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ORIGINAL ARTICLE

The timing and sequence of emergence of permanent teeth in Malay schoolchildren in Kota Bharu, Malaysia

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Abstract The purpose of this study was to determine the timing and sequence of emergence of the first 28 permanent teeth in a cross-section of Malay children in the district of Kota Bharu, in northeastern Peninsula Malaysia. The sample consists of 478 boys and 908 girls of Malay descent aged between 5-19 years. The criterion for tooth emergence was the appearance of the tooth through the gingivae. Descriptive statistics were calculated and probit regression analysis performed to determine the mean age of emergence of the permanent dentition. The mean age at emergence was found to conform to general trends, with emergence seen earlier in girls than in boys. Comparisons were made with the Chinese (Hong Kong) and the Punjabi (Chandigarh) profiles, which showed earlier emergence timings in those ethnic groups. The emergence timing in Malays, however, was earlier than in Thais (Central Thailand). The sequence of emergence was determined by referring to the mean age of tooth emergence of individual teeth and conforms to the general trend seen in other studies.

Introduction

The timing and sequence of tooth emergence provide an important foundation to understanding the biology and culture of past and present populations. This information is also of clinical significance in child health planning, diagnosis and treatment. It is also of interest to parents as it offers a simple and reliable method for the evaluation of the stages of development in children (Bailey, 1964).

Correlation studies using dental emergence or dental formation criteria promote the concept of dental age estimation as a maturity indicator, especially with regard to chronological age. Green (Green, 1961) in his study on the inter-relationship of somatic growth variables and chronological, dental and skeletal ages, concluded that there is a high correlation between dental and chronological age.

The emergence of teeth shows considerable variability. Ethnic influences have been reported in children in Hong Kong (Lee *et al*., 1965), Pakistan (Saleemi *et al*., 1996), Finland (Pahkala *et al*., 1991), Iceland (Magnusson, 1976), and American blacks and whites (Garn *et al*., 1973). Due to this variability, it is only prudent that the standards for emergence of the permanent teeth for a certain ethnic group be obtained from that population (Eskeli *et al*., 1999). The profile created can then be used for more accurate estimation of chronological age, proper dental health care planning, and as an index of physiological maturity.

The application of clinical emergence as an indicator of maturity has been much debated. Emergence of teeth refers to the appearance of the developing tooth in the oral cavity. The emergence of the deciduous dentition occupies a certain period of time after which there is a long interval before the emergence of the first permanent tooth. This interval, where no activity occurs in the oral cavity impedes the assessment of dental maturity. Virtually no information is available during this interval unless radiographic examination is instituted to observe intra-bony development of teeth. Ascertaining the exact time of emergence, when a tooth first pierces the gingiva is difficult and often missed, and may render data inaccurate. Recent studies support the dental calcification process as a more reliable indicator of maturity than clinical emergence of

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teeth, as it is a continuous developmental process (Demirjian, 1986; Ciaparelli, 1992). However, dental age assessment by emergence can still be considered an important dimension in the study of human biology and population diversity. Dental age estimates should be considered as approximates only, essentially designed to solve clinical problems, and assist in diagnosis and treatment planning.

Tooth emergence studies offer short span indicators with narrow distribution and are more informative than studies with long duration and wider distribution (Hägg & Taranger, 1985). Most studies on the emergence of permanent teeth utilise cross-sectional surveys, where means and standard deviations of the timing of emergence of each tooth can be ascertained from the data obtained (Demirjian, 1986). Cross-sectional studies provide for larger samples and are more representative than longitudinal studies, therefore affording a smaller margin of bias (Eskeli *et al*., 1999: Dahlberg & menegaz-Bock, 1958).

Studies on tooth emergence are usually done using one side of the jaws as it is widely agreed that there is symmetry in the emergence times of the right and left teeth although variability exists in the emergence of the upper and lower teeth (Pahkala *et al*., 1991; Demirjian, 1986; Townsend & Hammel, 1990).

Tooth emergence studies have been conducted using various sample populations in Asia, however, no such study has been carried on populations in Malaysia. Malaysia is a multi-racial and multi-cultural country with three major ethnic groups dominating, namely the Malays, the Chinese and the Indians. Other significant ethnic groups include the indigenous people in Malaysian Borneo; peoples originating from the Indonesian archipelago, namely the Javanese, the Bugis, the Achenese; those from mainland Asia, namely the Thai, the Arabs and the Pakistanis; and the descendants of the Portuguese and other Eurasians. Due to inculcated racial understanding and harmony, there is a high occurrence of inter-racial marriages, resulting in the present population of Malaysia. In the northeastern Malaysian state of Kelantan, however, the population is generally more homogenous, especially with respect to heredity. The Malays are the predominant group, with small populations of Chinese, Indians and Thais. The culture and tradition of the Kelantan Malays do not favour inter-marriages, making the absolute lineage of the Malays in Kelantan pure. This is in contrast to Malays in the other parts of Malaysia who, more likely than not, present phenotypes of several different ethnic genes.

Currently, data on tooth emergence in Malays are not available, often causing clinicians and researchers to resort to non-representative Caucasoid values. This research was instituted as a pilot study involving Malay children in the district of Kota Bharu, the capital of Kelantan, a state in the northeastern part of Peninsular Malaysia.

The objectives of the present study were: 1) To elucidate the mean ages at emergence of the first 28 permanent teeth in Malays, 2) To determine the usual sequence of emergence of permanent teeth in Malays.

Materials and methods

This was a cross-sectional study on school children from kindergartens, primary and secondary schools, in the district of Kota Bharu in Kelantan. Four kindergartens, four primary and four secondary schools were randomly selected. In the selected schools, children who met the inclusion criteria were taken as the study sample. The inclusion criteria were Malay descent with Malay parents, and apparently physically and mentally healthy children. A sample of 1,386 school children was obtained. To minimize inter-observer variation, only two dental surgeons were involved in the collection of data. Examinations were undertaken by one of the authors and recorded by a co-researcher.

Age was calculated from the birthday to the 1st of September 2000. All the subjects had known dates of birth supported by documents. Examinations were carried out by direct observations in daylight using a dental mirror. A tooth was recorded as emerged if any part of the crown was visible through the gingiva. All left side teeth except third molars were included in the study. Extracted teeth were recorded as being present. Descriptive statistics were calculated and probit regression analysis performed to determine the 5th percentile, median and 95th percentile of age of tooth eruption and their 95% confidence intervals. Assuming that the age of tooth eruption is normally distributed, the median age is equal to the mean age. The sequence of tooth eruption was determined by referring to the median/mean age of tooth eruption of individual teeth.

Results

The sample comprised 908 females and 478 males. The age in years ranged from 5 to 19 with the mean of 12.0 and standard deviation (SD) of 3.48. The age distribution by sex is shown in Table 1. The 5th, median and 95th percentiles for eruption of maxillary and mandible teeth in boys and girls are shown in Tables 2 and 3 respectively. The sequence of emergence for the first 28 permanent teeth according to the FDI notation for Malay children is shown in Figure 1.

17	13	15	14	12	11	16	26	21	22	24	25	23	27
47	45	43	44	42	41	46	36	31	32	34	33	35	37

Figure 1 The sequence of emergence for the first 28 permanent teeth presented in FDI notation

Table 1 Age and Sex Distribution of the Sample

Age (year)	Male	Female	Total
5	5	6	11
6	26	30	56
7	24	33	57
8	52	67	119
9	37	96	133
10	56	93	149
11	51	86	137
12	44	80	124
13	51	77	128
14	42	60	102
15	28	84	112
16	19	63	82
17	23	54	77
18	12	38	50
19	8	41	49
Total	478	908	1386

Table 2 5^{th} percentile, median, and 95^{th} percentile of age of tooth eruption for boys

Tooth	5^{th} (95%CI)	Median (95%CI)	95^{th} (95%CI)
Maxilla			
I1	5.88 (5.27, 6.26)	7.20 (6.96, 7.43)	8.53 (8.22, 9.02)
I2	6.70 (6.14, 7.10)	8.59 (8.34, 8.83)	10.48 (10.12, 10.98)
C	9.15 (8.64, 9.54)	11.37 (11.12, 11.62)	13.58 (13.18, 14.11)
P1	8.13 (7.61, 8.51)	10.06 (9.83, 10.30)	12.00 (11.65, 12.48)
P2	8.89 (8.38, 9.27)	10.96 (10.72, 11.20)	13.03 (12.65, 13.54)
M1	5.79 (5.25, 6.11)	6.83 (6.59, 7.03)	7.86 (7.59, 8.30)
M2	10.63 (10.14, 10.98)	12.49 (12.27, 12.73)	14.36 (13.98, 14.88)
Mandible			
I1	5.29 (4.53, 5.74)	6.71 (6.41, 6.96)	8.13 (7.80, 8.66)
I2	6.20 (5.64, 6.57)	7.62 (7.38, 7.84)	9.04 (8.72, 9.53)
C	9.08 (8.63, 9.40)	10.60 (10.39, 10.80)	12.11 (11.81, 12.55)
P1	7.62 (7.01, 8.07)	10.15 (9.88, 10.42)	12.69 (12.26, 13.26)
P2	8.95 (8.42, 9.34)	11.08 (10.83, 11.32)	13.20 (12.82, 13.72)
M1	4.45 (3.26, 5.14)	6.52 (6.04, 6.86)	8.59 (8.19, 9.22)
M2	9.43 (8.92, 9.81)	11.56 (11.31, 11.80)	13.69 (13.29, 14.21)

Table 3 5^{th} percentile, median, and 95^{th} percentile of age of tooth eruption for girls

Tooth	5^{th} (95%CI)	Median (95%CI)	95^{th} (95%CI)
Maxilla			
I1	5.04 (4.30, 5.54)	6.96 (6.64, 7.22)	8.89 (8.59, 9.29)
I2	5.64 (5.01, 6.10)	7.85 (7.58, 8.08)	10.06 (9.76, 10.46)
C	8.78 (8.42, 9.07)	10.95 (10.77, 11.14)	13.13 (12.81, 13.52)
P1	7.27 (6.80, 7.62)	9.54 (9.35, 9.73)	11.82 (11.50, 12.23)
P2	8.21 (7.80, 8.53)	10.59 (10.40, 10.79)	12.98 (12.65, 13.40)
M1	5.36 (4.71, 5.73)	6.51 (6.25, 6.71)	7.66 (7.39, 8.10)
M2	10.01 (9.64, 10.31)	12.22 (12.03, 12.42)	14.44 (14.13, 14.82)
Mandible			
I1	4.88 (4.06, 5.38)	6.47 (6.12, 6.73)	8.05 (7.75, 8.50)
I2	5.64 (5.08, 6.03)	7.23 (6.98, 7.44)	8.82 (8.55, 9.18)
C	7.82 (7.43, 8.13)	9.78 (9.60, 9.95)	11.73 (11.44, 12.10)
P1	7.36 (6.91, 7.72)	9.75 (9.55, 9.94)	12.13 (11.80, 12.54)
P2	8.31 (7.92, 8.62)	10.57 (10.38, 10.76)	12.82 (12.50, 13.22)
M1	4.56 (3.58, 5.14)	6.25 (5.83, 6.55)	7.95 (7.63, 8.42)
M2	9.24 (8.89, 9.53)	11.29 (11.11, 11.47)	13.33 (13.03, 13.70)

Discussion

The emergence of permanent teeth in female Malay children was found to be more advance than in males, conforming to results found in studies of other ethnic groups. In both males and females, the first mandibular molar was the first permanent tooth to emerge. This occurred approximately 0.27 years earlier in females than in males. This was followed by the emergence of the mandibular central incisor approximately 0.2 years later. The same pattern of emergence was seen in the maxilla with the first molar emerging almost immediately after the mandibular incisor in females and about 0.12 years later in males. The maxillary central incisor appeared on average of 0.42 years after the emergence of the maxillary first molars. The time difference between the emergence of the first mandibular molar and the first maxillary molar was on average 0.3 years. The emergence of the first mandibular molar in males coincided with the emergence of the first maxillary molar in females.

In both groups, the maxillary canine appeared after the second premolar, earlier in females by about 0.42 years. The mandibular canine, however, preceded the mandibular second premolar, emerging at 9.78 years in females and 10.60 years in males. In females, it emerged at approximately the same time as the mandibular first premolar (9.75 years). The second mandibular molar then emerged at approximately 0.79 years later. In males, the time difference between the emergence of the mandibular first premolar (10.15 years), canine (10.60 years) and second premolar (11.08 years) is about 0.46 years

Both the maxillary and mandibular second molars appeared at about 0.27 years earlier in females than in males. In females, the mandibular and maxillary second molars emerged at 11.29 years and 12.22 years respectively. In males, the mandibular second molar emerged at the age of 11.56, followed by the appearance of its maxillary counterpart 0.93 years later.

The emergence of the permanent teeth in Malay children commenced approximately at the age of 6.4 years, which is a little delayed compared to most of the other populations. A comprehensive review of studies on permanent tooth emergence which considered the effect of different ethnic origins had been presented by Jaswal (1983). This review, amongst others, included studies conducted on populations in Hong Kong, India, Canada, England and Australia. Comparison made with a more recent study on Finnish children by Eskeli *et al.* (1999) revealed the same results. These surveys were cross-sectional and used comparable criteria for emergence. Most of the studies used the median value to express the age at emergence. Hurme (1957) found that the mean ages of emergence were greater than median ages by up to three months. Evaluation and comparison of the above data should therefore take this difference into account.

It is important to contrast the emergence time of permanent teeth obtained from studies in other ethnic groups who are also significantly represented in Malaysia, although it would be unwise to make direct inferences as other factors affecting tooth emergence have to be taken into account. Nevertheless it can provide useful information for comparative population studies, until local population profiles can be established for each ethnic group in Malaysia.

Comparisons with the Chinese study by Lee *et al.* (1965) revealed earlier emergence of the first molars in the Chinese population by about 0.4 years. In general, the emergence of teeth in the Chinese study was earlier. The Malay maxillary central and lateral incisors, however, appeared earlier than in the Chinese study.

The tooth emergence study in Chandigarh by Kaul *et al.* (1975) showed that the emergence of teeth in Punjabi children was earlier than in Malays except for the premolars. The emergence of teeth in the Punjabis was comparable to the Chinese.

The timing of emergence of teeth in Malays is somewhat earlier than published Thai profiles. Kamalanathan *et al.* (1960) reported that the emergence of the first mandibular molar in Thai children in Bang Chan, Central Thailand, was at age 7.0 years for both sexes. The same tooth emerged at ages 6.25 years in Malay girls and 6.52 years in Malay boys. The mandibular central incisors emerged at the same age of 7.0 years in Thai boys and girls. In Malay children, these teeth emerged earlier by about 0.5 years in females and 0.3 years in males.

Ethnic origin has been proven by many investigators to have considerable influence on the timing of emergence of deciduous and permanent teeth. It is said to exert more influence that other variables such as the socio-economic status or nutrition. Socio-economic conditions may play a major role in general somatic growth but their effect on dental development is considered to be insignificant (Lee at al., 1965; Garn *et al.*, 1973).

Nutrition may play a role in the emergence of teeth. A small section of the sample in this study was derived from low socio-economic groups, however, malnutrition is non-existent in Malaysia. People in low socio-economic groups of the population are usually subsistence farmers, cultivating paddy and vegetables, and fishermen. Food is bountiful throughout the year. Malnutrition therefore can be eliminated from consideration in this study. Furthermore, only severe malnutrition is believed to have an effect on the skeletal system, but it is insignificant with respect to dental emergence, the maturation process of teeth being relatively independent of environmental influences (Demirjian, 1986).

The possible effects of premature eruption of permanent teeth due to the early extraction of deciduous predecessors were not considered in this study. A large proportion of the children examined had one or more of their deciduous teeth extracted, especially the molars, due to

caries. The incidence of caries amongst children in Kelantan is very high due to the lack of dental health awareness within the community combined with a diet high in sugar. Butler (1962) contended that there was no evidence to show that the early loss of deciduous teeth promoted the precocious emergence of permanent successors. Very premature extraction of a deciduous tooth, however, may delay the emergence of the permanent successor (Dahlberg & Menegaz-Bock, 1958).

Investigators have assumed that the dental system conforms to the secular trend of general growth. Advanced human growth and development is believed to have contributed to the secular trend of early emergence of the permanent teeth (Miller *et al*., 1965). Most of the subjects in this study experienced early loss of one or more of their deciduous teeth, but the emergence of their permanent teeth was slightly delayed in most cases as compared with Caucasian and other Asian standards. As this is a general trend seen in this population, it could well reflect the genetic constitution of the sample.

The results from this pilot study would be of benefit to clinicians in the treatment planning of children of Malay heritage. Clinicians have previously relied on Caucasian standards, as taught in the dental schools in Malaysia. The new standards resulting from this study, when adopted, will transform the usual treatment program instituted by clinicians, and will provide scientists with an interesting insight into aspects of dental development in Malay children. The results from this study represent an important milestone in research on the diversity of populations in Malaysia. Further investigations involving a larger sample from the whole country would provide additional insights into tooth emergence trends in Malays.

References

Bailey KV (1964). Dental development in New Guinean infant. *J Paediatr*, 1964, **64**: 97-100.

Butler DJ (1962). The eruption of teeth and its association with early loss of deciduous teeth. *Br Dent J*, **112**(11): 443-449.

Ciaparelli L (1992). The chronology of dental development and age assessment. In: Clark DH (ed.), *Practical Forensic Odontology.* Oxford: Butterworth-Heinemann, pp 22-42.

Dahlberg AA and Menegaz-Bock RM (1958). Emergence of the permanent teeth in Pima Indian children. *J Dent Res*, **37**(6): 1123-1140.

Demirjian A (1986). Dentition. In: Falkner F, Tanner JM (eds.), *Human Growth 2.* London: Baillier Tindall, pp. 268-98.

Eskeli R, Laine-Alava MT, Hausen H and Pahkala R (1999). Standards for permanent tooth emergence in Finnish children. *Angle Orthod*, **69**: 529-533.

Garn SM, Sandusky ST, Nagy JM and Trowbridge FL (1973). Negro-Caucasoid differences in permanent tooth emergence at a constant income level. *Arch Oral Biol*, **18**: 609-615.

Green LJ (1961). The interrelationships among height, weight, and chronological, dental and skeletal ages. *Angle Orthod*, **31**(3): 189-193.

Hägg U and Taranger J (1985). Dental development, dental age and tooth counts. *Angle Orthod*, **55**(2): 93-107.

Hurme VO (1957). Time and sequence for tooth eruption. *J Forens Sci*, **2**: 377-388.

Jaswal S (1983). Age and sequence of permanent-tooth emergence among Khasis. *Am J Phys Anthropol*, **62**: 177-186.

Kamalanathan GS, Hauk HM and Kittiveja C (1960). Dental development of children in a Siamese village, Bangchan. *J Dent Res*, **39**: 455-461.

Kaul S, Saini S and Saxena B (1975). Emergence of permanent teeth in schoolchildren in Chandigarh, India. *Arch Oral Biol*, **20**: 587-593.

Lee MMC, Low WD and Chang KSF (1965). Eruption of the permanent dentition of Southern Chinese children in Hong Kong. *Arch Oral Biol*, **10**: 849-861.

Magnusson TE (1976). Emergence of permanent teeth and onset of dental stages in the population of Iceland. *Community Dent Oral Epidemiol*, **4**: 30-37.

Miller J, Hubson P and Gaskell TJ (1965). A social study of the chronology of exfoliation of deciduous teeth and eruption of permanent teeth. *Arch Oral Biol*, **10**: 808-818.

Pahkala R, Pahkala A and Laine T (1991). Eruption pattern of permanent teeth in a rural community in northeastern Finland. *Acta Odontol Scand*, **49**: 341-349.

Saleemi MA, Hägg U, Jalil F and Zaman S (1996). Dental development, dental age and tooth counts: A prospective longitudinal study of Pakistani children. *Swed Dent J*, **20**: 61-67.

Townsend N and Hammel EA (1990). Age estimation from the number of teeth erupted in young children: an aid to demographic surveys. *Demography*, **27**(1): 165-174.