ORIGINAL ARTICLE

# Age estimation using maxillary central incisors: A radiographic study

Nitin Agarwal, Parul Ahuja, Abhishek Sinha, Anil Singh
*Department of Oral Medicine and Radiology, Sardar Patel Post Graduate Institute of Dental and Medical Sciences, Lucknow, Uttar Pradesh, India*

**Address for correspondence:**
*Dr. Nitin Agarwal, Professor and Head, Department of Oral Medicine and Radiology, Sardar Patel Post Graduate Institute of Dental and Medical Sciences, Chaudhary Vihar, Raebareli Road, Lucknow, Uttar Pradesh, India.*
*E-mail: nitinmds@yahoo.com*

## Abstract

**Background:** In the field of forensic dentistry, secondary changes in teeth with advancing age have been used as reliable predictors of age in various studies. **Aim:** The purpose of the present study was to present a method for assessing the chronological age based on the relationship between age and morphological parameters of maxillary central incisors. **Materials and Methods:** Fifty subjects between 20-70 years of age were included in the study. Intraoral periapical radiographs were taken in relation to maxillary central incisors using paralleling technique. The following measurements were recorded: lengths of tooth, pulp, root and width of root and pulp at three different points. Regression formulas were used to calculate the dental age. **Results:** The mean estimated age showed no statistically significant difference from the actual mean age ($P > 0.05$). Also, maximum difference was seen for root length variable (-1.035 ± 1.86 years).

**Key words:** Age estimation, central incisors, forensic identification, radiographic study

## Introduction

The study of the teeth and jaws as evident in law and justice is known as Forensic Odontology or Forensic Dentistry.[1] It is the most unexplored and intriguing branch of forensic sciences.[2] The main purpose of forensic dentistry is to identify deceased individuals, for whom other clues of biometric identification (e.g., fingerprints, face, etc.) may not be available.[3] Although the last century has witnessed major breakthroughs in the field of science and technology, crime still persists in all aspects of life.[4] Age is one of the essential factors in establishing the identity of a person.[5] Chronological age, as recorded by registration of birth date, is referred to throughout an individual's life.[6] This information is relevant in medical and dental practice for evaluating developmental progress, for educational purposes and in legal matters, particularly in criminal law and mass disaster situations.[6]

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The use of dentition for the assessment of age appears to date back to the early years of the nineteenth century. In 1889, Laccasagne was the first to use changes in the teeth of adults to estimate age. Later, Bodecker, in 1925, pointed out that some morphological changes in teeth could be related to increasing age.[7] Tooth formation is widely used to assess maturity and predict age. Within clinical dentistry, this aids in diagnosis and treatment planning.[6] Changes that are appreciable with increasing age are attrition, periodontal disease, and deposition of secondary dentine, root translucency, cementum apposition, root resorption, color changes and increase in root roughness.[5]

According to Kvaal *et al.*, various studies have shown that with advancing age, the size of the dental pulp cavity is reduced as a result of secondary dentine deposition, so that measurements of this reduction can be used as an indicator of age.[8] Such research has resulted in multi-factorial methods that help in age estimation.[8] Most morphological methods require extractions, and microscopic preparations of at least one tooth from the individual. These methods cannot be used in living individuals and in cases where

it is not acceptable to extract teeth for ethical, religious, cultural, or scientific reasons.[9] Radiographic assessment of age is a simple, non-invasive and reproducible method that can be employed both on living and unknown dead, either in identification cases or archaeological investigations.[10] Willems G., however, states that the most important aspect of dental age estimation for the forensic odontologist is that one should not restrict oneself to only one age estimation technique but apply different techniques available and perform repetitive measurements and calculations in order to establish maximum reproducibility.[11]

The purpose of the present study was to present a method for assessing the chronological age based on the relationship between age and morphological parameters of maxillary central incisors.

## Materials and Methods

The present study was a radiographic study for age estimation using morphological parameters of permanent right maxillary central incisors in adults. Fifty subjects above the age of 20 years were selected randomly for the study. Only fully erupted maxillary central incisors in normal functional occlusion were considered. Teeth with radio-opaque fillings, crowns/prosthesis, associated pathologies, malalignment, rotation, impaction and teeth with developmental anomalies were excluded from the study group.

The subjects were divided into five subgroups on the basis of age:

- 20-29 yrs
- 30-39 yrs
- 40-49 yrs
- 50-59 yrs
- 60 yrs and above

Informed consent was obtained prior to the investigatory procedure. Intra-oral periapical radiographs of maxillary right central incisor were taken by using paralleling cone technique [Figure 1]. The exposed films were developed in automatic processor in fresh solutions. The developed X-ray films were subsequently coded.

On the radiographs obtained, 15 standardized points were marked [Figure 2], on the basis of the original method for dental age calculation published by Kvaal *et al*., and measurements were taken using divider and scale with millimeter calibrations.

- Tooth length (T)
- Pulp length (P)
- Root length (R)
- Ratio of Pulp width to Root width
- A: Cemento-Enamel Junction
- B: Midpoint between A and C
- C: Midroot level

**Figure 1:** Intraoral periapical radiographs taken using paralleling technique

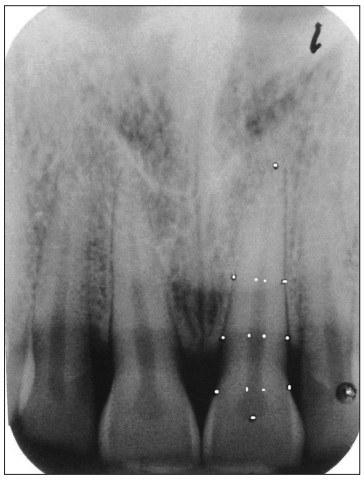

**Figure 2:** Intraoral periapical radiograph in relation to 11,12 with points marked for measurement of morphological parameters, according to Kvaal *et al.*

To test for reproducibility, measurements were repeated by a second observer. The demographic data obtained is presented in Table 1. The recorded chronological age along with morphological variables were entered on Excel worksheet. Analysis was carried out using SPSS statistical software. Paired "*t*" – test was used to investigate inter- and intra-observer variations. Regression analysis was carried out. Linear regression formulas derived were as follows:

Age = 73.044 - 1.678*T
Age = 83.327 - 2.501*P
Age = 58.474 - 1.630*R
Age = 31.452 - 3.050*A
Age = 35.294 - 6.981*B
Age = 19.945 + 50.212*C

## Observation

The mean calculated age for the present study was ranging

**Table 1: Demographic data**

| Age group | Males | Females | Total |
|---|---|---|---|
| 20-29 yrs | 16 | 10 | 26 |
| 30-39 yrs | 7 | 3 | 10 |
| 40-49 yrs | 4 | 2 | 6 |
| 50-59 yrs | 4 | 2 | 6 |
| 60 yrs and above | 2 | 0 | 2 |
| | 33 | 17 | 50 |

between 29.3-30.4 years. Mean estimated age showed no statistically significant difference from the actual mean age ($P > 0.05$). The minimum standard deviation was seen in the variables A and B. Also, it was observed that the maximum difference between the estimated and actual age was seen for R variable (-1.035 ± 1.86 years). *P* value was most significant in variables A and B [Table 2].

**Table 2: Comparison of mean estimated age with mean actual age**

| S.No | Age by | Mean | SD | Mean difference from actual age±S.E. | Significance of difference | |
|---|---|---|---|---|---|---|
| | | | | | *"t"* | *"p"* |
| 1. | Actual age | 30.42 | 13.04 | – | – | – |
| 2. | *P* | 30.417 | 5.864 | -0.003±1.73 | 0.003 | 0.998 |
| 3. | T | 30.423 | 4.503 | 0.003±1.82 | 0.000 | 1.000 |
| 4. | R | 29.387 | 3.849 | -1.035±1.86 | 0.556 | 0.581 |
| 5. | A | 30.423 | 0.219 | 0.003±1.92 | 0.000 | 1.000 |
| 6. | B | 30.422 | 0.967 | 0.002±.94 | 0.000 | 1.000 |
| 7. | C | 30.423 | 3.257 | 0.003±1.88 | 0.000 | 1.000 |

Standard deviation is minimum in variables A and B

## Discussion

A study using Kvaal's Age Estimation Method[7] on intra-oral periapical radiographs of six teeth including maxillary central incisor was done. It was suggested that except for the length variables, all other morphological parameters showed a significant correlation with age. The correlation coefficients derived for the maxillary central incisor were *P* = -0.77, T = -0.28, R = -0.63, A = -0.68, B = -0.2 and C = -0.58.

In the present study, a significant correlation of the morphological parameters of the central incisor with age was observed. *P* value for all parameters (except R) was >0.05 indicating a significant result.

Again, Willem *et al.*,[12] conducted a similar radiographic study on 100 teeth and found no statistically significant difference between the actual and estimated age.

Paewinsky, Pfeiffer and Brinkmann[13] conducted a study of six teeth (including the maxillary central incisor) on digital orthopantomograms to correlate the measurements of pulp cavity with age. It was found that the best correlations between the measurements and age were found at Level A i.e., the cementoenamel junction. This was in tandem with the present study wherein a statistically significant correlation was observed with width parameters, especially at Point A which indicated the cementoenamel junction.

In 2000, Schulze *et al.*,[14] investigated the accuracy of the measurements of the morphological parameters of teeth in orthopantomograms. He opined that vertical measurements were less reproducible and accurate than horizontal. In the present study, high reproducibility was found in both vertical and horizontal measurements. However, maximum standard deviation was seen in pulp length measurement (vertical parameter). Hence, it could be suggested that horizontal measurements are more reproducible than vertical measurements.

Similar age estimation studies were done on OPG by Cameriere *et al.*,[15] *and* Bosmans *et al.*,[9] and *P* value > 0.05, indicated no significant difference between the estimated and chronological age.

In present study, the *P* value was >0.05, indicating significantly positive result. Hence, no statistically significant difference was found between the estimated age and the actual chronological age.

## Conclusion

Maxillary central incisor proved to be a significant indicator of chronological age. However, this method had certain limitations. It cannot be used in multirooted teeth and errors in angulations and magnification could affect measurements. Also, when a three-dimensional image is projected on a two-dimensional film receptor, a discrepancy may occur in the morphologic measurements of the tooth. This method also has certain advantages. It can be applied in living individuals, is non-invasive, reliable and accurate. The future scope of this study lies in analyzing larger sample sizes in order to reduce the standard errors of the estimates and investigate the effect of race and culture.

## References


1. Barsley RE. Forensic and legal issues in oral diagnosis; Topics in oral diagnosis II. Dent Clin N Am 1993;37:133-56.
2. Sharma R, Srivastav A. Radiographic evaluation of dental age of adults using Kvaal's Method. J Forensic Dent Sci 2010:2:22-6.
3. Jain AK, Chen H. Matching of dental X ray images for human identification; Pattern Recognition 2004;37:1519-32.
4. Pateel DG. Efficacy of pulp/tooth area ratio in age estimation by using radiographs of permanant canine: A preliminary study. Indian J Forensic Odontol 2009;2:21-4.
5. Singaraju S, Sharada P. Age estimation using Pulp/tooth ratio: A digital image analysis. J Forensic Dent Sci 2009;1:37-41.
6. Balwant R, Anand SC. Tooth developments: An accuracy of

Age estimation of radiographic methods. World J Med Sci 2006; 1:130-2.

7. Landa MI, Garamendi PM, Botella MC, Aleman I. Application of method of Kvaal *et al*. to digital orthopantomograms. Int J Legal Med 2009;123:123-8.
8. Kvaal SI, Kolltveit KM, Thomsen IO, Solheim T. Age estimation of adults from dental radiographs. Forensic Sci Int 1995;74;175-85.
9. Bosmans N, Ann P, Aly M, Willems G. The application of Kvaal's dental age calculation technique on panoramic dental radiographs. Forensic Sci Int 2005;153:208-12.
10. Patil Karthikeyal, Mahima VG, Malleshi SN. Maxillary lateral incisor as biomarker of age- An *in-vivo* Radiographic study. Indian J Forensic Odontol 2009;2:17- 20.
11. Willems G. A review of most commonly used dental age estimation techniques. J Forensic Odontostomatol 2001;19:9-17.
12. Willems G, Romsee CM, Solheim T. Non-destructive dental-age calculation methods in adults:intra- and inter-observer effects. Forensic Sci Int 2002;126:221-6.
13. Paewinsky E, Pfeiffer H, Brinkmann B. Quantification of secondary dentin formation from orthopantamograms – a contribution to forensic age estimation methods in adults. Int J Legal Med 2005;119:27-30.
14. Schulze R, Krummenauer F, Schalldach F, d'Hoedt B. Precision and accuracy of measurements in digital panoramic radiography. Dentomaxillofacial Radiol 2000;29:52-6.
15. Cameriere R, Ferrante L, Cingolani M. Variations in pulp/tooth area ratio as an indicator of age: A preliminary study. J Forensic Sci 2004;49:317-9.

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