Age Estimation Using the Radiographic Visibility of the Periodontal Ligament in Mandibular Third Molars in Mysore Population- A Retrospective Study

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Abstract

Objectives: This study was conducted to assess the reliability of age estimation using the radiographic visibility of periodontal ligament surrounding the roots of completely erupted mandibular 3rd molar.

Materials and methods: Visibility ofperiodontal ligament was assessed in completely erupted mandibular third molars, in a sample of 135 panoramic radiographs, of which 55 belonging to females and 80 to males, from a Mysore population aged 18to 32 years. A classification of four stages based on the visual phenomenon of disappearance of the periodontal ligament of fully mineralized third molars was used. For each stage, mean, standard deviation, minimal & maximal age were assessed.

Results: The relationship between age and stage of periodontal ligament had a statistical significance for both sexes.In this population, stage 1 can be used for predictability of age above 19 years and stage 3 for predictability of age above 23 years. No significant correlation exists between periodontal ligament visibility and gender of the individual.

Conclusion: Thistechnique is advocated for determining age above 19 years as it is a relatively simple and reliable method. Differences exist in different ethnicities demanding specific population standards.

Key words: *Forensic sciences, forensic odontology, age estimation, third molar, panoramic radiography, periodontal ligament.*

Introduction

Age estimation by dental hard tissues holds importance in the field of forensic odontology. There are better ways to preserve teeth for a longer period of time than other parts of the body which shows that teeth can be a better indicator of age. Teeth are less susceptible to damage &they may be the only structures recoverable from human body after disasters or accidents. Edwin Saunders in 1837published the first article on age assessment usingteeth. He compared age assessment from teeth to that by means of person's height.

Dental age estimation methods are widely categorized into 4 groups. They include, clinical, radiological, histological, physical& chemical methods[1]. Advent of digital radiography has increased the popularity of dental age estimation from radiographs. Age estimation using panoramic radiographs is mainly based on mineralization stages. However, third molar mineralization is frequently completed under age 21 and in some populations, it gets completed even under age

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18. In such cases, newer methods are being employed for age estimation. For instance, Olez[2] et al proposed use of periodontal ligament visibility of mandibular 3rd molars as age estimation criteria, once the teeth are completely erupted. In this study, radiographic visibility of periodontal ligament (PDL) incompletely erupted mandibular 3rd molar was analysed using panoramic radiographs of Mysore population,in order to determine the suitability of this methodology in forensic age assessment, especially to determine age over 18 years.

Materials and methods

Panoramic radiographs from the oral radiology archives of Department of Oral Medicine & Radiology, JSS Dental College & Hospital, Jagadguru Sri Shivarathreeshwara University, Mysuru, Indiaof past 6 months prior to the study,satisfying the following inclusion criteria were selected.

Inclusion criteria: -

1. Panoramic radiographs showing completely erupted mandibular 3rd molar between age group of 18-32 years.

2. Panoramic radiographs with optimum image quality.

3. Panoramic radiographs with optimum PDL visibility on either right or left mandibular 3rd molars.

Panoramic radiographs with the following exclusion criteria were not included in the study purpose.

Exclusion criteria: -

1. Panoramic radiographs with unclear images due to geometric distortion or any superimpositions over mandibular 3rd molars and their roots.

2. Panoramic radiographs presenting impacted mandibular 3rd molars or 3rd molars with any developmental abnormalities.

3. Panoramic radiographs with incompletely formed roots of mandibular 3rd molars.

4. Carious / endodontically treated mandibular 3rd molars.

A total sample of 135 panoramic radiographs of subjects between 18 to 32 years of age were assessed, of which 80 belonged to males and 55 to females. Radiographs were divided into three groups based on age as: a): aged between 18-22 years; group b): aged between 23-27 years and group c): aged between 28-32 years.

The visibility of the periodontal ligament of completely erupted lower third molars [including apical closure] wasrecorded, as defined by Olzeetal[2]in the following four stages:

- Stage 0: PDL is visible along the full length of all roots;

- Stage 1: PDL is invisible in one root from apex to more than half root;

- Stage 2: PDL is invisible along almost the full length of one root or along part of the root in two roots or both;

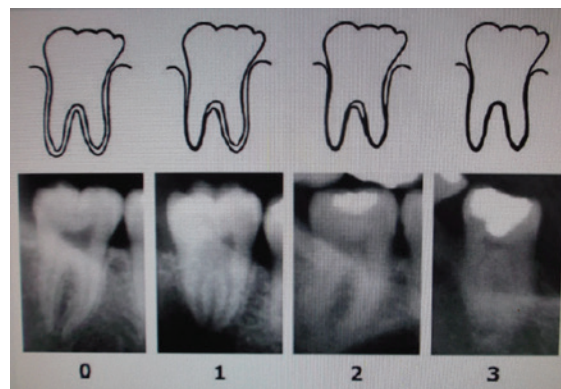- Stage 3: PDL is invisible along almost the full length of two roots

Fig 1 Stages of radiographic visibility of the PDL in lower molars (adapted from: Olze A, Solheim T, Schulz R, Kupfer M, Pfeiffer H, Schmeling A. Assessment of the radiographic visibility of the periodontal ligament in the lower 3rd molars for the purpose of forensic age estimation in living individuals. Int J Legal Med 2010; 124(5):445-8).

As suggested by Olez et al[2], in the case of single rooted mandibular 3rd molars, stage 3 was not applied. The periodontal ligament visibility was assessed on either right or left side on the radiograph as per the inclusion criteria mentioned above.In order to test the reliability of this method, selected panoramic radiographs were

assessed twice by a single observer, with one month intervalbetween thetwo observations. Cohen's kappa test was usedto determine the intra observer agreement. A descriptive analysis of the stages of visualization of the periodontal ligament in accordance with age was done. Spearman rank order correlation [rho] was performed to determinethe correlation between age and stage of visualization of the periodontal ligament. The level of significance was set at $p<0.05$. The mean age for each stage with respect to both genders were assessed by performingUNIANOVA test.

Microsoft Excel was used for data registration andstatistical analysis was performed usingIBM SPSS Statistics 20 [SPSS Inc., Chicago, IL, USA]. Study was approved by the Institutional Ethical Review Board, JagadguruSri Shivarathreeshwara University, Mysuru.

Results

Repeated scoring of radiographs revealed good agreement [k=0.962], depicting the good reproducibility and repeatability of this methodology**. (Table 1)**

Descriptive analyses of the different stages of visualization of the periodontal ligament in accordance with age is shown in table 2 & 3.

Stage 0 was almost exclusively seen below 21 years in both genders (2 cases of age 28 years showed stage 0). Stage 1 was seen exclusively above 21 years and stage 3 exclusively above 23 years. Stage 0, 1 & 3 first appeared in male gender before female gender for same age. There were no subjects in stage 2 category.

Spearman rho correlation was performed in order to assess the strength and direction of the linear relationship between periodontal ligament stage and chronological age.A strong positive correlation was found between age and periodontal ligament staging [Spearman Spearman rho=0.73, $p<0.001$]. No statistically significant correlation was seen between gender and periodontal ligament staging. (Table 4)

Table 1: Shows the KAPPA values.

		Value	Asymptotic Std. Error	Approximate T	Approximate Significance
Measure of Agreement	Kappa	0.962	0.022	15.237	0.000

Table 2: Shows Descriptive analyses of the different stages of visualization of the periodontal ligament according with age groups (S.D= Standard deviation)

STAGE	GEND	Mean	Std. Deviation	N
0	Male	19.5625	2.44864	16
	Female	20.2222	3.07318	9
	Total	19.8000	2.64575	25
1	Male	24.3684	2.89847	38
	Female	25.3421	2.98896	38
	Total	24.8553	2.96515	76
3	Male	28.7692	2.56605	26
	Female	30.0000	2.20389	8
	Total	29.0588	2.50987	34
Total	Male	24.8375	4.24098	80
	Female	25.1818	3.96321	55
	Total	24.9778	4.11852	135

Table 3 Shows staging

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			STAGE			Total
			0	1	3	
AGE	18.00	Count	7	0	0	7
		% of AGE	100.0%	.0%	.0%	100.0%
	19.00	Count	10	0	0	10
		% of AGE	100.0%	.0%	.0%	100.0%
	20.00	Count	3	4	0	7
		% of AGE	42.9%	57.1%	.0%	100.0%
	21.00	Count	3	6	0	9
		% of AGE	33.3%	66.7%	.0%	100.0%
	22.00	Count	0	7	0	7
		% of AGE	.0%	100.0%	.0%	100.0%
	23.00	Count	0	13	0	13
		% of AGE	.0%	100.0%	.0%	100.0%
	24.00	Count	0	14	1	15
		% of AGE	.0%	93.3%	6.7%	100.0%
	25.00	Count	0	5	2	7
		% of AGE	.0%	71.4%	28.6%	100.0%
	26.00	Count	0	0	4	4
		% of AGE	.0%	.0%	100.0%	100.0%
	27.00	Count	0	1	6	7
		% of AGE	.0%	14.3%	85.7%	100.0%
	28.00	Count	2	12	0	14
		% of AGE	14.3%	85.7%	.0%	100.0%
	29.00	Count	0	14	2	16
		% of AGE	.0%	87.5%	12.5%	100.0%
	30.00	Count	0	0	5	5
		% of AGE	.0%	.0%	100.0%	100.0%
	31.00	Count	0	0	8	8
		% of AGE	.0%	.0%	100.0%	100.0%
	32.00	Count	0	0	6	6
		% of AGE	.0%	.0%	100.0%	100.0%
Total		Count	25	76	34	135
		% of AGE	18.5%	56.3%	25.2%	100.0%

Table 4: Indicates Rho co-efficient

Table 4

Variable 1	Variable 2	Rho coefficient	Significance
Age	Stage	0.730	0.00 (P<0.05)

Discussion

Forensic method of age estimation has gained immense popularity worldwide. Dental identification is one of the accurate methods in the forensic field. It is usually observed that for a given chronological age, dental age shows less variability compared to skeletal age. Adverse environmental circumstances such as nutrition and disturbances ofendocrine functionaffect dental development very less when compared with bone. Age estimation is particularly useful for solving legal matters, as it helps in imprisoning the correct culprit. Appropriate diagnosis and treatment planning for orthodontic and surgical proceduresbenefit from estimation of accurate age[3].

Age estimation methods using third molars have proved to play a very significant role in forensic field especially for the age group of 18 years or more where other methods based on teeth cannot be employed[4]. Studies on significance of 3rd molar forestimation of age of an individual using Demirjian or Moorrees root stages was conducted by Liversidge and Marsden[5], Schmeling[6]*et al*.,and the results observed were associated with significant bias.Kullman[7]*et al.,* conducted a study and found that only wisdom teeth are useful for determining age as their maximum developmental age is only after 14 years.Its development tends to continue over a long period and until later age and it appears that formation of third molar is not different in males and females with respect to calcification or maturation[8]. Studies done by YildiraySisman et al[9] showed evidence for increased chance of congenital missing of maxillary teeth when compared with mandibular teeth.

Previous studies have shown that with advancing age periodontal ligament become so narrow that it cannot be seen on the radiograph. So radiographic visibility of the ligament can be used as an indicator of age.[10]

Use of panoramic radiography has proved to be very important for certain diagnoses. It is useful for determining the completion of the stages of teeth, viewing all the four regions of the jaw in a single radiograph and to know the position of the third molar teeth[8]. Panoramic radiographs often serve as survey radiographs. So, in order for age estimation no extra radiographs are needed. Incidental findings are well depicted in panoramic radiographs & it helps to carry out the treatment. The same panoramic radiograph taken for age assessment may be used for patient's diagnostic & therapeutic purposes.Thorson and Powel[11] indicated the value of completion of third mandibular molars in panoramic radiographs for determining age for young foreigners in Scotland whose exact birthdates were not known. So panoramic radiographs are preferred even though intraoral periapical radiographs better depict PDL surrounding a tooth.[12]

Therefore, selection of mandibular 3rd molar in the present study for periodontal ligament visibility using panoramic radiographs is justified.

In our study, the analyzed results showed that the P value was <0.05(Table 4), which meant that there is a significant correlation between chronological age and periodontal visibility staging. This was in accordance with the previous study conducted by Catarina-Dourado[10]*et al*. The correlation coefficient 'Rho' was found to be 0.73. This confirms that estimating age using periodontal ligament visibility staging is relatively

accurate. Present study also showed no intra-observer significant differences, underlining the reliability & reproducibility of this methodology.

Our study determined the effect of gender on periodontal ligament visibility staging, and we found that gender had no significant influence on the visibility staging of periodontal ligament.

In due course of the study, we however found that this method of age estimation has certain limitations. Our study population consisted of a single ethnic group. Further studies are needed to assess the usefulness of this method in other ethnic groups/population. Additionally, this method requires mandibular 3rd molars not impacted with complete root formation, absence of caries &endodontic treatments/restoration.Mandibular 3rd molars are more likely to get impacted if there is considerable space reduction in the jaw due to eruption of all other permanent teeth. Hence, this technique may not be suitable in every patient.

In the present study stage 0 of PDL visibility staging was almost exclusively seen below 21 years in both genders. According to this present study stage 1 shows the predictability of age above 19 years and stage 3 shows predictability of age above 23 years. Furthermore, stage 0, 1 & 3 first appeared in male gender before female gender for same age. Stage 2 was not present in any of the radiographs studied. This is not in accordance with the study conducted by Catarina-Dourado[10]*et al.* in Portuguese population, where they predicted stage 2 for persons with 21 years of age.This could probably be attributed to the ethnic differences in the mineralization and subsequent thinning of PDL surrounding the teeth roots.

Conclusion

Estimation of the human age is a strong factor in establishing the identity of the person. It is a procedure adopted by forensic scientists,anthropologists & archaeologists. Age estimation of an individual by examination of the PDL visibility of third molars using panoramic radiographs is a relatively simple & useful tool in the field of legal and forensic medicine. With our data, this method shows reliability as there is a strong correlation between the PDL visibility and age of the individual. Differences between ethnic populations are evident suggesting that specific population standards should be used when applying this technique.

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