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Reliability of Dental Attrition as a Sole Parameter for Age Estimation among North Western Adult Indians

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ABSTRACT

Dental ageing is important in medico legal cases when teeth are the only material available to the investigating agencies for identification of the deceased. Attrition, which is the wear of occlusal surface of tooth (a physiological change); can be used as a determinant parameter for this purpose. The present study has been undertaken to examine the reliability of attrition as a sole parameter for age estimation among North Western adult Indians. 109 (43males, 66 females) single rooted freshly extracted teeth ranging in age from 18-75years were studied. Teeth were fixed, cleaned and sectioned labiolingually upto thickness of 1mm. Sections were then mounted and attrition was graded from 0-3 according to Gustafson's method. Scores were subjected to regression equation to estimate age of an individual. Results of the present study revealed that this parameter is reliable in individuals of ≤ 60 years with an error of ±10years. However, periodontal disease severely affected the accuracy of age estimation from this parameter as is evident from the results. Statistically no significant difference was noted in absolute mean error of age in different age groups. No significant difference was observed in absolute mean error of age in both the sexes.

***Key Words**: Attrition, Age estimation, North Western Indians, Teeth*

INTRODUCTION

Determination of the chronological age is important for many medico-legal reasons (Leung, 2008). For decades, forensic scientists and anthropologists have been struggling to device reliable methods to establish identity of an individual where teeth are the only remains available. Tooth development and eruption are believed to be under strong genetic control and are therefore considered to be reliable in estimating age of an individual (Ubelaker, 1989; White and Folkens, 2005). Physiological changes in adults play an important role for identification rationale where conventional methods bear out unfeasible. Attrition is the gradual wear of tooth by occlusion and mastication and is more pronounced in older individuals. In severe conditions even the pulp is exposed. It is an important physiological parameter for age estimation in adults which was used by Broca in 1897(Sebecic et al. 2010). He used five-stage scale to score attrition which was further modified upon by several authors (Gustafson, 1950; Murphy, 1959; Helm & Prydso, 1979; Lovejoy, 1985) in 20th century. Dental ageing gained popularity after a standard method was proposed by Gustafson in 1950. He used four point scoring system (0-3 scores) to grade six physiological changes viz. attrition, secondary dentine deposition, cementum apposition, root resorption, periodontal disease and dentine translucency and estimated age on the basis of line of best fit. Later various researchers either with the same methodology as Gustafson (Nalbandian et al. 1960) or with certain modifications (Dalitz, 1962; Johanson, 1971; Maples, 1978) established relationship between these parameters and chronological age. Many researchers (Richmond et al. 1984; Clark et al. 1984; and Seligman et al. 1988) conducted their study on young adults and did not find any correlation of age with attrition. They suggested that it is basically a result of bruxism rather than functional wear.

On the other hand, several other studies revealed positive and significant correlation of attrition with increasing age (Helm and Prydso, 1979; Lovejoy, 1985; Kambe et al. 1991; Tomaru et al. 1993; Li and Ji, 1995; Selukar et al. 2012). To augment data in this direction the present study has been undertaken to examine the reliability of attrition as a sole parameter for age estimation among North Western adult Indians.

MATERIAL AND METHODS

North Western adult Indians of age ranging from 18-75 years were selected for the present study. The mean age of the sample was 44.58 ± 18.47 years. The study material consisted of 109 freshly extracted single rooted teeth which were extracted for valid clinical reasons such as periodontal disease, dental caries, and orthodontic and prosthetic reasons. Out of 109 teeth samples, 43 teeth belonged to males and 66 teeth were extracted from females. The number of teeth extracted for periodontal reasons were 65 and 44 teeth were extracted due to non periodontal reasons (caries, prosthetic and orthodontic). The samples were collected from the Department of Oral Health Sciences, PGIMER, Chandigarh. Information regarding age, sex, cause of extraction and periodontal status was noted before extraction. Periodontal status was noted with the help of periodontal probe. Single rooted teeth were chosen to reduce the complications that may occur due to difference between morphology, anatomy, and functions of bicuspid and molar teeth. Moreover, in these teeth there is low incidence of caries and thus tend to survive longer in mouth than other teeth. Samples were given certain codes so as to ensure the blind study. The teeth were kept in 10 % formalin immediately after extraction and fixed for at least 24 hrs. After fixation, teeth were cleaned and were sectioned labio-lingually up to 1mm. Thickness of the section was confirmed using digital caliper (accuracy 0.02mm, Mitutoyo, Kanagawa, Japan). Finally, the sections were cleaned in distilled water for 30 seconds in ultra sonicator. Cleaned and unstained dried sections were mounted on slide using DPX and viewed under 40X magnification using light microscope (Olumpus CH30). For the purpose of analysis, extracted teeth were divided into 4 age groups: (a) ≤30 years; (b) 31-45 years; (c) 46-60 years and (d) 61-75 years. Teeth were also analyzed on the basis of gender and reason of extraction i.e. teeth extracted for periodontal disease and without periodontal disease. All the sections were given score for attrition using four point system suggested by Gustafson (cited from Vij, 2002) as given below:

(A0) No Attrition; (A1) Attrition upto Enamel; (A2): Attrition upto dentine ;

(A3): Attrition upto Pulp cavity (Figure 1).

The score was subjected to regression equation to estimate age of an individual.

Figure 1: Different stages of Attrition

Attrition (A0)-No Attrition

Attrition (A1) - Attrition upto enamel

Attrition (A2) – Attrition upto dentine

Attrition (A3) - Attrition upto Pulp

Statistical analysis

The data was entered and analyzed on MS Office 2007 Excel spreadsheet (Microsoft Corp. Remond.WA) and SPSS 17.0 statistical program (SPSS Inc. Chicago, IL). Score of attrition was correlated to known age and the line of best fit was calculated. Separate linear regression equation was formulated for non periodontal diseased teeth which was applied to periodontal diseased teeth. Absolute mean error of age was calculated as absolute value of difference between actual and estimated age. ANOVA was performed to evaluate potential difference of

absolute mean error in different age groups. An independent t-test was used to confirm presence of significant difference in absolute mean error of age in periodontal & non periodontal diseased teeth as well as in two sexes. A value of $p<0.05$ was set as statistically significant. In order to assess intra-observer variations, scores of thirty teeth were repeated at the interval of 15 days. It was found that there were no intra-observer variations in all the repeated scores of attrition.

RESULTS

Results of the present study have been presented in tables 1& 2 and illustrated in figures 2 & 3. Line graph showed an increase in score of attrition with age (Figure 2). A significantly high correlation was found between attrition and actual age in pooled data ($r=0.7$, $p<0.001$), in both sexes($r=0.7$, $p<0.001$) as well as in teeth without periodontal disease ($r=0.8$, $p<0.001$) which dropped to 0.4 in case of periodontal diseased teeth (Table 1).

On the basis of line-of-best-fit, age was estimated using attrition as an independent variable for pooled data and teeth without periodontal disease (Fig.3&4). According to the present study, in pooled data absolute mean error of age was found to be ±10.9 years. When data was analyzed on the basis of periodontal status, it revealed highly significant difference ($p<0.001$) between absolute mean errors of age in teeth without periodontal disease (±4.73 years) and with periodontal disease (±18.05years). Statistically no significant difference was observed in absolute mean error of age (between known age and estimated age) in two sexes (Table 1). Absolute mean error of age in lowest age group (≤ 30 years) was found to be ± 8.95 years which increased to ± 13.76 years in the highest age group (61-75 years). Statistically no significant difference was noted in the error age in different age groups by one way ANOVA (Table2).

Table: 1 Correlation coefficient (r), actual age, estimated age and absolute mean error in pooled data and in two sexes

	r	**Actual age (in years)**	**Estimated age (in years)**	**Absolute mean error (in years)**
Pooled data (n=109)	0.7	44.58±18.47	44.58±13.02	±10. 90
Periodontal status				
Non periodontal teeth (n=44)	0.8	27.02±11.62	27.02±9.25	±4.73
Periodontal teeth (n=65)	0.4	56.46±11.40	38.94±9.56	±18.05*
Sex wise				
Males (n=43)	0.7	46.74±18.54	43.84±12.50	±10.78
Females (n=66)	0.7	43.17±18.43	45.06±13.41	±10.98

Unpaired t-test *p<0.001

Table 2: Actual age, estimated age and absolute mean error in different age groups

Age groups	Actual age (in years)	Estimated age (in years)	Absolute mean error (in years)
≤30	21.79±4.74	30.93±3.50	±8.95
31-45	39.3±3.91	46.7±6.21	±11.68
46-60	52.2±4.01	54.5±8.33	±10.10
61-75	66.5±3.63	57.7±8.56	±13.76

Figure 2: Line graph showing trend of attrition in different age groups

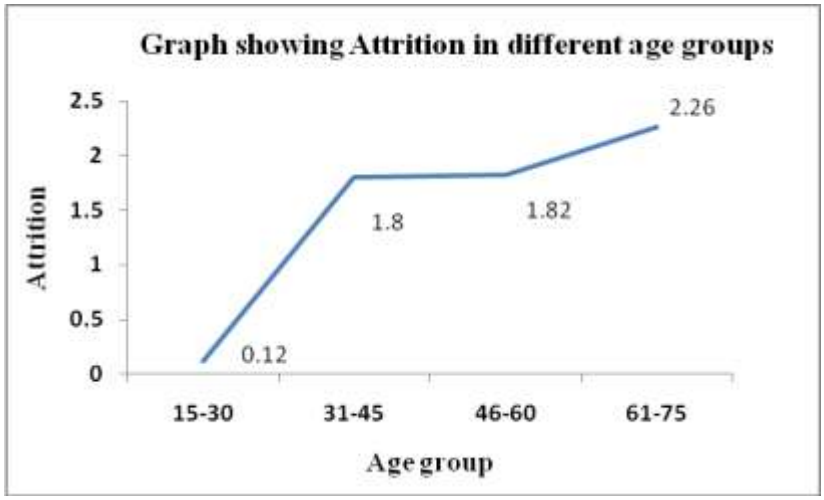


Figure 3: Linear Regression equation for the pooled data (n=109)

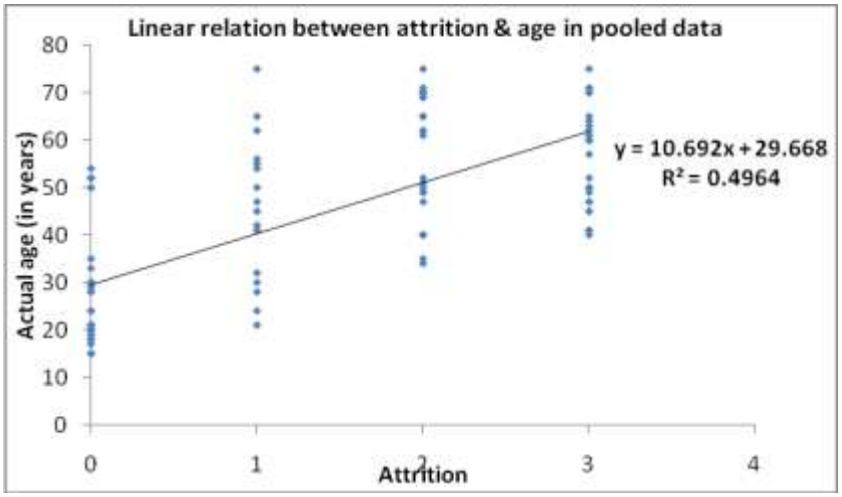
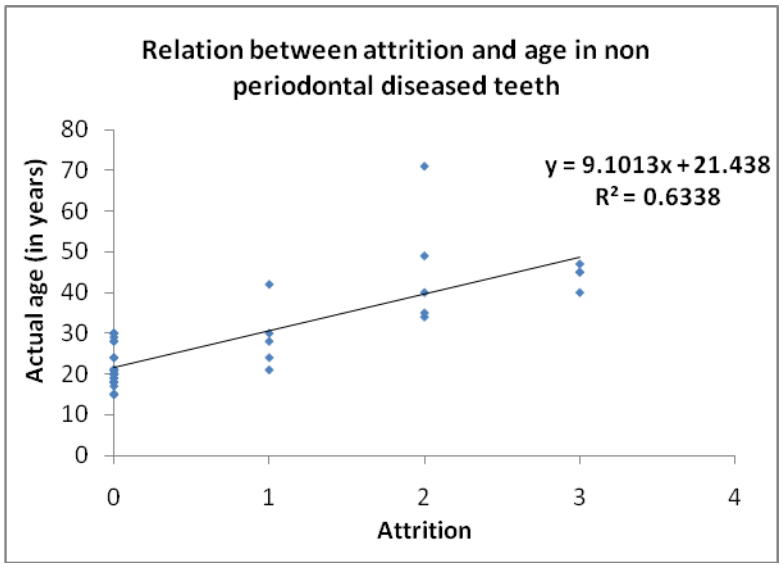


Figure 4: Regression equation for non periodontal diseased teeth (n=44)



DISCUSSION

For the present study sectioned teeth were used, however, many researchers (Miles, 1958; Brothwell, 1981; Smith, 1984) used unsectioned teeth and dental casts (Kim et al. 2000; Telang et al. 2014) for scoring attrition. It is evident from the results that score of attrition increases with increasing age which was in concordance with the previous studies (Gustafson, 1947; Pillai & Bhaskar 1974; Singh et al.2004; Selukar et al. 2012). In the present study, when the attrition score of two sexes was compared, statistically no significant sex difference was found in absolute mean error of age. A similar finding has been reported by Li & Gi, (1995). According to Kim et al. (2000); Singh et al. (2004) and Telang et al. (2014) attrition contributes more in males than females. It may be attributed to the stronger masticatory forces developed in males than in females (Seligman et al. 1988; Donachie and Walls, 1995). Also, consumption of more food in males than females can contribute to high degree of attrition in case of males (Sebecic et al. 2010).

Correlation coefficient of attrition with known age for the present study was found to be 0.7 which was slightly less than reported in many studies. It was lower than that found by Lovejoy, (1985) 0.9; Kambe et al. (1991) 0.9; Li and Ji (1995) (0.9); Selukar et al. (2012) (0.8); but was

superior to Tomaru et al. (1993) (0.6); Mandojana et al. (2001) (>0.5) and Monzavi et al. (0.3) (2003). On the other hand Clark et al. (1984); Richmond et al. (1984) and Seligman et al. (1988) conducted their study on young adults and did not find any correlation of age with attrition. They attributed it to bruxism rather than attrition. The absolute mean error of age was found to be ±10.9 years which was higher than found by Song and Jia, (1987) where it ranged from 1.9-5.7 years ; Zang and Ji, (1988) (2.7 -5.4 years) and Li and Ji, (1995) i.e. ±4.5 years. The present study demonstrated that attrition is a reliable parameter for age estimation among North Western Indians with in range of absolute mean error (≤ 10 years) in individuals of below 60 years. Santini et al. (1990) reported attrition as an inaccurate indicator of age. Morse, (1974) and Will, (1985) believed that attrition was not a reliable parameter for age estimation.

CONCLUSION

The results demonstrated that attrition is a reliable parameter for age estimation among North Western adult Indians with a mean error of ± 10 years in individuals of below 60 years. The study further revealed that periodontal disease severely affects the accuracy of technique as is evident from the values of correlation coefficient and absolute mean error of age. It is suggested that age estimation from attrition can be improved by combining it with other factors like secondary dentine formation, cementum apposition and root dentin translucency. All types of teeth do not bear same forces during lifetime thus tend to wear at different rates. So, tooth specific studies may improve the accuracy of the technique. Moreover, factors like diet, malocclusion, bruxism may enhance the wear of occlusal surface of tooth. These factors should be included in the future studies to validate the results.

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