UP-TO-DATE STANDARDS OF PERMANENT TOOTH ERUPTION IN ROMANIAN CHILDREN

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Abstract

Standards of tooth development are important for medical fields, biology and anthropology. The last surveys in order to determine permanent tooth eruption standards in Romanian population were undertaken more then 30 years ago. The aim of this study was to present new data on the timing and sequence of permanent tooth emergence, using three different methods and to determine the correlations with age and other somatic growth parameters. Cross-sectional and longitudinal data on permanent tooth eruption were collected by examining 382 children (189 girls and 193 boys). The total number of recordings acquired between 2009 and 2011 was 646. Each present permanent tooth was scored: 0, 0.25, 0.5 or 1. The recordings were introduced in a database and statistical analysis was performed. The number of teeth was determined for each age interval of one year. It was significantly higher for girls in two age intervals: 9.5-10.4 and 11.5-12.4. The first permanent tooth that erupts is the lower first permanent molar, followed by first permanent upper molar or lower central incisor. The age of eruption of lower lateral incisor is much closed to the age of upper central incisor and it can sometimes precede or erupt simultaneously. The lower canines erupt after the upper and lower first premolars, around 10.5 years. The upper canines erupt around 11.5 years, after the eruption of both lower second premolars and much closed to the eruption of lower second molar. The last tooth to erupt is the upper second molar, after the age of 12 years. Photographs or study casts represented good proofs and we could verify the assessed data. The correlations were determined. The correlation with weight and height could be taken in account, but not the correlation with body mass index (BMI). The number of permanent teeth erupted, does not depend on the presence or absence of menstruation at the date of assessment, for our girls sample.

Keywords: permanent teeth, timing of tooth emergence, tooth eruption sequence, sex differences, height, weight, body mass index, menstruation, sequential intraoral photography, and sequential study casts

Introduction

The exfoliation of primary teeth and the subsequent eruption of permanent teeth is a developmental phenomenon that forms part of the body's continual process of growth. It is a physiological phenomenon having characteristics not seen in any other body organ [1].

Development of the occlusion, in other words, eruption of the teeth and formation of the interrelationship between the teeth of the upper and lower jaws, is a genetically and environmentally regulated process [2].

The term "tooth eruption" generally refers to the appearance of some part of a tooth above the surface of the gingiva. However, eruption actually includes the entire embryological process from the formation of the tooth germs, in the mandible and maxilla, to calcification, crown formation and root formation. The root is only about one-third formed when the crown begins to erupt into the oral cavity. Not only is the embryological process part of eruption, but so is the long process of occlusal development. Thus, the emergence of the teeth into the oral cavity is only one part of the total eruption process [3].

Eruption of the teeth can be divided into different stages: preemergent eruption when the developing tooth moves inside the alveolar bone; emergence, the moment when a cusp or an incisal edge of a tooth first penetrates the gingiva; postemergent eruption follows and a tooth erupts until it reaches the occlusal level. Eruption speed is faster during this stage and therefore the stage term postemergent spurt is sometimes used. When a mesiolingual cusp of the lower first permanent molar has emerged, two months later the occlusal surface can be seen [2].

The mixed dentition period can be theoretically divided in three sub periods: between 6 and 8 years- the eruption of front teeth; between 8 and 10 years-intermediate period; between 10 and 12 years-the eruption of the teeth that belong to lateral segments [4,5]. In general teeth erupt earlier in girls than in boys [2] and the intermediate period is a little shorter in girls then in boys [4,5].There is a great individual variation in the eruption timing of permanent teeth. Delay or acceleration of 12 months from the average eruption timetable is still within the normal range [2, 6].

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Adequate knowledge of timing and pattern of tooth eruption are important for the diagnosis and treatment planning when working with children in pediatric dentistry and orthodontics [1]. From a dentist's point of view it is necessary to reconsider tooth eruption times occasionally. Over the years, changes in sequence and time of tooth eruption are possible [7]. It is also useful in the field of surgery and for determination of age in forensic science [1]. Age estimation for humans plays an important role in mass disasters and unaccompanied or asylum-seeking minors in the absence of proper documents. It also contributes to anthropology [8]. Variation more than one year in timing of tooth development could be the indicator of one disease in pediatric medicine and pediatric endocrinology [6].

Dental age is determined from three characteristics. The first is which teeth have erupted. The second and third, which are closely related, are the amount of resorption of the roots of primary teeth and the amount of development of permanent teeth [9].

Many authors have reported differences in the permanent tooth eruption between ethnic groups and genders [1, 7, and 8].These studies showed that variation exists in the eruption times of permanent teeth and this may be attributed to numerous racial differences [10]. Because a variety of factors relate to emergence, standards for emergence of the permanent teeth are most useful when they derive from the population to which they are applied [11].

The endogen factors (genetically or hormone derived) have the greatest influence on tooth eruption [12]. Socioeconomic and nutritional factors, caries conditions and the secular trend have also been found to have some effect on the eruption of permanent teeth [11,13].

Females generally precede males in the eruption timing by an average of 5 months [14]. The reason for the differences of tooth eruption in male and females are still poorly understood. It is assumed that the earlier onset of the permanent dentition is part of the different sexual maturity of both sexes at a given age [15, 16].

Children who are below average weight and height showed a later eruption time than those children who are within standard range [11, 17].

Recent studies reveal that teeth emerged at similar times on right and left sides, the mandibular teeth tended to emerge earlier than their maxillary counterparts and that girls tended to be advanced compared with boys [1, 10, 11, 15, 18].

Most of the studies concerning tooth emergence are cross-sectional, although a few longitudinal studies exist [3, 11, 19]. The prospective longitudinal studies provide most actual results.

When we take in account the short period of research time that we have, when we investigate such a dynamic, complex and long biological process we come to conclusion that we have to do our research as a cross-sectional survey or we have to investigate the most dynamic periods when doing mixed longitudinal studies. Another possibility is to create a good database; witch can be used by future researchers in a longitudinal study [20].

Clinical findings are not enough in order to have the possibility to control the assessed data, to verify the inclusion criteria, to have good research proofs and database for future research [21].

Sequential intraoral photographs and sequential study casts, taken in the most dynamic stages, are tools needed to accompany clinical findings in each eruption research (Fig.1, Fig.2).

Fig.1 Sequential intraoral photographs of a boy at 6.8 (6 years 10 months), 7.3 (7 years 4 months), 7.8 (7 years 10 months), 8.3 (8 years 4 months) and 8.6 years (8 years 7 months).
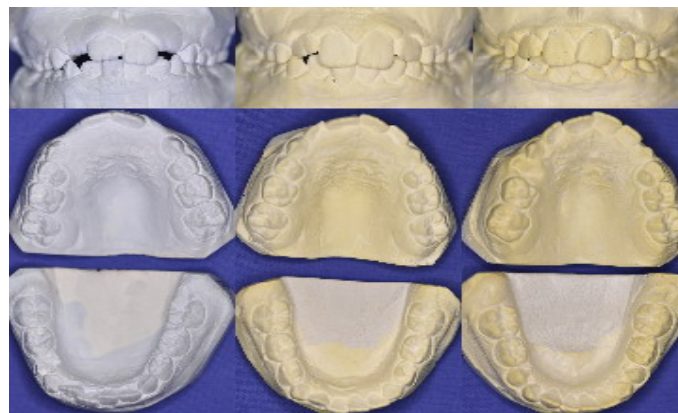

Fig.2 Sequential study casts of a boy at 7.3 (7 years 4 months), 7.9 (7 years 11 months) and 9.3 (9 years 4 months).

Although the most accurate method for studying eruption order (and positions) of permanent teeth is to trace the dental history of the same individual, many researchers, in consideration of the many years and the various difficulties involved in this method, have opted to study this order in terms of average eruption times (average age at time of eruption) [3].

Purpose

Our clinical day by day observations proved that there are differences between the clinical findings regarding the age and sequence of eruption of some teeth and the mean ages that were determined more than 30 years ago on Romanian population. The *objectives of this study* were: to determine the mean age and the sequence of eruption of permanent teeth, the differences between three different methods, the number of teeth erupted at different ages and the sex differences, to find out the correlations between age, height, weight, body mass index, the presence of menstruation and the number permanent teeth erupted.

Material and methods

The data used for this study were collected from 382 children (189 girls and 193 boys), aged between 3.5 and 15.5 years. The children were from 3 different schools (one from Timisoara and two schools from two villages closed to Timisoara), one nursery school or were patients at the Clinic of Paedodontics-Orthodontics and one dental practice from Timisoara. Some of the children have only one recording and some of them have from two to five recordings at different age intervals. The total number of recordings acquired between 2009 and 2011 was 646 (331 recordings for girls and 315 recordings for boys). We divided the sample in groups, considering an age interval of one year. Our survey was prospective cross-sectional, but included longitudinal data as well (Fig. 3).

The *inclusion criteria* were: healthy children, free from any known disorder affecting growth, mental disease or congenital anomalies. The majority of the children were most likely to be of Romanian ancestry based on their names. No selection was made concerning caries, primary tooth premature extractions, differences in physical development, social status, religion, ethnicity or whether the patient was born in Timisoara or not. The children with known or suspected anodontia and children wearing fixed orthodontic appliances were excluded from our study.

The data were collected by two examiners: one who did the examination and second who registered the information on a dental chart, at the same time. Most of the registrations were accompanied by photographs or study casts. Date of birth and sex were taken from school register. The date of assessment was also registered. The age was calculated in years and years and months from each child's date of birth to the date of examination.

Age group	Sex		
	f	**m**	**Total**
3.5-4.4	5	4	9
4.5-5.4	11	10	21
5.5-6.4	18	22	40
6.5-7.4	14	29	43
7.5-8.4	32	29	61
8.5-9.4	41	46	87
9.5-10.4	49	39	88
10.5-11.4	57	37	94
11.5-12.4	47	44	91
12.5-13.4	33	36	69
13.5-14.4	21	12	33
14.5-15.4	3	7	10
Total	**331**	**315**	**646**
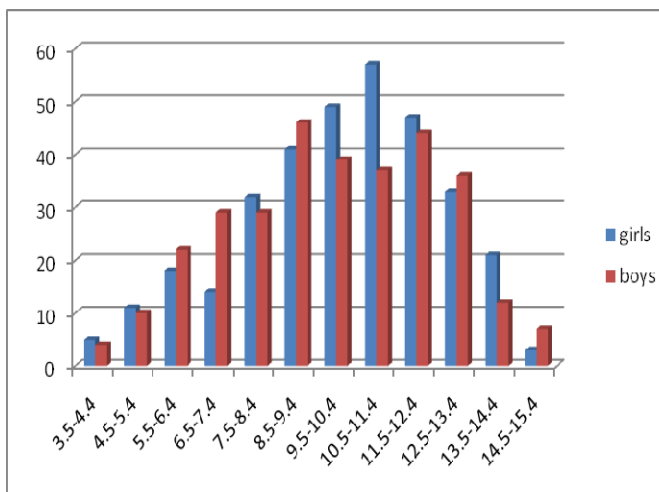
Fig.3   The distribution of cases by age group and gender represented by a table (left) and by a histogram (right).

Height and weight and the date of the first menstruation (at girls) were assessed in the same time.

Each present permanent tooth was scored: value 0 - the moment of tooth eruption (the tooth penetrates the gingiva with one part or all the incisal edge, for the incisors or with one or two cusps, for other teeth); value 0.25- if a quarter of the height of the tooth is erupted; value 0.5- if a half of the height of the tooth is erupted; and score 1 if the tooth has more then half until the whole clinical crown erupted. If the tooth was absent it was not scored (Fig. 4). Primary teeth were also scored and occlusion assessed because this study is part of a more extended survey: a dentofacial growth and development study.

Fig. 4 The developmental stage of each tooth was determined by scoring the tooth according to its clinical eruption.

All the determined data where included in a large database in order to be analyzed with statistical methods in the Department of Medical Informatics and Biostatistics from Timisoara (Fig. 5). The program used was *SPSS v. 17*. The following data were introduced in our database: the identity number and assessment number of each patient, date of birth, primary and permanent molar occlusion, date of first menstruation and if it is present/absent , date of assessment, age interval to which it belongs, age in years, age in months and years, height, weight, the body mass index calculated according to formula, the number of permanent teeth counted by computer, the values for each tooth from 1.7 to 2.7 and from 3.7 to 4.7, followed by primary teeth scores and the number of primary teeth present and absent.

Fig.5 Part of the Excel database ordered by age where tooth eruption data were registered
(left table continues with the right table)

Results

The age of each child and the number of permanent teeth was counted by the computer. We included each child in the corresponding one year age group. The mean number of present permanent teeth (all the values were counted, only blank cells were excluded) was determined for boys and girls and t-test was applied in order to compare the two groups. The differences between boys and girls were significant for 9.5-10.4 years (girls have mean number of 17.82 teeth, comparing to 15.23 which is the mean number

of teeth for boys, p=0.007) and 11.5-12.4 years (the mean number of teeth is 25.45 for girls and 23.00 for boys,

p=0.004). *At these age groups, girls from our sample have significant more permanent teeth erupted than boys (Fig.6).*

Age group (1y)	Number of girls	Mean number of teeth for girls	SD	Number of boys	Mean number of teeth for boys	SD	p value[sign]
3.5-4.4	5	0,00	0,000	4	0,00	0,000	-
4.5-5.4	11	0,45	1,508	10	0,70	1,889	0.74[ns]
5.5-6.4	18	3,44	3,034	22	3,59	3,127	0.879[ns]
6.5-7.4	14	7,71	3,268	29	6,93	3,494	0.487[ns]
7.5-8.4	32	11,13	2,311	29	10,21	2,883	0.172[ns]
8.5-9.4	41	13,44	2,899	46	12,52	2,510	0.116[ns]
9.5-10.4	49	17,82	4,644	39	15,23	4,151	0.007[s]
10.5-11.4	57	20,89	4,894	37	20,38	4,172	0.603[ns]
11.5-12.4	47	25,45	2,819	44	23,00	4,956	0.004[s]
12.5-13.4	33	26,52	1,623	36	25,58	3,434	0.157[ns]
13.5-14.4	21	27,52	1,030	12	27,50	0,905	0,956[ns]
14.5-15.4	3	26,67	2,309	7	28,00	0,000	0.134[ns]

Fig.6 The number of permanent teeth erupted for boys and girls of our sample.

We determined the timing of tooth eruption in three different ways: for 0 values (the moment of tooth eruption, when the tooth penetrates the gingiva), which is the most accurate for large samples; for 0 and 0.25 values (we take in account both values, the moment of tooth eruption and the moment when a quarter of the height of the tooth is erupted), which is not so accurate but it has the advantage that the number of teeth that we take in our determination is larger then before; for 0 and 0.25 values (we take in account both values, like before, but we apply a correction that should improve our last results). The sequence of tooth eruption is not determined by tracing the dental history of

the same individual, like in longitudinal studies, but taking in account the mean age of eruption of each homolog tooth pairs (Fig.7).

When taking in account the whole sample, the correlation between the number of teeth and age is almost perfect (r=0.914, p<0.001), with height and weight is strong and direct(r=0.86 and r=0.792, p<0.001 for both correlations) but low with body mass index (BMI) (r=0.344, p<0.001) (Fig.8). The number of permanent teeth erupted, for 124 girls, does not depend on the presence or absence of menstruation at the date of assessment.

Tooth pair	N	Mean age(y) for (0)	SD	Tooth pair	N	Mean age(y) for (0;0,25) without corection	SD	Pereche dinti	N	Mean age(y) for (0;0,25) with corect	SD
4.6+3.6	10	5,9	0,31	4.6+3.6	35	6.6	1.45	4.6+3.6	35	6.5	1.426
1.6+2.6	9	6,4	1,155	4.1+3.1	35	6.7	0.899	4.1+3.1	35	6.6	0.897
4.1+3.1	7	6,6	0,716	1.6+2.6	38	7	1.433	1.6+2.6	38	6.8	1.414
4.2+3.2	19	7,2	0,966	1.1+2.1	41	7.4	0.793	1.1+2.1	41	7.3	0.791
1.1+2.1	16	7,3	0,89	4.2+3.2	53	7.6	0.941	4.2+3.2	53	7.5	0.926
1.2+2.2	19	8,4	0,655	1.2+2.2	47	8.3	0.8	1.2+2.2	47	8.2	0.812
1.4+2.4	46	10,1	1,306	1.4+2.4	101	10.1	1.281	1.4+2.4	101	9.8	1.301
4.4+3.4	25	10,3	1,51	4.4+3.4	67	10.2	1.405	4.4+3.4	67	9.9	1.427
4.3+3.3	45	10,5	1,059	4.3+3.3	91	10.5	1.014	4.3+3.3	91	10.4	1.016
1.5+2.5	27	10,7	1,344	1.5+2.5	66	10.8	1.294	1.5+2.5	66	10.7	1.294
4.5+3.5	20	10,9	1,524	4.5+3.5	37	11	1.343	4.5+3.5	37	11.0	1.339
1.3+2.3	49	11,5	0,954	1.3+2.3	96	11.4	1.061	1.3+2.3	96	11.2	1.082
4.7+3.7	58	11,6	0,947	4.7+3.7	93	11.6	0.918	4.7+3.7	93	11.6	0.918
1.7+2.7	20	12,2	0,76	1.7+2.7	43	12.2	0.854	1.7+2.7	43	12.1	0.855

Fig.7 The mean age and the sequence of eruption of permanent teeth.

Correlation between the number of teeth and age

Correlation between the number of teeth and height

Correlation between the number of teeth and weight

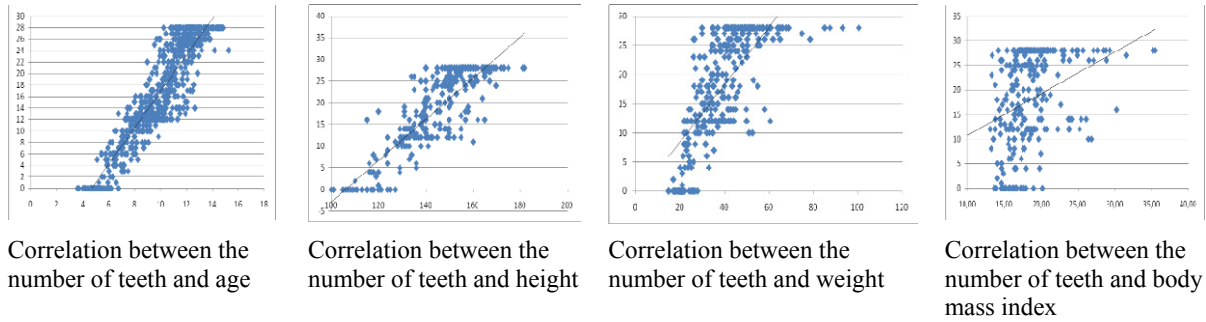Correlation between the number of teeth and body mass index

Fig.8 Correlations between the number of teeth and other parameters.

Discussions and Conclusions

The correction for 0.25 was taken from the atlas [3], because we could not examine enough children at such age intervals. Each of the three methods applied in our study had advantages and disadvantages. That is why we try to analyze the results in three different ways, being conscious that small errors are part of each one. For the first method the number of teeth included is not enough. The sample of teeth enlarges when we use the second method, but the mean ages determined are higher, because in many situations a quarter of the tooth is already erupted. We needed a correction and the third method was developed. The disadvantage was that the correction was not original, but determined on Japanese sample 20 years ago. There is a demand for a future study in order to determine tooth eruption speed on Romanian children.

Girls have usually more teeth erupted, but significantly more at two age intervals. This could suggest that *sexual differences are implied*.

The lower canine erupts at 10.5. It is different comparing to national standards, determined long time ago [6, 12], but quite similar to European and American (of Caucasian origin) actual standards. In many cases it erupts

after the first premolars and sometimes after the second premolars.

The upper canine erupts at 11.5 and the second lower molar erupts immediately after.

We know that inter individual variation is larger where SD is higher (more than 1). The standard deviation related to premolars is higher, because it depends on caries and the premature lost of the primary molars.

Lower first molars are always the first, but the related SD is always high. We have quite large inter individual variation regarding the mean age of eruption of the first permanent tooth.

The differences in sequence between the three methods occur between upper first molars and lower central incisors and between lower lateral incisors and upper central incisors. Our clinical observations are according to these results (Fig.7, Fig.9)

Because the eruption data were collected in the past two years and verified with photographs and study casts, the tables that we developed could be used as standards and clinically tested until a new survey, more organized and including more children, will be undertaken.

Fig. 9 The different order of eruption between lower lateral incisors and upper central incisors.

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