Research Article

Age Estimation using pulp/tooth Volume Ratio of Mandibular First Premolar Obtained from Cone Beam Computed Tomography in the Indian Population

Vane Swetah. C. S. [*], Dr. Nithya Jagannathan [**]
*BDS Student, Saveetha Dental College and Hospitals, Saveetha University, 167, PH Road, Velappanchavadi, Chennai, Tamil Nadu, India
** Senior Lecturer, Saveetha Dental College and Hospitals, Chennai, Tamilnadu, India.
*Corresponding author's E-mail: vaneshines@yahoo.co.in

ABSTRACT

The aim of this study is to assess the age of an individual using pulp/tooth volume ratio of mandibular first premolar using cone beam computed tomography in the Indian population. Pulp size is known to decrease with age and Secondary dentine is responsible for a decrease in the volume of the dental pulp cavity with aging. The Cone beam CT units can be adjusted to scan small regions for specific diagnostic tasks, have great accuracy and the scan time is shorter which overall helps in the accuracy of the study. This study will include collection of 23 Mandibular first premolar and calculating its pulp tooth ratio using CBT. CBCT is used to reconstruct the tooth structure using X-Ray principle. Age estimation is an important aspect in the field of forensics. Pulp cavity size is known to decrease with age and thus examination of this opens new methods of age estimation methods in the field of forensic odontology.

Keywords: Forensic science, forensic odontology, age estimation, Indian, pulp volume, tooth volume, cone beam computed tomography, mandibular premolar.

INTRODUCTION

Age is one of the several critical factors used in establishing a person's identity. Age determination is widely used by anthropologists, archaeologists and forensic scientists. Examination of teeth is a unique as they are the most durable and resilient part of a skeleton [2]. The field of science dealing with the identify of a person based on teeth is known as forensic odontology.

In children, age determination from the teeth is relatively simple and accurate; it is based on the stage of development and eruption of teeth (Komínek, Rozkovcová 1984). In adults, estimating age is more problematic. Out of many stomatological criteria the most common ones for the estimation of age at death of adult individuals involve changes in the hard tooth tissues. Gustafson was the first to devise the microscopic method for age estimation based on the histological examination of ground thin sections of teeth using a scale of 03 points (0; 1; 2; 3). He evaluated the extent of six changes correlated teeth with increasing age. These are: the degree of attrition (A), the position of epithelial attachment (G), the amount of secondary dentine (D), the cemental thickness (C), the degree of root resorption (R) and the transparency of root dentine (T). Their total value should correspond to a certain age. Figuration of changes in hard tooth tissues Estimation of Age at Death Using Teeth 41 is ± 3.6 years (Gustafson 1950). However, this statement has been contested (Nkhumeleni et al. 1989; Lucy and Pollard 1995)[4]. Johanson in 1971 used the same six criterions but the ranking scale was different[2] ' The estimation of age performed on the basis of histological examination and evaluation of morphological changes in hard tooth tissues was believed to be one of the most

reliable methods, yet it has become the subject of heavy criticism especially when used with past. Nevertheless, the principle of the histological evaluation of the changes introduced by Gustafson has become the basis for all other techniques which aim at the increase of precision of measurement[5].
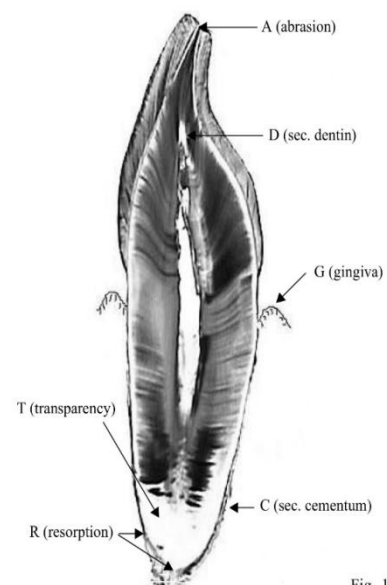

Figure 1: Figuration of changes in hard tooth tissues

Examination of pulp offers new methods for age identification and the most commonly used method is secondary dentine apposition. This alters the size of pulp chamber which can only occur with age of under pathological influence [1] .The most common method used to study pulp chamber size is radiograph. However, this

two-dimensional method is at a disadvantage as it is subjected to distortion [1].

The Cone Beam Computed Tomography is compact, faster and is a safer version of the regular CT due to minimised radiation dosage.

MATERIALS AND METHODS

Sample

Twenty three intact mandibular premolars were collected from dental practioners. Those teeth ranged from 10-45 years in age. All teeth were from indigenous Indian population and no other ethnic minorities were involved. The selection was confined to teeth that showed neither profound caries nor restorations and showed normal anatomy.
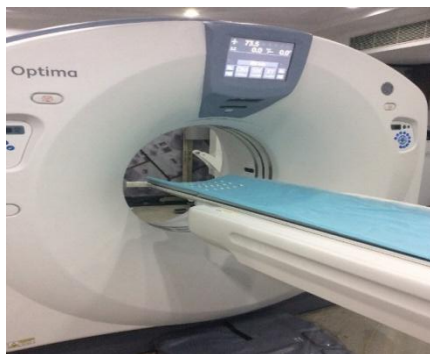

Figure 2: The sample of teeth
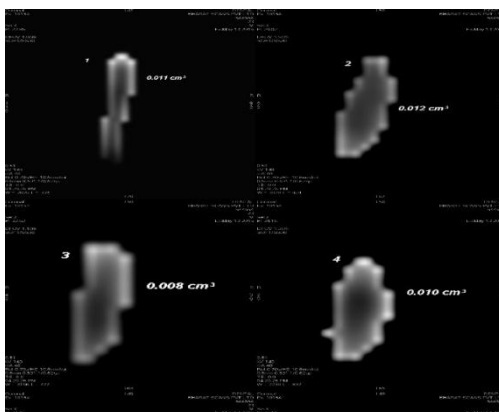

Figure 3: The Cone Beam Computed Tomography in work.
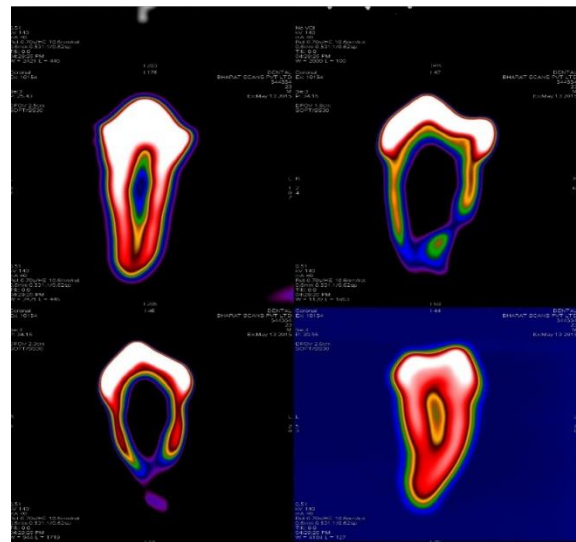

Figure 4: Volumetric Reconstruction of pulp space

Figure 5: The Original CT images of teeth

Table 1: Sample Distribution based on age and gender

Number	Age(In Years)	Gender
1	10	Male
2	10	Male
3	12	Female
4	13	Female
5	14	Male
6	14	Female
7	22	Female
8	23	Female
9	24	Male
10	27	Female
11	28	Male
12	29	Male
13	29	Female
14	30	Female
15	31	Male
16	31	Male
17	32	Male
18	35	Female
19	35	Female
20	37	Female
21	39	Male
22	43	Female
23	45	Female

Cone Beam Computed Tomography

The sample was stored until the collection was complete after about one month after washing extensively under tap water. They were then washed with tap water and immersed in sodium hypochlorite for 30-35 minutes to remove soft tissues.

The teeth were then images by a Cone Beam Computed Tomography (Optima CT660 FREEdom Edition) with a constant thickness slice of about 10 mm and exposure conditions of 140kV and 40mA. Volume rendering and volume reconstruction was performed. Using a method previously used by Fan Yang, the pulp/tooth ratio was determined. Age was then calculated using the linear regression derived by Yang [5].
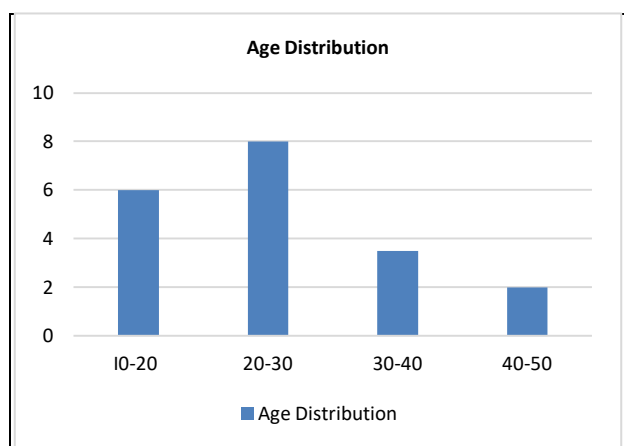

Figure 6: The age distribution of the selected sample in Age groups.

Measurement

All the results were measured along with additional information such type of tooth (left or right), age and gender were entered in a spreadsheet (Microsoft Excel 2013). From the differences between actual and predicted age ages in the mean absolute error (MAE) was calculated to obtain a measure of the accuracy of the age prediction [7]. The percentage of estimates with deviations of more than ± ten years, which is considered ' acceptable' in forensic age prediction, was also determined [8]. The data set was then finally allowed comparisons with the Indian and Belgian formulate [5].

Statistical Analysis

The statistical analysis was carried out using NCSS (Utah, USA, http://www.ncss.com/.). Linear regression analyses were performed in order to establish a correlation between chronological age and pulp/tooth volume ratio.

RESULTS

The pulp/tooth volume varied from 0.006 to 0.016. A difference between samples in terms of type of tooth or gender of patient was insignificant.

Regression analysis yielded a moderate negative correlation between pulp/tooth volume ratio and age and the following linear regression equation

$$AGE = (60.4054732041049) + (-3368.75712656785) * (Pulp\_tooth\_volume)$$

Application of this formula yielded an MAE of 7.24 years which is within ± 10 years of the actual age.

In contrast to this, the use of Yang's formula produced an MAE of 19.84 in all the cases. Age estimates were within ±10 years in only 5.11% of cases, which are significantly different form the MAE obtained in our new formula [10].
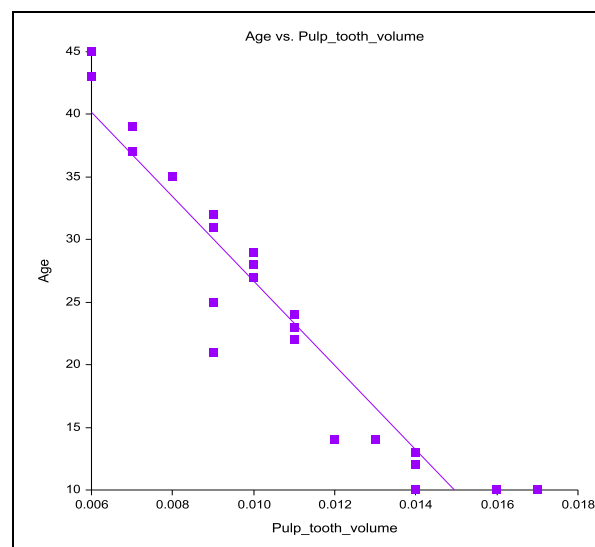

Figure 7: Graphical representation of age as a function of the pulp/tooth volume ratio

DISCUSSION

This study indicates that the pulp/tooth volume ratio of mandibular premolars is useful in age identification but the formula used must be varied according to geography. As the secondary dentine deposition is an age-associated process in internal surface, a part of the external factors can be eliminated [1].

Cone Beam Computed Tomography is used as it shows the accurate anatomy in a three dimensional plane. The latest units also have the ability to have a higher resolution and lower exposure. They are also use less time to produce much more profound results. [10]

A similar estimation was done in the Belgian population but the error exceeds by ten years and thus, is not a formula which can be adopted [5]. The reason could be that the Indian population is a hybrid of several ethnic groups such Caucasian, Mongoloid and Negroid Races. [9] Thus, these could account for the variation in results.

CONCLUSION

The present research showed that the modification of Yang's formula can be used to estimate age in the Indian population using pulp tooth volume. However, caution should be exercised in the practical application. Thus, newest modalities and optimization of CBCT can therefore make the technique mature and prominent in the field of forensic odontology.

REFERENCES

1. 1.N. Jagannathan, a P. Neelakantan,b C. Thiruvengadam,a P. Ramani,a P. Premkumar,a A. Natesan,a J.S. Herald,a H. U. Luder.c, Age estimation in an Indian polutaion using pulp/tooth volume ration of mandibular canines obtained

from Cone Beam Computed Tomography. J Forensic Odontostomatol. 29(1), 2011 Jul 1, 1-6.

2. Gustafson G. Age determination on teeth. J Am Dent Assoc 41, 1950, 45-54.

3. Johanson G. Age determination from teeth. Odontol Revy 22, 1971, 1-126.

4. Kagerer P, Grupe G. Age-at-death diagnosis and determination of life-history parameters by incremental lines in human dental cementum as an identification aid. Forensic Sci Int 118, 2001, 75-82.

5. Yang F, Jacobs R, Willems G. Dental age estimation through volume matching of teeth imaged by cone-beam CT. Forensic Sci Int 159(Suppl 1), 2006, S78-83.

6. Cameriere R, Ferrante L, Belcastro MG, Bonfiglioli B, Rastelli E, Cingolani M. Age estimation by pulp / tooth ratio in canines by periapical X-rays. J Forensic Sci 52, 2007, 166-70.

7. Cameriere R, Ferrante L, Liversidge HM, Prieto JL, Brkic H. Accuracy of age estimation in children using radiograph of developing teeth. Forensic Sci Int 176, 2008, 173-177.

8. Solheim T, Sundnes PK. Dental age estimation of Norwegian adults: a comparison of different methods, Forensic Sci Int 16, 1980, 7-17.

9. Reich D, Thangaraj K, Patterson N, Price AL, Singh L. Reconstructing Indian population history. Nature 24, 2009, 489 - 494.

10. Dr Mohammed A. Alshehri, Dr Hadi M. Alamri & Dr Mazen A. Alshalhoob, Saudi Arabia, CBCT applications in dental practice: A literature review, 06-Dec-2010 | General Dentistry

11. Babshet M, Acharya AB, Naikmasur VG. Age estimation in Indians from pulp/tooth area ratio of mandibular canines. Forensic Sci Int 197, 2010, 125.e1-4.

12. Neelakantan P, Subbarao C, Subbarao CV. Comparative evaluation of modified canal staining and clearing technique, cone-beam computed tomography, peripheral quantitative computed tomography, spiral computed tomography, and plain and contrast medium-enhanced digital radiography in studying root canal morphology. J Endod 36, 2010, 1547-1551.

13. Ubelaker DH, Parra RC. Application of three dental methods of adult age estimation from intact single rooted teeth to a Peruvian sample. J Forensic Sci 53(3), 2008, 608-611.

14. Acharya AB, Vimi S. Effectiveness of Bang and Ramm's formulae in age assessment of Indians from dentin translucency length. Int J Leg Med 123, 2009, 483-488

15. Wittwer-Backofen U, Gampe J, Vaupel JW. Tooth cementum annulation for age estimation: Results from a large known-age validation study. Am J Phys Anthropol 123, 2004, 119-129.

16. Drusini A, Calliari I, Volpe A. Root dentin transparency: age determination of human teeth using computerized densitometric analysis. Am J Phys Anthropol 85, 1991, 2530.

17. Kvaal SI, Kolveit KM, Thomsen IO, Solheim T. A non-destructive method for age estimation. J Forensic Odontostomatol 12, 1994, 6-11.

18. Paewinsky E, Pfeiffer H, Brinkmann B. Quantification of secondary dentine formation from orthopantomograms—a contribution to forensic age estimation methods in adults. Int J Legal Med 119, 2005, 27-30.

19. Cameriere R, Ferrante L, Cingolani M. Variations in pulp/tooth area ratio as an indicator of age: a preliminary study. J Forensic Sci 49, 2004, 317-319.

Source of Support: Nil, **Conflict of Interest:** None.