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AGE ESTIMATION USING CANINE PULPAL AREA IN ADULTS: A CBCT IMAGE ANALYSIS IN SOUTH TAMILNADU POPULATION - A PILOT STUDY

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Abstract

The aim of this study is to estimate the age by measuring pulpal area of maxillary and mandibular canine of both sides using CBCT image analysis with a voxel resolution of 0.15mm. This study was performed on CBCT images of 40 individuals of South Tamilnadu population between 20 and 70 years of age with fully erupted maxillary and mandibular canine teeth. NNT viewer software was used to trace the outline of the pulp cavity and the mean pulpal area is calculated. An independent t-test was performed to assess the correlation between pulpal area of different age groups. The result was not statistically significant with overall age group but there was a significant result between 20 and 40 years age group.

Keywords: Canine Pulpal Area, Cone Beam Computed Tomography (CBCT), Forensic Odontology

INTRODUCTION

Age estimation can be performed using different parts of the human body. However, the natural form of human parts will be lost during burns or in buried bodies or in severe accidents.[1]For estimating the chronological age in deciduous and permanent dentition, the pattern of tooth development and eruption plays an important role.[2]Among the dental structures, pulp-dentinal complex show some modifications related to age mainly by reducing the pulpal area with the deposition of secondary dentin by odontoblasts.[3]After completion of eruption of tooth, the deposition of secondary dentin commences and there will be reduction in the size of the pulp cavity which was first investigated by Bodecker in 1925.[4] Age estimation in forensic dentistry plays an accurate importance ,mainly in the identification of unknown individuals those who are affected by war or natural disasters, undocumented immigrants, criminals and

those who are injured in accidents. The application of dental indexes is better than those based on somatic development, as the development of teeth is less affected by hormonal and nutritional changes.[5] The deposition of secondary dentin can be assessed by extraction of tooth or by various imaging techniques.[6] Panoramic and periapical radiographs have been used to assess the deposition of secondary dentin.[7] However the radiographic techniques have various disadvantages of being two-dimensional and provides a distorted view. This two-dimensional view also fail to provide accurate measurements due to the overlap of anatomical structures, radiographic geometry and magnification.[8] Thus limitations of two-dimensional imaging modalities is overcome by the application of three dimensional modalities in age estimation to assess the pulpal area of maxilla and mandibular canine in South Tamil Nadu population.Thus the goal of this study was to evaluate the accuracy of a simple and conservative method for estimating the age of the adults based on CBCT(Cone Beam Computed Tomography) analysis of pulpal area of maxillary and mandibular canine teeth of both sides respectively.

MATERIALS AND METHODS

Sample Selection

Archival CBCT images of 100 patients who came for diagnostic and treatment purposes to Rajas Dental college and hospital during the period from November 2021 to February 2022 were retrospectively analysed. CBCT images of patients between 20 and 70 years with fully erupted maxillary and mandibular canine teeth of both right and left sides were included in the study. CBCT images of those with decayed and restored canine teeth, teeth with periodontitis, abrasion, erosion, fracture and rotation were excluded from the study. In addition, teeth with developmental and morphological anomalies such as pulp stones and calcified canal were also not included in the study. After screening, CBCT images of 40 patients fit the inclusion criteria of the study.

Among 40 CBCT scans, the sample was divided into 4 groups. Group I includes age group of 20-30 years, Group II includes 30-40 years of age group, Group III includes 40-50 years of age group and Group IV includes above 50 years of age. In each group 10 samples were selected including both sides of maxillary and mandibular canine.

Acquisition Of Image

All CBCT images were analysed using a CBCT system (NEW TOM CBCT UNIT) (Imaging features 90 kV, 4mAs, 8mA, 0.500S). The axial setup was set around 0.15 mm thickness (range: 0.15/5mm). The panorex setup was viewed in a single view with the thickness of 25mm (range:0.15/250mm) and the cross set up was made with a width of 30mm (range:30/250mm) and thickness of minimum 0.15mm (range:0.15/250mm). The multiplanal view was preferred to select the canine teeth individually and each side was calculated separately.

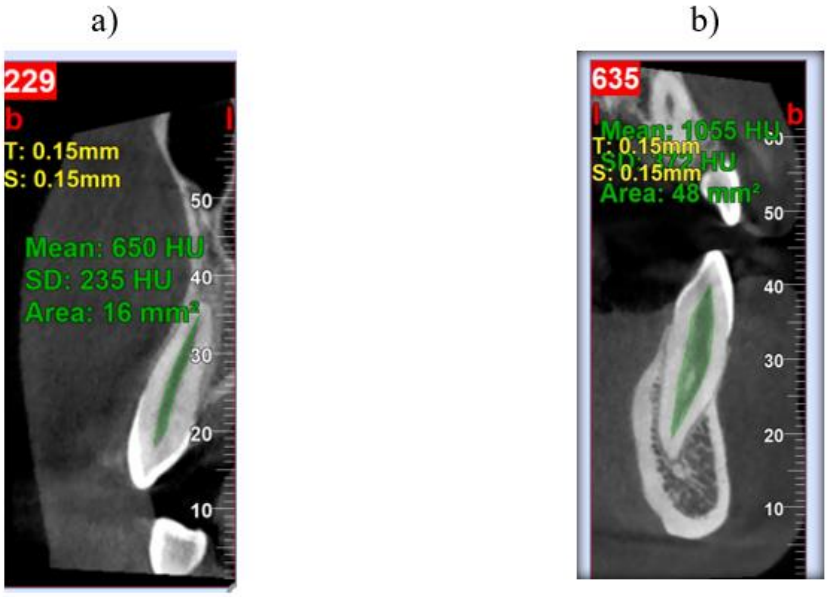

Fig 1 a) Sagittal section of maxillary right canine b) Sagittal section of mandibular left canine.

Interpretatıon Of Image

Each selected image was oriented into (Axial, Coronal and Sagittal) planes in NNT viewer software. Manual segment was performed because of reliability and improvement in apical region as compared with automatic segmentation. After orientation of the image in all three planes, the sagittal sections were selected for the pulp contour measurements. 'Trace region tool' was selected from the annotation tools for pulpal area measurements. The outline of the pulp cavity is traced and the mean area is calculated.

SATISTICAL ANALYSIS

The statistical analysis was performed using SPSS software version 21. The correlation between pulpal area and chronological age was assessed using Pearson's correlation Co-efficient. An independent t-test was applied was applied to compare the difference between pulpal area of both sides of maxilla and mandible. A value of $p< 0.05$ was considered as statistically significant for differences.

Table 1

			N	Mean	Standard Deviation	p-value
20-30 Years	**MAXILLA**	**RIGHT**	10	18.200	11.193	0.016
		LEFT	10	16.200	4.263	
	MANDIBLE	**RIGHT**	10	15.100	7.156	0.839
		LEFT	10	14.500	5.778	

Bar Graph

a) Group -I=20 to 30 years

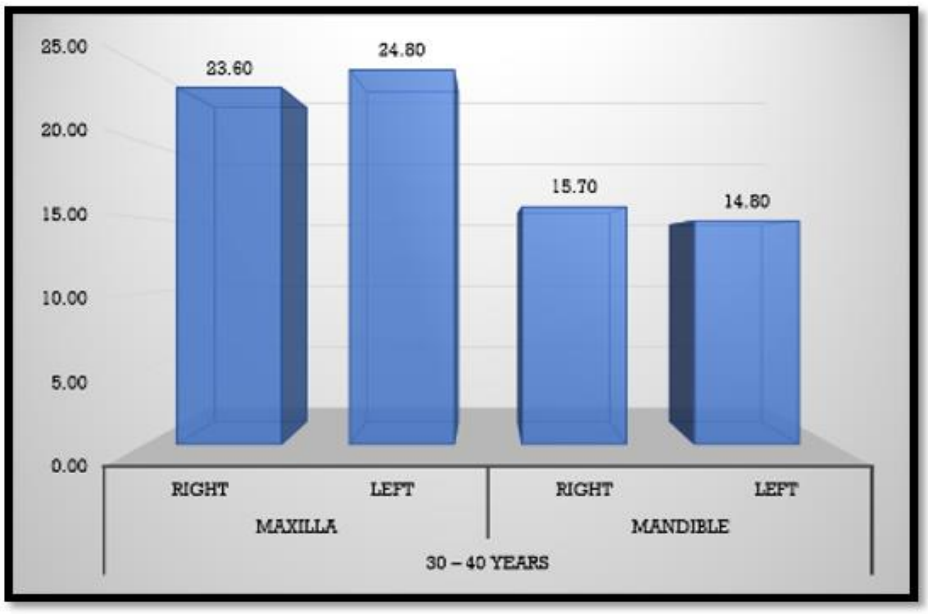

Table 2

			N	Mean	Standard Deviation	p-value
30-40 Years	**MAXILLA**	**RIGHT**	10	23.600	3.717	0.575
		LEFT	10	24.800	5.513	
	MANDIBLE	**RIGHT**	10	15.700	4.691	0.674
		LEFT	10	14.800	4.709	

Bar Graph

b) Group-II=30 to 40years

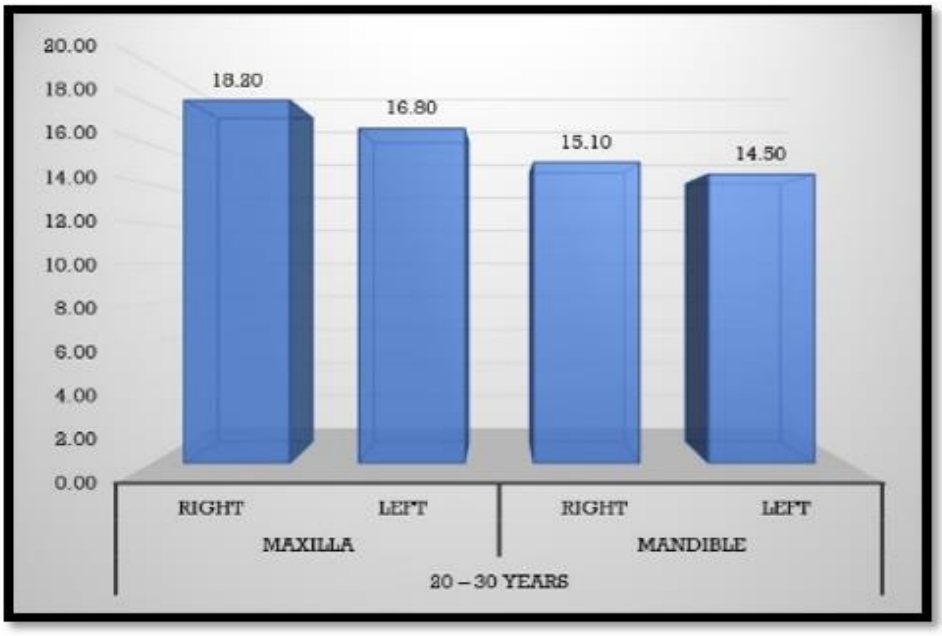

Table 3

			N	Mean	Standard Deviation	p-value
40-50 Years	MAXILLA	RIGHT	10	23.000	5.033	0.020
		LEFT	10	20.200	5.711	
	MANDIBLE	RIGHT	10	19.200	4.541	0.031
		LEFT	10	17.100	6.887	

Bar Graph

c) Group-III=40 to 50 years

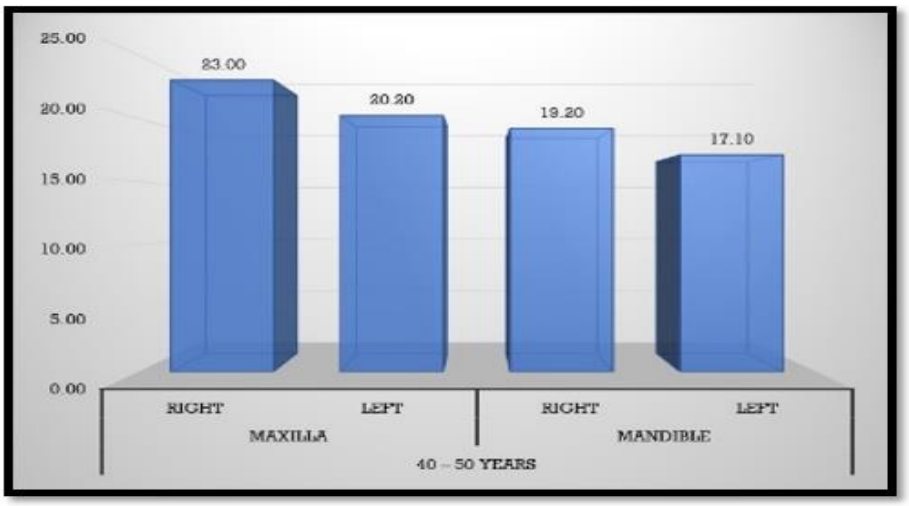

Table 4

			N	Mean	Standard Deviation	p-value
>50 years	MAXILLA	RIGHT	10	18.500	3.922	0.802
		LEFT	10	19.000	4.830	
	MANDIBLE	RIGHT	10	16.600	5.037	0.636
		LEFT	10	17.700	5.186	

Bar Graph

d) Group-IV=>50 years

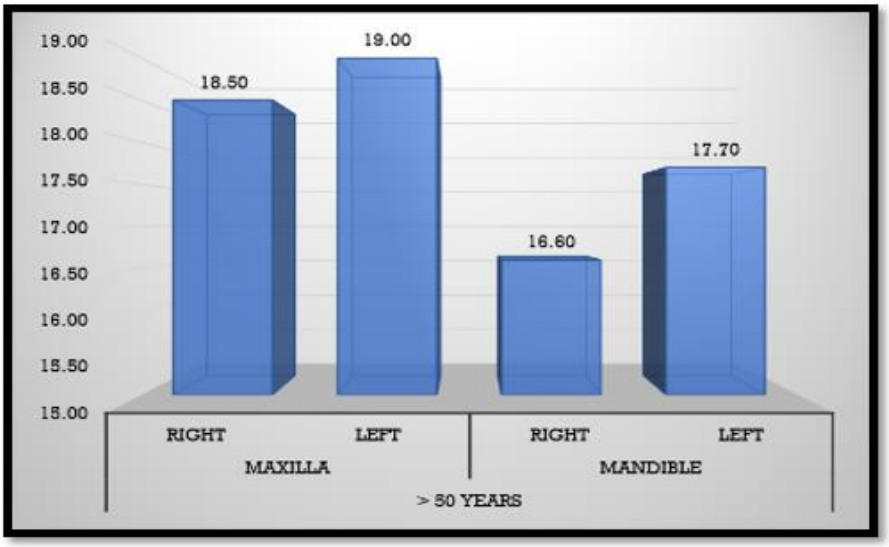

Table 5

			N	Mean	Standard Deviation	p-value
Overall	**MAXILLA**	**RIGHT**	40	20.825	6.196	0.661
		LEFT	40	20.200	5,734	
	MANDIBLE	**RIGHT**	40	16.650	5.479	0.617
		LEFT	40	16.025	5.645	

RESULTS

The study consisted of 40 participants. The mean age group was around 24.8±14.5. Distribution of age and anatomical site of both the sides is given in Table(1-5). The results suggest that group I of age between 20-30 years had the significant p value (0.016) of right maxilla compared to the other age groups shown in Bar graph(a). Group III of age group 40-50 years also had a significant P value (0.020) and (0.031) for maxilla and mandible as shown in Bar graph (c) respectively. But, the overall p value was greater than 0.05 which was not statistically significant.(Table 5)

DISCUSSION

Methods of age estimation is more accurate in children when compared to adults. It is, therefore, necessary to improve the age estimation in adults.[9] The teeth which is less affected by occlusal loads and periodontal disease, are the canine teeth which is particularly used in age estimation which usually remain in the mouth for longest period of time.[2] After tooth eruption, the formation of secondary dentine causes pulpal area to decrease. This change is considered as a valuable dental age predictor for adults.[10] In the present study pulpal area of maxillary and mandibular canine was evaluated for estimation of age in south tamilnadu population. Several studies suggested that the measurement of the pulpal size area in canines revealed better secondary dentinal deposition than the other teeth groups with smaller pulp areas (*e.g.* lateral incisor).[11]

In our study we preferred CBCT to eliminate various disadvantages that are occurring during routine radiographic techniques. Because the periapical and panoramic radiograph's are not always standardized and have low resolution, distortion and dimensional changes due to magnification.[12] The disadvantages of Micro-CT is that it has a high radiation dose, longer scanning time ,inability to use in living individuals.[13] The highest cost and increase in ionizing radiation dose to the individual, medical CT is not preferred in our study.[14]In order to eliminate all these disadvantages, images of patients who had previously received CBCT for any reason were used in our study.

Dehghani, Mahdieh et al ,conducted Age estimation by canines' pulp/tooth ratio in an Iranian population using digital panoramic radiography in 2018 using AutoCAD software on maxillary and mandibular canines and concluded that the pulp/tooth area ratios of canines are a reliable method for age estimation in Iranians. The pulp/tooth area ratio of upper canine was better correlated with chronological age than that of lower canine.[15]In our study, age estimation was done using CBCT using NNT viewer software in both upper and lower canine of both the sides in south tamilnadu population.Instead of measuring the tooth pulpal area we analyzed only the pulpal of both canine teeth. The pulpal area of upper and lower canine of both sides are calculated. A significant result was found in maxillary canine between 20 and 40 years of age group ,But there was a insignificant result was found between both upper and lower canines.

In many studies investigating age estimation using CBCT, sagittal section images were used[16] similar to our study. On the other hand, Rai et al, reported no correlation between PTR and chronological age using sagittal and coronal sections of maxillary canine teeth on CBCT images, but there was a significant correlation using the axial section.[17] In some studies, the correlation between chronological age and PTR differed according to tooth group, but not in other studies.[18] In the present study,we analysed all the teeth in sagittal section and measured the mean pulpal area and there was no significant relation between different age groups.In the current study we assessed the pulp tooth ratio in south Tamilnadu population using maxillary and mandibular canine of both sides.In contrast to our study Asif et al.,in 2018 have done a study on Malaysian population to asses the volumetric analysis of pulp/tooth ratio on maxillary canines of both sides and maxillary central incisors.He concluded that a volumetric change in the pulp cavity with age is a valuable assessment method for dental age estimation among Malaysian population.[19]According to the study conducted by Zhi Pu Ge et al., the pulp chamber volume of first molar is a useful index for the estimation of human age with reasonable precision and accuracy using maxillary and mandibular first molar.[20]This was not similar to our study in which we analysed only maxillary and mandibular canines.

According to Jegannathan et al., the pulp/tooth volume ratio is a useful indicator of age,in which he analyzed only mandibular canines in Indian population which was not similar to our study which was done in south Tamilnadu population.[21]Another study conducted by Yang et al.,was done to find the ratio between pulp canal versus tooth volume,and found that there was a moderate correlation between pulp.tooth volume ratio which was in contrast to our study which assesed only the pulpal area.[22]In the present study we evaluated maxillary and mandibular canines using cone beam computed tomography and found that age estimation using canine pulpal area can be used as a tool to estimate the age.But in contrast to our study Medha et al,done a study in mandibular canine using intraoral periapical digital radiographs in Indian population between the age of 20 and 70 years and concluded that age estimation can be used as an forensic investigation tool.[23]According to the study conducted by Someda et al.,he conducted a study to investigate an age estimation method that considers gender as well as three-dimensional measurement of the components, specifically enamel and dentin and concluded that estimated age was higher in males compared to females for the same volume ratio of the pulp cavity. The highest correlation in both genders with age was observed for the volume ratio of the pulp cavity to the whole tooth excluding the enamel. Therefore, he concluded that the use of gender-specific equations is recommended for age estimation.[24]

CONCLUSION

Thus we conclude the study that maxillary right canine showed a significant result compared to that of the mandibular canine between 20 and 40 years age group.Thus pulpal area can be used for age estimation in south tamilnadu population.However,there is a need to investigate the relationship of pulpal area with age in a larger population using different age groups and gender.

References

1) D.A. Prince, E.H. Kimmerle, L.W. Konigsberg, A Bayesian approach to estimate skeletal age-at-death utilizing dental wear, J. Forensic Sci. 53 (May (3)) (2008) 588–593.

2) Tardivo D, Sastre J, Catherine J-H, Leonetti G, Adalian P, Foti B. Age determination of adult individuals by three-dimensional modelling of canines. Int J Legal Med. 2014;128(1):161–169.

3) Singaraju S, Sharada P. Age estimation using pulp/tooth area ratio: a digital image analysis. J Forensic Dent Sci. 2009;1(1):37.

4) Bodecker CF (1925) A consideration of some of the changes in the teeth from young to old age. Dental Cosmos 67(6):543–549

5) Mehrdad Abdinian , Mehdi Katiraei , Hosein Zahedi , Carlo Rengo , Parisa Soltani 1,* and Gianrico Spagnuolo,*Age Estimation Based on Pulp–Tooth Volume Ratio of Anterior Teeth in Cone-Beam Computed Tomographic Images in a Selected Population: A Cross-Sectional Study, Appl. Sci. 2021, 11, 9984.

6) Litsas G, Lucchese A. Dental and Chronological Ages as Determinants of Peak Growth Period and Its Relationship with Dental Calcification Stages. Open Dent J. 2016 Apr 8;10:99-108.

7) Dehghani M, Shadkam E, Ahrari F, Dehghani M. Age estimation by canines' pulp/tooth ratio in an Iranian population using digital panoramic radiography. Forensic Sci Int. 2018 Apr;285:44-49.

8) Cameriere R, De Luca S, Soriano Vázquez I, Kiş HC, Pigolkin Y, Kumagai A, Ferrante L. A full Bayesian calibration model for assessing age in adults by means of pulp/tooth area ratio in periapical radiography. Int J Legal Med. 2021 Mar;135(2):677-685.

9) De Angelis D, Gaudio D, Guercini N, Cipriani F, Gibelli D, Caputi S, Cattaneo C. Age estimation from canine volumes. La radiologia medica. 2015;120(8):731–736.

10) Star H, Thevissen P, Jacobs R, Fieuws S, Solheim T, Willems G. Human dental age estimation by calculation of pulp-tooth volume ratios yielded on clinically acquired cone beam computed tomography images of monoradicular teeth. J Forensic Sci 2011; 56(Suppl. 1): S77–S82. doi: 10.1111/j.1556-4029.2010.01633.

11) Tardivo D, Sastre J, Ruquet M, Thollon L, Adalian P, Leonetti G, et al. Three-dimensional modeling of the various volumes of canines to determine age and sex: a preliminary study. J Forensic Sci 2011; 56: 766–70. doi: 10.1111/j.1556-4029.2011.01720.x

12) Marroquin TY, Karkhanis S, Kvaal SI, Vasudavan S, Kruger E, Tennant M. Age estimation in adults by dental imaging assessment systematic review. Forensic Sci Int 2017;275:203–11.

13) Rodt T, Luepke M, Boehm C, von Falck C, Stamm G, Borlak J, et al. Phantom and cadaver measurements of dose and dose distribution in micro-CT of the chest in mice. Acta Radiol 2011;52(1):75–80.

14) Qu XM, Li G, Zhang ZY, Ma XC. Comparative dosimetry of dental cone-beam computed tomography and multi-slice computed tomography for oral and maxillofacial radiology. Chinese J Stomatol 2011;46 (10):595–9.

15) Dehghani M, Shadkam E, Ahrari F, Dehghani M. Age estimation by canines' pulp/tooth ratio in an Iranian population using digital panoramic radiography. Forensic Sci Int 2018;285:44-9.

16) Sue M, Oda T, Sasaki Y, Ogura I. Age-related changes in the pulp chamber of maxillary and mandibular molars on cone-beam computed tomography images. Oral Radiol 2018;34(3):219–23.

17) Rai A, Acharya AB, Naikmasur VG. Age estimation by pulp-to-tooth area ratio using cone-beam computed tomography: a preliminary analysis. J Forensic Dent Sci 2016;8(3):150–4.

18) Jain S, Nagi R, Daga M, Shandilya A, Shukla A, Parakh A, et al. Tooth coronal index and pulp/tooth ratio in dental age estimation on digital panoramic radiographs – a comparative study. Forensic Sci Int 2017;277:115–21.

19) Asif MK, Nambiar P, Mani SA, Ibrahim NB, Khan IM, Lokman NB. Dental age estimation in Malaysian adults based on volumetric analysis of pulp/tooth ratio using CBCT data. Leg Med (Tokyo). 2019 Feb;36:50-58. doi: 10.1016/j.legalmed.2018.10.005. Epub 2018 Oct 21. PMID: 30415192.

20) Zhi Pu Ge et al. , Ruo-han Ma a , Gang Li a, *, Ji-zong Zhang b , Xu-chen Ma a Age estimation based on pulp chamber volume of first molars from cone-beam computed tomography images/ Forensic Science International 253 (2015) 133.e1–133.

21) Jagannathan N, Neelakantan P, Thiruvengadam C, Ramani P, Premkumar P, Natesan A, Herald JS, Luder HU. Age estimation in an Indian population using pulp/tooth volume ratio of mandibular canines obtained from cone beam computed tomography. J Forensic Odontostomatol. 2011 Jul 1;29(1):1-6. PMID: 21841263; PMCID: PMC5734837.

22) Yang F, Jacobs R, Willems G. Dental age estimation through volume matching of teeth imaged by cone-beam CT. *Forensic Sci Int*. 2006;159 Suppl 1:S78–83. 10.1016/j.forsciint.2006.02.031.

23) Babshet M, Acharya AB, Naikmasur VG. Age estimation in Indians from pulp/tooth area ratio of mandibular canines. Forensic Sci Int. 2010 Apr 15;197(1-3):125.e1-4. doi: 10.1016/j.forsciint.2009.12.065. Epub 2010 Jan 27. PMID: 20106616.

24) Someda H, Saka H, Matsunaga S, Ide Y, Nakahara K, Hirata S, Hashimoto M. Age estimation based on three-dimensional measurement of mandibular central incisors in Japanese. Forensic Sci Int. 2009 Mar 10;185(1-3):110-4. doi: 10.1016/j.forsciint.2009.01.001. Epub 2009 Feb 7. PMID: 19201557.