Five Markers of Changes in Teeth: An Estimating of Age

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Abstract

The teeth are frequently better preserved than other material, their use for identification of an individual's age at death is very important. Dental aging received considerable attention within the forensic medicine and forensic odontology. Kilian's method is based on the subjective evaluation of six markers: the degree of attrition, the secondary dentine, the secondary cementum, the resorption, the transparency and the position of epithelial attachment. Kashyap and Koteswara Rao's method is based on the quantitative evaluation of four markers: the abrasion, the secondary dentine, the secondary cementum and the transparency. Our research is based on the confrontation of modification of Gustafson's aging method with using five markers: the degree of attrition, the secondary dentine, the secondary cementum, & the resorption and the transparency and made the regression equations for age determination of Indian population. Our results of age estimation were obtained using the Gustafson's aging method and Kilian's method after multiple regression of all studied were applied (absolute mean error of estimation 4.95 years — 95% CI ± 2.04).

INTRODUCTION

Identification of the living person and the dead is of paramount importance in forensic practice routinely. Age estimation is one of the prime factors employed to establish identity. Estimating age from teeth is generally reliable as they are naturally preserved long after all the tissues and even bones have disintegrated. For decades, osteologists and paleodemographers have strived to improve methods for determining age and sex. The importance of this research was recently highlighted in a new approach to paleodemography described previously.[1]

Almost all established macroscopic methods for age estimation in skeleton are problematic.[2,3] This because only changes in biological age can be observed in skeletons. High inter-individual variability results in error margins that may reach 7 years, at best, for ages after skeletal growth is complete.[2,3,4] The problem intensifies at older ages, as individual variability of age dependent changes in skeleton increases. Thus, methodological problems increase with the age of the person. It is clear, then, that an age – estimation method is needed that is less sensitive to continuous and non-qualified age-dependent changes in skeleton. The microscopic method for age estimation based on the histological examination of ground thin sections of teeth using a scale of 0-3 points (0,1,2,3) and evaluation of the extent of six changes correlated teeth with increasing age.[5] These are: the degree of attrition (A), the position of epithelial attachment (G), the amount of secondary dentine (D), the cemental thickness (C), the degree of root resorption (R) and the transparency of root dentine (T). Their total value should correspond to certain age. The standard error of estimation for the single examination of the single examination of the tooth is ± 3.6 years. Another method is based on the quantitative evaluation of four markers, the abrasion, the secondary dentine, the secondary cementum and the transparency.[6] The present study is based on the subjective evaluation of five markers: secondary dentine, the secondary cementum the degree of attrition the resorption and the transparency.

MATERIAL AND METHODS

Our sample consists of 113 freshly extracted permanent teeth collected from Department of Oral and Maxillofacial Surgery, Government Dental College associated with Pt. Bhagwat Dayal Sharma Post-graduation of Medical Sciences (Rohtak) Haryana, India. Acquired through extractions, the teeth were consecutively disinfected by formaldehyde solution for 17 days. The following information was collected: exact date of birth of the patient, date of extraction of the tooth, sex profession, type and place of the tooth in dentition. The teeth were first cleaned with pumice slurry and polishing brush in a slowly rotating hand piece. The teeth were then thoroughly washed under running water.

Each tooth was cut into four sections using a high diamond tipped disc. The sections were again rinsed under running water to clear them of debris and particles. Following grinding and dehydratation, tooth sections were embedded in penta between a slide and cover glass for microscopic observation. The ground sections were evaluated by two modifications of Gustafson's method using the light microscope with the possibility of image analysis. The present study is based on evaluation of five of the six Gustafson markers. We did not score the epithelial attachment position because this evaluation is very difficult especially with the historical materials.[7] And not possible with historical tissues while previous study have reported epithelial attachment in freshly extracted tooth. The individual changes were classified using a 13 point scale (0,0.25,0.5,0.75,1,.....3) in this method. The ground sections were examined four times at low magnification.

All the statistical analysis were performed using SPSS software package (version 7.0) and the Microsoft Excel 95 (version 7.0). The relationships between measured histological changes and age were analyzed by computing the Pearson and Spearman rank co-efficient. Equations for age prediction were derived using least squares regression analysis. Absolute mean error of estimation was counted from absolute values of residuals. The formula for age prediction were calculated from multiple regression analysis in methods.

RESULTS

The multiple regression analysis regarding all deserved changes with age as dependent variable. The resulting formula of age estimation was then established as follows.[6]

$$\text{Age} = e^{(2.41+0.04\sqrt{}_{Ai\%}+0.201nDi\%+0.18In\ C1\%+0.06\sqrt{}_{Ti\%})}$$

$r^2 = 0.81$; absolute mean error of estimation 8.32 years; 95% CI ± 1.61.

The formula of age estimation with transparency not regarded was then established as follows:

$$\text{Age} = e^{(2.43+0.06\sqrt{}_{Ai\%}+0.22InDi\%+0.20InC1\%)}$$

The formula of age calculation for relationship between sum of point values SPV and without transparency regarded (SPV-T) and age using the regressive analysis was estimated as follows:-

Age = (SPV% + 2.27) / 1.12

Age = ((SPV-T%)+3.42) / 1.16

$r^2 = 0.92$; absolute mean error of estimation 5.72 years; 95% CI ± 1.14. r^2 = coefficient of determination CI = confidence interval

The study formula of age calculation for relationship between sum of point values SPV and without transparency regarded (SPV-T) and age using the regression analysis was established as follows:

Age = (SPV% + 12.8) / 4.73

Age = ((SPV-T%) + 27.31) / 7.43

$r^2 = 0.85$; absolute mean error of estimation 6.28 years; 95% CI ± 2.45.

Better results of age estimation were obtained after multiple regression analysis for India (modification of Kilian's multiple regression equation) of changes applied. The changes using the multiple regression analysis was obtained as follows:

$\text{Age} = e^{(2.62+0.02\sqrt{}_{A\%}+0.05\sqrt{}_{C\%}+0.03\sqrt{}_{R\%}+0.03\sqrt{}_{t\%}+0.07\sqrt{}_{D\%})}$ where "e" is the base as natural logarithm.

$r^2 = 0.92$; absolute mean error of estimation 3.97 years; 95% CI ± 2.00.

The resulting formula of age estimation with transparency not regarded using the multiple regression analysis was established as follows:

$$\text{Age} = e^{(2.68+0.02\sqrt{}_{A\%}+0.04\sqrt{}_{C\%}+0.07\sqrt{}_{D\%}+0.05\sqrt{}_{R\%})}$$

$r^2 = 0.95$; absolute mean error of estimation 4.95 years; 95% CI ± 2.04.

DISCUSSION AND CONCLUSION

In forensic dentistry, determination of dental age-using stages of tooth development to gauze an individual's degree of maturity is one of a few biologic methods for monitoring physiologic development, and the dentition arguably is the only system available from prior to birth to early childhood. Dental development can also be used to estimate chronological age, such as, age at death of an unidentified person or the age of a suspect without legal documentation at birth. Analysis's of data revealed that previous method.[6] (Absolute maximum error of estimation is 9.94 years at the 95% confidence interval) enables to give more accurate estimations of age than present method.

Results are comparable with the reports using other methods($_{5,8,9}$). The results of age estimation were obtained using earlier methods after multiple regression of all studied changes were applied (absolute mean error of estimation 4.97 years 95%, CI ± 1.00). The estimation of age performed on the basis of histological examination and evaluation of morphological changes in hard tooth tissues was believed to be one of the most reliable methods, yet it has become the subject of heavy criticism especially when used with past populations.($_{9,10,11}$)

The best results of age estimation using earlier reports were obtained after multiple regression of all variables was applied. Analysis of the data revealed that Kilian's method (absolute maximum error of age estimation is 7.72 years at the 95% confidential interval)$_{9,11}$enables us to give more accurate estimations of age than Kashyap and Koteswara Rao's methods (absolute maximum error of estimation is 9.94 years at the 95% confidential interval)$_6$ while in the study give best results (absolute maximum error of estimation is 4.95 years at the 95% confidential interval). In conclusion these methods do not estimate direct relationship with age in years but they allow to individuals into a set of broad range age categories as the previous methods.($_{5,6,9}$) Evidently, the issue of the estimation of age of adult individual's from teeth will remain a subject of further research.

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