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ORIGINAL ARTICLE

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Eruption times of permanent teeth in children and young adolescents in Athens (Greece)

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Abstract In a study in Athens, Greece, during the summer of 2003, 2,304 patients (1,168 boys and 1,176 girls) were examined by a young dentistry. The examination occurred within the framework of a routine dental check-up performed at the National and Kapodistrian University of Athens. The age span ranged from 3.00 to 24.93 years of age. Sex, age and present permanent teeth were recorded. Wisdom teeth were excluded. The sequence of tooth eruption differs significantly in the lower and upper jaw, whereas no significant differences existed when comparing the sides of each jaw. The tooth eruption in the lower and upper jaw of male and female probands is symmetrical. In comparing the upper and the lower jaw of both genders, it becomes evident that there is a tendency for earlier tooth eruptions in the lower jaw. In respect to the tooth eruption sequence, a change was noted in the upper jaw. Contrary to the reports of other authors, the second premolar has changed places with the canine and erupts prior to this tooth. This could also be demonstrated in recent studies from New York and Bremen (Germany). Otherwise no major differences concerning the sequence of tooth eruptions were observed, when compared with the results gained from other populations. Concerning the entire dentition, no acceleration of the tooth eruption could be noted. The computed differences of teeth eruption as a mean value calculated over all teeth was ±1 year at maximum, compared with studies from different continents. Oral examination of teeth is a simple tool to calculate tooth eruption intervals. This first investigation in a population of Athens revealed a change in the eruption sequence of permanent teeth. These findings are relevant for dental treatment planning and should be reconfirmed at certain intervals.

Keywords Permanent teeth · Sequence of tooth eruption · Tooth eruption

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Introduction

From a dentist's point of view it is necessary to reconsider tooth eruption times occasionally for the planning of dental treatment (e.g. extraction of deciduous tooth, orthodontics treatment). Over the years, changes in sequence and time of tooth eruption are possible. Therefore, it makes sense to have a new look at tooth eruption times.

The aim of this study was to determine the eruption times of permanent teeth in a population of Athens, Greece, and to compare the data with reports from the literature. The findings were further evaluated for their applicability in age determination of living individuals.

Material and methods

This study comprises data from 1,168 male and 1,176 female patients (total: 2,344) aged 3.00–24.93 years. This wide range of age was chosen in order to include the dentition completely. The data were recorded from June 5–24, 2003. Neither the individual health status nor chronic diseases were considered as a cause of exclusion from evaluation. Further, no selection was made concerning differences in physical or mental development, social status, religion, ethnicity or whether the patient was born in Athens or not.

The source for this evaluation was dental findings which were kindly provided by the National and Kapodistrian University of Athens, Dental School Athens University, section of social dentistry. The investigations took place in this University Hospital of Athens. The dental findings

were evaluated according to gender and age [14] by one of the authors.

Data collection

The eruption or emergence of a tooth is the biological process that follows the formation of the dental crown and is essentially the penetration of the covering oral mucosa by any part of a single tooth [5]. All permanent teeth, except the third molars, were included in the evaluation.

A tooth was considered to be 'erupted' when the crown or any part there of penetrated the oral mucosa, becoming clinically visible. A tooth in the process of eruption was therefore part of the dentition. Each patient was examined once so that the total number of findings corresponded to the number of patients. It was attempted to assign nearly 100 patients, 50 male and 50 female patients, to each age-group (1-year intervals), leading to an even distribution of probands within the groups. The chronological ages of the patients were noted and rounded off to the full month.

Data registration

Primarily, the findings were recorded by hand from the dental findings. The teeth were identified according to the two digit system of the FDI [7]. Further, the initial records included the name, the date of birth, the gender, the current number of the case and the date of the dental investigation. The age of the probands was calculated by subtracting the date of birth from the date of the investigation.

Following the acquisition of these basic data, the findings were then transferred to an IBM-compatible Pentium computer using standard software (Microsoft Access, version 2000) and a specially designed desktop surface to govern and control the input of the complete dental status in every case.

In order to minimise mistakes related to the data transfer, all the values were checked twice, both after writing the dental findings and after registering these findings in the computer.

The calculations were then performed according to earlier studies on the subject of tooth emergence [14]. The statistic method for the calculation was the Maximum-Likelihood-Method. The parameters μ (mean), σ (standard deviation) and 2σ (two standard deviations) were calculated with the aid of a non-linear optimizing routine [1]. The calculations were performed with standard statistical software tools (SPSS Version 11.0, S-Plus Version 4.5, and JMP, Version 4.0).

Results

In our collective, the sequence of tooth eruption revealed a change when compared with reports from earlier studies. The emergence of the maxillary canine precedes the emergence of the second premolar (see Fig. 1). Tables 1 and 2 show the mean age of life and eruption of permanent teeth in males and females. The numbers following the decimal point are the months of age calculated in decimal system.

No statistical differences related to the side of the body and tooth eruption of synergets were observed. Thus, the

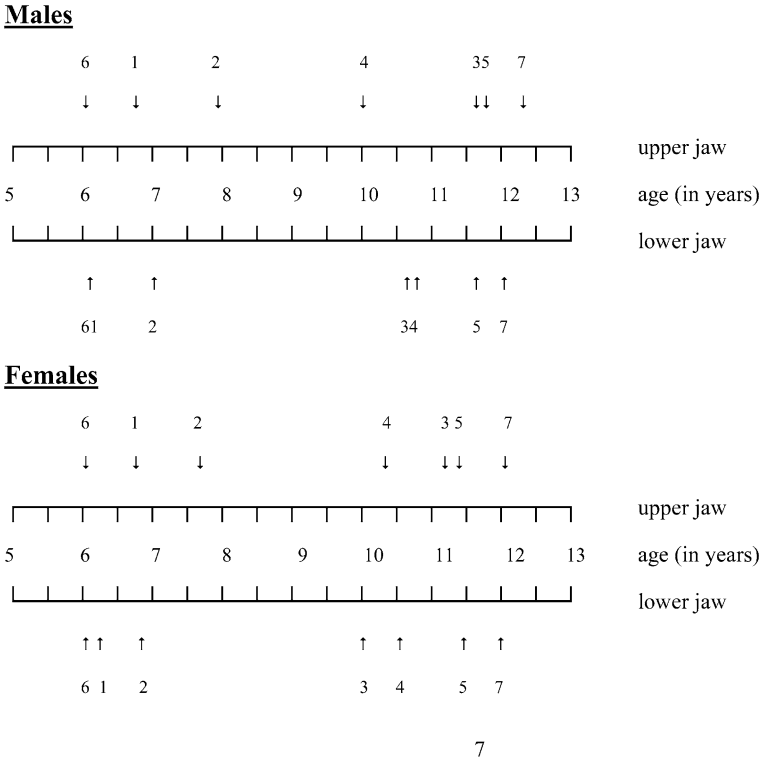

Fig. 1 Chronological sequence of the tooth eruption of the upper and lower jaw in males and females

Table 1 Mean chronological age (males) forthe emergence of permanent teeth of both jaws (in years, Athens, Greece)

Tooth		Mean (μ)	SD (σ)	2 SD (2σ)
Upper jaw	1	6.77	0.86	1.72
	2	7.98	1.07	2.14
	3	11.63	1.74	3.48
	4	10.61	1.55	3.1
	5	11.72	1.67	3.34
	6	6.01	0.72	1.44
	7	12.37	1.28	2.56
Lower jaw	1	6.09	0.81	1.62
	2	7.05	0.88	1.76
	3	10.66	1.31	2.62
	4	10.73	1.4	2.8
	5	11.58	1.5	3.00
	6	6.08	0.88	1.76
	7	12.01	1.62	3.24

μ mean eruption age in years, σ standard deviation,2σ two standard deviations

Table 2 Mean chronological age (females) forthe emergence of permanent teeth of both jaws (in years, Athens, Greece)

Tooth		Mean (μ)	SD (σ)	2 SD (2σ)
Upper jaw	1	6.72	0.82	1.64
	2	7.65	0.91	1.82
	3	11.22	1.45	2.90
	4	10.33	1.54	3.08
	5	11.44	1.64	3.28
	6	6.06	0.81	1.62
	7	12.00	1.13	2.26
Lower jaw	1	6.18	0.89	1.78
	2	6.88	0.81	1.62
	3	9.98	1.28	2.56
	4	10.48	1.54	3.08
	5	11.41	1.42	2.84
	6	6.00	0.83	1.63
	7	11.73	1.29	2.58

μ mean eruption age in years, σ standard deviation,2σ two standard deviations

graphs do not differentiate between the left and right side of the body.

Discussion

Patients

The collective comprised of 2,344 children and young adults aged 3.00–24.93 years equally distributed according to gender. The sample size and age distribution is similar to other studies of this kind [4].

Data acquisition

The sequence of tooth eruption of permanent teeth in humans is characterised by three periods [9]. During the first period the permanent first molars erupt and the incisors are exchanged. In the second period the other decidious teeth are exfoliated and replaced and the second molar emerges. The last period covers the eruption of the third molars.

Due to the large variability of eruption times known for the third molars and the frequent missing germ of these teeth, we excluded third molars from our evaluation [8]. This procedure is in accordance with other studies on tooth emergence [14].

We found no significant differences of tooth eruption related to laterality, these findings being in accordance with the results of other authors in the literature [14]. It was suggested that the endocrine impact on symmetrically developing organs acts synchronically [9]. On the other hand, the separation of the results related to gender proved mandatory because significant differences were noted between males and females [14].

The reason for the differences in tooth eruption in males and females is 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 [12].

Statistics

Comparative studies on ethnological or gender-related differences and the eruption periods of teeth prove difficult due to the numerous different evaluation techniques that have been applied by the various authors [7]. A comparison of the studies would imply that results are compared that were gained with different methods, making a valid comparison practically impossible.

In this study the “Probit” analysis was applied using the numerical approximation of a maximum-likelihood-estimation [6]. This method is internationally well established and has been repeatedly applied for the estimation of tooth eruption [14, for review]. This method provides reliable results even in small-sized samples [7].

A prerequisite for the application of this method is an all-or-nothing event, i.e. only two variables of the same character are allowed (e.g. tooth present or tooth missing). Following this prerequisite for every single tooth, an upper limit can be calculated (expressed as an age) where the tooth was missing and a lower limit where the tooth was present. From these values the mean values and standard deviation can be calculated for each tooth. With this in mind, it was attempted to compare the results of this study with others that made use of similar statistical and mathematical methods [14].

Discussion of results

In comparing the results of international studies, it must be kept in mind that depending on the infrastructure and cultural practises indigenous to each region, data related to the date of birth might be misleading. In some areas of the world, no central registration boards or no precise proof of age exist. If patients are recruited for studies of this nature, although a precise definition of their age is not possible, the results would be falsified and incorrect. This must be kept in mind.

It is postulated that there are numerous factors which influence the development and eruption of teeth, including endocrine, genetic, dysmorphic and environmental factors. Endogenous determinants can be summarised as genetically or hormone derived. Many authors are of the opinion that the endogenic factors have greater influence on the tooth eruption than exogenic or environmental factors. Numerous articles have been published concerning these phenomena [2, 3, 10].

There are no substantial differences in the sequence and timing of the permanent dentition compared with other studies involving other populations. When we compare our results with those of others international studies, the maximum difference for the eruption of a single tooth lies ±1 year. The impact of ethnicity on the eruption process is probably lower than proposed by some authors and was substantiated by a recent meta-analysis [14]. Studies from Finland [10] and the USA (Orlando, FL) [13] confirm the sequence found in this study. A new finding is the sequence of mandibular tooth eruption in males [15, 16].

The change in the sequence of tooth eruption revealed for the canine and second premolar is relevant for dental treatment planning. In fact, these results have bearing on the orthodontic treatment in cases of a space deficit in the canine region. The threat of a dystopic eruption of the canine is eminent in an eruption sequence with the canine following both premolars when the first molar emerges mesially [9]. According to our results this dangerous situation is unlikely to occur. The replacement of the decidious canines and molars causes no problems in cases with a normal ratio of tooth and bone sizes; in turn, if this is not the case, problems must be expected.

The intermaxillary comparison revealed a chronological difference of tooth eruption. Cartwright noticed this phenomenon way back in 1857, as well as Unglaube in 1923, both being confirmed by other authors thereafter [for review: 14]. In the present study the mandibular teeth erupted earlier than their synergets of the maxilla, with the exception of the premolars and molars in males. Only in (red-) Indians from South America, the USA and some regions of Finland was an earlier eruption of the mandibular permanent teeth observed [14]. The phenomenon "acceleration" was not noticed in this study and it must be assumed that this phenomenon has reached its end point in the current human development of the last 50 years [8]. It can be postulated that we have reached the upper end of the scale in respect to the tooth eruption times and it could be assumed that an earlier eruption, contrary to other physiognomical parameter like body size and weight which are increasing, will not take place [11]. These findings do not differ significantly from current studies [15, 16].

Conclusion

Oral examination of teeth is a simple tool to calculate tooth eruption intervals. This first investigation on a population of Athens revealed a change in the eruption sequence of permanent teeth, compared with other European studies. These findings are relevant for dental treatment planning and forensic evaluation. They should be reconfirmed at certain intervals.

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