

# Association of age to the linear and volumetric changes of maxillary permanent canine's assessment through cone beam computed tomography: Across-sectional observational study

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## ABSTRACT

**Aim:** To assess the impact of age on the pulp chamber-to-crown ratio of permanent maxillary canines using CBCT scans in participants from Peshawar's dental teaching hospitals.

**Method:** A cross-sectional study was conducted. The research was conducted at Khyber College of Dentistry and Sardar Begum Dental College in Peshawar, from September 2021 to June 2022. A total of 180 CBCT scans from participants aged 13 to 60 years, comprising 117 males and 63 females, were analyzed. The teeth were examined for crown length, width, volume, and pulp chamber dimensions. Measurements were taken in axial, coronal, and sagittal planes using Planmeca Romexis software. A significance level of  $p \leq 0.05$  was used for statistical analysis.

**Results:** Participants were divided into five age groups. The highest frequency was in Group I (13-23 years, 41.1%), and the lowest in Group V (54+ years, 3.3%). The mean age was  $27.23 \pm 10.48$  years. Pearson correlation analysis showed a negative correlation between age and all measured variables, indicating a decrease in pulp chamber and crown sizes with increasing age. Significant differences were noted across age groups ( $p = 0.005$ ).

**Conclusion:** The study concluded that the size of the pulp chamber decreases as individuals age.

**Keywords:** Cone-beam computed tomography, linear measurements, maxillary canine, Planmeca Romexis software.

## INTRODUCTION

With age, teeth undergo changes such as accumulation of secondary dentin, transparency of root, formation of cementum, regeneration of roots, discoloration and roughness of roots<sup>1</sup>.

Various forms and radiological techniques have been developed to detect age-related changes in an individual tooth<sup>1</sup>. Dental radiological examination is a straightforward, non-invasive way to get data that doesn't involve extractions.<sup>2</sup> Following tooth eruption, secondary dentin starts to build up, and as people age, the pulp chamber gets smaller. With aging and a reduction in pulp chamber volume, the secondary dentine is placed on the pulp chamber walls. In 2018, Sue and her colleagues performed a research in Japan using CBCT scans of 316 first molars (162 maxillary molars and 154 mandibular molars) in 87 patients ranging in age from 11 to 74<sup>3</sup>. It was shown that the mandibular and maxillary molars had average pulp chamber areas of  $R^2 = 0.586$  and  $R^2 = 0.609$ , respectively. The number  $R^2$  is frequently used to show the link between age and the pulp chamber's size in relation to dental chamber parameters<sup>3</sup>.

Canines frequently stay in the mouth until they are very old<sup>3,4</sup>. They have a single pulp chamber and root, and their risk of cavities is decreased. They are therefore appropriate for age estimation<sup>5,6</sup>.

The pulp to tooth ratio can be measured via periapical and panoramic radiographs<sup>7</sup>. However nowadays, three-dimensional (3D) computed tomography (CT) and cone-beam computed tomography (CBCT) scans allow for more accurate measurement of tooth and pulp dimensions and provide useful information about teeth<sup>8</sup>. The most reliable and precise way to measure the pulp to tooth ratio is with Computed Tomography<sup>4</sup>.

Because it offers lower radiation exposure and higher resolution than standard CT, CBCT is becoming more popular novel imaging technique in Forensic Odontology. Additionally, it allows for the precise measurement of pulp and teeth<sup>8,9</sup>. Recent research on age estimation have mostly employed CBCT images for this purpose because of the lower patient radiation dosage and higher image quality of CBCT<sup>8</sup>.

To date, no published data is available for the local population of Khyber Pakhtunkhwa. This study will help physicians to diagnose and treat endodontically compromised teeth i.e., the dentist will better understand the crown of the tooth and its root canal system and therefore the chances of failure will be avoided. The information gathered on this topic for estimating the age of individuals will be used in forensic dentistry.

The primary goal of this study was to determine whether aging has any impact on the ratio of the pulp chamber to tooth crown in permanent maxillary canines in subjects visiting dental teaching hospitals of Peshawar using cone beam computed tomography.

## METHODOLOGY

This cross-sectional study was approved by the Institutional Review Board (IRB) of Prime Foundation on September 10, 2021 (approval no: Prime/IRB/2021-358). The study was carried out from September 2021 to June 2022 on 180 subjects of both genders at Radiology Department of Khyber College of Dentistry and Sardar Begum Dental College, Peshawar. Non-probability convenience sampling technique was used for sampling process. Both male and female participants ranging in age from 13 to 60 years were recruited in the study. The subjects' cone-beam computed tomography (CBCT) images, which were recommended by dental clinicians for routine treatment planning were used for the study.

### Inclusion Criteria:

1. Fully developed and structurally sound maxillary permanent canines as seen on CBCT.
2. Crown and root of bilaterally erupted permanent maxillary canines seen on CBCT.
3. CBCT images of both genders females and males having an age group of 13 – 60 years.

### Exclusion Criteria:

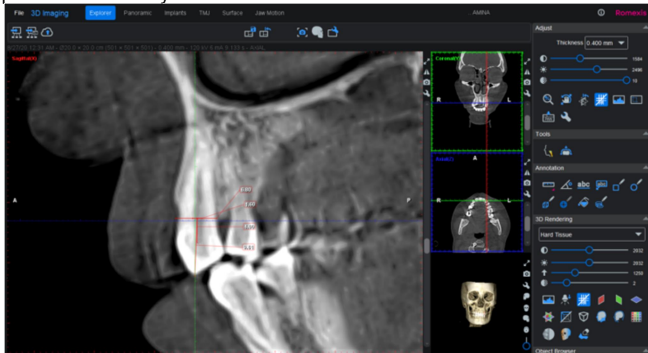
1. CBCT images showing maxillary canines with pulp stones or calcified canals.
2. CBCT images of permanent maxillary canines having root canal treatment, post and core build-ups, crowns, resorption defects, calcification and fractures.

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Planmeca Romexis 6th version software was utilized to calculate the linear measures of permanent maxillary canines. Using this software, the images were exported in Digital Imaging and Communication in Medicine (DICOM) file format. After importing CBCT images as DICOM files, the Mimics program was used to adjust the images' brightness, contrast, and sharpness to produce better results. First, the picture was orientated in axial, coronal, and sagittal planes in order to calculate the tooth crown length, width, volume, and pulp chamber length, width, and volume of permanent maxillary canines. The optimal midsagittal section of pulp area was chosen in the sagittal plane by scrolling the image on the software's cross-sectional plane after longitudinal axis of the tooth from crown tip to the root apex was identified (Figure 1).

Figure 1: Linear measurements of the crown and pulp chamber of the permanent maxillary canine



**Statistical analysis:**

- Statistical analysis was performed using SPSS version 22.
- Descriptive statistics such as the frequency, mean and standard deviation were employed.
- Pearson correlation coefficient was utilized to calculate the relationship between age and pulp chamber to tooth crown ratio, as well as the relationships between pulp chamber length, width, and volume.
- For differences to be statistically significant,  $P \leq 0.05$  was used.

**RESULT**

Table 1: Age groups distribution of patients CBCT included in the study.

Groups	Age groups	Frequency	Percent	Mean	Mode	Std. Deviation
Group I	13-23	74	41.1	27.2333	25.00 <sup>a</sup>	10.48867
Group II	24-33	68	37.9			
Group III	34-43	22	12.4			
Group IV	44-53	10	5.7			
Group V	54-60	6	3.3			

Table 1: Distribution Characterization for Correlation with age

	Age groups	Tooth Crown Length	Tooth Crown Width	Tooth Crown Volume	Pulp Chamber Length	Pulp Chamber width	Pulp Chamber Volume	Ratio
Mean	13-23	-.068	-.013	-.032	-.080	-.113	-.053	.127
	24-33	-.063	-.012	-.030	-.073	-.104	-.049	.117
	34-43	-.020	-.004	-.009	-.024	-.034	-.016	.038
	44-53	-.009	-.0018	-.004	-.011	-.015	-.007	.017
	54-60	-.005	-.0010	-.002	-.006	-.009	-.004	.010
P value		.005	.005	.005	.005	.005	.005	.004

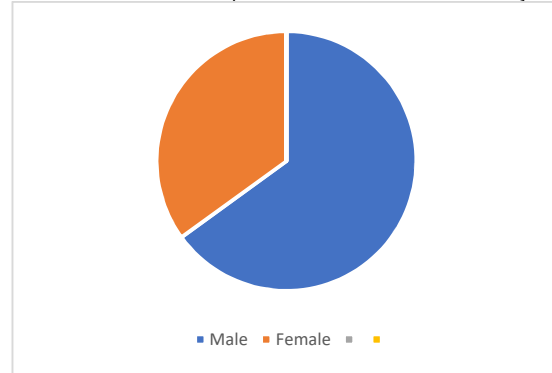
Df = 179

**DISCUSSION**

In the present study, maxillary permanent canines were selected because they often remain unaffected and are well anchored in the jaw for declining years. Therefore, canines carry less risk of caries. Such characteristics of the permanent maxillary canines allow an easy approach for the morphological quantification<sup>10,11</sup>.

In this study total sample size was 180, in which males were n= 117 (65%) and females were 63(35%)(Figure 2).The age group included in this study was from 13 to 60 years which was further divided into 5 main groups. Group I: (13-23), Group II: (24-33), Group III: (34-43), Group IV: (44-53) and Group V: (54 and above). In Group I the frequency was higher (41.1%), followed by Group II, Group III, Group IV and lowest in group V in which frequency was 3.3%. (Table 1) The mean age group calculated was 27.2333±10.48 (SD)and the mode of the group was 25 (Table 1).

Figure 2: Gender distribution of patients CBCT included in the study.



The associations between age groups and measured variables were assessed using Pearson correlation coefficient (Table 2). As shown, a negative correlation coefficient for all measured variables was found, indicating that with increasing age, the magnitude of these variables decreased. In Group I (13-23) the mean tooth crown length was (-.068), width was(-.013) the mean crown volumewas (-.032), whereas the mean pulp chamber length was (-.080), width was (-.113) and the mean pulp chamber volume was (-.053) and the mean ratio was (.127) (females= .015, males = .027). With increasing age, the mean value decreased in Group II, III, IV and V. In Group V (54-60), the mean for variables like tooth crown length was (-.005), crown width was (-.0010), volume was (-.002) while the pulp chamber length was reported to be (-.006), width (-.009) and volume was (-.004). The mean ratio was (.010) (females = .001, males= .002). As age is compared with variables (tooth crown length, width and volume) (pulp chamber length, width and volume) it showed that P-value was highly significant (P = .005) (Table 2).

Age-related changes in pulp are of utmost importance in clinical dentistry because of the continuous deposition of secondary dentin which may be used as a tool for the determination of age<sup>12</sup>. Secondary dentin primarily accumulates in the pulp chamber wall and may cause sclerosis and a decline in pulp chamber's volume with aging. When teeth are young, the pulp cavity is rather large, but as time goes on, the pulp chamber's size is greatly diminished due to the development of secondary and

tertiary dentin. The mesial-distal direction is where this decline generally happens<sup>13</sup>. Later in life, between 60 and 70 years, there is a decrease in vestibular direction because of fibrous dentin development. Apart from the marginal variation in pulp volume size across genders, there is a notable reduction in pulp cavity size between the ages of 22-30 and 51-60 years, with a greater loss in volume in the older age group from 61 to 70 years.

The transformation of pulp dentin in the pulp chamber area is clearly seen on CBCT<sup>14</sup>. Therefore, rather than selecting the volume of the complete tooth pulp for this investigation, only the volume of the pulp chamber and the volume of the tooth crown were chosen in order to achieve reliable measurements. This study's findings are consistent with those of earlier investigations<sup>15,16,17</sup> which showed that teeth were unaffected by aging. Jagannathan et al., 2011 found that there was a correlation ( $R^2 = 0.397$ ) between the age of the mandibular canines and the dental chamber's volume<sup>18</sup>. The association between maxillary canine volume and age was demonstrated by De Angelis et al (2015), with  $R^2 = 0.389$ <sup>19</sup>.

Ge et al (2016) used CBCT images to estimate age from pulp chamber volume<sup>20</sup>. Recent research has assessed the pulp's area and examined how aging relates to it<sup>21</sup>. In the present study, the relationship between gender and age of the tooth crown volume and volume of pulp chamber of permanent maxillary canines was compared which demonstrated a substantial correlation between age and sagittal view of the maxillary canine pulp chamber's volume. ( $p = 0.004$  and  $p = 0.005$ ). As a result, the current investigation demonstrated a stronger relationship between pulp chamber capacity and age. Accordingly, similar studies have suggested canines to measure pulp cavity rather than other dental groups<sup>22,23,24,25,26</sup>.

The present study shows a significant inverse relationship between age and volume of permanent maxillary canine. This is in line with Adisen et al., (2020)<sup>23</sup> who conducted a study on 131 CBCT images of patients aged 17 to 75 years with fully developed maxillary canines. The author<sup>27</sup> conducted a study on 150 CBCT images of mandibular canines in the Egyptian population between the ages of 18 and 70 and showed a statistically significant and highly negative relationship between pulp and tooth volume ratio and age ( $r = -0.869$ ,  $p < 0.001$ ).

## CONCLUSION

Within the confines of the current investigation, it may be concluded that there is a statistically significant ( $p = 0.005$ ) relationship between age and pulp chamber volume, indicating that the pulp chamber's size decreases with age.

**Ethical consideration:** Consent was taken from patients or their attendants who were already advised CBCT for treatment.

**Author contributions:** Correspondence, project formulation, data administration, data analysis, writing and editing of manuscripts, and critical manuscript revision, adherence to moral principles

**Conflict of interest:** The author states that she has no financial interests in the work she did or conflicts of interest.

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