Age estimation from periapical radiographs of individual tooth

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Abstracts

One major criterion for dental age estimation is the evaluation of secondary dentine formation. Teeth provide several useful points about an individual age. With advancing age secondary dentine is deposited along the wall of the dental pulp chamber leading to reduction in the size of the pulp cavity. This age related changes can be determined and measured from dental radiographs. The aim of this study was to explore if the measurements of area of pulp to tooth performed on periapical radiographs of individual tooth can be used for individual age estimation. The Periapical radiographs of maxillary and mandibular teeth, aged 7 to 69 years were selected. Dental maturity was evaluated by measuring the pulp tooth area ratio on all teeth. The ratios of the pulp/tooth area showed significant correlation to the chronological age and the coefficient of determination (r^2) was highest in maxillary canine when an exponential or a linguistic regression model was constructed.

Key words: Pulp area; Tooth area; Secondary dentine; Periapical radiographs.

Introduction

Tooth formation is widely used to assess maturity and predict age. Within clinical dentistry this information aids in diagnosis and treatment planning. In archaeology and forensic odontology, age estimation methods can aid the identification of age at death of a decreased child and also give important information with regard to past populations[1]. Age estimation is also proving valuable when birth data is lacking or doubted in the management of immigration to help determine physiological age. Several age estimation methods apply the various forms of tooth modification. Including wear, root dentine transparency, tooth cementum formation, racemization of asparatic acid, opposition of secondary dentine, various staging of tooth formation in radiographs, physiological change in tooth and odontometically [1-30]. Wear and the apposition of secondary dentine are currently available non-destructive methods although wear is influced by various external factors [12-24]. However, secondary dentine is continuing, regular process, which is only modified by caries and abrasion. It is very difficult to differentiated primary and secondary dentine, so that it is estimated by indirect technique in which reduction of pulp area. It has been reported that pulp to tooth area ratio an indicator of age [7-14]. Hence, we planned a study to estimate the age estimation from individual tooth periapical radiographs from North Indian population.

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Materials and Methods

Study design: The design of this study was a retrospective cross sectional study of good quality periapical radiographs.

Sample: Periapical radiographs of : 110 central incisors [51 maxillary (25M : 26F) 59 mandibular (27 M, 32 F)], 107 lateral incisors [52 maxillary (26M, 26 F), 55 Mandibular (33 M, 22 F)],101 Canine [51 Max. (26 M, 25 F), 50 Mand. (25 M, 25 F)], 106 First premolar [54 Max. (23 M, 31 F), 52 Mand. (26 M,25 F)],102 Second premolar [51 Max. (26 M, 25 F), 51 Mand. (26 M, 25 F)], 106 First Molar [53 Max. (26M, 27 F), 53 Mand. (25M, 28 F)], 103 Second molar [51 Max. (25 M, 26 F) 52 Mand (26 M, 26 F)] and 102 third molar [51 Max. (25 M, 25 F) 52 Mand (26 M, 26 F)] aged between 7 years and 69 years were analyzed. The ethnic origin of sample was North Indian. Radiograph that were unclear or that showed hypodontia, gross pathology, and previous orthodontic treatment were excluded. The chronological age of each subject was calculated by subtracting the data of the radiograph from the date of birth after having converted both to a decimal age using

Eveleth and tanner[14]. Teeth without pathologies were chosen and if both were present, bilateral teeth were studied. Periapical radiographs were taken digitally at an exposure of 10ma, 70kvp. It was possible to use normal X-rays. Pulp and tooth area ratio was calculated as in our previous study [4].To test intra-observer reproducibility, reexamined after an interval of one week. Intra-observer reproducibility of measurements was studied using the concordance correlation coefficient. Statistical analysis was performed with SPSS version 11.0 and student's' test and regression equation was applied. Finally, to validate the regression model we randomly chose a new sample of 10 peripheral radiograph of each tooth were analyzed. Hence the ages at death at those person's were compared with ages estimated using the regression equation.

Results

There was no statistically significant intra-observer differences between the paired sets of measurements carried out on the re-examined periapical radiographs. Pearson's correlation coefficients between age and morphological variables showed that all of them were significantly correlated with age and all correlation coefficients between age and morphological variables were significant. Age at death was modeled as a function of the morphological variables and, to optimize the model, a stepwise regression procedure was applied. Statistical analysis showed that gender did not contribute significantly to the fit (P=0.931) where as variables ($x_{1.....} X_8$ (maxillary teeth) and (mandibular teeth) y_1 ….. y_8), x1 (maxillary central incisors = right plus left /2 and the first order interaction between them, so that only these variables were included in the regression model, yielding the regression formulae (Table-I).

Discussion

In adulthood undergo time related changes representing biological aging and many studies have shown that several features of aging and many studies have shown that several features of aging can be used for age determination. Gustafson developed the first systemic dental method for estimation of age in adults based on six criteria: attrition, secondary dentine in the pulp, cementum annulations, root resorption, periodontal recession and root translucency[16]. Many other studies followed using different age-related features of teeth [1-30].

Our study represents in important contribution to the already existing age determination methods in adults. The advantage of this method is that it can be applied to living persons and when only one tooth periapical radiograph is exist. When pulp and tooth areas were measured on digitized periapical images of canines, the concordance correlation coefficient showed that these were no significant intra-observer difference as in previous study [17].

The degree of secondary dentine formation on the average was ranked in the order of first premolar > second molar > second premolar > first molar > canine > central incisor > lateral incisor. In the present study, no significant influence of gender on age estimation which support the previous studies[15,17]. By putting the pulp to tooth area into these formulae, the chronological age was estimated (Table 1).

The accuracy of these formulae depends on the precision of the measurements and quality of the periopical radiographs. Factors that may interfere would be caries, dental fillings and intra observer error[18]. Therefore, it is recommended that only tooth without any pathologic changes should be examined. Future research should aim at acquiring even large sample size in order to reduce standard errors of estimates, and at investigating the effect of race, geography and other factors in formulae.

Sr.No.	Tooth	Regression formula	r^2
1.	Maxillary central incisor	82.436 – 562.832 x1	0.912
2.	Maxillary lateral incisor	97.326 – 593.842 x2	0.832
3.	Maxillary canine	84.562 – 462.632 x3	0.923
4.	Maxillary first premolar	92.462 – 632.498 x4	0.896
5.	Maxillary second premolar	99.784 – 643.932 x5	0.736
6.	Maxillary First molar	102.432 – 832.121 x6	0.838
7	Maxillary Second molar	104.563 – 432.836 x7	0.864
8	Maxillary third molar	108.632 – 732.941 x8	0.532
9	Mandibular Central incisor	84.536 – 893.432 y1	0.692
10	Mandibular Lateral incisor	96.832 – 932.843 y2	0.789
11	Mandibular canine	98.962 – 432.643 y3	0.863
12.	Mandibular first premolar	109.873 – 563.463 y4	0.797
13.	Mandibular second premolar	93.897 – 932.469 y5	0.786
14.	Mandibular first molar	106.967 – 847.632 y6	0.764
15.	Mandibular second molar	108.623 – 867.497 y7	0.787
16.	Mandibular third molar	95.632 – 992.432 y8	0.797

Table 1. Linear regression analysis linear regression formulas, correlation coefficients between age and the ratio of pulp to tooth area measurement from the periapical radiographs

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