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Permanent Tooth Formation as a Method of Estimating Age

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Abstract

The aims of this study were to describe maturity data of permanent tooth formation from a large sample and to adapt these for estimating age, to compare mean age dental formation stages between ethnic groups and sexes. **Methods:** This was a retrospective, cross-sectional study of 1,050 panoramic radiographs of healthy dental patients in London aged 2 to 22. Similar numbers of each sex and ethnic group (White and Bangladeshi) were selected for each year of age. Permanent mandibular teeth were scored using 14 stages described by Moorrees and co-workers in 1963 plus crypt stage. Mean age of each t stage (age when 5M of sample had reached/passed each stage) was calculated using probit regression for males and females by ethnic group for each stage. Data were combined where no significant difference between mean age for groups was observed. Average age 'within a stage' was also calculated for each tooth stage. **Results:** No ethnic difference was noted in mean age. Canine root stages and third molar apex stages were significantly different between the sexes. The average age of most stages was considerably later than that given by Moorrees and co-workers. Accuracy of age estimation on a separate test sample of radiographs was considerably more accurate using these new data. **Conclusions:** These results provide an accurate method to estimate age from developing permanent mandibular teeth. The lack of ethnic difference in dental maturity of individual teeth, suggest that these findings might be appropriate to accurately estimate age for other groups.

Precision ✓
Reliability

Developing teeth are often used to estimate age, but few dental developmental standards encompass the entire growth span. The aim of this study was to present timing of permanent tooth stages from a large, wide age range radiographic sample and present these data adapted for estimating age. In addition, mean age of attainment of permanent tooth formation times was compared between males and females and between two ethnic groups in London, UK.

Material and Methods

The sample studied was archived panoramic radiographs of 1,050 healthy dental patients in London, made up of similar numbers of two ethnic groups (white and Bangladeshi local residents) for each year of age from 2 to 22. Radiographs fïoin 25 males and 25 females were selected for each year of age with the exception of two year olds where the numbers were 29 male and 21 female. The same number of individuals per year of a e was selected to improve accuracy (standard deviation) of estimating Age or younger and older individuals.

All }adiographs had been taken in the course of diagnosis and treatment. All permanent teeth were scored using 14 stages described by Moorrees et al. [1] plus crypt stage. These include cusp tip initiation, coalescence of cusp tips, cusp outline complete, crown fractions, crown complete, initial root, root cleft formation, root fractions,

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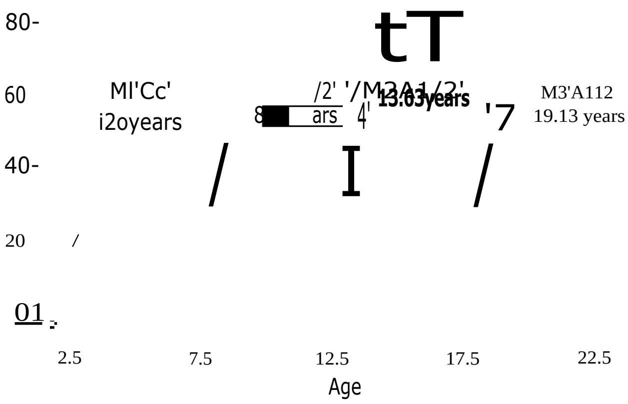

Fig. 1. Comparison of cumulative curves showing similarity of mean age of ethnic groups for MI stage ICc' and 'A1/2 M2 stage 'Al/2' and M3 stage 'A1/2 Solid line = Percentage of White London children; dashed line= percentage of Bangaldeshi London children for age group.

root length complete, apex half closed and apex closed (radiographically). Some stage descriptions for molars and intra observer variation are detailed elsewhere [2). Mean age of each dental maturational event (age when 50% of sample had reached/passed each stage) of each tooth was calculated using probit regression for males, females and ethnic group using one year age groups. Mean age was adapted for estimating age by adding half the interval to the next stage (3), with the exception of 'apex closed' stage as once a tooth apex matures, it can no longer be used to estimate age using this method. Average age 'within a stage' was also calculated.

Results

No ethnic differences in mean age were observed. The similarity between ethnic groups is illustrated in figure 1, where the proportion of children in some molar stages is plotted against age. This üiiiso shows the wide age range for these stages. The steep slope of the line for 'crown complete' of the first permanent molar (Ml) reflects a small age range, while the range for 'apex half closed' for the third permanent molar is from 15 to 22 years. Most comparisons (85 of 97) of mean age were not significantly different between males and females. Exceptions were the latter half of root stages of the canine, apex closure of the first molar and apical stages of the third molar. Of these, mean age in females was earl thjj.ies except for third molar stages. Mean age and standard deviation for combined groups and adapted mean age for estimating age are presented in table 1. Average age 'within a stage' (plus standard deviation and N) are shown in table 2.

Discussion

The mean ages of many teeth from the present study are considerably later than some previous standards (1, 4-6), although these early studies do not give details of standard error of mean age. Mean age in the present study was more than a year later in almost a third of comparison with Moorrees et al. [1]. Consequently, estimating age of London children using maturity data from Moorrees et al. [1] is likely to underestimate age considerably. This was tested using the test sample of Maber et al. [7] and accuracy (bias) using Moorrees et al. [1] was more than 1 year (under

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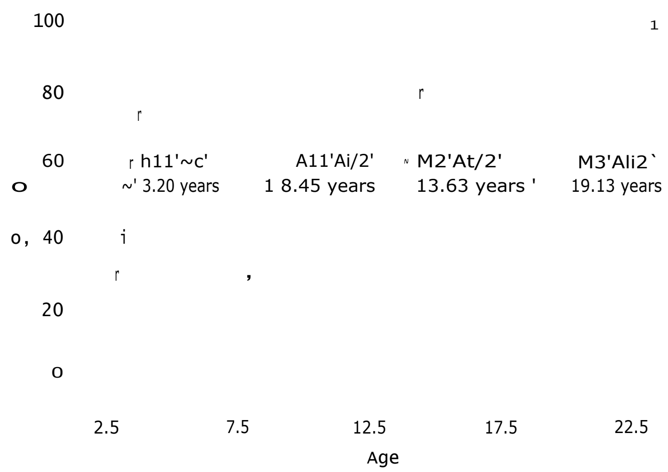

Fig. 1. Comparison of cumulative curves showing similarity of mean age of ethnic groups for M1 stage 'Cc' and 'A1/2', M2 stage 'A1/2' and M3 stage'Al/2'. Solid line = Percentage of White London children; dashed line = percentage of Bangaldeshi London children for age group.

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root length complete, apex half closed and apex closed (radiographically). Some stage descriptions for molars and intra observer variation are detailed elsewhere (2). Mean age of each dental maturational event (age when 50% of sample had reached/passed each stage) of each tooth was calculated using probit regression for males, females and ethnic group using one year age groups. Mean age was adapted for estimating age by adding half the interval to the next stage (3], with the exception of 'apex closed' stage as once a tooth apex matures, it can no longer be used to estimate age using this method. Average age 'within a stage' was also calculated,

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Discussion

The mean ages of many teeth from the present study are considerably later than some previous standards [1, 4-6], although these early studies do not give details of standard error of mean age. Mean age in the present study was more than a year later in almost a third of comparison with Moorrees et al. [1]. Consequently, estimating age of London children using maturity data from Moorrees et al. [1] is likely to underestimate age considerably. This was tested using the test sample of Maber et al. [7] and accuracy (bias) using Moorrees et al. [1] was more than 1 year (under estimating age by 1.19 year) with median absolute difference of 1 year. Accuracy of Smith's [3] adaption fared considerably better with bias of 0.67 years (underestimating age) and median absolute difference of 0.64 years. Accuracy of the adapted data from table 1 on the large test sample was considerably better at 5 weeks (0.10 years) with a median absolute difference of around 6 months (0.55 years). Table 2 was marginally more accurate at 2 weeks (0.04 years) with a similar median absolute difference (0.53 years).

There are several reasons why results from the present study differ to previous dental maturity studies. The Fels/Forsyth collaboration [1, 4-6] was unique in that individuals were X-rayed from birth and remain the major studies reporting early tooth formation from radiographs. It is no longer considered ethical to X-ray growing children without a diagnostic reason. The minimum age of the present study was 2 years from archived panoramic radiographs of children with caries. Another explanation is assessment or scoring of tooth stages; particularly fractions of crown height or root length(Secular trend in the timing of tooth formation is a possible explanation but seems unlikely as more detailed results become available from histological studies showing similarities between the past and the present and between different world group.

The variation in the timing of individual tooth maturation is large for most stages of tooth formation and increases with age. Radiographic evidence of M2 crypt was seen in the present study from age 2 to 4 while the M3 crypt could be as early as age four or as late as eleven. Standard deviation for most stages was from just less than a year to just over 2 years. This has implications when using dental maturity to estimate age as the 95% Cl for an individual is likely to be between 3 and 4.5 years.

Conclusions

These finding present a new method to estimate age more accurately from individual developing mandibular permanent teeth. The lack of ethnic difference in average age of tooth formation stages between whites and Bangladeshis in London suggests that this method of estimating age might be appropriate to other groups. '

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