International Journal of Medicine
pISSN 1468-3814 | eISSN 2667-7008
https://theinternationalmedicine.com/

Original Research Article DOI: 10.61336/im/26-3-25

ROOT DENTINE TRANSPARENCY - A TOOL IN AGE DETERMINATION

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Received: **January 13, 2026**
Revised: **February 18, 2026**
Accepted: **February 26, 2026**
Published: **March 13, 2026**

Abstract

The purpose of present study was to examine the Tooth Root Dentine transparency (RDT) by histological method and to measure RDT to find correlation of advancing age with area and length of RDT to estimate the age of unknown bodies. Thirty healthy right maxillary 1st premolars extracted from 30 different patients of known age ie 11-30 years (males and females) for orthodontic treatment, were included in this study belonging to Punjab and Haryana (States of North India). Teeth were sectioned longitudinally and ground sections of 250-350µ thickness were prepared, stained with 1% methylene blue and observed under light microscope at 4 X magnification. Area and length of transparent dentine were measured by SketchAndCalc area calculator. Statistical analysis of data was done by applying Mann-Whiteny Test and Kruskal-Wallis Test. Spearman's correlation coefficient ρ for mean area was 0.971 which was significant at the level of 0.01 and for length Spearman's correlation coefficient was 0.736 which was significant at the level of 0.01. Regression equations were created both for RDT area and RDT length. Regression analysis of data indicated better correlation of advancing age with mean RDT area than mean RDT length, as value of $R^2 = 0.972$ where R^2 is coefficient of determination, $\beta = 0.924$ for RDT area where β is standardized coefficient and for RDT length $\beta = 0.065$. Measurable RDT was observed at the age of 11 year and females have shown greater amount of RDT as compared to males. It is concluded that area of RDT can be used to estimate the age of unknown bodies if the observations have been done very carefully.

Keywords: Age, Root dentine transparency, Teeth.

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INTRODUCTION

Teeth and bones are important parts of exhumed, unknown bodies that are used for identification and age estimation in forensic sciences.1 Teeth are considered better than bones because they are hardest structures in the human body and secondly, they can be examined in the living humans.2 Physiological growth of dental tissues is uniform from infancy to adolescence. It has been observed that teeth after attaining maturity continue to undergo changes which can be used for estimation of age even in adults.3 There for dental age can be used as a measure of chronological age and the dental indicators have reported low variability.4 Dentine of tooth normally appears opaque to the transmitted light due to difference in the refractive indices of intratubular organic matter and peritubular dentine. It appears transparent to the transmitted light when dentinal tubules are completely mineralised and refractive indices of intratubular and peritubular dentine becomes same.5 Gustafson was first to report that amount of dentine translucency can be used to estimate the age.6 Johanson stated that dentine translucency was best for age estimation out of the six variables of Gustafson. Later on a number of researchers reported that this variable alone can be used in estimating the age.7 Bang and Ramm in 1970, presented a method for age estimation based on the measurement of only the length of the apical translucent zone in mm of a given tooth as translucency starts from apex of root.8 Solheim stated that RDT is better correlated with age in the maxillary teeth.9 The previous studies have been done on various teeth and no specific data on the basis of a particular tooth is available. Therefore, this study has been designed to examine the regressive changes in the right maxillary first premolar tooth. The aim of present study was the statistical analysis and regression analysis of database to create regression equation for estimating the age of unknown bodies.

MATERIALS AND METHODS

Thirty freshly extracted teeth of thirty different patients of known age undergoing orthodontic treatment were collected. Teeth were stored in 10% formalin to prevent fungal infection till used for the study. The individuals between the age group 11-30 years were included in the study. Teeth with periodontal disease, caries and various developmental anomalies were excluded from the study. Total cases were divided into four groups depending upon the age. Group1. 11-15 years, Group 2. 16-20 years, Group 3. 20.5-25 years, Group 4. 26-30 years. Extracted teeth were cleaned, washed with water and sectioned with diamond disc fitted in a micro motor straight hand piece. Teeth with straight roots were sectioned buccolingually and teeth with roots distally deviated were sectioned mesiodistally up to the maximum extent of root apex. Initially the sections of 1-2 mm thickness were made with diamond disc and further thinning of sections was done manually by grinding the sections on carborundum stone till thickness of 250-350 µm is formed. Then sections were stained with 1% methylene blue. Stained sections were dried in air, mounted on glass slides with DPX mountant and covered with glass cover slip and then examined histologically under light microscope. Transparent calibrated scale (mm) was placed on the root apex of each section to calibrate the length in SketchAndCalc area calculator as shown in the figure 1. The apex of each root of length 4-4.5 mm and of area 130-140 mm^2 was examined to determine the length of transparent dentine under light microscope at 4x magnification. The length for the examination of apices of roots was taken 4-4.5 mm as the maximum length that can be clearly visualised in single observation under light microscope is 4.5 mm. Then images of root apex of each tooth at single observation were captured to reduce measurement error. Transparent dentine present in the observational area of each root was measured with SketchAndCalc area calculator as shown in figure 2.

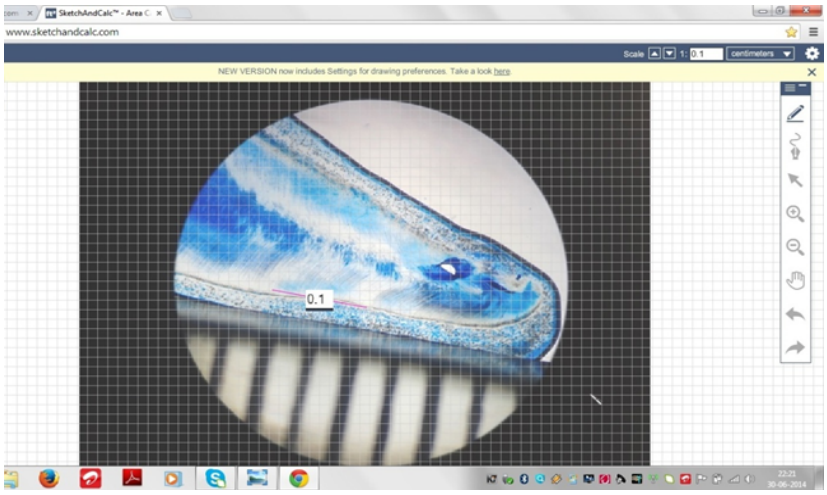


Figure 1. Picture showing the length in SketchAndCalc area calculator was standardized by placing transparent calibrated mm scale on permanent stained section of sample tooth no.5 under light microscope. Dark pink line visible in the image indicates, 1mm actual length = 0.1 cm

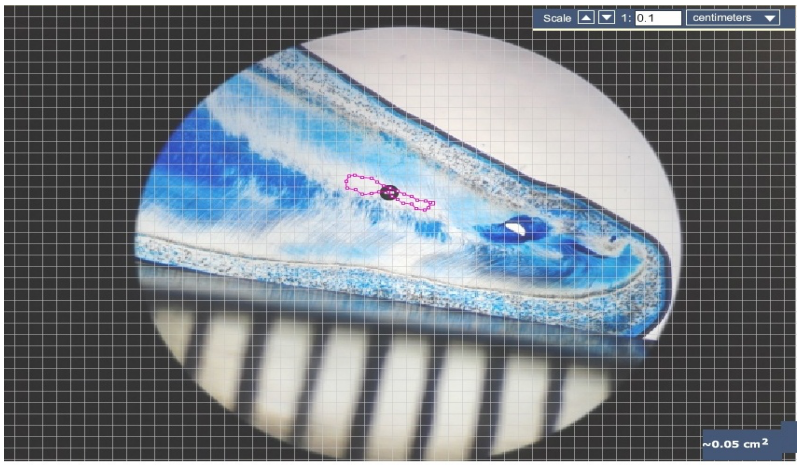
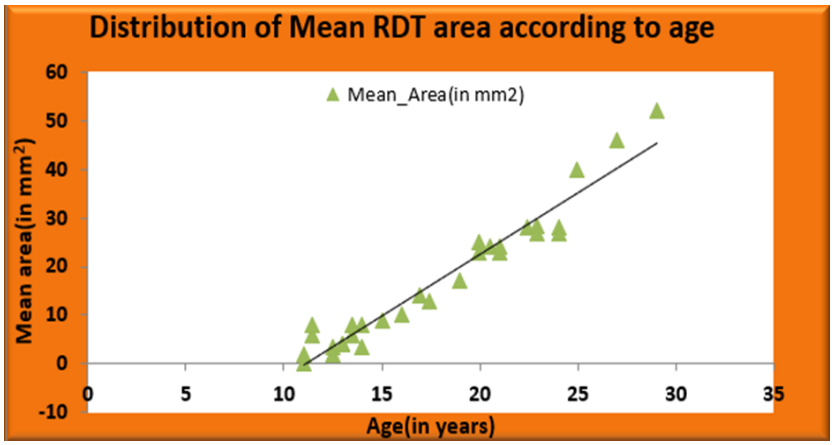


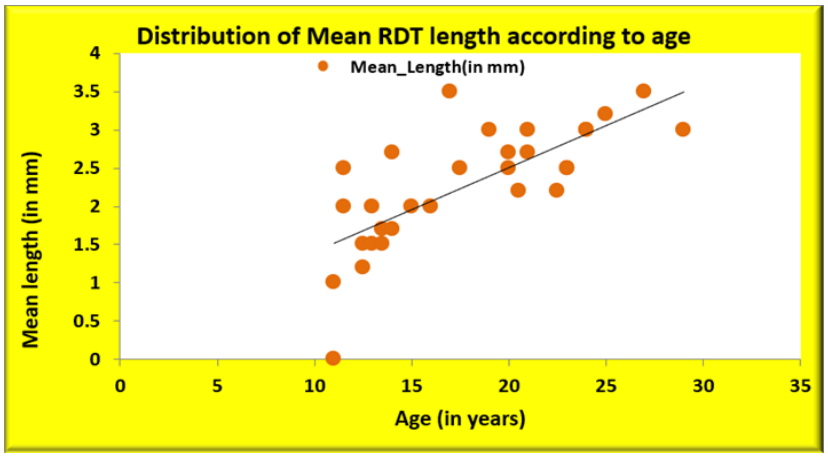
Figure 2. Picture shows measurement of RDT area in R1 root of stained section of double rooted tooth no. 5 at 4X magnification under light microscope.

RESULTS

It was observed that both RDT area and RDT length have strong correlation with advancing age as shown in the graphs 1a, and 1b.



Graph 1a. Scattered plot where age is along x-axis and mean area in mm2 is along y-axis. Total cases =30 (Males and females)



Graph 1b. Scattered plot where age is along x-axis and mean length in mm is along y-axis Total cases =30 (males and females)

Mean RDT area and mean RDT length were observed in age groups as shown in table 1. It was seen that both were increased with advancing age.

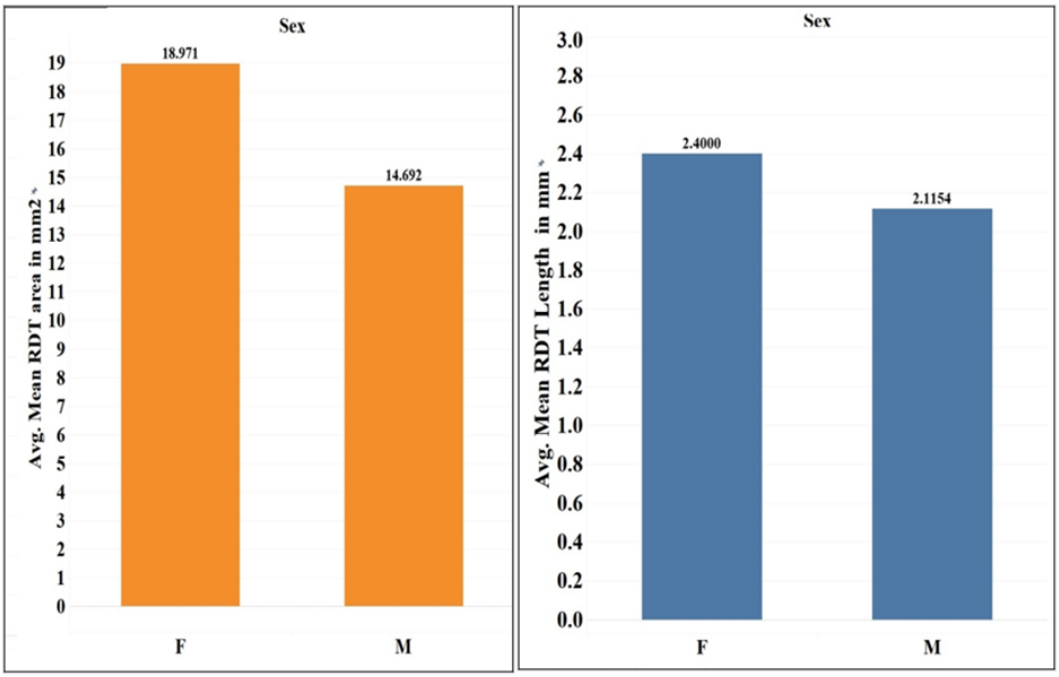
Table: 1. Bifurcation of age groups with respect to mean RDT area and mean RDT length.

Age Group(years)	Mean RDT Length(mm)	Mean RDT Area(mm^2)
Group 1 (11-15)	1.63	4.90
Group 2 (16-20)	2.70	17
Group 3 (20.5-25)	2.70	27.72
Group 4 (26-30)	3.25	49

When mean RDT area and mean RDT length were compared in females and males, it was observed that mean RDT area and mean RDT length were more in females as compared to males as shown in table 2 and bar chart 1a and 1b.

Table 2. Males (n= 13), Females (n=17)

Parameters (Mean ± SD)	Male (n=13)	Female (n=17)
No. of Roots	1.69 ± 0.48	1.41 ± 0.50
RDT Length (mm)	2.11 ± 0.89	2.40 ± 0.70
RDT Area (mm^2)	14.69 ± 12.42	18.97 ± 14.74



1a. Mean RDT area in males and females **1b. Mean RDT length in males and females**

Bar chart: 1a and 1b.

Regression analysis of data indicated value of $R^2 = 0.972$ (where R^2 is coefficient of determination) with standard error of estimation 1.27 years. When β coefficient (β is standardized coefficient) was calculated for mean RDT area and mean RDT length, mean RDT area was better correlated than mean RDT length. For mean RDT area $\beta = 0.924$ which was significant at the level of 0.01 and for mean RDT length $\beta = 0.065$, which was very less significant.

Regression Equation calculated from mean RDT area for age estimation is:

$$X = Y + 28.059 \div 2.530$$

Where X is mean estimated age, Y is mean RDT area. When estimated age calculated with mean RDT area and compared with actual mean age, the mean error was ± 1.4 years. Regression Equation calculated from mean RDT length for age estimation is:

$$X = Y - 0.3114 \div 0.1101$$

Where X is estimated age, Y is RDT length. When estimated age calculated with mean RDT length and compared with mean actual age, the mean error was ± 1.3 years.

In each group, for every case the estimated age was calculated by applying the above equations both for RDT area and length and compared with actual known age.

Group1. It was observed that RDT area was better correlated than RDT length when estimated age was compared with actual age in every individual. The lowest age was 11 years, had shown measurable RDT area and length. No regularity had been observed between advancing age and increase in RDT area and RDT length.

Group 2. This group had shown regular increase in RDT and RDT length with advancing age, with abrupt increase in RDT area in some cases. RDT area was more reliable than RDT length.

Group 3. This group had shown better regularity of increase in RDT area and RDT length than group 1 and group 2.

Group 4. As the number of cases was only two in this group, but there was definite increase of RDT area as compared to RDT length.

From this study it is concluded that there is a strong correlation between tooth root dentine transparency and advancing age. Apical RDT can be used as a reliable tool to estimate the age of unknown bodies. RDT area is more reliable than RDT length for age estimation.

DISCUSSION

Tooth development and sequence of tooth eruption has been commonly used as method of age estimation in children and adolescent, but in adults when growth stops, it becomes difficult to estimate the age from teeth.3 Gustafson stated that regressive changes occurring in the teeth with advancing age can be used to estimate the age in adults and translucency of root dentine is one of these changes. The amount of root dentine translucency is directly related to chronological age.6 Several authors have stated that the translucency of root dentine is best indicator of chronological age.10 In the present study it was observed that root dentine transparency started from the apex migrating towards the coronal part of root and there was a strong correlation of apical RDT with advancing age. Both mean RDT area and mean RDT length were well correlated with age when statistical analysis of data was done. When mean RDT area and mean RDT length of total cases were compared in regression analysis, the mean RDT area was better correlated with advancing age than mean RDT length, with standard error of estimation 1.27 and value of R^2 = 0.946 where R is the correlation coefficient, value of β = 0.924 for mean RDT area and value of β = 0.065 for mean RDT length. This study was done on healthy teeth extracted from healthy individuals and single tooth was taken from single individual to reduce the chances of error. In the present study mean error in estimated age from RDT area is ±1.4 years and from RDT length is ±1.3 years which is considered good if it is compared with mean error in estimation of age as calculated by Acharya on Indian population which is ± 1.43 years.3

Another important observation in this study was that the cases of 11-12 years age has shown measurable RDT area and RDT length whereas the previous studies have stated that RDT normally starts in the 2nd or 3rd decade of life.3 It may be due to the reason that in Indian population RDT starts at an early age, another reason may be that all the teeth included in this study were extracted premolars of patients undergoing orthodontic treatment. Some teeth were extracted pretreatment and some mid of treatment and it was not sure which teeth belong to pretreatment and mid-treatment category. Therefore, teeth which would have been extracted mid-treatment might had undergone stress and strain of orthodontic wires during orthodontic movement of these teeth leading to increased RDT area and RDT length, but this assumption requires further studies because stress and strain effects of orthodontic wires on the teeth vary depending upon the type of material of the wires. In this study RDT area and RDT length both were more in females as compared to males. It may be assumed that in Indian set up, RDT is affected by gender. It is more in females than males. Solheim reported large amount of RDT in males as compared to females in his study and suggested that this difference may be due to differences in masticatory forces.11 Singh A reported that RDT has no significant relation with gender.12

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