ORİJİNAL ARAŞTIRMA ORIGINAL RESEARCH

DOI: 10.5336/dentalsci.2022-90860

Assessment of Dental Development in Children with Supernumerary Teeth: Case-Control Study

Sürnümerer Diş Gözlenen Çocuklarda Diş Gelişiminin Değerlendirilmesi: Olgu Kontrol Araştırması

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ABSTRACT Objective: The term supernumerary tooth is one of the important dental anomalies affecting children and is used to describe excess teeth in the dental arch. Knowledge of changes in tooth development accompanying supernumerary teeth provides information about both orthodontic problems and changes in bone and teeth. This study aims to evaluate the relationship between the presence of supernumerary teeth and dental development in children and to raise awareness about the conditions associated with the presence of supernumerary teeth. **Material and Methods:** 175 (114 males and 61 females) children with supernumerary teeth were examined and compared to 175 normal control subjects matched for sex and age. Dental development was evaluated from panoramic radiographs using the dental age estimation method of Demirjian et al. Data were statistically analyzed using the Shapiro-Wilk test. **Results:** Significant differences were found in the mean of dental age and chronological age difference between case controls and children with supernumerary teeth (0.4±0.7 and 0.8±0.7 years, respectively). The mean differences between dental age and chronological age in hyperdontic males and females were 0.77±0.7 years and 0.96±0.7 years, respectively, and the results of the controls were 0.39±0.7 for males and 0.47±0.8 years for females. The differences between the hyperdontic and control groups were significant for both genders (p<0.001). **Conclusion:** Children with supernumerary teeth appear to have advanced dental development compared to children with normal dentition. The presence of supernumerary teeth in children is a condition that affects dental development.

Keywords: Demirjian method; tooth; developmental biology; supernumerary

ÖZET Amaç: Sürnümerer diş terimi, her iki dental arkta fazla dişleri tanımlamak için kullanılır ve çocukları etkileyen en önemli diş gelişim anomalilerinden biri olarak kabul edilir. Sürnümerer dişlere eşlik eden birçok değişiklik söz konusudur ve bu dişlere eşlik eden dental gelişimdeki değişikliklerin bilinmesi, hem ortodontik problemler hem de kemik ve dişlerdeki değişiklikler hakkında bilgi verir. Bu nedenle çalışmanın amacı, sürnümerer diş varlığının çocuklarda dental gelişim ile ilişkisini değerlendirmek ve sürnümerer diş varlığının ilişkili olabileceği durumlar konusunda farkındalık sağlamaktır. **Gereç ve Yöntemler:** Sürnümerer dişleri olan 175 (114 erkek ve 61 kız) çocuktan oluşan bir grup incelendi. Bu çocuklar cinsiyet ve yaş açısından eşleştirilmiş 175 normal dentisyona sahip çocuklardan oluşan kontrol grubu ile karşılaştırıldı. Diş gelişimi, Demirjian ve ark.nın diş yaşı tahmin yöntemi kullanılarak, panoramik radyografilerden elde edilen verilerin gruplar arası karşılaştırılması ile değerlendirildi. Veriler, Shapiro-Wilk testi kullanılarak istatistiksel olarak analiz edildi. **Bulgular:** Vaka kontrolleri ve sürnümerer diş gözlenen çocuklar arasında diş yaşı ve kronolojik yaş farkının ortalamasında önemli farklılıklar bulundu (sırasıyla 0,4±0,7 ve 0,8±0,7 yıl). Hiperdontik kızlarda ve erkeklerde diş yaşı ve kronolojik yaş arasındaki ortalama farkı sırasıyla 0,96±0,7 yıl ve 0,77±0,7 yıl olarak bulundu. Vaka kontrollerinin sonuçları kızlarda 0,47±0,8 ve erkeklerde 0,39±0,7 idi. Hiperdontik ve vaka kontrol grupları arasındaki farklar, her iki cinsiyet için de anlamlı bulundu (p<0,001). **Sonuç:** Sürnümerer dişleri olan çocukların, normal çocuklara göre daha yüksek diş gelişimi oranlarına sahip olduğu gözlenmiştir. Çocuklarda sürnümerer diş varlığı dental gelişimi etkileyen bir durumdur.

Anahtar Kelimeler: Demirjian metodu; diş; gelişim biyolojisi; süpernümerer

Supernumerary teeth (ST), which are considered one of the important dental anomalies, is defined as any odontogenic structure or tooth that develops from a tooth germ exceeding the number of normal dental arches.[1] These teeth may be observed as an isolated finding or as part of syndromes or development disorders.[2] The prevalence of ST ranges from 0.1-3.8% in various populations. The most common form of

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Peer review under responsibility of Turkiye Klinikleri Journal of Dental Sciences.

Received: 25 Apr 2022 ***Received in revised form:*** 27 Oct 2022 ***Accepted:*** 21 Nov 2022 ***Available online:*** 23 Nov 2022

ST is mesiodens, which is a ST present between the 2 central incisors.[3]

The etiology of ST is unclear but several theories, including atavism theory, and dental lamina hyperactivity, have been assumed. Both environmental factors and genetics have been noted as reasons for their occurrence. ST may lead to many complications, such as malocclusion, dentigerous cyst formation, compromising esthetics, impingement on nerves leading to pain and/or paresthesia, prolonged retention of deciduous teeth, deviant root formation, and variance in the eruption pathway of permanent incisors.[2]

Although they may be symptomless, ST cause dental development alterations associated with orthodontic implications and changes in the bone and teeth.[4] A better understanding of tooth development in patients with ST is important both for age assessment in cases where birth data are incomplete or controversial for forensic reasons and for planning dental treatments.[5] As ST are developmental anomalies, they can influence dental development. Although dental development in hypodontic children has been reviewed in most studies, only a few studies investigated dental development in children with ST.[4]

Thus, this study aims to evaluate dental development in children with ST by calculating dental ages and comparing them with age- and sex-matched controls.

MATERIAL AND METHODS

Parental consent was obtained for each child included in this study, and ethical approval was obtained from the Ethics Committee of Zonguldak Bülent Ecevit University (date: December 12, 2015, no: 2015-146-30/12). The article was prepared in accordance with the principles of the Declaration of Helsinki. All children with ST between the ages of 3-15 who applied to Zonguldak Bülent Ecevit University, Faculty of Dentistry, Department of Pediatric Dentistry for 1 year period were included in the study. Patients with ST were determined according to the radiographs of children who appealed to the pediatric dentistry department and required panoramic radiographs for dental treatment planning. In most, the patients were appealed because of trauma, dental inspection, or caries-related pain. Patients with syndromes and developmental anomalies, in addition to those who were receiving orthodontic treatment, were excluded from the study.

Children's radiographs included the ST group that had at least one supernumerary tooth present. To eliminate the possible differences in terms of type and location of ST, only the patients who had maxillary mesiodens tooth or teeth were included in the present study as the ST group. For the same reason, patients who had other types of ST were excluded from the study. According to Anthonappa et al., a high level of dental education is required to define ST using panoramic radiographs.[6] Therefore, in the present study, the identification of ST was independently managed by 2 observers who had at least 10 years of experience in pediatric dentistry. Both observers agreed on all the ST cases.

For every patient with ST, a case-control that had a normal dentition was matched for gender and chronological age (CA) (matched to within±0.1 years) with the patient for whom a panoramic radiograph was taken. All children in the control group were healthy and had normal dentitions with no surgery or history of the disease, which may affect the development of permanent teeth. Panoramic radiographs of the children in the control group were taken for dental reasons. Inclusion criteria for radiographs evaluated in the study were that all teeth in the left mandibular segment were sufficiently visible to assess tooth development. Radiographs with low-quality images were not included in the study.

Among 9,722 children examined, 175 (61 females and 114 males) were identified to have mesiodens in a 1-year period. Data were collected to obtain information on patients' sex, age, date of panoramic radiography, and date of birth. The CA for each child was estimated by subtracting the date of birth of the child from the date of the panoramic radiograph. Tooth development was calculated from panoramic radiographs using Demirjian et al.'s dental age (DA) estimation method, which is grounded on the 7 left mandibular teeth development.[7] According to the

Demirjian method, the development of a tooth is split up into 8 stages. For each tooth, a biologically weighted score is assigned in accordance with its development, and the sum of the points is recorded. The sum of these points is then transformed to DA using the Demirjian tables.[5,7] Children's dental development was estimated twice by one of the authors, blinded to age and gender. A high-reliability coefficient (0.999, p=0.001) was obtained. Therefore, a potential inter-observer error was eliminated.

Because ST could be easily identifiable on panoramic radiography, it was not possible to blind DA evaluation to the presence of ST. The evaluation was made in a dark setting with the radiographic illuminator. In addition to calculating the difference between DA and CA (DA-CA), reliability analysis was performed with the intra-class coefficient of the measurements obtained in one month in a subset of 20 children.

DATA ANALYSIS

Descriptive parameters were denoted as mean±standard deviation. The Shapiro-Wilk test was then used to test all variables for normality. Data were analyzed with a 2-sided analysis of variance and t-tests. Logarithmic transformation was applied to variables that failed the normality test. After analysis of variance and t-tests, logistic regression was used to reduce the effect of the confounding factor (i.e., gender), and 95% confidence intervals were obtained.[8] A value of $p<0.05$ was considered statistically significant. Statistical analyses of the data were conducted using EpiInfo 7.1.5 [Centers for Disease Control and Prevention (CDC), Atlanta, USA].

TABLE 1: Descriptive data for children with ST and the control groups.

Groups	Gender	C-AGE (mean±SD)	D-AGE (mean±SD)
Children with ST	Females	9.73±2.85	10.70±2.94
	Males	9.56±2.60	10.34±2.59
Case controls	Females	9.58±2.92	10.05±2.86
	Males	9.61±2.67	10.01±2.55

ST: Supernumerary teeth; SD: Standard deviation.

RESULTS

According to the result of the reliability analysis, the study yielded a high-reliability coefficient (0.999, p=0.001). Descriptive data for all children included in this study are shown in Table 1. The study group was composed of 175 (114 males and 61 females) children with a mean CA of 9.56±2.60 and 9.73±2.85 years, respectively. DA was directly comparable as each case-control child was matched with a child in the study group within 0.1 years of CA.

Table 2 demonstrates the mean differences in DA-CA between the case controls and patients with ST. A positive value for DA-CA indicates increased dental development compared with the standards of Demirjian et al.[7] Significant differences were found in the mean DA-CA between the case controls and children with ST (0.4±0.7 and 0.8±0.7 years, respectively). The DA-CA of the children with ST was numerically greater than that of the controls, and this result was found statistically significant ($p<0.001$). Figure 1 shows a panoramic radiograph from each group.

TABLE 2: Mean differences between the dental and chronological ages (DA-CA) in groups.

Group	n	Mean (DA-CA)	SD	p value
ST group	175	0.8446	0.73458	<0.001
Control group	175	0.4253	0.77208	
ST group-females	61	0.9677	0.78392	<0.001
Control group-females	61	0.4754	0.85493	
ST group-males	114	0.7787	0.70145	<0.001
Control group-males	114	0.3984	0.72646	

DA-CA: Dental age-chronological age; SD: Standard deviation; ST: Supernumerary teeth.

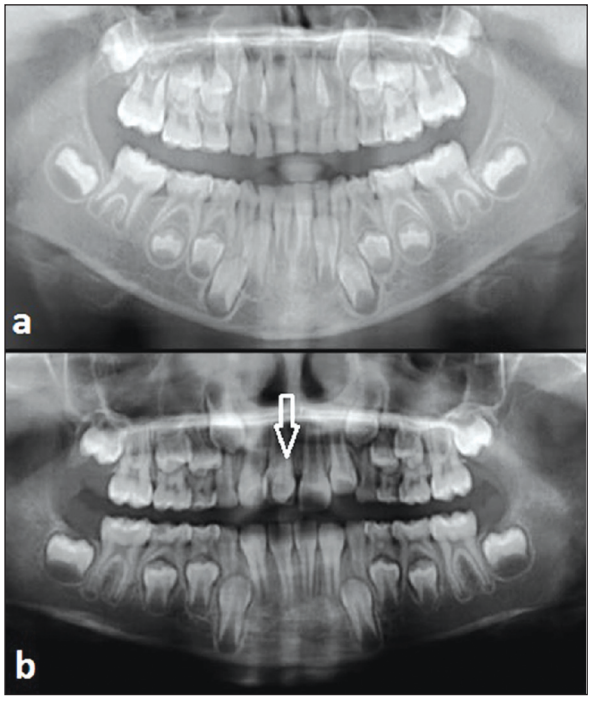

FIGURE 1: Examples of panoramic radiographs from each group. **(a)** An individual in the control group (CA=7, DA=7.4), **(b)** An individual in the ST group (CA=7.1, DA=8.4; white arrow shows the ST in the radiograph).
CA: Chronological age; DA: Dental age; ST: Supernumerary teeth.

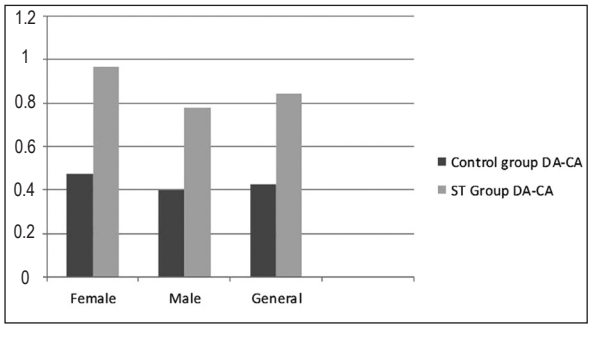

FIGURE 2: Mean differences between the dental and chronological ages (DA-CA) in females with ST, males with ST, and all children with ST compared with the controls.
DA-CA: Dental age-chronological age; ST: Supernumerary teeth.

Males and females with ST (Table 2) respectively showed that the mean DA-CA was greater than those of the controls (p<0.001). Figure 2 compares the mean DA-CA among males with ST, females with ST, and all patients with ST with the controls. Table 3 shows that the group difference variable is a statistically significant predictor of the DA-CA variable (p=0.001) when taking gender into account.

TABLE 3: Mean differences in the dental and chronological ages (DA-CA) predictors according to logistic regression and adjusted for gender.

	B (CI 95%)	t	p value
Constant	0.51 (0.35-0.66)	6.47	0.0001
Group	0.41 (0.26-0.57)	5.21	0.0001
Gender	-0.13 (-0.29-0.03)	-1.57	0.11

DA-CA: Dental age-chronological age; CI: Confidence interval.

DISCUSSION

ST are one of the commonly reported anomalies that affect the primary and permanent dentition in children. These teeth can be observable in the oral cavity, or they may be undetectable unless they cause complications.[3] Studies on these teeth are commonly related to prevalence and their characteristics, but their effect on dental development has not been adequately evaluated.[9] Only one study was found that investigated dental development in children with ST.[4] Kan et al. assessed dental development using the Demirjian method in 115 (63 females and 52 males) children with hypodontia and 61 (22 females and 39 males) children with ST.[4] They reported no significant differences between children with the case controls and ST. In comparing the DA and CA of patients with ST with those of the control group in our study, it was found that the DA-CA value in patients with ST was higher than the control group and this result was statistically significant. Kan et al. assessed 61 children with ST, whereas we performed the study on 175 children with ST.[4] We believe that this greater number of subjects studied makes our results more robust.

ST can be classified according to their location, shape, and morphology. They can occur in any region of the maxilla and mandible and in various forms. According to the ST position, it is classified as mesiodens if it is between the maxillary central incisors, as paramolar if it is in the buccal or palatal of one of the maxillary molars or in the buccal interproximal space of the 2nd and 3rd molars, and as distomolar if it is distal to the 3rd molar.[2] Mesiodens is the most frequently observed ST, followed by premolars and 4th molars.[10] Thus, study groups were created for the patients who have mesiodens in the present study. This

grouping aimed to eliminate a probable discrepancy in data that could occur because of the location of ST.

ST can be related to various developmental disorders and syndromes, such as Fabry-Anderson syndrome, Gardner syndrome, cleidocranial dysplasia, orofaciodigital syndrome, and cleidocranial dysplasia, cleft lip and palate, Ehlers-Danlos syndrome, facial fissures, and Nance-Horan syndrome.[11] Evaluation of dental development provides important evidence of diseases and syndromes that can influence teeth at any stage during formation.[12] Case selection and examination criteria were used carefully and scrupulously, children with any disorders or syndromes were excluded from the present study.

It is known that ST is seen more frequently in males than females at a ratio of 2:1.[11] In the present study, ST were approximately observed twice as many in males than in females (114 males and 61 females), consistent with other studies. DA-CA differences were significantly higher in children with ST than in the control group in both females and males. Kan et al. found that children with ST showed no differences from the control group in terms of dental development, although they discovered similar results between males and females.[4] When the effect of gender discrepancy on the DA-CA differences was assessed, gender was found to be not related to age differences, but the presence of ST appeared to have an effect according to our study. Moreover, logistic regression analysis confirmed the significant relationship between DA-CA differences and groups. Dental development was affected by ST regardless of gender. In dental development assessment studies, no significant differences were found in DA in terms of gender groups.[13] These findings are consequent with this study's results.

Various methods have been described to determine tooth development.[7,14] The Demirjian method, has been favored extensively by various authors for years.[7] The reasons why this method is widely preferred are that the maturity scoring system is universal, the method is practical and simple, and it includes clearly defined changes.[15-17] Although many studies have used this method for DA assessment, some authors suggested that due to ethnic differences, it should be adapted to different populations and individual assessment parameters should be included.[18] However, in this study Demirjian et al.'s method was not used to derive an exact DA for this population, but was used only for the assessment of tooth development as a way to determine the DA of children with ST.[7,19] The differences between DA and CA were evaluated with different characteristics in the same population. This method was used for an accurate comparison with the control group of the same age and gender as the study group.[15] The Demirjian method provides a useful set of comparative standards for studies of tooth development, even in different population groups where it is used.[4] For example, this method has been used effectively in many studies to assess dental development in preterm children and those with amelogenesis imperfecta, cleidocranial dysplasia and X-linked hypophosphatemia, cerebral palsy, mental retardation, acute lymphoblastic leukemia, dental agenesis, and syndrome of Crouzon and Apert.[12,17,20-25] Moreover, Omer et al. applied this method to evaluate the determination of a convenient time for unerupted ST surgical removal.[26]

The development of teeth is an important determinant for anthropology, forensic science, and dentistry. DA estimation proves to be useful during an individual's growing period, and it is of particular interest to pedodontists, orthodontists, and surgeons for treatment planning and exact diagnosis.[12,27] Dental development is also important in children with ST because it is the cause of some complications. In these cases, the removal of ST resolves complications and prevents further undesirable complications.[2,3] However, the treatment of ST is controversial among authors, particularly with regard to the timing of its surgical removal, and includes a wide variety of opinions.[28] However, the determination of a convenient time for the ST surgical removal is important in these cases to avoid further complications that may occur in adjacent teeth depending on root development stages.[26] Nevertheless, after the surgical removal of ST, patients' age is the most influential factor for the normal eruption of adjacent teeth.[28] In addition, tooth development in children with ST is important for orthodontists. Estimates of the child's dental develop-

ment can help determine the best time to start orthodontic treatment, determine treatment stages, ensure tooth movement, and evaluate the prognosis of remaining teeth.[29,30]

CONCLUSION

Even though ST treatment involves controversies and varied opinions among authors, dental development remains the main factor in treatment planning. Children with ST exhibit advanced dental development. Therefore, clinicians should be careful with treatment planning to consider that children with ST are more advanced in dental development than children with normal dentition.

Source of Finance

During this study, no financial or spiritual support was received neither from any pharmaceutical company that has a direct connection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Ebru Hazar Bodrumlu;* ***Design:*** *Ebru Hazar Bodrumlu, Sadık Toprak;* ***Control/Supervision:*** *Sadık Toprak;* ***Data Collection and/or Processing:*** *Ebru Hazar Bodrumlu, Levent Demiriz;* ***Analysis and/or Interpretation:*** *Ebru Hazar Bodrumlu, Levent Demiriz;* ***Literature Review:*** *Ebru Hazar Bodrumlu;* ***Writing the Article:*** *Ebru Hazar Bodrumlu;* ***Critical Review:*** *Sadık Toprak;* ***References and Fundings:*** *Ebru Hazar Bodrumlu, Sadık Toprak, Levent Demiriz.*

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