E. Hazar Bodrumlu*, L. Demiriz*, S. Toprak**

* Assistant Professor, PhD, Bülent Ecevit University, Faculty of Dentistry, Department of Pediatric Dentistry, Zonguldak, Turkey
** Associate Professor, PhD, Bülent Ecevit University, Faculty of Medicine, Department of Forensic Medicine, Zonguldak, Turkey

email: hazarebru@yahoo.com

DOI: 10.23804/ejpd.2018.19.02.11

Relationship between Severe Early Childhood Caries and dental development

ABSTRACT

Aim *Severe early childhood caries (sECC) is a public health problem that continues to affect infants and preschool children worldwide. Knowledge of the changes in dental development is important for paediatric dentists in order to determine a treatment plan. The aim of this study was to investigate dental development in children with sECC, compared to age and gender-matched controls, by calculating the dental age (DA).*

Materials and methods *A total of 300 children (144 females, 156 males) with sECC aged 5 years were studied and compared with 300 control subjects (caries-free), case-matched for gender and age. The dental development was assessed using the DA estimation method of Demirjian et al. [1973], and data were statistically analysed using a 2-sided t test and chi-squared test.*

Results *The mean differences between the DA and chronological age (CA) in the sECC females and males were 0.67±0.6 years and 0.98±0.6 years, respectively, whereas the results of the case controls were 1.44±0.8 years for the females and 1.57±0.6 years for the males. The differences between the sECC and case control groups were significant for both genders (p<0.001).*

Conclusion *Children with severe early childhood caries have lower rates of dental development when compared to normal children.*

Keywords *Dental age, Dental development, Severe early childhood caries.*

Introduction

Early childhood caries (ECC) is a severe form of dental caries, which is described as the presence of one or more decayed (noncavitated or cavitated) or filled tooth surfaces and/or missing teeth (due to caries), in a child under the age of six years old. For children aged three to five years old, one or more decayed, missing, or filled teeth, or a decayed, missing, or filled score of >4 (three years old), >5 (four years old), or >6 (five years old) teeth constitutes severe early childhood caries (sECC) [AAPD, 2016a].

The prevalence of ECC ranges from 3% to 74% worldwide, and although ECC is the most commonly observed chronic disease in children, it remains largely untreated under the age of three in many countries [AAPD, 2016a]. ECC begins in the upper primary incisors along the margin of the gingiva, and the progress of caries can lead to the complete destruction of the crown [Kawashita et al., 2011]. Not only does sECC affect teeth, the outcomes of this disease may also lead to more health and health-related problems, including restricted activity, a reduced quality of life, increased treatment time and costs, loss of school days, reduced ability to learn, emergency room visits, and delayed growth and development [AAPD, 2016b]. Children with sECC have been observed to be underdeveloped in both height and weight [Vania et al., 2011]. Growth is a significant indicator; therefore, it is crucial that the World Health Organization (WHO) recognises it as the best single measure for delineating the nutritional condition and health of children. In many studies, the relationship between the body mass index (BMI) and dental caries in children has been evaluated [Vania et al., 2011], but there are no studies about dental development in children with ECC. Therefore, the aim of the present study was to investigate dental development in children with sECC, compared to age and gender-matched controls, by calculating the dental age (DA).

Methods

Ethical approval for the present investigation was obtained from the Ethics Committee of the Bulent Ecevit University (Protocol number: 2016-03-10-02), and parental consent was obtained for each child for the present study. Any child aged 5 years old with sECC that attended our clinic (Bulent Ecevit University Faculty of Dentistry Department of Pediatric Dentistry in Zonguldak, Turkey) during a one year period was eligible for this research. For every child with sECC, a case control that was caries free was selected, and matched for gender and chronological age (CA) (matched to within ±0.1 year). The close matching of the CA of a sECC subject with its case control allowed

a direct comparison of the DAs. The patients included in the present study were referred to our clinic due to trauma, dental visit, or caries-related pain, and the panoramic radiographs which were taken for the evaluation of the patient complaints were evaluated. No panoramic radiographs were taken specifically for the study purpose. The criteria for the acceptance of the panoramic radiographs for use in this study were that all of the teeth in the mandibular left segment of the mouth were visible, and the images of the teeth were sufficiently clear to assess the dental development. Radiographs with poor quality images were excluded from this research.

All of the children were evaluated to expose any contributing medical conditions. Those patients undergoing orthodontic treatment, and those with developmental anomalies and syndromes were excluded from this study. Additionally, children having primary teeth with apical periodontitis in the mandibular left segment were excluded. In case of severe apical periodontitis, the inflammation can affect the development of successional tooth germ resulting in the delay of the timing of its maturation. All children included were healthy, with no histories of disease or surgery which could influence the development of their teeth. To rule out any geographical variations, only those children who were residents of Zonguldak city were included. A single trained examiner performed the comprehensive clinical examinations. The intraoral hard tissue examination included recording the caries with regard to the decayed, missing, or filled surfaces (defs) index [Klein et al., 1938], using a sterilised mouth mirror and periodontal probe. The children were then divided into two groups: Group 1, containing 300 children with defs=0, and Group 2, with 300 children affected with sECC according to the American Academy of Pediatric Dentistry (AAPD) definition [AAPD, 2016a].

The following data were collected for each patient: sex, age, date of birth, and date of panoramic radiograph. The CA for each child was calculated by subtracting the date of the panoramic radiograph from the child's date of birth, after having converted it to a decimal age. The dental development was estimated from the panoramic radiographs, using the DA estimation method of Demirjian et al. [1973], which is based on the development of the seven left permanent mandibular teeth. The dental development of the children was estimated by one of the authors twice, while they were blinded to subject's age and sex, and a high reliability coefficient (0.999; p=0.001) was obtained. In this way, any potential interobserver error was eliminated.

Since sECC can be readily identifiable in a panoramic radiograph, a blinding of the DA assessment to the presence of sECC was not possible. The estimation was carried out in a darkened room with a radiographic illuminator, and the difference between the DA and CA (DA-CA) was calculated and recorded. A reliability analysis was conducted, with the intraclass coefficient of the measurements obtained in one month in a subset of 20 subjects.

	Gender	C-AGE (mean± SD)	D-AGE (mean± SD)
Children with sECC	Females	5.0684±0.3892	5.7458±0.7936
	Males	5.0656±0.4155	6.0485±0.7144
Case controls	Females	5.1512±0.3808	6.6007±0.7427
	Males	5.0967±0.3729	6.6673±0.6943

TABLE 1

Group	N	Mean (DA-CA)	Std. Deviation	p
sECC group	300	0.8364	0.6716	
Control group	300	1.5125	0.6479	0.0001
sECC group-Females	144	0.6778	0.6714	
Control group-Females	144	1.4495	0.6844	0.001
sECC group-Males	156	0.9828	0.6398	
Control group-Males	156	1.5706	0.6087	0.001

TABLE 2

Data analysis

The descriptive parameters were shown as the mean±SD. We analysed the data using a 2-sided t test and chi-squared test. In addition, we obtained the 95% confidence intervals using a linear regression analysis in the models that controlled gender. We considered a p value <0.05 to be statistically significant, and the statistical analyses of the data were carried out using Epi Info 7.1.5 (Licenced to CDC).

Results

As a result of the reliability analysis, a high reliability coefficient (0.999; p=0.001) was detected, and Table 1 shows the descriptive data for all of the children in this study. The study group consisted of 300 children (144 females, 156 males) who had mean CAs of 5.0684±0.3892 years and 5.0656±0.4155 years, respectively. Every case control child was matched to within 0.1 year of the CA of a child in the study group, so that the DAs could be compared directly. There were significant differences in mean DA-CAs between the children with sECC and the case controls (Table 2), and the DA-CA of the children with sECC was lower when compared to the DA-CA in the control group. A sample panoramic radiograph for each group is shown in Figure 1.

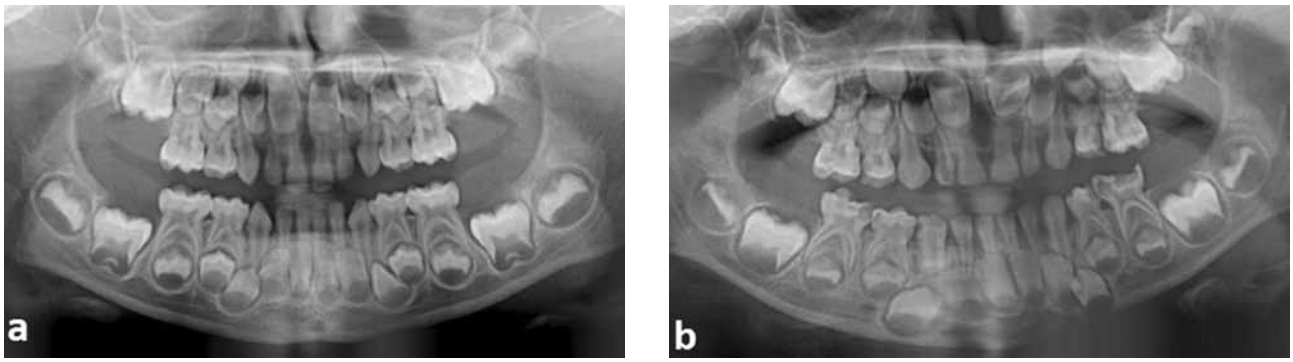


FIG. 1

The females and males with sECC (Table 2) showed mean DA-CA differences that were lower than the case controls. Figure 2 compares the mean DA-CAs between the females with sECC, males with sECC, and all of the children with sECC in relation to the case controls. As shown in Table 3, the gender-adjusted sECC present in early childhood is an independent predictor of the future difference between the DA and CA.

Discussion

ECC is the most common childhood disease that continues to affect children worldwide. When tooth decay remains untreated in children with ECC, it can lead to significant impact on general health, quality of life, and development. Untreated caries affect growth and development in a variety of ways; for example, the pain and discomfort associated with untreated caries can result in reduced food intake and malnutrition [Benzian et al., 2011]. In addition, a reduced quality of life can include decreased sleep, restricted activity, and concentration deficits, which may be due to the inhibition of the release of growth hormone (GH). Moreover, the increased secretion of glucocorticoids, commonly linked to body reactions to stress and pain, can lead to the inhibition of the release of GH [Vania et al., 2011; Jenni et al., 2007]. The development of sECC could also be associated with chronic inflammation from the odontogenic infections which alter the metabolic pathways, resulting in increased cytokine production. Cytokines inhibit the erythropoiesis in bone marrow [Benzian et al., 2011; Means, 2003]. In addition, it has been suggested that sECC may be a risk factor for iron deficiency anemia, which affects development [Clarke et al., 2006].

Although there have been studies investigating the effects of ECC on general health, there have been no studies evaluating the effects of ECC on dental development. To the best of our knowledge, the present study is the first evaluation of the effects of ECC on dental development. In our study, when we

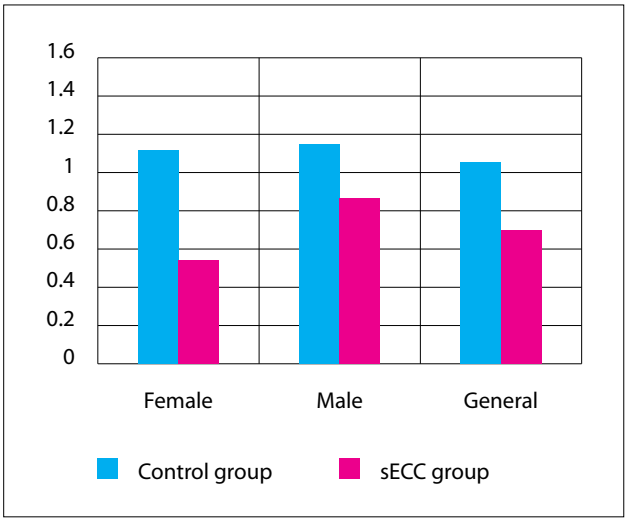


FIG. 2

Variable	Significance	exp(B)	95% CI
Group (sECC vs Control)	0.000	0.67	0.57-0.78
The sample comprised 600 subjects (male 312, female 288). Vs: versus			

TABLE 3

compared the DA and CA of the children with sECC to the children in the control group, we found that the difference (DA-CA) in the children with sECC was significantly lower than in the control group. This result may be due to the malnutrition caused by sECC. The extension of the lesions and pain causes changes in the diet, which tend to reduce the caloric intake [Jenni et al., 2007; Clarke et al., 2006]. Most of the studies that have evaluated the nutritional status of children with sECC have reported that untreated caries was responsible for the age-adjusted weight differences observed, and a significant number of children with sECC were underweight due to the chewing alterations

related to the dental pain and missing teeth. According to the WHO, malnutrition can rapidly affect children aged three to six years old [Vania et al., 2011; Clarke et al., 2006]. Moreover, children with sECC are also deficient in vitamins, including vitamin D, which regulates calcium levels and plays an important role in craniofacial development. Therefore a deficiency in vitamin D may cause developmental defects [Scroth et al., 2013].

The effects of malnutrition on oral health have been assessed in a variety of studies. For example, Gaur and Kumar [2012] assessed the influence of undernutrition on the emergence of primary teeth. They reported that undernourished children have a greater risk for the delayed emergence of teeth [Gaur and Kumar, 2012]. In a study which evaluated Haitian children, early childhood malnutrition was reported to delay both the exfoliation of the primary teeth and the eruption of the permanent teeth [Poster et al., 2008]. Heinrich-Weltzien et al. [2013] evaluated the relationship between the number of permanent teeth and malnutrition in Filipino children, and reported a delay in permanent tooth eruption in stunted and thin children. However, Camerierre and et al. [2007] assessed the relationship between nutrition and the timing of the tooth mineralisation using the Demirjian method in 287 Peruvian schoolchildren (aged 9.5–16.5 years old), and they reported that malnutrition did not affect tooth development. Elamin and Liversidge [2013] evaluated the impact of malnutrition on the timing of tooth formation, and reported that the impact was negligible. These different results may be explained by the fact that in these studies only those individuals who had nutritional deficiencies were evaluated. Actually, ECC affects development in many ways, not only malnutrition [Vania et al., 2011; Benzian et al., 2011; Jenni et al., 2007]. Moreover, the age groups in these studies were older than early childhood.

Dental development provides important evidence of disturbances during odontogenesis and other factors, such as syndromes and diseases, which can affect teeth at any phase prior to complete formation and calcification [Diz et al., 2011]. Detailed examination criteria and case selections were used in the present study, and those children with any associated syndromes or disorders were excluded.

In the dental development assessment studies, there were no significant differences in the DAs with regard to the gender groups [Avşar et al., 2013; Şen Tunç et al., 2013], which is consistent with our results. Different methods have been defined to identify dental development [Demirjian et al., 1973; Haaviko, 1970]; for example, the method of Demirjian et al. [1973], which was used in the present study, has been widely used by various authors over the past three decades. The reasons for the common acceptance of this method include the fact that the maturity scoring system is universal in its application, it is simple and practical, and it is comprised of clearly defined changes which do not require speculative estimation. In many studies, this method has been used for DA assessment, and the authors have reported that it should be adapted to different populations. Individual assessment parameters also need to be included due to ethnic differences [Baghdadi and Pani, 2012]. However, in this study, the Demirjian et al. [1973] method was used for the dental development assessment only as a way to determine the DA of the children with sECC. It was not used to acquire a precise DA for this specific population. The differences between the DA and CA were evaluated in the same population with different characteristics, and were used for an accurate comparison with the control group, which consisted of the same age and gender ranges as the study group. Although the method of Demirjian et al. [1973] was applied to a different population group, it provides a useful comparative set of standards for studies on dental development. This method has been used effectively in several studies to compare the rates of dental development in children with birth prematurity [Seow, 1996], amelogenesis imperfecta [Seow, 1995], X-linked hypophosphatemia and cleidocranial dysplasia [Seow and Hertzberg, 1995; Seow et al., 1995], molar incisor hypomineralisation [Şen Tunç et al., 2013], cerebral palsy, mental retardation [Diz et al., 2011], acute lymphoblastic leukemia [Vasconcelos et al., 2009], dental agenesis [Ruiz-Mealin et al., 2012], and Crouzon and Apert syndrome[Reitsma et al, 2014]. In addition, Kumar et al. [2013] used the dental stages of this method to determine the DA and compare it with the CA in underweight children.

Dental development is a particularly important determinant for dentistry to formulate a treatment plan, and is an additional source of information in the fields of orthopaedics, forensics, haematology, paediatrics, and anthropology. An estimation of the DA has been proven to be useful along the period of growth of an individual, and it is of particular interest to pediatric dentistry, orthodontics, and maxillofacial surgery for the exact diagnosis and treatment planning [Diz et al., 2011]. An estimation of the dental development of a child can help to determine the most convenient time to begin orthodontic treatment, the treatment steps, the assurance of dental movement, and to evaluate the prognosis of the remaining teeth [Coutinho et al., 1993].

The present study does have some limitations because the caries rates were not assessed, and all of the children with sECC had multiple cavitated carious lesions. The commonly reported symptoms included: eating sparingly or not finishing meals, pain, problems eating certain foods, and poor sleep. The study design did not permit us to distinguish between the cause and effect, and some factors were difficult to control.

Additionally, the children in our study were matched by age and sex between the control and study groups, but we were unable to match them by socioeconomic status. The majority of the children came from middle income families and lived in the same region of the country in both the study and control groups. Despite these limitations, the large sample size ensured sufficient statistical power, allowing greater confidence in our findings.

Conclusion

This is the first study showing a significant association between ECC and dental development. The children with ECC exhibited lesser dental development when compared to the children without caries. Clinicians should take care in their treatment planning by considering the fact that these children are further ahead in their dental development when compared to children with normal dentition. Overall, the importance of the timely intervention and management of caries should not be ignored in children. Comprehensive dental care programmes must be organized to improve the oral health of children, and further studies are necessary to confirm the results of this research.

References

› American Academy of Pediatric Dentistry. Policy on early childhood caries (ECC): classifications, consequences, and preventive strategies. Pediatr Dent 2016a ;38(6):52-54.
› American Academy of Pediatric Dentistry. Policy on early childhood caries (ECC): unique challenges and treatment option. Pediatr Dent 2016b ;38(6): 55-56.
› Avsar A, Topaloglu B, Hazar-Bodrumlu E. Association of passive smoking with dental development in young children. Eur J Paediatr Dent 2013; 14(3):215-218.
› Baghdadi ZD, Pani SC. Accuracy of population specific Demirjian curves in the estimation of dental age of Saudi children. Int J Paediatr Dent 2012; 22(2):125-131.
› Benzian H, Monse B, Heinrich-Weltzien R, Hobdell M, Mulder J, Van Palenstein Helderman W. Untreated severe dental decay: a neglected determinant of low Body Mass Index in 12-year-old Filipino children. BMC Public Health 2011 ;11:1.
› Cameriere R, Flores-Mir C, Mauricio F, Ferrante L. Effects of nutrition on timing of mineralization in teeth in a Peruvian sample by the Cameriere and Demirjian methods. Ann Hum Biol 2007; 34(5):547-556.
› Clarke M, Locker D, Berall G, Pencharz P, Kenny DJ, Judd P. Malnourishment in a population of young children with severe early childhood caries. Pediatr Dent 2006; 28(3):254-259.
› Coutinho S, Buschang PH, Miranda F. Relationships between mandibular canine calcification stages and skeletal maturity. Am J Orthod Dentofacial Orthop 1993; 104(3):262-268.
› Demirjian A, Goldstein H, Tanner JM. A new system of dental age assessment. Hum Biol 1973; 45(2):211-227.
› Diz P, Limeres J, Salgado A, Tomás I, Delgado LF, Vázquez E, Feijoo JF. Correlation between dental maturation and chronological age in patients with cerebral palsy, mental retardation, and Down syndrome. Res Dev Disabil 2011; 32(2):808-817.
› Elamin F, Liversidge HM. Malnutrition has no effect on the timing of human tooth formation. PLoS One 2013; 8(8):e72274.
› Gaur R, Kumar P. Effect of undernutrition on deciduous tooth emergence among Rajput children of Shimla District of Himachal Pradesh, India. Am J Phys Anthropol 2012; 148:54-61.
› Haavikko K. The formation and the alveolar and clinical eruption of the permanent teeth. An orthopantomographic study. Suom Hammaslaak Toim 1970; 66(3):103-170.
› Heinrich-Weltzien R, Zorn C, Monse B, Kromeyer-Hauschild K. Relationship between malnutrition and the number of permanent teeth in Filipino 10-to 13-year-olds. Biomed Res Int 2013;2013:205950.
› Jenni OG, Molinari L, Caflisch JA, Largo RH. Sleep duration from ages 1 to 10 years: variability and stability in comparison with growth. Pediatrics 2007; 120(4):e769-e76.
› Kawashita Y, Kitamura M, Saito T. Early childhood caries. Int J Dent 2011; 2011:725320.
› Klein H, Palmer CE, Knutson JW. Studies on dental caries: I. Dental status and dental needs of elementary school children. Public Health Reports (1896-1970) 1938; 53(19):751-765.
› Kumar V, Venkataraghavan K, Krishnan R, Patil K, Munoli K, Karthik S. The relationship between dental age, bone age and chronological age in underweight children. J Pharm Bioallied Sci 2013; 5(5):73.
› Means Jr RT. Recent developments in the anemia of chronic disease. Curr Hematol Rep 2003; 2(2):116-121.
› Psoter W, Gebrian B, Prophete S, Reid B, Katz R. Effect of early childhood malnutrition on tooth eruption in Haitian adolescents. Community Dent Oral Epidemiol 2008; 36(2):179-189.
› Reitsma JH, Balk-Leurs IH, Ongkosuwito EM, Wattel E, Prahl-Andersen B. Dental maturation in children with the syndrome of crouzon and apert. Cleft Palate Craniofac J 2014; 51(6):639-644.
› Ruiz-Mealin EV, Parekh S, Jones SP, Moles DR, Gill DS. Radiographic study of delayed tooth development in patients with dental agenesis. Am J Orthod Dentofacial Orthop 2012; 141(3):307-314.
› Şen Tunc E, T. Ulusoy A, Bayrak S, Cankaya S. Dental development in children with severe molar-incisor hypomineralization in Samsun, Turkey. J Oral Sci 2013; 55(3):203-207.
› Schroth RJ, Levi JA, Sellers EA, Friel J, Kliewer E, Moffatt ME. Vitamin D status of children with severe early childhood caries: a case–control study. BMC Pediatr 2013; 13(1):1.
› Seow W. Dental development in amelogenesis imperfecta: a controlled study. Pediatr Dent 1995;17(1):26-30.
› Seow WK. A study of the development of the permanent dentition in very low birthweight children. Pediatr Dent 1996; 18:379-384.
› Seow WK, Hertzberg FJ. Scientific Article Dental development and molar root length in children with cleidocranial dysplasia. Pediatr Dent 1995; 17(2):101-105.
› Seow WK, Needleman H, Holm I. Effect of familial hypophosphatemic rickets on dental development: a controlled, longitudinal study. Pediatr Dent 1995; 17(5): 346-350.
› Vania A, Parisella V, Capasso F, Di Tanna GL, Vestri A, Ferrari M, Polimeni A. Early childhood caries underweight or overweight, that is the question. Eur J Paediatr Dent 2011; 12(4):231-235.
› Vasconcelos NP, Caran EM, Lee ML, Lopes NN, Weiler RM. Dental maturity assessment in children with acute lymphoblastic leukemia after cancer therapy. Forensic Sci Int 2009; 184(1):10-14.