-0.07 x (TA x TA))** by translucency area. The study revealed smaller mean difference and larger frequency of errors for area in compared to length by digital method<sup>[14]</sup>.

**Chopra et al in 2015** use a digital method to estimate dentinal translucency on **sectioned teeth** and compared digital measurements by using computer based hardware and image analysis with a scanner followed by analyzing using American Board of Forensic Odontology (ABFO) no. 2 scale on the scanner platen by plotting axis method to conventionally root dentin translucency measurement method. Age estimation was performed by conventional method using

**Age = 29.720 + (4.102 x translucency length)** and by digital method using **Age = 29.823 + (3.930 x translucency length)**. The study concluded that the results obtained by both the method are similar and constant with findings of various previous similar studies<sup>[15]</sup>.

**Bommanavar and kulkarni in 2015** measured root dentin translucency on 50 single rooted teeth **sectioned longitudinally to obtain 0.25 mm** uniform thickness manually and using a custom built software program Adobe Photoshop 7.0 version. The study illustrated age estimation using linear regression

equations showed better efficiency of the digital method using regression formulae of

**Age = 22.809 + (5.364 × translucency length)** when compared with the caliper method using regression formulae of **Age = 25.874 + (5.597 × translucency length)** for assessment<sup>[16]</sup>.

**Narayan VK et al in 2017** assessed whether physiological changes of the teeth allow probable correlation for age estimation using conventional caliper method. Root dentin translucency of **unsectioned tooth** was observed under stereomicroscope by modifying Johansson and Lamendin method. Age was derived by using

**Age = 0.2 x X1 + 1.1 x X2 + 0.3 x X3 + 0.7 x X4 + 17.9** (where X1 – Root dentin translucency; X2 – Root dentin color; X3 - PDL attachment; X4 - Attrition). The study showed root dentin translucency evaluated by using stereomicroscope and Vernier caliper produced the strongest correlation to actual age when compared to other morphological features<sup>[17]</sup>.

**Gupta et al in 2017** conducted a study to measure translucency on sectioned teeth using digital hardware or software and to correlate degrees of root dentin translucency length with age by using

**Predicted Age = 25.28 + 1.81 × TD (Translucent Dentin length)**. 62 freshly extracted single-rooted permanent teeth were sectioned to 250µm thickness and scanned by flatbed scanner using digital software. Each tooth section was positioned next to an ABFO No. 2 scale on the platform and scanned at a resolution of 600 dpi. The images were obtained in Adobe Photoshop 7.0.1 image software followed by measurement of translucency length of the scanned images by using guides<sup>[18]</sup>.

**Bhardwaj et al in 2019** performed an investigatory study to compare the effectiveness of conventional, stereomicroscopic and digital method for age estimation by measuring root dentin translucency. **Buccolingual sections** of 30 freshly extracted permanent teeth were made of thickness 250µm by using micro motor and Arkansa stone. Analysis was performed by obtaining linear regression formula of

**Age: -9.947+ (8.610 x translucency length)** by conventional method, **Age: -7.797+ (8.742 x translucency length)** by stereomicroscopic method and

**Age: -8.9+ (8.430 x translucency length)** by digital method derived. The author observed Digital method using image analysis software is statistically significant method followed by Conventional with the least being the Stereomicroscopic method<sup>[19]</sup>.

### Discussion

Physical or somatic changes, secondary sexual features, radiological examination of primary or permanent teeth eruption sequence, ossification centers are various significant approaches of age estimation. There is progressively strong evidence that dentine transparency is directly proportional to the increase in age and hence serves as a consistent tool to aid the determination of age estimation in both living and the deceased<sup>[23]</sup>. Many studies have used custom-made software American Board of Forensic Odontology No. 2 scale on the scanner platen, stereomicroscopy and digital Vernier caliper measurements to measure the root dentine transparency level. Conventionally, root dentin translucency was measured microscopically using calipers on sectioned teeth. The Translucency also can be assessed macroscopically on intact unsectioned teeth by using digital calipers but tooth sections offer improved results. In recent times, the use of custom fabricated software programs have been recommended owing to its accuracy and reliability<sup>[24]</sup>.

Over the years root dentin translucency was measured using a digital caliper on the teeth sectioned using a hard tissue microtome. The major shortcoming using this method was that the sectioned teeth could not be properly stabilized and thus increasing the risk of damage or fracture by the pointed beaks of the caliper scale. Also, the magnifying glass could not enhance the exact clarity between the translucent and the opaque zone<sup>[10]</sup>.

The improvement of the digital method is that the translucency measurements obtained were magnified at  $\times 3$  magnifications using the Zoom Tool, which permitted better visualization of the junction between the opaque and transparent zone. This could not be accomplished by the caliper method; hence that amount of magnification necessary for accurate age estimation can be determined<sup>[9,19]</sup>. However, the values of the root dentin translucency obtained by conventional and digital were very analogous, with no clear superiority of one method over the other by various studies. Furthermore, translucency can be measured by tooth sections provide

better detail irrespective of the section thickness. Combination of sectioning of teeth followed by digital image analysis is often recommended.

### Conclusion

Though conventional sectioning of teeth with observation using caliper or under microscope was gold standard and accurate, it is a more time-consuming destructive approach and is significant often for postmortem cases where utilization of numerous tooth is possible but less practical for living individual where tooth has to be extracted for such identification method in case of medico legal conflicts. Due to advancement in technology and more precise results digital method could possibly serve as more reliable where estimation of age plays a vital role in identification process in the field of forensics. Hence, further studies on a large scale are necessary to determine reliability of digital approach method without sectioning or compromising the tooth to estimate the age without damaging the integrity of tooth.

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