

Original Article

Pulp Length/Tooth Length Ratio: Whether a Reliable Tool for Analyzing Forensic Age?

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INTRODUCTION

Forensic identification is a multidisciplinary act that utilizes various methods relying on team effort as well as methodologies which may be speculative or conventory.^[1] Forensic odontologists utilize parameters such as age, race, sex, and ethnicity on both living and dead individuals.^[2] Age of an individual has been measured since ages from the days of creation.^[3]

The most important aspect of personal identification of unidentified dead bodies is age estimation and also reconstructing the profile of individual where the ante-mortem records are not available.^[4] Apart from forensic odontology, archaeologists also use age estimation as a tool for estimating the age of archaeological samples.^[5] Teeth present as substantial evidence for civil and medico-legal

identification because of their hardness, durability, and resistance to environmental factors such as bacterial degradation and teeth are most commonly used for forensic studies with considerable amount of accuracy, reliability, and precision.^[6] The reliability of these studies depends on proper planning followed by execution of appropriate methods of age estimation. Therefore, correct and accurate estimation of age of an individual reduces the need of comparative personal identification. Thus, our study aims to assess the chronological age of individuals by analogizing the relationship between pulp length/tooth length ratio and age in the mandibular canine using odontometry by visual and

ABSTRACT

Background: Age is considered an important parameter used in the personal identification of deceased or missing or live individuals. A number of researches have been done on age estimation, and these studies proved to be beneficial demonstrating various degrees of precision, accuracy, and reliability. Teeth are the most common material used nowadays for the estimation of age as they can be preserved for longer time after all the body tissues have disintegrated.

Aim: This study aimed to devise a method for interpreting the chronological age by correlating age and pulp length/tooth length ratio in the mandibular canine.

Materials and Methods: In the present study, 120 extracted permanent mandibular canines were included from individuals with known age (between the age group of 20 and 50 years) and sex. The unsectioned method was adopted to measure the pulp length/tooth length ratio. Digital Vernier caliper was used to measure the maximum tooth length, and K-file was used to measure the maximum pulp length. The obtained data were statistically analyzed using one-way analysis of variance test for continuous variables and unpaired *t*-test for unmatched variables.

Results: Appreciable difference was seen in all the parameters such as pulp length/tooth length ratio of all the samples, having different age without any significant difference between the genders. With ascending age, gradual reduction in pulp size was observed when compared to total pulp length and cervical pulp width, depicting outstanding correlation with the chronological age.

Conclusion: As teeth could be retained in the original form for a long period, dental age assessment is of use in normal day-to-day life and mass disasters. The results and observations depicted that, with advancing age, the length of the dental pulp chamber decreases vertically as well as horizontally as a result of secondary dentin deposition. However, these variables could not differentiate between genders. Thus, assessment of pulp length/tooth length ratio on the mandibular canine using odontometric procedure manually without any sophisticated instruments can be used as an alternative method to estimate the nearest chronological age with reasonable accuracy when radiographs are not available.

KEY WORDS: Age estimation, forensic science, identification, mandibular canine, Pulp/tooth length

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nondestructive methods, thereby helping in the assessment of the nearest chronological dental age of the individual with appreciable accuracy.

MATERIALS AND METHODS

In this study, 120 extracted permanent mandibular canines with details such as age (between the age group of 20–50 years) and sex were collected from dental practitioners of Bharatpur, Chitwan. Record of age and sex of all the samples was kept. Of the 120 samples obtained, 70 teeth were of males and 50 teeth were of females. The teeth were divided into three groups (20–30 years, 30–40 years, and 40–50 years), with each group having forty teeth. All teeth were obtained from Bharatpur population preventing chances of any bias. Teeth obtained after extraction were immediately washed under running tap water and were then stored in 2.5% sodium hypochlorite for 30 min so as to remove attached soft tissue. Teeth which were morphologically sound and were having fully formed roots were included in the study. Teeth with development defects, caries, and restorations were excluded from the study. All these teeth were then placed in 10% formalin, and the name and age of the patient were also accorded properly.

The task of recording tooth measurements was then carried out with hemisectioning of the tooth. Digital vernier caliper being used to measure the tooth length (length from tip of the cusp to root apex) while length of the pulp was measured with the help endodontic K-file by passing it through the apical foramen, till the point where it cannot be pushed further and was marked by rubber stopper to assess pulp length. The K-file was then removed, and the pulp length was measured using digital Vernier caliper.

STATISTICAL ANALYSIS

SPSS software version 16.0 (IBM, India) was used to statistically analyze the data. Mean and standard deviation were assessed out. Significance was assessed at 5% level of significance. To find the significance of the study variables across the various age groups, analysis of variance was used. Turkey's test was used to find out the variations between different groups and between different variables.

RESULTS

The sample consisted of 120 freshly extracted mandibular canines that were stored in formalin. The teeth were categorized based on the patients' age [Table 1]. Each category consisted of forty teeth: Group I: 20–30 years, Group II: 30–40 years, and Group III: 40–50 years.

The mean pulp length/tooth length ratio was found to be 0.87 ± 0.036 for the age group of 20–30 years, 0.86 ± 0.017 for 30–40 years, and 0.81 ± 0.02 for 40–50 years [Table 2]. There was a statistically significant difference between the various age groups [Tables 3 and 4]. The results of the study showed a statistically significant difference when the mean difference of pulp length/tooth length ratio of Group 1 was compared with Group 3 and Group 2 was compared with Group 3, whereas no significant difference was seen between Group 1 and Group 2.

Table 1: Distribution of the sample based on the different age groups

Age group (years)	Frequency (%)
20-30	40 (33.3)
30-40	40 (33.3)
40-50	40 (33.3)
Total	120 (100)

Table 2: Descriptive statistics of the study variables across the various age groups (one-way analysis of variance test) (pulp length/tooth length ratio)

Age group (years)	Frequency (n)	Missing	Mean±SD	SEM
20-30	40	0	0.874±0.0360	0.00569
30-40	40	0	0.864±0.0165	0.00260
40-50	40	0	0.814±0.0198	0.00314

SEM: Standard error of mean, SD: Standard deviation

DISCUSSION

To grow or becoming older in humans refers to a participation of psychological, physical, and social variables. Some variables become evident with time, while others may decline. Estimation of age in individuals has received considerable attention in individual identification for verification involving forensic science/legal/civil rights/social benefits. Various dental age calculation methods are described in literature. Most of them offer a destructive approach in the form of extraction and preparation of microscopic sections of teeth, which may not be acceptable for ethical, religious, and scientific reasons.

Primarily, these are based on the formation of secondary dentin, studied since 1950,^[7] and the subsequent narrowing of the pulp cavity, which can be observed in dental radiographs, offers a relatively nondestructive method and eliminates the need for extraction of teeth.

But the primary disadvantage of radiographs is that, they only deliver are two-dimensional view which are vulnerable to abnormal magnification and distortion errors.^[8] Thus, to prevent this concurrent use of the mesio-distal and bucco-lingual dimensions analysis of teeth is advised.^[9] The ideal method for assessment of pulp tooth ratio is Computed tomography (CT) but because it could not be used at every site within the oral cavity and also is very expensive with high radiation exposure, its use is limited.^[10] In any method, the accuracy of these dental methods of age estimation should be verified by conducting studies in different populations.

Unlike pulp/tooth area ratio which is a radiographic assessment, we assessed ratio directly on teeth. This parameter has an advantage as it has the potential to eliminate at least part of the effects of external factors which may cause external resorption or destruction of tooth structure.^[11,12] Hence, age estimations among the adults become considerably more diverse and definite. Our method did not involve radiographs or any sophisticated laboratory procedure.^[13,14] It is user friendly, inexpensive and can be used in adverse conditions during identification of victim or dental profiling.^[15]

Table 3: All pair-wise multiple comparison procedures (Tukey's test)

Source of variation	Degree of freedom	Sum of squares	MS	F	P
Between groups	2	0.0827	0.0413	63.232	<0.001
Residual	117	0.0765	0.000654		
Total	119	0.159			

MS: Mean of squares

Table 4: Comparison between different groups

Comparison	Difference of means	P	q	P	P<0.050
Group 1 versus Group 3	0.0600	3	14.842	<0.001	Yes
Group 1 versus Group 2	0.0100	3	2.474	0.192	No
Group 2 versus Group 3	0.0500	3	12.369	<0.001	Yes

Mandibular canines were chosen as they are the single-rooted teeth with the largest pulp area and thus the easiest to analyze whereas other smaller single rooted teeth with smaller size give a faint idea of the pulp/root ratio.^[16] Multi-rooted teeth on the other hand show clear pulp changes but less evident root changes.^[17,18] Canines are normally the oldest teeth and undergo less wear as a result of diet than posterior teeth. But; in conditions where these teeth are missing the method cannot be employed.

The results of this study are promising; however, it cannot be generalized to other populations. Some doubts/questions regarding the accuracy of measurement methodology using digital measurements have been reported in literature. Hence, in future, steps toward development of image analysis programs which could easily recognize pulpal outlines in radiographic images should be undertaken so as to minimize human errors and reduce both intra- and inter-observer variability.

CONCLUSION

Dental age prediction has been successfully used in routine and mass fatalities for identification purpose as teeth can be preserved for a long time. The present work showed that, by assessing the chronological age of an individual by correlating the relationship between age and pulp length/tooth length ratio in mandibular canine by using odontometric measurements with visual and nondestructive methods, appreciable degree of age predictions can be made possible for any given population. However, one has to exercise precautions before concluding these results to practical applications. Further research should be conducted on different types of teeth of different populations, which could possibly enhance age prediction.

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CONFLICTS OF INTEREST

There are no conflicts of interest.

REFERENCES

- Stimson GP, Mertz AC. Forensic Dentistry. London: CRC Press; 1997. p. 1-2.
- Pillai PS, Bhaskar GR. Age estimation from teeth using Gustafson's method – A study in India. Forensic Sci 1974;3:135-41.
- Pathak SK, Mathur PN, Jain S, Saini OP. A study of eruption of third molar in relation to estimation of age in people of 13 to 25 years age group. J Forensic Med Toxicol 1999;16:17-9.
- Subramanyam BV. Death from asphyxia. Modi's Medical Jurisprudence and Toxicology. 22nd ed. India, New Delhi: Butterworths; 1999. p. 251-7.
- Soomer H, Ranta H, Lincoln MJ, Penttilä A, Leibur E. Reliability and validity of eight dental age estimation methods for adults. J Forensic Sci 2003;48:149-52.
- Metska E, Stavrianos C, Vsiliadis L. Estimation of dental age using root dentin translucency. Surg J 2009;4:21-8.
- Gustafson G. Age determination on teeth. J Am Dent Assoc 1950;41:45-54.
- Jagannathan N, Neelakantan P, Thiruvengadam C, Ramani P, Premkumar P, Natesan A, *et al.* Age estimation in an Indian population using pulp/tooth volume ratio of mandibular canines obtained from cone beam computed tomography. J Forensic Odontostomatol 2011;29:1-6.
- Ohtani S, Yamamoto K. Age estimation using the racemization of amino acid in human dentin. J Forensic Sci 1991;36:792-800.
- Takasaki T, Tsuji A, Ikeda N, Ohishi M. Age estimation in dental pulp DNA based on human telomere shortening. Int J Legal Med 2003;117:232-4.
- Meinl A, Tangl S, Pernicka E, Fenes C, Watzek G. On the applicability of secondary dentin formation to radiological age estimation in young adults. J Forensic Sci 2007;52:438-41.
- 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 2005;119:27-30.
- Cameriere R, Cunha E, Sassaroli E, Nuzzolese E, Ferrante L. Age estimation by pulp/tooth area ratio in canines: Study of a Portuguese sample to test Cameriere's method. Forensic Sci Int 2009;193:128.e1-6.
- Cameriere R, Ferrante L, Belcastro MG, Bonfiglioli B, Rastelli E, Cingolani M. Age estimation by pulp/tooth ratio in canines by mesial and vestibular peri-apical X-rays. J Forensic Sci 2007;52:1151-5.
- 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.
- Vandevoort FM, Bergmans L, Van Cleynenbreugel J, Bielen DJ, Lambrechts P, Wevers M, *et al.* Age calculation using X-ray microfocus computed tomographical scanning of teeth: A pilot study. J Forensic Sci 2004;49:787-90.
- Babshet M, Acharya AB, Naikmasur VG. Age estimation in Indians from pulp/tooth area ratio of mandibular canines. Forensic Sci Int 2010;197:125.e1-4.
- Cameriere R, Ferrante L, Belcastro MG, Bonfiglioli B, Rastelli E, Cingolani M. Age estimation by pulp/tooth ratio in canines by peri-apical X-rays. J Forensic Sci 2007;52:166-70.