Timing of Permanent Teeth Eruption in Turkish Children

Bayrak S*/ Sen Tunc E**/ Tuloglu N***/ Acikgoz A****

Objective: *To identify the mean time of permanent teeth eruption in children aged 5-15 years in Samsun, Turkey.* ***Study Design:*** *A total of 1,491 children aged 5-15 years (Female: 773; Male: 718) were included in this study. Teeth were recorded as either "not erupted" or "erupted," which was defined as having at least one cusp visible in the oral cavity. Differences between eruption times for males and females and for maxillary and mandibular teeth were analysed using independent t-tests.* ***Results:*** *Eruption tended to be earlier in females than in males, but this difference was significant only for maxillary and mandibular canines and mandibular first premolars ($p<0.05$). For both females and males, the first teeth to erupt were the central incisors and first molars, and the last to erupt were the second premolars, molars and canines. Mandibular incisors and canines erupted significantly earlier than their maxillary counterparts in both females and males ($p<0.05$).* ***Conclusion:*** *In comparison with other studies, eruption times of permanent first molars, central and lateral incisors were delayed by several months, whereas eruption times of other teeth were accelerated by several months. The findings regarding eruption times should be considered when planning dental treatment.*

Keywords: *Eruption sequence; Permanent teeth; Tooth eruption.*

INTRODUCTION

The term 'eruption' refers both to the process of axial movement of a tooth from its non-functional position in the bone to functional occlusion[1] and to the moment the tooth appears in the oral cavity.[1,2] Accurate and detailed information regarding the timing of dental eruption is needed to monitor occlusal development, diagnose malocclusion and efficiently plan the dental treatment of children and adolescents in pediatric dentistry and orthodontics.[2-4] Information related to tooth eruption is also used to supplement other maturity indicators in the diagnosis of certain growth disturbances and in forensic dentistry to estimate the chronological age of children with unknown birth records.[5-7]

The normal eruption of permanent teeth into the oral cavity occurs over a broad chronologic age range.[1] Factors that have been shown to exert an influence on eruption patterns include sex, ethnicity, geography, hereditary and hormonal factors, socioeconomic status, nutrition and caries status.[1,4,8-12]

* Sule Bayrak, DDS, PhD, Assistant Professor, Department of Pediatric Dentistry. From the Faculty of Dentistry, Ondokuz Mayis University, Samsun, Turkey.

** Emine Sen Tunc, DDS, PhD, Associate Professor, Department of Pediatric Dentistry.

*** Nuray Tuloglu, DDS, Research Assistant, Department of Pediatric Dentistry.

*** Aydan Acikgoz, DDS, PhD, Professor, Department of Oral Diagnosis and Radiology.

Send all correspondence to: Sule Bayrak, Department of Pediatric Dentistry, Faculty of Dentistry, Ondokuz Mayis University, 55139, Kurupelit, Samsun, TURKEY

Tel: +90 362 3121919/3359
Fax: +903624576032

E-mail: suleb76@yahoo.com

Numerous studies have evaluated the eruption times of permanent teeth in different populations and different ethnic groups.[2-4,9-17] However, only one study to date has been conducted among Turkish children.[18] Therefore, the aim of the present study was to clinically identify the time and sequence of eruption of permanent teeth in male and female children in Samsun, Turkey between the ages of 5 and 15 years.

MATERIALS AND METHOD

The study population consisted of 1.491 children aged 5-15 years (Females, 51.8%; Males, 48.2%) receiving care at the Ondokuz Mayıs University Faculty of Dentistry's Department of Pediatric Dentistry between April-November 2010. Table 1 shows the distribution of children according to age and sex. Only children in good general health were included in the study. Children with localized pathology, anomalies or severe malocclusion (substantial skeletal discrepancy, blockedout teeth, etc.), children undergoing active orthodontic treatment and children with a sibling accepted for inclusion in the sample population were excluded from the study.

Data collection

Data was collected by two dentists through clinical examinations performed in a dental chair. Date of examination, date of birth, sex, case number and absence/presence of each permanent tooth was recorded and coded for subsequent statistical analysis. No radiographs or additional dental records were taken in this study.

The age of the child was calculated in months from the child's date of birth to the date of the examination. Permanent teeth were scored according to clinical eruption stage (adapted from Carvalho *et al*).[19] Each tooth was classified as either "not erupted" or "erupted," which was defined as having any part of the crown penetrating the gingiva and visible in the oral cavity. Teeth extracted for orthodontic reasons were recorded as erupted.

Table 1. Distribution of study subjects according to age and sex in Samsun, Turkey.

Age (years)	Range (months)	Females	Males	Total
5	54-65	5	11	16
6	66-77	68	71	139
7	78-89	129	115	245
8	90-101	137	130	267
9	102-113	123	103	225
10	114-125	115	101	217
11	126-137	96	101	197
12	138-149	65	57	122
13	150-161	17	19	35
14	162-173	12	6	18
15	174-185	6	4	10
Total	54-185	773	718	1491

Table 2. Mean eruption times of the permanent teeth for children from Samsun, Turkey.

Tooth	Eruption time (Mean±SD)		p
	Females	Males	
I^1	88.84±10.05	87.71±12.14	p=0.772
I_1	75.35±10.53	78.61±8.62	p=0.714
	p= 0.00	**p= 0.019**	
I^2	100.91±15.25	105.20±15.14	p=0.463
I_2	87.89±10.43	89.43±13.17	p=0.714
	p=0.004	**p=0.013**	
C^{max}	123.53±15.39	133.00±10.59	**p=0.042**
C_{mand}	114.08±12.47	126.92±10.59	**p=0.00**
	p=0.025	**p=0.044**	
PM^1	115.33±18.31	118.00±15.59	p=0.540
PM_1	113.25±8.98	125.33±13.08	**p=0.002**
	p=0.636	p=0.105	
PM^2	117.71±11.00	123.47±12.75	p=0.180
PM_2	123.40±11.55	127.89±6.53	p=0.308
	p=0.214	p=0.347	
M^1	78.19±13.51	76.67±6.84	p=0.764
M_1	77.82±10.19	79.50±10.92	p=0.719
	p=0.944	p=0.513	
M^2	127.17±23.66	128.37±9.49	p=0.877
M_2	133.37±13.66	132.00±8.51	p=0.730
	p=0.524	p=0.279	

p values in columns indicate statistically comparison between maxillar and mandibular counterpart teeth.

p values in row indicate statistically comparison between females and males.

Bold p values indicate statistically significant results.

Inter-examiner reliability was assessed through an initial examination of 30 children by the two authors. Good inter-examiner agreement was observed (0.97). Intra-examiner consistency was assessed by having each author re-examine 30 children after an interval of 2 weeks. Complete agreement was observed between the two examinations.

All statistical analysis was performed using the statistical software program SPSS for Windows, Version 16.0 (SPSS Inc, Chicago, IL, USA). Descriptive statistics of eruption time were computed for each tooth. Independent t-tests were used to assess the differences between males and females and between the maxillary and mandibular arch. P-values of less than or equal to 0.05 were considered statistically significant.

RESULTS

Of the 1.491 children from whom data was collected over a six month period, 773 were females (Mean age: 9.06±2.04 years) and 718 were males (Mean age: 8.98±2.05 years).

Teeth were identified as follows: I^1, maxilary central incisor; I_1, mandibular central incisor; I^2, maxillary lateral incisor; I_2, mandibular lateral incisor; C^{max}, maxillary canine; C_{mand}, mandibular canine; PM^1, maxillary first premolar; PM_1, mandibular first premolar; PM^2, maxillary second premolar; PM_2, mandibular second premolar; M^1, maxillary first molar; M_1, mandibular first molar; M^2, maxillary second molar; M_2, mandibular second molar.

No statistically significant differences were found in the eruption times of permanent teeth on the right and left sides of the jaw; therefore, only one side (right) was assessed.

The eruption sequence in the maxilla was as follows: M^1, I^1, I^2, PM^1, PM^2 and either C^{max}, M^2 (in females) or M^2, C^{max} (in males). The eruption sequence in the mandible was as follows: I_1, M_1, I_2, PM_1, C_{mand}, PM_2, M_2. Tooth eruption sequences in the mandibular arch were the same for females and males (Figure 1 and 2).

Mean eruption times and statistical comparisons are given in Table 2. Whereas eruption for females started at 75 months (I_1) and ended at 133 months (M^2), for males, eruption started at 76 months (I_1) and ended at 133 months (C^{max}). Most teeth erupted earlier in females than in males, with the difference in mean age ranging from

Table 3. Distribution of children by eruption sequence and stage in Samsun, Turkey.

Stage I	**I1-M1**	**M1-I1**	**Same age**			
Maxilla	3.9%	89.6%	6.5%			
Mandible	43.9%	38.7%	17.4%			
Stage II	**C-PM1**	**PM1-C**	**Same age**	**PM2-M2**	**M2-PM2**	**Same age**
Maxilla	2.7%	94.9%	2.4%	97.3%	1.9%	0.8%
Mandible	38.7%	41.4%	19.9%	81.8%	16.7%	1.5%

I1-M: I1 erupted before M1; M1-I1: M1 erupted before I1; Same age: two teeth erupted within the same age range.
C-PM1: C erupted before PM1; PM1-C: PM1 erupted before C; PM2-M2: PM2 erupted before M2; M2-PM2: M2 erupted before PM2.

1-13 months, depending on tooth type. Differences in mean eruption times between males and females were statistically significant for C^{max}, C_{mand} and PM_1 (Table 2).

As shown in Table 2, the average±SD for eruption of individual teeth in the combined sample was about 1 year (range of 7 months - 1 year and 6 months) except M^2 for females. There was a broader spectrum of variation for females, ranging from minimum interval of 18 months for PM_1 to a maximal interval 48 months for M^2. Overall, there was less variance in males; the minimum interval was 14 months for PM_2 and the maximum was 32 months for PM^1.

When maxillary and mandibular teeth were compared, mandibular incisors and canines were found to erupt earlier than their maxillary counterparts in both males and females ($p<0.05$) (Table 2).

The sequence of tooth eruption was divided into two stages. Stage I was comprised of the first molars and central and lateral incisors, and Stage II was comprised of the canines, first premolars, second premolars and second molars. The distribution of the study population by eruption sequence and stage is given in Table 3. In Stage I, the maxillary first molar erupted before the maxillary central incisor and the mandibular central incisor erupted before the mandibular first molar in the majority of children (89.6% and 61.3%, respectively). In Stage II, the maxillary first premolar erupted before the canine in 94.9% of children, whereas the mandibular first premolar erupted before the canine in only 41.4% of children. Also in Stage II, the second premolar erupted before the second molar in the majority of children in both the maxilla and mandible (97.3%, 81.8%, respectively) (Table 3).

DISCUSSION

Understanding the timing and sequence of permanent teeth eruption is important for general dental practitioners as well as specialists involved in managing dental problems in growing children.[20] Eruption timing and sequence can be determined either clinically or radiographically; however, radiographic methods may not be feasible in developing countries in practice and may not be appropriate in community-based studies in either developing or developed countries for ethical reasons.[5] Therefore, in the present study, the eruption time of teeth was determined clinically. Considering that to date, only one study has been published on tooth eruption in Turkey,[18] there is a clear need for reliable reference tables on permanent tooth eruption in the Turkish population. Therefore, the present study aimed to assess the eruption times of permanent teeth in children living in the province of Samsun in northern Turkey.

Up until the pre-adolescent years, somatic growth and development in females is generally more advanced than in males. This holds true for the eruption of permanent teeth occurring between the ages of 6 and 12.[21] In line with earlier studies,[2,5,9,14,18] the present study found eruption times of permanent teeth in females to be, in general, earlier than in males, with the average difference ranging from 1-13 months. The distinct differences were observed for the C^{max} and C_{mand} and PM_1. Other studies have also found C_{mand} to erupt significantly earlier in females when compared to males.[4,7,13,15,22]

In our study, the mandibular incisors and canines were observed to erupt significantly earlier than their maxillary counterparts in both males and females. These results are in line with several other similar studies carried out in various countries.[2,5,6,9,11,13,23] However, there is no general agreement as to whether or not mandibular premolars and molars erupt before their maxillary counterparts.[18,23] In the present study, no statistically significant differences were observed between the eruption times of maxillary and mandibular premolars and molar in either males or females. This conflicts with an earlier study of Turkish children[18] that reported maxillary premolars and molars to erupt earlier than their mandibular counterparts in males.

According to the results inter-individual differences were not exceed 2 years except for eruption of M^2 for females. Although some studies reported high range differences in the eruption timing previously,[9,24] the less variations that similar to the present study were reported in the later studies belong to various populations.[3,18,23,25-27] This difference could be explained ethnical differences and secular trends in the dental eruption patterns that previously reported by Rousset *et al* (2003).[3]

When Eruption Stage I was evaluated, in line with several previous studies,[27-29] in both males and females, maxillary first molars were found to erupt before the maxillary incisors, whereas mandibular central incisors were found to erupt before mandibular first molars.

Many interceptive orthodontic procedures depend upon a specific order of eruption.[23] For example, in cases of crowding in the maxilla, emergence of the first premolar before the canine would favour interceptive extraction of the first premolar.[18,23] The present study found that the maxillary first premolar erupted before

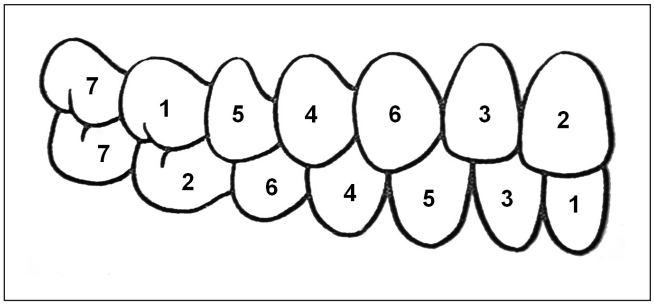

Figure 1. Sequence of eruption of maxillary and mandibular teeth in females in Samsun, Turkey.

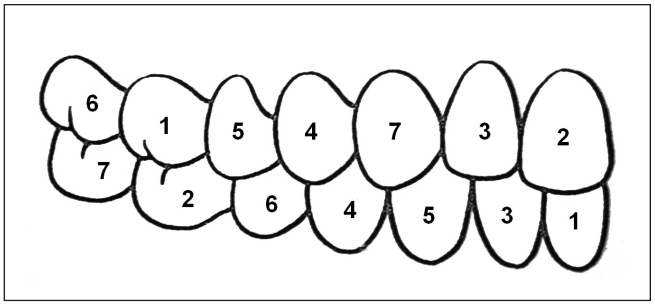

Figure 2. Sequence of eruption of maxillary and mandibular teeth in males in Samsun, Turkey.

the maxillary canine in 94.9% of cases (Table 5). This finding is in agreement with other studies.[17,23,30,31]

In the present study, emergence of the mandibular canine before the mandibular first and second premolars was observed in 38.7% of children. This sequence is desirable for maintaining adequate arch length and preventing lingual tipping of the incisors,[32] which can lead to a loss of arch length as well as the development of an increased overbite.[30] However, eruption of the canine after the first and second premolars does not necessarily create orthodontic problems, since the primary second molar can be maintained and its mesiodistal width is large.[30]

In the maxilla, eruption of the second molar before the second premolar can also result in a loss of arch length;[32] however, the present study found this unfavorable eruption pattern to occur very rarely (1.9% of children). Similarly, the mandibular second premolar should ideally erupt before the second molar, and this sequence was observed in 81.8% of cases in the present study (Table 5). If the sequence is reversed, eruption of the second molar can exert a strong force on the first molar, causing mesial drift.[23,30]

The wide variation in the sequence of eruption was reported[23] but it is generally accepted for maxilla C^{max} erupted before M^2.[3,4,18,25,27,31] In the present study according to mean eruption timing data conversely to this sequence M^2 erupted before C^{max} in males. This uncommon sequence may be disadvantage for the maintaining length of the maxillary arch during the transitional dentition. However, all males may not show same sequence but it is certainly an important consideration when managing the occlusal development and orthodontic treatment of Turkish children. In order to more clearly determine eruption times and sequences of permanent teeth, future studies should include detailed analyses of large and homogenous population subsets.

When compared to other studies, the present study reported eruption times of central incisors, lateral incisors and first molars to be slightly later (1-8 months) than the times reported for children in Greece, Northern Ireland, Saudi Arabia and India[23,25,26,31] as well as for children in the Aegean Region of Turkey.[18] However, eruption times of premolars and second molars were generally earlier than the times reported in other studies.[23,25,26,31] Extraction of primary teeth prior to exfoliation as a result of extensive caries may accelerate the eruption of premolars (2-18 months). In general, the numerous differences reported in the timing of permanent teeth emergence by different studies may be a reflection of racial differences.[5] However, differences in reported eruption times may also be related to differences in the definitions of emergence and eruption, sampling effects, sample sizes, systems of age assignments, nutritional and socio-economic effects and data compilation and reporting methods.[5]

CONCLUSION

The results of this study showed the eruption of permanent first molars and central and lateral incisors to be delayed by several months in comparison to previous studies, whereas the remaining teeth exhibited slightly accelerated eruption when compared to previous studies. In order to more clearly determine eruption times and sequences of permanent teeth, future studies should include detailed analyses of large and homogenous population subsets.

REFERENCES

1. Suri L., Gagari E., Vastardis H. Delayed tooth eruption: pathogenesis, diagnosis, and treatment. A literature review. Am J Orthod Dentofacial Orthop 126: 432-445, 2004.
2. Nizam A., Naing L., Mokhtar N. Age and sequence of eruption of permanent teeth in Kelantan, north-eastern Malaysia. Clin Oral Investig 7: 222-225, 2003.
3. Rousset M.M., Boualam N., Delfosse C., Roberts W.E. Emergence of permanent teeth: secular trends and variance in a modern sample. J Dent Child 70: 208-214, 2003.
4. Leroy R., Bogaerts K., Lesaffre E., Declerck D. The emergence of permanent teeth in Flemish children. Community Dent Oral Epidemiol 31: 30-39, 2003.
5. Mugonzibwa E.A., Kuijpers-Jagtman A.M., Laine-Alava M.T., van't Hof M.A. Emergence of permanent teeth in Tanzanian children. Community Dent Oral Epidemiol 30: 455-462, 2002.
6. Elmes A., Dykes E. A pilot study to determine the order of emergence of permanent central incisors and permanent first molars of children in the Colchester area of the U.K. J Forensic Odontostomatol 15:1-4, 1997.
7. Garn S.M., Sandusky S.T., Nagy J.M., Trowbridge F.L. Negre-Caucasoid difference in permanent tooth emergence at a constant income level. Arch Oral Biol 18: 606-615, 1973.
8. Hatton M.E. A measure of the effects of heredity and environment on eruption of the deciduous teeth. J Dent Res 34: 397-401, 1955.
9. Pahkala R., Pahkala A., Laine T. Eruption pattern of permanent teeth in a rural community in northeastern Finland. Acta Odontol Scand 49: 341-349, 1991.
10. Virtanen J.I., Bloigu R.S., Larmas M.A. Timing of eruption of permanent teeth: standard Finnish patient documents. Community Dent Oral Epidemiol 22: 286-288, 1994.
11. Manji F., Mwaniki D. Estimation of median age of eruption of permanent teeth in Kenyan African children. East Afr Med J 62: 252-259, 1985.
12. Saleem M.A., Hagg U., Jalil F., Zaman S. Dental development, dental age and tooth counts. A prospective longitudinal study of Pakistani children. Swed Dent J 20:61-67, 1996.
13. Houpt M.I., Adu-Aryee S., Grainger R.M. Eruption times of permanent teeth in the Brong Ahafo region of Ghana. Am J Orthod 53: 95-99, 1967.
14. Eskeli R., Laine-Alava M.T., Hausen H., Pahkala R. Standards of permanent tooth emergence in Finnish children. Angle Orthod 69: 529-533, 1999.
15. Krumholt L., Roed-Peterson B., Pindborg J.J. Eruption times of the permanent teeth in 622 Ugandan children. Arch Oral Biol 16: 12811288, 1971.

16. Billewicz W.Z., McGregor I.A. Eruption of permanent teeth in West African (Gambian) children in relation to age, sex and physique. Ann Human Biol 2: 117-128, 1975.
17. Hassanali J., Odhiambo J.W. Ages of eruption of the permanent teeth in Kenyan African and Asian children. Ann Human Biol 8: 425-434, 1981.
18. Wedl J.S., Schoder V., Blake F.A., Schmelzle R., Friedrich R.E. Eruption times of permanent teeth in teenage boys and girls in Izmir (Turkey). J Clin Forensic Med 11: 299-302, 2004.
19. Carvalho J.C., Ekstrand K.R., Thylstrup A. Dental plaque and caries on occlusal surfaces of first permanent molars in relation to stage of eruption. J Dent Res 68: 773-779, 1989.
20. Diamanti J., Townsend G.C. New standards for permanent tooth emergence in Australian children. Aust Dent J 48:39-42, 2003.
21. Demirjian A., Levesque G.Y. Sexual differences in dental development and prediction of emergence. J Dent Res 59: 1110-1122, 1980.
22. Garcia-Godoy F., Diaz A.N., del Valle J.M., Arana E.J. Timing of permanent tooth emergence in a South-eastern Dominican schoolchildren population sample. Community Dent Oral Epidemiol 10: 43-46, 1982.
23. Kochhar R., Richardson A. The chronology and sequence of eruption of human permanent teeth in Northern Ireland. Int J Paediatr Dent 8: 243-252, 1998.
24. Hägg U., Taranger J. Dental development dental age and tooth counts. Angle Orthod 55: 93-107, 1985.
25. Wedl J.S., Danias S., Schmelzle R., Friedrich R.E. Eruption times of permanent teeth in children and young adolescents in Athens (Greece). Clin Oral Investig 2005 9:131-134, 2005.
26. Khan N.B., Chohan A.N., Al-Mograbi B., Al-Deyab S., Zahid T., Al-Moutairi M. Eruption time of permanent first molars and incisors among a sample of Saudi male schoolchildren. Saudi Dent J 18; 18-24, 2006.
27. Moslemi M. An epidemiological survey of the time and sequence of eruption of permanent teeth in 4-15-year-olds in Tehran, Iran. Int J Paediatr Dent 14: 432-438, 2004.
28. Lysell L., Magnusson B., Thilander B. Time and order of eruption of primary teeth. Odontology Revy 13: 217-234, 1962.
29. Carlos J.P., Gittelsohn A.M. Longitudinal studies of the natural history of caries. I. Eruption patterns of the permanent teeth. J Dent Res 1965;44: 509-516, 1965.
30. Leroy R., Cecere S., Lesaffre E., Declerck D. Variability in permanent tooth emergence sequences in Flemish children. Eur J Oral Sci 116: 11-17, 2008.
31. Agarwal K.N., Gupta R., Faridi M.M., Kalra N. Permanent dentition in Delhi boys of age 5-14 years. Indian Pediatr 41: 1031-1035, 2004.
32. McDonald R.E., Avery D.R. Eruption of the teeth: local, systemic, and congenital factors that influence the process. In: McDonald RE, Avery DR, eds. Dentistry for the child and adolescent. St Louis; Washington, DC; Toronto: The CV Mosby Co., 1987; 189-218.