Standards for permanent tooth emergence in Finnish children

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Abstract: Two groups of Finnish children, 1008 from the eastern part of the country and 569 from the western part, aged 5 to 16 years, were examined to determine the timing of permanent tooth emergence and any regional variation therein. The probit analysis was used to calculate the median ages of eruption. Permanent teeth in the first phase of the mixed dentition erupted earlier and premolars erupted later than previously reported for Scandinavian populations. The former finding could reflect the secular trend; the latter is probably related to the dramatically improved dental health in Finnish children. No regional variation in eruption was found. The median ages of eruption of permanent teeth determined in the present study are suggested for use as national standards for permanent tooth emergence in Finland, separately for girls and boys.

Key Words: Tooth eruption, Tooth emergence, Permanent teeth

When working with children in pediatric dentistry and orthodontics, it is essential to have adequate knowledge of the timing and pattern of eruption of permanent teeth for diagnosis and treatment planning. Because a variety of factors relate to tooth emergence,[1] standards for emergence of the permanent teeth are most useful when they derive from the population to which they are applied. Several authors have reported differences in permanent tooth eruption between ethnic groups[2-4] and genders.[4-10] Socioeconomic[2,11] and nutritional factors,[12] caries conditions,[13] and the secular trend[5,9,14] have also been found to have some effect on the eruption of permanent teeth. Differences have even been reported within a population of the same ethnic origin.[15-17]

Nyström et al.[16] stated that there are differences in dental maturity in the Finnish population, with the dental age of children in at least certain age groups in northeastern Finland higher than that of children of same age in southern Finland. Accordingly, Pahkala et al.[17] found advanced dental development in Finnish children living in the northeastern part of the country, compared with the results of an earlier study in a group of children in southern Finland.[6]

The aim of the present study was to further evaluate the possible differences in emergence timing and pattern of permanent teeth in different parts of Finland.

Materials and methods

The study was based on two cross-sectional samples of Finnish children, one from Juuka, in eastern Finland, and the other from Vimpeli, in western Finland. Both are rural communities where most of the population has lived for many generations.

The eastern group (EG) consisted of 1008 subjects, 483 girls and 525 boys, from the municipality of Juuka, which has a population of about 7500. All the children and adolescents in that area 5 to 15 years old were studied, the age cohorts varying from 69 to 115 individuals. One child with cerebral palsy and a few with mental handicaps who did not attend school were not studied. Data were collected by four dentists (RP, SK, HK, AP) during annual dental check-up visits in the school dental care center of Juuka in 1988 and 1989. The sample has been described elsewhere.[17]

The western group (WG) comprised 569 children, 304 girls and

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265 boys, living in the municipality of Vimpeli, which has a population of about 3800. The number of children in different age cohorts varied from 37 to 71. Age cohorts from 5 to 15 years participated in the study. A few children with handicaps children and those who were ill during the examination dates were not included. In addition, 11 four-year-olds and 30 sixteen-year-olds were studied. One dentist (RE) collected the data during annual dental check-up visits or during separate appointments from 1990 to 1992.

The ages of the subjects were calculated to the nearest month and later recoded into 4-month groups. The age for each group was then stated as the mean of the respective 4-month period. Distribution of the subjects according to age and gender in the eastern and western study groups is presented in Table 1.

The clinical dental examination was performed using the same method in both groups. The developmental stage of the dentition was determined by grading each tooth according to its clinical eruption. The grades were as follows:

Grade 0: tooth not visible in the mouth

Grade 1: at least one cusp visible

Grade 2: entire occlusal surface/mesiodistal width of tooth visible

Grade 3: tooth in occlusion or at the occlusal level, if the antagonistic tooth is not fully erupted

Grade 1 was used to determine the clinical eruption age for each tooth. Based on the patient records, confirmed congenitally missing and extracted teeth in the EG group were omitted from analysis for that tooth. Correspondingly, in the WG group, information about extractions was obtained from the patient records. The tooth was regarded as congenitally missing if it had not erupted within the expected time of eruption, which was considered to be the mean emergence time of each individual permanent tooth plus four standard deviations. The mean emergence times reported by Hägg and Taranger[10] for a Scandinavian population were used. Children who were missing a particular tooth were not included in the analysis for that tooth.

In both the eastern and western samples, interexaminer and intraexaminer consistencies were evaluated by kappa values for the 28 variables studied, based on double measurements of 40 cases. The interexaminer consistencies within EG between four dentists (RP, SK, HK, AP) varied from satisfactory to excellent, from 0.57 to 1.00. For calibration, because the western group was measured by another dentist (RE), the consistency of the measurements was tested between RE and RP. The kappa values ranged from 0.46 to 1.00. The intraexaminer consistencies for RE, based on double mea-

Table 1
Distribution of two groups of children, one from eastern (EG) and one from western (WG) Finland, according to age and gender

Age midpoint (years)	Range (months)	EG (n=1008) Girls %	Boys %	Total n	WG (n=569) Girls %	Boys %	Total n
4	42-53	0.0	0.0	0	1.3	2.6	11
5	54-65	1.0	2.1	16	3.0	8.3	31
6	66-77	10.6	10.9	108	3.0	3.0	17
7	78-89	8.1	11.4	99	5.3	4.5	28
8	90-101	8.3	7.4	79	12.5	8.7	61
9	102-113	12.6	10.7	117	12.5	12.8	72
10	114-125	9.3	8.4	89	8.6	8.7	49
11	126-137	7.0	9.7	85	10.5	7.2	51
12	138-149	6.4	7.4	70	8.9	9.4	52
13	150-161	12.0	12.6	124	11.8	8.3	58
14	162-173	9.7	7.8	88	9.2	10.6	56
15	174-185	8.3	7.6	80	7.9	10.9	53
16	186-197	6.6	4.0	53	5.6	4.9	30
Total				1008			569

Table 2
Median eruption ages (years) of the maxillary and mandibular permanent teeth in Finnish children

Tooth	Girls	Boys	Ratio of median ages (Girls/Boys)	95% confidence interval for the ratio
Maxilla				
M_2	11.90	12.39	0.96	0.94 , 0.98
M_1	6.13	6.30	0.97	0.94 , 1.01
P_2	11.59	11.72	0.99	0.96 , 1.02
P_1	10.32	10.92	0.95	0.92 , 0.97
C	10.81	11.34	0.95	0.93 , 0.98
I_2	7.64	8.08	0.95	0.92 , 0.97
I_1	6.75	6.80	0.99	0.96 , 1.02
Mandible				
I_1	5.85	6.03	0.97	0.93 , 1.01
I_2	6.82	7.05	0.97	0.93 , 1.00
C	9.74	10.50	0.93	0.87 , 0.98
P_1	10.27	10.69	0.96	0.89 , 1.03
P_2	11.32	11.56	0.98	0.93 , 1.03
M_1	6.10	6.21	0.98	0.95 , 1.02
M_2	11.59	11.96	0.97	0.95 , 0.99

surements of 40 cases with one week interval, were excellent with kappa values for individual teeth varying from 0.91 to 1.00.

Median values for age at the emergence of the teeth were calculated by probit analysis.[18] Calculations were based on the relative frequencies of emergence in 4-month age groups. The ratio of median ages of emergence of the teeth between girls and boys was counted separately for every tooth, as were the 95% confidence intervals for that ratio. The statistical significance of the differences in the emergence pattern of contralateral teeth was evaluated by McNemar tests, one pair of teeth at a time.

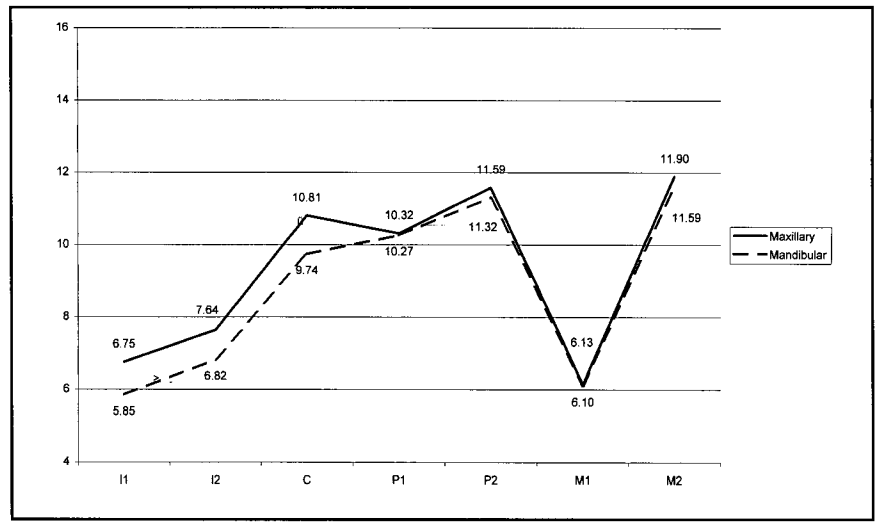

Figure 1
Median ages (years) of maxillary and mandibular permanent tooth eruption in Finnish girls

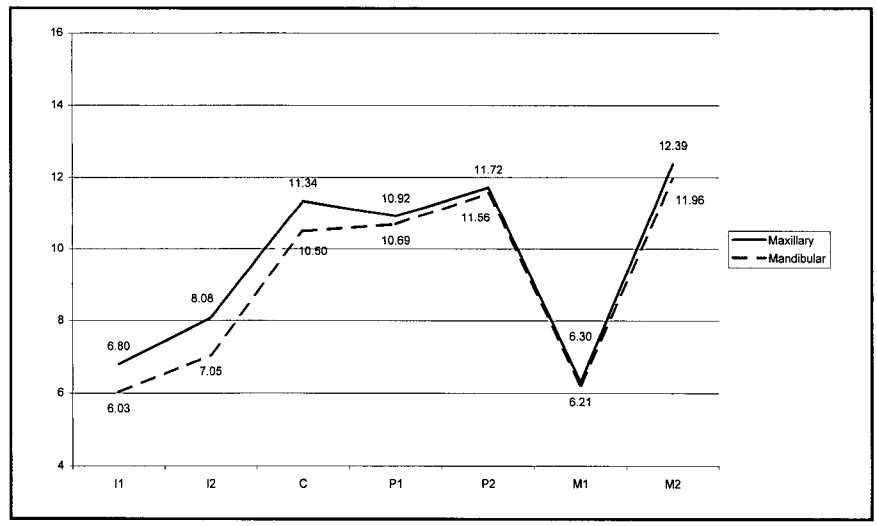

Figure 2
Median ages (years) of maxillary and mandibular permanent tooth eruption in Finnish boys

Results

Table 2 gives the median ages for emergence of permanent teeth for girls and boys in the whole sample.

All the permanent teeth except the maxillary left second premolar exhibited advanced eruption among girls as compared with boys. For maxillary lateral incisors, maxillary first premolars, maxillary and mandibular canines, mandibular left first premolar, maxillary right second molar, and mandibular right second molar, the null value (1) was not included in the 95% confidence interval of the ratio of median eruption ages between girls and boys, which implies that these differences between girls and boys were statistically significant at the 0.05 level. Gender was therefore included in further analyses.

Because no statistically significant differences in the eruption pattern of contralateral maxillary and mandibular teeth, tested by McNemar test, were found within the two samples, only the teeth in the right side of the maxilla and mandible were considered in the sequel.

Permanent mandibular teeth in the incisor and canine regions were advanced in eruption compared with maxillary teeth in both girls and boys (Figures 1 and 2). Differences in the median eruption ages between maxillary and mandibular teeth were largest for the central incisors (10.80 months in girls and 9.24 months in boys), lateral incisors (9.84 months in girls and 12.36 months in boys), and canines (12.84 months in girls and 10.08 months in boys). There were few differences in the lateral segments in eruption of antagonists.

Because there were statistically significant differences between girls and boys in the timing of eruption, differences between the eastern and western groups were tested for both genders separately. Differences in the timing of eruption of permanent teeth varied equally among girls between the eastern and western groups. The largest difference was seen in emergence of the maxillary second molars, namely 5.04 months. Differences for the other permanent teeth ranged from zero to 3.84 months. None of the differences

was statistically significant. Similarly, differences in the median eruption ages of permanent teeth in eastern and western boys were minimal, ranging from 0.12 to 2.76 months, and were not statistically significant.

Discussion

The two groups of Finnish children included in the present study originated from rural communities. There are divergent opinions on the impact of urbanization on the eruption of permanent teeth. Some authors have reported accelerated eruption in rural children,[19] other in urban children,[20] while still others have said there is no significant difference in eruption between provincial and metropolitan children.[5] The Finnish people can be considered ethnically and socioeconomically homogenous and to have the same kind of lifestyle, regardless of where they live. The prevalence of dental caries, which can affect eruption,[13] is about the same all over the country, and is low.[21] Therefore, it is highly unlikely that factors causing differences in the eruption of permanent teeth in urban and rural Finnish children would be found. The present study group can thus be considered representative of Finnish children and the median emergence ages obtained can be applied to the whole population.

Most of the studies concerning tooth emergence, including the present one, are cross-sectional,[5-9] although a few longitudinal studies exist.[10,22] The cross-sectional method means larger samples can be collected, with more representative results; the risk of bias is smaller than in the longitudinal studies, which can give later estimates of eruption times, as stated by Dahlberg and Menegaz-Bock.[23]

The probit analysis is used quite often in tooth emergence studies[4,10,15,24] and is found by some authors to be the best method of analyzing tooth eruption.[1,25] The emergence ages of permanent teeth are agreed to be normally distributed,[23,26] which is the prerequisite of using the probit procedures assuming an underlying normal distribution.

Our results of equal eruption of contralateral teeth, earlier eruption of mandibular teeth compared with maxillary ones, and the differences between girls and boys all agree with earlier studies.[4-10,27]

It has been reported that Finnish children[6] have advanced eruption of permanent teeth compared with children of other Scandinavian countries.[7,8,10] In the present study, a clear tendency was found for permanent teeth in the first phase of the mixed dentition to erupt one to five months earlier than reported in an earlier Finnish study[6] and in other Scandinavian studies.[7,8,10] There was a time span of one to four decades between the years of birth of the children examined in these different studies, so the observed variation in tooth emergence ages may reflect the secular trend proposed to be seen in tooth eruption.[5,9,14] On the contrary, the situation in the second phase of the mixed dentition was quite different. The premolars erupted considerably later in the present sample than reported in earlier studies.[6,7,8,10] The differences in the eruption ages of premolars ranged from one to 17 months. One reason for the later emergence of these teeth in the present sample may be the dramatically improved dental health of Finnish children.[21] The premature loss of deciduous teeth, especially the first and second deciduous molars, due to caries and its accelerative effect on tooth eruption, has decreased. Differences in eruption of the canines and second molars between the present and other Scandinavian studies were variable and not as great as for the eruption of premolars. Both earlier and later eruption of these teeth was found in our study compared with previously mentioned studies, reflecting the wide variation of tooth emergence during the last stages of dental development.

Some authors have reported differences in the timing and pattern of emergence of permanent teeth between population groups of the same ethnic origin. Lavelle[15] studied four groups of Caucasian children from four regions in England and found considerable variation both in the order and timing of tooth eruption. Factors such as heredity, morphology (including body weight and head circumference), and hormonal status of the individuals were speculated to have some effect on the diverging results. Further, it was mentioned by Lavelle[15] that variability in the timing of tooth eruption may reflect the variability of tooth formation, movement through alveolar bone, or penetration of the oral mucosa.

Nyström et al.[16] suggested the existence of differences in dental development of children living in different parts of Finland. They concluded that children living in northeastern Finland had an earlier eruption pattern than children living in southern Finland. In the present study we did not find any significant regional variation between children from eastern and western Finland in the timing of permanent tooth eruption. The conflicting results of these two Finnish studies may be due to different sampling and methods used. The northeastern sample in the Nyström et al. study[16] was quite small and some age groups were missing. The southern group was composed of people living in the city of Helsinki, without reference to the region they were originally from. Continuous migration to Helsinki makes the population

there a mixture of people from all parts of Finland. In the present study, the two communities were chosen to get more homogeneous samples. Migration in these areas is minimal and the population has stayed there for many generations. The differences in dental maturity within the Finnish population observed by Nyström et al.[16] can be attributed to factors other than regional variation.

In addition to distinct sampling, the research methods used in these two studies were different. Nyström et al.[16] used retrospective orthopantomograms from the files of the public dental care center, taken for different reasons (caries, trauma, orthodontic treatment) from 1979 to 1985, for their eastern sample. Their southern sample consisted of orthopantomograms taken by 1986 for a longitudinal follow-up study of dental development in healthy children. They used the method published by Demirjian and Goldstein,[28] where the dental maturity of an individual is estimated by rating the developmental stage of the seven left mandibular permanent teeth, and the dental age of an individual is calculated according to those scores. In the present study, the examination was done clinically with no X-rays, and median age of emergence, analyzed by probit analysis, was determined instead of using dental maturity index. Differences in both sampling and research methods could explain the conflicting results of these two studies.

In summary, results of the present study of permanent tooth eruption confirmed earlier findings of contralateral and intermaxillary variations in timing of eruption. The intermaxillary variation was greatest between central and lateral incisors and canines. In the first phase of the mixed dentition, the median emergence ages of permanent teeth were earlier, while premolars erupted distinctly later than in other Scandinavian studies, indicating the need for updated standards for permanent tooth eruption. No regional variation in the emergence of permanent teeth among Finnish children was found. Thus, the results reported here apply to the whole population of Finland.

In conclusion, the present results provide new standards for the emergence of permanent teeth in Finnish children with separate values for girls and boys, to replace those given several decades ago.

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