PHYSIOLOGICAL EFFECTS OF IMPACTED MESIODENS ON THE DEVELOPMENT OF ADJACENT TEETH
GÖMÜLÜ MEZİODENSLERİN KOMŞU DİŞLERİN GELİŞİMİ ÜZERİNDEKİ FİZYOLOJİK ETKİLERİ

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ABSTRACT

In the present retrospective study, it was aimed to analyze the physiological effects of impacted mesiodens on adjacent teeth with dental and chronological age determination in cone beam computed tomography (CBCT). In the study, 68 CBCT images were examined. Two groups were formed, including 34 individuals with mesiodens (mesiodens group) and 34 without mesiodens (control group). Dental age and chronological age were compared in both groups. Demirjian's method was utilized to determine the dental age. The position and location of mesiodens were categorized. Statistical analysis was performed with SPSS software version 18.0 (Chicago, IL, USA). Median diastema was seen in 16 cases (47.10%) in the mesiodens group. The mesiodens was most commonly impacted in the palatal (76.50%, n=26) and vertical (n= 19, 55.90%) position. There were significant differences between the incisor tooth development scores of the groups (p= 0.047 and p= 0.030, respectively). While the prevalence of H score of bilateral incisors in the control group (88.20% for both incisors) was higher than that of the mesiodens group (58.20% for both incisors), the G score was higher in the mesiodens group (20.60% and 23.50%) than in the control group (2.90% for both teeth). Mesiodens can delay root development of adjacent teeth. For this reason, extraction of these teeth may be considered in the early period to avoid affecting adjacent teeth and anatomical structures. It may also cause erroneous calculations in dental age determination. This situation should be taken into account in terms of forensic dentistry.

ÖZ

Bu retrospektif çalışmada, Konik Işınlı Bilgisayarlı Tomografide (KIBT) gömülü meziodenslerin komşu dişler üzerindeki fizyolojik etkilerinin dental ve kronolojik yaş tayini ile analiz edilmesi amaçlanmıştır. Çalışmada 68 KIBT görüntüsü incelendi. 34 meziodensi olan (meziodens grubu) ve 34 meziodensi olmayan birey (kontrol grubu) olmak üzere iki grup oluşturuldu. Diş yaşı ve kronolojik yaş her iki grupta karşılaştırıldı. Diş yaşını belirlemek için Demirjian yöntemi kullanıldı. Meziodenslerin pozisyonu ve konumu kategorize edildi. İstatistiksel analiz SPSS yazılımı sürüm 18.0 (Chicago, IL, ABD) ile yapıldı. Meziodens grubunda 16 (%47.10) olguda orta hatta diastema görüldü. Meziodens en sık palatinal konumda (%76.50, n=26) ve vertikal (n= 19, % 55.90) pozisyonda görüldü. Grupların kesici diş gelişim skorları arasında anlamlı fark vardı (sırasıyla p= 0.047 ve p= 0.030). Kontrol grubunda bilateral kesici dişlerin H skoru prevelansı (her iki kesici diş için %88.20) meziodens grubundan (her iki kesici diş için %58.20) daha yüksek iken, G skoru meziodens grubunda kontrol grubuna göre (%20.60 ve %23.50) daha yüksekti (Her iki diş için %2.90). Meziodens komşu dişlerin kök gelişimini geciktirebilir. Bu nedenle komşu dişlerin ve anatomik yapıların etkilenmemesi için erken dönemde bu dişlerin çekimi düşünülebilir. Diş yaşı tespitinde de hatalı hesaplamalara neden olabilir. Bu durum adli diş hekimliği açısından dikkate alınmalıdır.

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INTRODUCTION

Dental anomalies may appear as anomalies of shape, number, or size of teeth in general. Supernumerary teeth, one of the number anomalies, can be seen in both permanent and primary dentition. Although supernumerary teeth are not common formations, their incidence in the clinic may vary depending on many factors.[1] Considering the gender variable, the incidence of supernumerary teeth is higher in men than in women.[2,3] However, supernumerary teeth can be found in many quadrants of the jaws. It often accompanies the clinical findings of Down syndrome, Ellis-Van Creveld syndrome and Ehler Danlos syndrome.[4] They are seen between the central incisors and are specifically called mesiodens.

Mesiodens are the most common supernumerary teeth with a prevalence of 0.15-1.90% in the general population.[5] These teeth can be impacted or inverted.[1] Mesiodens are classified into two subgroups according to their shape and size. The first group includes mesiodenses of normal shape and size, while the second group includes mesiodenses of amorphous shape and size.[4] Although there are many theories about the etiology of mesiodens, there is no definite information about their formation. The most accepted view is that the lingual extensions of the dental bud, which is formed due to increased activity in the dental lamina cause mesiodens formation.[6,7] Only 25% of the mesiodens appear in the mouth. These teeth, which are more in the maxilla anterior, affect growth and development more than those in the posterior region and cause aesthetic-functional complications. Some of the complications caused by mesiodenses are eruption problems in permanent teeth, root malformations, crowding and diastema in anterior teeth.[8] Studies have shown that mesiodenses in vertical positions cause more delays in tooth eruption than in inverse positions.[9,10]

Age determination is a necessary examination in forensic dentistry, anthropology, forensic medicine, pediatrics, and orthopedics. It is important for the treatment planning of living individuals as well as forensic cases. Odontological data are important in forensic studies related to age determination. Teeth are frequently used in age determination as they are the hardest structures of the body, least damaged by external factors, and least affected by nutrition and systemic diseases. Dental age estimation by radiographic methods is non-invasive and take relatively less time compared to other methods.[11-13]

Mesiodens can be detected on any plain tooth radiograph that includes the premaxillary region. However, in two-dimensional radiographs, the superposition of mesiodens on adjacent structures may cause misinterpretation due to its disadvantages such as magnification and loss of clarity. Therefore, it is important to determine the three-dimensional (3D) location of the mesiodens in order to reach a definitive diagnosis and treatment plan. CBCT is preferred in maxillofacial imaging due to its advantages such as fast scanning time, image accuracy and reduced patient radiation dose compared to other three-dimensional imaging methods.[14]

The basis of radiological methods in dental age determination is based on determining the developmental stage of the teeth with the help of radiographs and determiningthe tooth age by comparing the data with the tooth development scales formulated by different researchers.[15] Among these researchers , the most used method of calculating tooth age is the method developed by Arto Demirjian.[16]

The developmental stages of 7 teeth in the mandible are evaluated in calculating tooth age with the Demirjian method.[17] This method has also been tested on people living in different regions and positive results have been obtained.[18-21]

In this study, we hypothesized that the presence of mesiodens does affect the development of adjacent maxillary central teeth.

The aim of this study is to precisely define the 3D position of the mesiodens using CBCT and examine its effects on the root development of adjacent teeth.

MATERIALS AND METHODS

The study protocol was carried out according to the principles described in the Declaration of Helsinki, including all changes and revisions. The Local Ethics Committee of Bolu Abant İzzet Baysal University was approved the study (protocol no:2021/144).

The images of the patients who had CBCT between 2018 and 2021 years in the Dento-maxillofacial Radiology Clinic were scanned retrospectively. The CBCT scans were obtained using an I-Cat imaging system(17-19 Model, Imaging Sciences International, Hatfield, PA, USA) at 120 kVp and 15 mA, with a voxel size of 0.3 mm and an exposure time of 4.8 sec. Images were investigated using i-CAT vision Q imaging software. Dental arches in the upper alveolar process from the lower edge of the nasal cavity and the anterior region of the maxilla were included in the field of view (FOV) of all individuals with CBCT. CBCT examinations were performed by an oral and maxillofacial radiologist and surgeon with three years of experience.

Patients with pathological conditions such as trauma, presence of congenital malformed incisors, mesiodens teeth erupted into the mouth, presence of plate and screw, bone graft material, cyst, tumor, and anterior maxilla fracture were not included in the study. Also, the presence of artefacts in the anterior maxilla were excluded from the study. Patients aged between 7 and 25 years with embedded mesiodens in the anterior maxilla were included in the study. In the radiographs examined, they were examined as multi-plane images with a thickness of 0.3 mm and the presence and position of mesiodens in all sections (coronal, sagittal, vertical planes) were evaluated (Figure 1).

Two groups were formed, including 34 individuals with mesiodens (mesiodens group) and 34 without mesiodens (control group). If there is a mesiodens, its position were stated and root development stage were evaluated according to the Demirjian method [16](Figure 2).

Additionally, the age and gender of the patients were recorded. If there was disagreement between two observers and consensus could not be reached, a third observer was consulted to reach agreement. To analyze intraobserver agreement, 8 randomly selected cases were evaluated and repeated one week later.

Statistical Analysis

A priori power analysis was performed based on the repeated Kappa Test using the software G*power version 3.1.9.4.[22] A sample size of 68 was found to be ade-
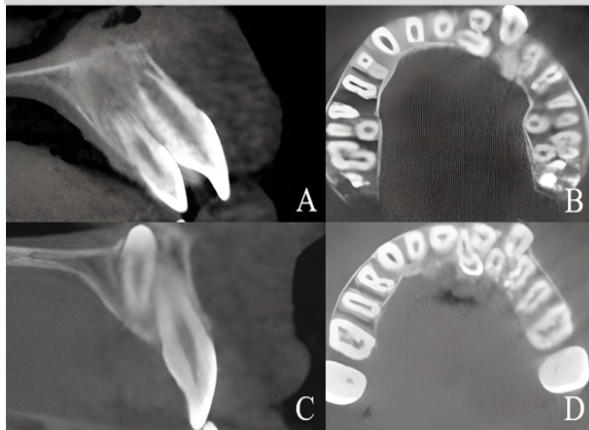
Figure 1.The orientation of unerupted supernumerary teeth is classified into 4 directions such as vertical **(A)**, horizontal **(B)**,
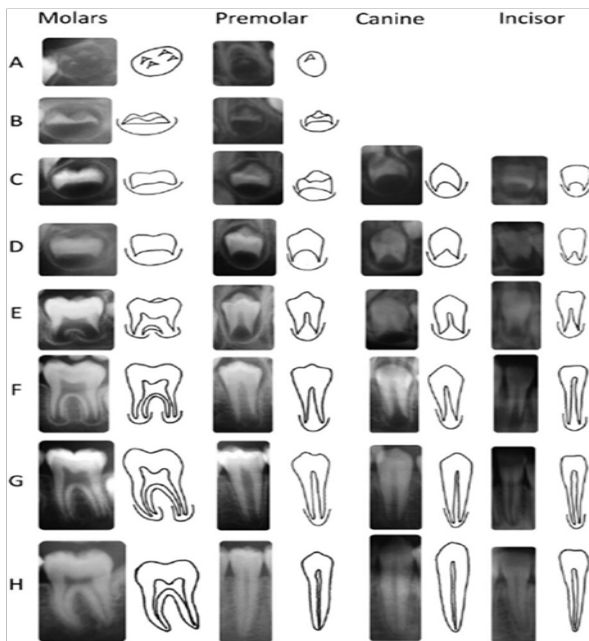

Figure 2. Developmental stages in Demirjian's method[16]

quate to detect a difference in terms of the effect size of f=0.25 with 80% statistical power at α = 0.05. Study data was analyzed using SPSS software version 18.0 (Chicago, IL, USA). Intraobserver reliability was examined by Kappa Test. The level of interobserver agree-ment and the intraobserver reliability of both observers were excellent. The compatibility of the ages of the individuals included in the study with the normal distribution was made with the Shapiro-Wilks test, and the comparison of the mean ages between the two groups according to the tooth stages was made with the independent sample t-test. Age differences between within-group tooth stages were analyzed with the one-way ANOVA model, and the stages that were significantly different were analyzed with the Tukey post-hoc test. The distribution of tooth development stages was analyzed with the chi-square test. $p<0.05$ was accepted as statistical significance level.

RESULTS
The study sample included 34 patients with mesiodens (35% females, 65 % males; age range: 7–25 years; mean age**:** 14.05 ± 5.39) and 34 controls (41% females and 59% males; mean age: 14.14±5.47). In both groups, no statistically significant difference was observed according to age and sex ($p= 0.945$ and $p=0.803$, respectively). Median diastema caused by mesiodens was seen in 16 cases(47.10%). In bucco-palatal direction, mesiodens were most frequently observed in the palatal position (76.50% , n=26).
According to the results of direction of impaction, mesiodenses were most frequently observed in the vertical position (n= 19, 55.90%). Horizontal position was very rarely observed (14.70%) appearing in only 5 cases, and inverted orientation were seen in 10 cases (29.40%) (Table 1).
There was no significant relationship between the presence of diastema and the bucco-palatal position of the mesiodens ($p= 0.429$) and the direction of impaction ($p= 0.500$).
In addition, there was no significant difference between the adjacent incisive teeth development scores and bucco-palatal positions and the direction of impaction of the mesiodens ($p= 0.841$ and $p= 0.929$, for right central incisor, respectively; $p= 0.718$ and $p= 0.885$, for left central incisor, respectively).
Table 2 shows tooth formation of right and left central incisive teeth of each group. A significant difference was found between incisive teeth development scores by groups ($p=0.047$ and $p=0.030$, respectively).
While the root maturation completion rate of bilateral incisors in the control group was high with an H score

Table 1. Demographic and radiographic characteristics of cases.

Variables		Mesiodens n (%)	Control n (%)
Gender	*Male*	22 (64.7)	20 (58.8)
	Female	12 (35.3)	14 (41.2)
Age	*mean±SD**	14.05±5.39*	14.14±5.47*
Bucco-palatalposition	*Palatalposition*	26 (76.5)	-
	BuccalPosition	8 (23.5)	-
Direction of impaction	*Vertical*	19 (55.9)	-
	Horizontal	5 (14.7)	-
	Inverted	10 (29.4)	-
Mediandiastema	*Present*	16 (47.1)	-
	Absent	18 (52.9)	-

SD: Standard Deviation.
*Numerical data

Table 2. Distribution and comparison of maturation levels of centralincisors according to groups

		Right Central Incisor		Left Central Incisor	
		Mesiodens (n=34)	Control (n=34)	Mesiodens (n=34)	Control (n=34)
D		1 (2.9%)	0	0	0
E		3 (8.8%)	2 (5.9%)	5 (14.7%)	3 (8.8%)
F		3 (8.8%)	1 (2.9%)	1 (2.9%)	0
G		7[a] (20.6%)	1[b] (2.9%)	8[a] (23.5%)	1[b] (2.9%)
H		20[a] (58.8%)	30[b] (88.2%)	20[a] (58.8%)	30[b] (88.2%)
p		0.047*		0.030*	

*Differentupper letters show significant difference between columns. *Statistically significance level is at p<0.05.*

(88.20%), the root maturation was more in the G score (20.60% and 23.50%) in the mesiodens group. D score was determined only in one case belonging to the mesiodens group (Figure 3).

Table 3 shows the distribution of development scores of all teeth by groups. It was determined that root maturation increased with increasing age in the mesiodens groups (p= 0.001 for the right central, p= 0.005 for the left central).

The majority of cases in the control group had an H score. No statistically significant difference was observed in terms of mean age between the groups in each scoring (p>0.05).

DISCUSSION
Supernumerary teeth are a number anomaly. They are frequently encountered in the anterior region of the maxilla.[3] Supernumerary teeth seen between the inci-
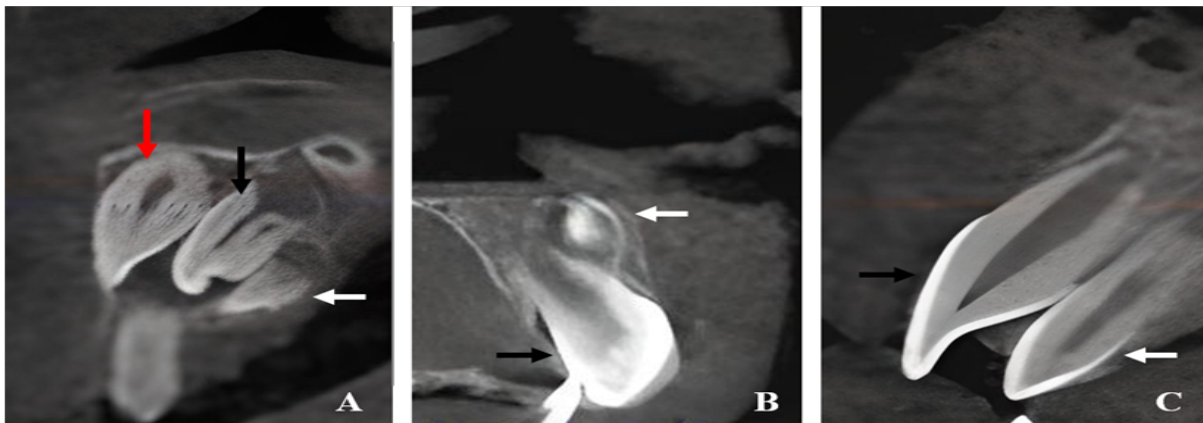

Figure 3. A. CBCT image of the patient with a D score. Red arrow: Upper lateral incisor tooth, Black arrow: Upper santral incisor tooth, White arrow: Mesiodens. **B.** CBCT image of patient with an E score; Black arrow: Upper santral incisor tooth, White arrow: Mesiodens, **C.** CBCT image of patient with a G score, Black arrow: Upper santral incisor tooth, White arrow: Mesiodens.

Table 3. Comparison of ages according to dental maturation level score (E-H).

Teeth	Groups	E	F	G	H	p
Right Central incisor	*Mesiodens*	8.250 ±0.957[a]	9.333 ±.577[b]	10.857 ± 1.864[c]	17.210 ± 5.137[d]	0.001
	Control	7.000±0.000	8	9	15.000±5.258	
	P	0.157	-	-	0.155	
Left Central incisor	*Mesiodens*	9.400±2.701[a]	-	10.875±1.356[b]	16.650 ±5.556[c]	0.005
	Control	7.333±0.577[a]	-	9	15.000 ± 5.525[b]	
	P	0.252	-	-	0.293	

*Statistically significance level is at p< 0.05.
*No comparison was made for D level due to the being present in just one teeth.
*Different upper letters show significant difference between columns (The comparison of the meanage of the scores with the ANOVA test for the mesiodens group, p=0.001 for the right central, p=0.005 for the left central). *Since the majority of the patients in the control group had an H score, the ages of the scores did not be compared.
*P values in the rows belong to the independent samples t-test, which the meanages of the control group and mesiodense group are compared according scores.
*Since there was one case each in certain groups in the G and F scores, the average ages of the mesiodense and control groups could not be compared. Descriptive values for the age of each case are given in the table.

sors are called mesiodens. Mesiodens may cause delay in the eruption of permanent teeth, midline diastema formation, tooth displacement and cyst formation.[23,24] It is reported in the literature that it causes root resorption and cyst formation in permanent teeth.[25,26] In this study, median diastema was observed in 47.10% of mesiodens cases, while root resorption and cyst formation were not observed in the examined cases.

Tay et al.[23] found in their study that the incidence of mesiodens was 84.30% in men and 15.60% in women. Thomas van Arx et al.[27] found mesiodens at a rate of 72.20% in men and 27.70% in women, supporting these data in their study. Kim et al.[28] found that the prevalance of mesiodens in children was 71.70% in males and 28.30% in females. Barham et al.[14], Mason et al.[29], and Kocataş et al.[30] also found the male-female ratio as 2.4:1, 2:1 and 3:1, respectively, in their studies on excess teeth in the jaws. In the presented study, the finding that the incidence of mesiodens is higher in men supports these data (64.70% male, 35.30% female).

In a study of 90 patients, Thomas van Arx et al. [27] found that 78% of the patients had a only one mesiodens tooth, 20% had two mesiodens teeth, and 2% had multiple mesiodens teeth. In this study, all except that twopatients had only one mesiodens.

Smailiene et al. [31] and Liu et al. [32] found in their radiological examinations on mesiodens teeth that these teeth are often located in the palatal position. In the present study, mesiodens buried palatinally was observed in 26 cases, while it remained buried in the buccal area in 8 patients.

In studies on mesiodens, researchers also evaluated the burial aspect of the mesiodens. Thomas van Arx et al.[27] found in their study on 90 patients that 44% of the cases were in the vertical position. They found mesiodens in the inverse position in 37% of the patients. Kocataş et al.[30] found in the data collected from 34 patients that the mesiodenses were vertical in 31 patients, inverse in 2 patients, and horizontal in 1 patient. Rajab et al.[33] found mesiodens in the vertical position at a rate of 83.10% in their study. 10.10% of the cases consisted of mesiodens in the inverse position. Gregg et al. [9] similarly showed that 67% of the supernumerary teeth, which cause delayed eruption in permanent teeth, are in the vertical position. In this study, similar to these researchers, mesiodens teeth were found in vertical position in 19 cases, inverse position in 10 cases, and horizontal position in 5 cases. However Liu et al. [32], Kim et al.[28] and Tay et al. [23] found most of the mesiodens in the inverse position in their studies. This difference may be due to the different populations studied.

Yun-Hoa Jung et al.[34] found that the presence of teeth in an inverted position was 60.60% and that teeth in a vertical position caused a greater delay in the eruption of adjacent teeth. Barham et al.[14] observed that 6.30% of individuals with mesiodens had a delay in the eruption of the adjacent tooth. They also reported that root development was incomplete in 71.60% of the teeth adjacent to the mesiodens. In this study, the majority of the mesiodens were seen in a vertical position, but the relationship between the position of the mesiodens and the adjacent tooth development stages was found to be statistically insignificant.

In some studies, it is stated that mesiodens causes a delay in the formation of adjacent tooth roots. It has also been observed that these teeth do not erupt into the mouth.[35,36] Mallineni et al., calculated a lower dental age in patients with supernumerary teeth, but the results were not statistically significant. They observed a greater delay in dental age in male patients with bilateral supernumerary teeth.[37] In this study, when the average ages of the teeth were compared with each score, no significant difference was found between the mesiodens and contol groups. However, when looking at the distribution of the scores of the right and left central teeth, the G score was higher in the mesiodens group than in the control group, and the prevalence of H scores was higher in the control group. This situation can be interpreted as the mesiodens may prolong the transition time from the G phase to the H phase in some cases.

The main limitation of this study is that the voxel size of the images is 0.3 mm. In high resolution images obtained with smaller voxels, the 3 dimensional position of the mesiodens and the developmental stages of the affected teeth can be observed more clearly and more accurate results can be obtained. Another limitation of the study is the small sample size due to age restrictions.

CONCLUSION

Mesiodens are the supernumerer teeth with a rate of 0.15- 1.90%. The higher prevalence of G score in the mesiodens group and H score in the control group in the present study suggests that mesiodens may prolong the transition time from G phase to H phase. These teeth can delay the root tip formation of adjacent teeth. It may cause miscalculations in the determination of dental age. This situation should be considered for the forensic dentistry. Also, in the presence of mesiodenses the development of adjacent teeth can be evaluated with CBCT, and early extraction of supernumerary teeth can be considered so that it does not affect tooth development. The most important limitation of this study is the small sample size. More precise results can be obtained with studies to be carried out with larger samples in larger archives.

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