Review Article

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REVIEW OF AGE ESTIMATION TECHNIQUE DEPENDING ON DEPOSITION OF SECONDARY DENTIN

Sonune Shrikant[1], Shete Mrinal[2], Karande Prasad[3], Singh Pratibha[4], Nagpal Deepak[5]

1. Assistant Professor, Dept of Oral Pathology, D Y Patil Dental School, Lohegaon, Pune, Maharashtra, India
2. Assistant Professor, Dept of Oral Pathology, D Y Patil Dental School,Lohegaon, Pune, Maharashtra, India
3. Reader, Dept. Oral Pathology & microbiology, D Y Patil Dental School, Lohegaon, Pune, Maharashtra, India
4. Assistant Professor, Dept of Oral Pathology, D Y Patil Dental School, Lohegaon, Pune, Maharashtra, India
5. Professor, Dept of Oral Pathology, D Y Patil Dental School, Lohegaon, Pune, Maharashtra, India

ABSTRACT:

Forensic dentistry, from its earliest conception, is more or less an off shoot of forensic medicine, As with the passage of time, the role of dentistry in forensic context has been increased. One of the most intersesting and necessary application of the forensic odontology is to estimate age. Various parameters are used to estimate age like deposition of secondary dentin, incremental deposition of cementum etc. Out of various methods the methods based on deposition of secondary dentin are widly used. Various technique has been applied for the same.

This review article is focusing on the age estimation techniques using deposition of secondary dentin.

Keywords: Age estimation, Forensic odontology, Secondary Dentin.

INTRODUCTION:

Forensic dentistry, from its earliest conception, is more or less an off shoot of forensic medicine, the dental surgeon being consulted only in cases where dental data and details are evident. As with the passage of time, the role of dentistry in forensic context has been increased.[1]

It is often necessary to estimate an individual's age due to certain questions related to legal requirements or in a forensic context.[2] A variety of physiological systems has been used for age estimation like long bones, skull bones and teeth. Teeth are one of the strongest structures in the human body and are known to be preserved for long after most of the other tissues, even bone, have disintegrated. The dentition's integrity usually facilitates its preservation irrespective of decomposition, incineration and high-impact trauma.[3]

Historically, *Thomson (1836)* who was one of the pioneers of medical jurisprudence noticed that first molar erupts at six to seven years of age and so he claims that those children in whom first permanent molars had not erupted, they must not have reached the age of seven.[4]

Scientific study of Age assessment using teeth was first published by *Edwin Sunders(1837)*, who claimed that teeth provided the most reliable guide to age compared to age estimation from height

*Corresponding Author Address: Dr Sonune Shrikant Email: drshrikantwinner@gmail.com

which was a standard method used during that time. *Wedl(1872)* made the first observation of changes with age in the permanent dentition and described degenerative changes in pulp and notable diminution in the size of pulp cavity due to continued deposits of new dentinal layers.[4]

This article focus on the various aspect of the deposition of secondary dentin, various technique used in past for estimation of age using the same criteria.

Bilogy of deposition of secondary Dentin

Dentin is a continuously forming appositional tissue. The secondary dentin is built physiologically and is formed slowly by odontoblasts lining the pulp chamber. Secondary dentin formation is initiated subsequent to completion of root formation. There is only little difference between primary and secondary dentin, which can sometimes be detected in stained preparations, via microradiography or in polarizing microscopy. The continuous formation of secondary dentin is thought to be the biological response and provides sign of aging.[5] Thus the deposition of secondary dentin can be used as the criteria for age estimation.

Studies using Deposition of Secondary Dentin.

Bodecker (1925) was the first to establish that the apposition of secondary dentin is correlated with chronological age. The apposition of secondary dentin leads to a gradual reduction in size of the pulp chamber and can affect the obliteration of the root canal.[6] *Solheitn T(1992)* conducted study in which dentin deposition had been measured according to various scoring systems. He studied 1000 teeth, secondary dentin was estimated according to three scoring systems. The area of the coronal pulp and the widths of the root and pulp chamber were measured in a stereomicroscope at the cemento-enamel junction and at three other defined points along the root. They found correlation between age and secondary dentin, also such correlation varied in different types of teeth and in different technique. Multiple regression analyses showed that by combining several types of measurements, the correlation with age was increased. A tendency was also observed towards reduced speed of secondary dentin formation in elderly and in women.[2]

Kvaal SI, Kolltveit K. M., Thomsenb, Solheima T (1995) conduced a study using periapical radiographs from 100 dental patients, the radiographs of six teeth from each patient were examined. The various ratios calculated were pulp/root length, pulp/tooth length, tooth/root length and pulp/root width at three different levels. They concluded that measurement on dental radiographs a non-invasive technique for estimating the age of adults. It could be applied to both living and dead, in forensic work and in archaeological studies. [7]

Kolltveit K M, Solheim T, Kvaal S I (1998) compared the reliability of manual and computer-assisted measurements of morphological parameters like lengths and widths at various levels of tooth and pulp on dental radiographs. Manual measurements were made conventionally using a pair of vernier callipers and a stereomicroscope with a measuring eyepiece. An image analysis software program was employed for the computer assisted measurements. They concluded that despite advanced technology, conventional methods may be better suited for measuring linear morphological parameters in dental tissue. Further they suggested that use of areas of the tooth and the pulp for estimation of age seems promising, but this method needs further investigation. In future computer assisted measurements may provide an objective approach to age estimation based on dental morphology as viewed in radiographs.[8]

Bosmansa N, Annb P, Alya M, Willems G (2005) evaluated the relationship between chronological age and the two-dimensional dental pulpal size. They used 197 panoramic radiographs. Radiographs were evaluated including six anterior teeth. When the age was calculated based on measurements of all six teeth or of all three mandibular teeth, no significant differences were found between the real age and the calculated one. They concluded that no significant difference was observed between applying the original technique on standard long-cone periapical radiographs or on orthopantomograph, especially when carrying out measurements on all six selected teeth. They further concluded that that the use of Kvaal's technique in adults and the application of the original regression formulas on data obtained from panoramic radiographs instead from the typical apical radiographs as originally described, may lead to age estimations that are comparable to those based on the original technique if at least the selection criteria are respected and good quality orthopantomographs with clear radiological image are used.[9]

Yang F, JacobsR, Willems G (2006) had undertaken a study in an attempt to establish a correlation between the chronological age and the pulp/tooth volume ratio of one of the teeth, using Cone-beam Computed Tomography scanning, and acquired the 3D images of teeth in living individuals, Obtained 3D images are subject to pulp/tooth volume ratio calculation. The results of the analysis showed a moderate correlation between the pulp/tooth volume ratio and biological age. They concluded that the method was showing promising results for age estimation based on the pulp/tooth volume ratio in a non-invasive manner using cone-beam CT images in living individuals. [10]

Cameriere R, Ferrante L, Belcastro GM, Bonfiglioli B, Rastelli E, Cingolani M (2007) conducted a study that examined the possible application of the pulp/tooth area ratio by peri-apical images as an indicator of age at death.

200 peri-apical X-rays of upper and lower canines were assembled. The correlation between pulp/tooth area ratio and actual age found. They also suggest residual standard error of about 5.4 years. [11]

Rai B, Cameriere R, Ferrante L(2009) conducted study in Haryana population including 259 orthopantomographs from healthy children aged between 5-15 years and applied Cameriere et al regression equation. They found that regression equation could not be applied to Indian populations Hence, new equation will be required for Indian population. The method should be used together with other methods of age estimation in order to increase the accuracy.[12]

Singaraju S, Sharda P (2009) had presented a method for assessing the chronological age based on the relationship between age and measurement of the pulp/tooth area ratio on single-rooted teeth, using 200 rotational pantomographs and a computer-aided drafting program AutoCAD 2000. They found that no significant difference between estimated age and chronological age. Further they found that the width of the pulp had a strong correlation with age. They mentioned the limitations of the method like method of age estimation cannot be employed in multirooted teeth, as accurate measurements of multirooted teeth were difficult to perform. [13]

Babshet M, Acharya AB, Naikmasur VG (2010) used the digital intraoral periapical radiographs of mandibular canines. The study included 143 individuals between with age range of 20–70 years. The radiographs were taken using the paralleling technique; pulp and tooth areas were measured using a commercially available computer software program and the pulp/tooth area ratio was computed. They found that calculated age using the Italian formula revealed a mean absolute error of 11.01 years in Indians, an error greater than the 4.38 years reported in the Italian sample. Therefore they concluded that the divergence may be due to population differences that exist between Italians and Indians as well as variation in the pattern of secondary dentine deposition in Indians. They concluded that no recognizable improvement in age assessment was seen by using established formula, hence recommended that the population-specific equation be used that may produces more 'stable' age estimates.[14]

Sharma R, Srivastava A (2010) used the digital long-cone intraoral periapical radiographs from 50 subjects of either sex in the age group of 15–60 years. The pulp width and length from radiographs of 6 selected teeth, maxillary central incisor, lateral incisor, and second premolar and mandibular lateral incisor, canine, and first premolar of either right or left side were measured using the RVG trophy software. Different regression formulae for all six teeth, three maxillary teeth, three mandibular

teeth, and each of the individual teeth were derived and the age was assessed. They concluded that Kvaal's method can be used for age estimation and is feasible. Furthermore, from among all the chosen teeth, the results may be better when lower first premolar is taken.[15]

Cameriere R, Luca SD, Alema´n I, Ferrante L, Cingolani M (2011) examine the relationship between age and age-related changes in the pulp/tooth area ratio in monoradicular teeth, with the exception of canines, by using 606 orthopantomographs of Spanish white Caucasian patients, aged between 18 and 75 years. They found out that pulp/tooth area ratio was useful variable for accessing age with reasonable accuracy. They concluded that the use of established age-related variables in lower premolars and the application of the new regression formulae on data obtained from orthopantomographs lead to accurate age estimates.[16]

Talreja PK, Acharya AB, Naikmasur VG (2011) conducted study including intraoral periapical digital radiographs of 100 Indians. Pulp and tooth lengths and widths were measured (using commercially available computer software) and their ratios substituted in Kvaal's formulae; also, population-specific formulae were developed by using principal component regression analyses. Results reveal that average errors of age estimation were smaller for samples when the customized Indian formulae produced was used. The Indian formula was an improvement over Kvaal's formulae. They concluded that large errors from Kvaal's formulae may be due to primarily to variation in the rate of secondary dentinal deposition in Indians influenced both by environmental and genetic variation. Further they found out that first premolar have recognizably better correlation to age compared to canine.[17]

N. Jagannathan et al (2011) assessed the suitability of pulp/tooth volume ratio of mandibular canines for age prediction in an Indian population by volumetric reconstruction of scanned images of mandibular canines from 140 individuals (aged 10-70 years), computed tomography was used to measure pulp and tooth volumes. The pulp/tooth volume ratio is a useful indicator of age, although correlations may vary in different populations and hence, specific formulae should be applied for the estimates. They concluded that with a modification of Yang's formula acceptable age predictions are possible for the Indian population using pulp/tooth volume ratio measurements (of mandibular canines) from Cone Beam Computed Tomography.[18]

Babshet M, Acharya AB, Naikmasur VG (2011) assessed the lateral incisor and first premolar in addition to canine alone and in combination for pulp size tooth size ratio. They used periapical radiographs from 61 Indians with age range of 21-71 years. The evaluation of the pulp/tooth area ratio of three

mandibular teeth revealed that the lateral incisor had the highest correlation to age when used alone, followed by the first premolar and canine. They noticed error was ranged from 12.13 to 13.08 years. Such high errors are may be explained on account of the low-to-moderate age correlation of in Indian sample. Therefore, examination of secondary dentinal deposition on radiographs, specifically the pulp size tooth size ratio, for dental age estimation of living adults of Indian origin may need to be used carefully and judiciously, although further research on well-distributed age-groups in larger samples is required in the context.[19]

Erbudak HO, Murat OZ, Uysal S, Karabulut E (2011) applied Kvaal's method to panoramic radiographs from Turkish individuals involving 123 patients with ages ranging from 14 to 57years. They found the difference of more than 12 years between the chronological and estimated ages derived using Kvaal's original formula. Hence they concluded that Kvaal's original method is not recommended and the modification in present technique and application of newer technique is required in this context.[20]

Saxena S (2011) had developed a method for estimating the chronological age of Indian adults based on the relationship between age and various morphological variables of canine teeth, obtained using orthopantomographs. Orthopantomographs of 120 selected patients were digitized, and radiographic images of the right maxillary canine in each case were processed using a computer aided drafting program. Pulp/ tooth area ratio, pulp/root length ratio, pulp/root width ratio at the cemento-enamel junction level, pulp/root width ratio at midroot level, and pulp/root width ratio at the midpoint between the cemento-enamel junction and the midroot of the canine were calculated by measuring various features on the images. Even though the method was showing accurate results, differences between observed and estimated ages of the subjects were not statistically significant. Hence he concluded that linear relationship of pulp/root width ratio at mid-root level and pulp/ tooth area ratio of the right maxillary canine with chronological age in the Indian population. Age of subjects can therefore be estimated with a good degree of accuracy using regression equations.[2]

Agarwal N, Ahuja P, Sinha A, Singh A (*2012)* conducted radiographic study for age estimation using intraoral periapical radiograph of central incisor from 50 subjects with age range of 20-70 year of age. Intraoral periapical radiograph were taken, 15 standard points were marked on radiograph and various dimensions were measured. They concluded that maxillary central incisor proved to be significant indicator of chronological age. They had mentioned advantages like it can be applied to living individuals, non-invasive, reliable and accurate method. They suggested the further scope of same method using larger sample size to

reduce standard error and specific for race and culture.[21]

CONCLUSION:

Thus the basic principal of deposition of dentin can be quantified to estimate the age of individual. Precise method, regional studies and further resaerch are required in the same context.

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