




Estimation of dental age in children in a Turkish population with tooth agenesis

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Highlights

Teeth are used as a source of human identification. Age estimation through teeth plays an important role in this field.

In this study, delayed tooth development was observed in children with oligodontia compared to children without tooth agenesis.

The Haavikko method, which estimates teeth by using radiographic images of teeth, can be used in age determination, especially in children with tooth agenesis.

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Abstract

Aim: The aim of this study was to investigate tooth development according to chronological age in children with tooth agenesis and to determine whether the severity of tooth agenesis (hypodontia and oligodontia) has an effect on tooth development. **Methods:** In this retrospective study, the records of children diagnosed with hypodontia and oligodontia referred to the Department of Pediatric Dentistry between January 1, 1999 and January 1, 2018 were examined. The control group was matched with children diagnosed with oligodontia and hypodontia in terms of age and gender. A total of 288 children aged between 6-15 years were included in the study and the control, hypodontic and oligodontic groups were formed as Group I, Group II and Group III, respectively. Chronologic age was calculated and Haavikko's method was used for dental age. The difference between chronological and dental ages was analyzed by ANOVA test and Tukey test was used for multiple comparisons. **Results:** There was a difference was determined between groups I and III in dental age determined by Haavikko's method ($p < 0.05$). When the difference between chronological age and dental age determined, it was found that in Group I, II, III, dental age was 0.71, 1.17, 1.88 years behind respectively chronological-age and this difference was statistically significant ($p < 0.05$). **Conclusions:** In this study, delayed tooth development was observed in children with oligodontia compared to children without tooth agenesis.

Keywords: Age Determination by Teeth; Forensic Dentistry; Tooth Agensis Selective

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INTRODUCTION

Forensic dentistry is a part of forensic medicine that uses dental or orofacial findings to serve the forensic system.¹ Human identity is the main memory of societies and therefore age estimation is of great importance in human identification in fields such as forensic medicine, anthropology, demography and paleontology.^{2,3}

Indicators such as physical development, skeletal development and dental development are examined to estimate chronological age. Since the development of teeth is mainly controlled by genetic factors and their natural structure is less affected by environmental factors, they are considered the most indestructible parts of the body.⁴ Therefore, methods based on radiographic examination in tooth development are thought to give more reliable results.⁵

Tooth agenesis refers to the developmental absence of at least 1 primary/permanent tooth, excluding the third molars. In the literature, terms such as hypodontia, oligodontia and anodontia are used for dental agenesis according to the number of tooth agenesis.⁶ PAX9 and MSX1 are among the main genes that cause tooth agenesis, and it has been suggested that these genes cause delayed tooth development in the remaining teeth.⁷ Garn et al.⁸ were the first researchers to describe delayed tooth development in children with hypodontia, but they did not express this quantitatively.

Although delayed tooth formation has been described in children with dental agenesis, there is no consensus in the literature.⁹⁻¹⁵ The different results obtained may be due to the racial differences and variations of the studied populations and the use of different methods in age estimation. One of these methods, the Haavikko's method, which is recommended for use in cases of tooth agenesis, is a radiological method based on the mineralization of teeth and

performs age estimation with 12 radiographic mineralization stages.¹⁶ This method, in which the data are generated separately for each tooth and the average tooth age is determined, is very valuable in terms of better understanding of tooth development in patients with dental agenesis, pedodontic and orthodontic treatment planning. It is also important to provide a reference for age assessment specific to patients with tooth agenesis in cases where birth data are missing and age is disputed for forensic purposes.

The aim of this study was to investigate tooth development according to chronological age in children with tooth agenesis and to determine whether the severity of tooth agenesis (hypodontia and oligodontia) has an effect on tooth development. The null hypotheses of our study were (1) there was no significant difference in tooth development in children with tooth agenesis compared to the control group and (2) there was no significant difference in tooth development according to the severity of tooth agenesis.

METHODS

Ethical approval

This study was approved by Tokat Gaziosmanpasa University Clinical Research Ethics Committee 22-KAEK-067 Date: 26.05.2022).

Sample size calculation

The sample size was estimated using G Power Software v.3.1.9.2. A minimum of 288 children was required to detect a significant difference using the "ANOVA: Fixed effects, omnibus, one-way" test, with a type I error (α) of 0.05, power (1-beta) of 85%, and effect size of 0.196.¹⁷

Study procedure

In this retrospective study, the records of children who were admitted to the Department of

Pedodontics, Faculty of Dentistry, Suleyman Demirel University, between January 1, 1999 and January 1, 2018 and diagnosed as tooth agenesis were examined.

Children diagnosed with oligodontia and hypodontia, aged 6-15 years, with complete records (date of birth, date of panoramic radiography, systemic and dental anamnesis, qualitative and quantitative description of tooth agenesis), without any systemic disease/syndrome diagnosis and with panoramic radiographs of adequate quality (to determine tooth development) were included in the study. Patients with incomplete records and panoramic radiographs that were not standard and clear (distorted, elongated or discolored) were excluded.

The study included 96 children with oligodontia (50 girls - 46 boys) and 96 children with hypodontia (50 girls - 46 boys). The control group consisted of 96 children (50 girls - 46 boys) randomly selected by envelope method from children without tooth agenesis and matched with oligodontic and hypodontic children in terms of age and gender. The control, hypodontic and oligodontic groups were defined as Group I, Group II and Group III, respectively. Chronological age of the children was determined by using a formula [(the date that the panoramic radiograph was taken)-(date of birth)/365].v Haavikko's method was used to estimate tooth age. This method is based on the evaluation of seven left mandibular teeth, excluding the third molar, and the recognition of 12 radiographic stages for each tooth. A tooth that has passed the beginning of any stage is considered to belong to that stage of development until the tooth reaches the beginning of the next stage determined. The degree of calcification was converted to age for each tooth using Haavikko's sex-specific tables. Teeth with closed apices and missing teeth were not included in the calculation. Chronologic age was then calculated as the mean of the total score.¹⁶

Statistical analysis

The IBM Statistical Package for Social Sciences (SPSS) version 22.0 for Windows (IBM SPSS Inc., Chicago, IL, USA) was used to process the data of the study. Before starting the study, dental ages were calculated by 1 researcher who was intra-calibrated. To determine the difference between chronological age and estimated dental age by the Haavikko's method, variance analysis repeated in factorial design (ANOVA) was performed. TUKEY test was used for multiple comparisons. $p < 0.05$ was considered statistically significant.

RESULTS

ICC value for the intra-observer agreements was found to be 0.95. The value was considered to be high and reliable.

The distribution of 96 control (50 girls, 46 boys), 96 hypodontia (50 girls, 46 boys) and 96 oligodontia (50 girls, 46 boys) individuals according to age and gender are presented in Table 1. The chronological age of children ranged from 6 to 15 years.

Evaluating the number of tooth agenesis between groups I, II and III, a statistically difference was found between the groups ($p < 0.05$). The number of tooth agenesis between the groups was found to be 0.0, 2.47 and 8.78, respectively (Table 2).

When the chronological ages average of the individuals in the groups were evaluated without gender discrimination, it was found in Groups I, II and III were 11.17, 11.17 and 11.25, respectively, and there was no statistically significant difference ($p > 0.05$). When the dental age determined by Haavikko's method was evaluated between the groups, there was no statistically significant difference between the groups I-II and II-III ($p > 0.05$). However, there was a statistically difference was found between groups I and III in the dental age determined by Haavikko's method

($p < 0.05$). When the difference between chronological age and dental age determined by Haavikko's method was examined, it was found that in Group I, II and III, dental age was 0.71, 1.17 and 1.88 years behind respectively chronological age and this difference was statistically significant ($p < 0.05$) (Table 3).

DISCUSSION

The aim of this study was to investigate tooth development according to chronological age in children with dental agenesis. Using the Haavikko method, tooth development in children with both oligodontia and hypodontia was significantly delayed in children with oligodontia compared to children without dental agenesis.

The limitation of this study is that the patient selection criteria were based only on the medical history of the individual and as a result, some undiagnosed systemic and syndromic conditions may have been missed. Future studies can be conducted by clarifying systemic and syndromic conditions through medical consultations.

Age estimation has been one of the useful methods to determine biological age in fields of

study such as archaeological and forensic medicine. Tooth development is thought to be a better indicator of chronological age than skeletal development in assessing the biological development of an individual.¹⁰ Since skeletal development is generally affected by environmental, nutritional or hormonal factors, it may not give consistent results with chronological age. However, tooth development is less affected by environmental, nutritional or hormonal factors than skeletal maturity indicators. From a forensic perspective, estimating the chronological age of an individual based on dental development is a more reliable approach to identifying missing and deceased children.^{8,18}

There are different clinical, morphologic and radiologic methods proposed to evaluate tooth development and estimate dental age. When determining the dental age of children, tooth emergence or mineralization stages observed on radiographs are taken into account. Since tooth emergence is affected by space deficiency, systemic and nutritional factors, it is considered to be less reliable than the radiographic method.¹⁹ In this study, the radiographic method was used because it is more reliable, simpler and more useful.²⁰

Table 1. The distributions of children in Group I, Group II and Group III by gender and age

		Age										Total (n) (%)
		6 (n)	7 (n)	8 (n)	9 (n)	10 (n)	11 (n)	12 (n)	13 (n)	14 (n)	15 (n)	
Group 1	Girl	1	1	6	4	4	7	7	13	6	1	50 (52.1)
	Boy	2	1	3	4	10	6	6	7	3	4	46 (47.9)
Group 2	Girl	1	1	6	4	4	7	7	13	6	1	50 (52.1)
	Boy	2	1	3	4	10	6	6	7	3	4	46 (47.9)
Group 3	Girl	1	1	5	5	4	7	7	13	6	1	50 (52.1)
	Boy	2	1	3	4	10	6	6	7	3	4	46 (47.9)

Table 2. The distributions of Group I, II and III by the number of tooth agenesis

	Group			P
	Group I	Group II	Group III	
Number of tooth agenesis	0.00±0 (a)	2.47±0.99 (b)	8.78±3 (c)	<0.001

*a, b, c common letters indicate statistical insignificance

Table 3. Comparison of chronological age and dental age estimated by Haavikko's method at Group I, II and III

	Group			p
	Group I	Group II	Group III	
Chronological age	11.17±2.28	11.17±2.28	11.25±2.2	0.959
Dental age by Haavikko's Method	10.47±2.44 (a)	9.99±2.1 (ab)	9.37±1.95 (b)	0.002
Difference	-0.71±0.89 (a)	-1.17±1.08 (b)	-1.88±1.09 (c)	<0.001

*a,b,c common letters indicate statistical insignificance. Difference= Chronological age-Dental age by Haavikko's Method

Several methods have been described to estimate tooth age using radiographs.^{5,16,21} Although Demirjian and Nolla's methods are frequently used due to their simple and practical use, their use in children with dental anomalies is controversial. Because when used without modification, it is thought that the dental age determined by these methods will be inaccurate in individuals with oligodontia since the total values will change in case of any missing teeth.^{5,21} In the Haavikko's method, which is recommended to be used in cases of tooth agenesis, the calcification degrees are created separately for each tooth and the average tooth age is calculated, so it is thought to be more appropriate to be applied in children with tooth agenesis.¹⁶ Maber et al.²² reported that Haavikko's method was more reliable than Demirjian and Nolla's methods in estimating tooth age in immature teeth. Uslenghi et al.¹⁰ used Haavikko's method in patients with dental agenesis. They stated that Haavikko's method is advantageous to use in patients with hypodontia and oligodontia because it calculates the average age for each tooth separately when estimating tooth age. Therefore, Haavikko's method, which is

also recommended for use in the Turkish population was used in this study.²³

All permanent tooth crowns, except third molars, start mineralization at the age of 6 years.²⁴ Therefore, children younger than 6 years of age were not included in this study. However, it is also known that mandibular second premolars sometimes start to develop later. In this study, radiographs were followed longitudinally and missing teeth were confirmed.

In the study, dental ages of children of similar chronological age were determined by Haavikko's method and the groups were compared and it was observed that tooth development was significantly delayed in children with oligodontia compared to the control group ($p < 0.05$). However, tooth development in the hypodontia group was similar to both oligodontia and control group ($p > 0.05$). When comparing similar studies determining tooth development using the Haavikko's method in individuals with dental agenesis, there were studies that estimate tooth age 0.57-1.51 years behind chronological age,^{9,10,12,14} as well as studies showing that there was no significant difference between chronological age and tooth age.^{11,13,15} When the

previous studies were examined, it was seen that they are actually compatible with this study. In this study, the average number of missing teeth in individuals with hypodontia was 2.47 ± 0.99 , while the average number of missing teeth in individuals with oligodontia was 8.78 ± 3 . When children with 1 or 2 missing teeth were examined, no significant difference was found between dental age and chronological age,^{11,13,15} whereas significant differences were observed in studies with a higher number of missing teeth. In addition, in these studies, a correlation was found between the severity of dental agenesis and the magnitude of the delay in tooth development.^{9,10,12,14} When the difference between chronological age and dental age was evaluated, it was determined that dental age was 0.71, 1.17 and 1.88 years behind the chronological age in Groups I, II and III, respectively. Although it was determined that the dental age determined by the Haavikko's method was calculated further behind the chronological age, it was observed that this delay was related to the severity of dental agenesis.

Although these studies were similar to the present study in terms of methodology and patient groups, the fact that dental agenesis was not grouped within itself suggests that the results may differ from the present study. In addition, it should not be ignored that the difference between the studies may be related to geographical differences, method accuracy, sample size, sampling age, statistical approach and individual biological variability of development. In this study, individuals with dental agenesis were evaluated separately as hypodontia and oligodontia and their tooth development was determined. It is believed to contribute to the literature in this respect.

CONCLUSIONS

In this study, delayed tooth development was observed in children with oligodontia compared to

children without tooth agenesis. This delay compared to chronological age in children with tooth agenesis is one of the important issues that should be taken into consideration when planning pedodontic and orthodontic treatment. It is also important in terms of guiding identification in forensic cases where identification is required.

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Declarations

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