



Original article

Retrospective Evaluation of the Gubernacular Tract in Impacted/Unerupted Teeth with Cone-Beam Computed Tomography

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Abstract

Aim: Gubernaculum dentis guides the tooth eruption. This formation, which disappears after teething, continues to exist in impacted teeth. This study aimed to evaluate the gubernacular tract in patients with impacted/unerupted teeth who had previously received Cone-beam Computed Tomography (CBCT) for a variety of reasons.

Material and Methods: In this study, the presence and characteristics of the gubernacular tract were evaluated according to age, gender, tooth groups, root development stages and positions of the teeth. 231 patients were included in this study. A total of 431 teeth were evaluated and the mean age of the patients was 28.0±0.90. Impacted teeth were classified according to their location. The presence and features of the gubernacular tract were evaluated using CBCT.

Results: In the study, the presence of gubernacular tract was most common in canines. The mesioangular and vertical position of impacted teeth exhibited higher gubernacular tract presence, and these data were statistically significant. (P<0.05)

Conclusion: This study stated that the frequency of incidence in the tooth groups was evaluated separately, it was determined that the incidence in canine teeth was significantly higher. Characteristics gubernacular tract such as no change, obliteration or contraction are more common in impacted teeth in vertical and mesioangular positions. This process may affect the impact of permanent teeth, but more studies with clinical follow-up are needed to reach definitive conclusions.

Keywords: Gubernacular Tract, CBCT, Impacted Teeth, Unerupted Teeth.

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INTRODUCTION

The tooth follicle was initially positioned close to the bone cortex. In the later stages, the follicle symmetrically expands towards the buccal, occlusal, and apical (1). The crown development of the tooth is completed; when the root length is about 2-4 mm, the movement of rising begins in the tooth (2). While there is resorption in the bone in the eruption direction, on the opposite side apposition occurs in the bone in the root area (3). The bone crypts on the occlusal surface of the primary teeth are not fully fused, and the bone cavity (iter dentis) in which the tooth germs are located opens to the outer surface of the jawbone with a thin canal (4). In this tiny bone canal; there are epithelial islets, which are the remnants of the lateral tooth bands that connect the enamel organ to the tooth crown, and the fibrous tissues of the tooth follicle including abundant collagen fibers (5). All of these structures in the bone canal, it is called "gubernaculum dentis". The Gubernaculum Dentis or Gubernaculum Cord is crucial to the eruption process because it guides the tooth germ as it develops and progresses through the bone (6). Normal eruption or alignment of the teeth may be affected by the guidance of the gubernacular tract (GT) (7). Abnormalities in GT can cause problems in the eruption of teeth, which may affect orthodontic treatments (8). There are many tooth eruption theories in the literature. The most up-to-date tooth eruption theory today is the "alveolar remodeling theory" (9). Eruption of teeth; it requires a well-programmed serial communication and interaction between dental follicle cells and the surrounding alveolar cells (10). More osteoclasts, which will provide resorption in the coronal of the follicle While active, osteoblast activity is more intense, which will provide selective bone growth in the apical (11). The osteoblast/osteoclast balance is governed by the gubernaculum dentis (3). After the tooth erupts, the gubernaculum dentis completes its task and disappears. In the buried teeth, the gubernaculum dentis continues to exist in the coronal part of the teeth (12). This residue containing fibrous connective tissue can be the starting point of many pathologies (2). Non-eruptive teeth are also one of the main causes of malocclusion (13). That is, the persistence of the gubernacular dentis in impacted teeth can lead to many pathologies and orthodontic problems (14). The eruption process of teeth such as canines and third molars have a long path (15, 16). This may be the reason why it is the most frequently impacted tooth (14). Insufficient space in the jaws for teeth, nutritional habits, and pressure forces, genetics, increased bone thickness after infection, hormonal imbalances may cause teeth to remain impacted (17).

The formation and development times of each tooth in the mouth and their movements from their initial position to occlusion are quite different. Therefore, for the diagnosis of a clinically impacted tooth, it is necessary to know the movement and time of eruption of the teeth (18). Gubernaculum dentis is our biggest source of information about eruption (19). If there are no teeth on palpation and bone deficiency until the age of 10 years, radiographic examination is required (20). For this purpose, radiographs such as periapical, occlusal, panoramic, anteroposterior, lateral cephalometric, and submentovertex are used (21). Recent developments in 3D imaging techniques and the use of cone-beam

computed tomography (CBCT) in the dental field has become widespread (22). CBCT also provides very useful information in the diagnosis and treatment of impacted teeth (23). Periapical, occlusal, and panoramic radiographs are still important for diagnosis, but two-dimensional imaging techniques have problems such as superposition, magnification, and distortion (24). In addition, CBCT is of great importance because the teeth are outside the area not covered by these methods, and it helps to determine the position, form, and neighbor relations of the teeth in three dimensions (25). This study aimed to evaluate the GT in patients with impacted/unerupted teeth who had previously received CBCT for a variety of reasons.

MATERIAL & METHOD

This retrospective study was performed on CBCT images obtained for various purposes at Eskişehir Osmangazi University Faculty of Dentistry. The Clinical Research Ethics Committee of the Eskişehir Osmangazi University Faculty of Medicine approved the study (approval no. 25403353-050.99-E.285; January, 02, 2019).

Inclusion criteria for the study were determined as individuals in the permanent dentition period who did not have craniofacial syndrome, cleft lip and palate, craniofacial region bone diseases and did not undergo orthognathic surgery. CBCT sections with poor image quality were excluded from the study.

In this study, the presence and characteristics of the GT were evaluated according to age, gender, tooth groups, root development stages and positions of the teeth. The presence of the GT in permanent teeth in the intraosseous on 231 CBCTs (471 teeth), and the characteristics of the GT on the cross-sectional and parasagittal sections in cases where the GT was detected were determined. GT characteristics were evaluated by dividing into five groups according to the classification used by Nishida et al.(3): no alteration, bending, contraction, obliteration and difference between erupted direction (Figure 1).

According to the root development of the teeth; root development has not yet formed, coronal 1/3, middle 1/3, apical 1/3 opened apex and apical 1/3 closed apex, divided into five stages.

Teeth evaluated in terms of GT are incisor teeth, canine teeth, premolar, 2nd molar and 3rd molar teeth.

The teeth were divided into four groups according to their positions as vertical, horizontal, mesioangular and distoangular. The obtained data were evaluated statistically. Statistical analysis was performed using SPSS v. 22 for Windows (IBM Corp., Armonk, NY, USA). Basic descriptive statistical analysis and normality tests of all variables were performed. The presence of GT, the position of impacted teeth, root development, GT characteristics, distribution in terms of gender and age, the relationship between GT characteristics and positions of impacted teeth, tooth groups and root

development levels were evaluated with the Chi-Square test. The statistical significance level was taken as $p < 0.05$.

RESULTS

The mean age of the individuals included in the study was 28.0 ± 0.90 , the mean age of female was 28.15 ± 1.16 , and the mean age of male was 24.59 ± 0.99 and no statistically significant difference was found ($p:0.57$). The mean age according to gender of the individuals included in the study was statistically similar. While GT was observed in 31% (n: 146) of 471 teeth, it was not detected in 69% (n: 325). The incidence of GT was 30.7% in women and 31% in men, and there was no significant difference in terms of genders (Table 1).

The third molars and canines comprised the majority of the 146 teeth seen in the GT. When the frequency of incidence in the tooth groups was evaluated separately, it was determined that the incidence in canine teeth was significantly higher.

The incidence of GT according to root development was 16.7%, 46.7%, 32.7%, 25.8%, and 28.6% in coronal 1/3, middle 1/3, apical 1/3, apex open, and apical 1/3 apex closed groups, respectively. Among the incidences, the detectability of the GT was found to be statistically significant in only those with coronal 1/3 root development ($p < 0.05$) (Table 2). GT was found to be statistically significantly higher in teeth with mesioangular and vertical positions according to their positions ($p < 0.05$).

Considering the GT characteristic; it was determined that the most frequent change was found in the no type GT. No difference was found between the genders ($p:0.88$) (Table 3).

When the positions of the impacted teeth and the GT characteristics were evaluated together, the rate of GT that did not change in the mesioangular and vertically positioned impacted teeth was found to be statistically higher than the teeth in the horizontal position. The distribution of GT characteristics according to tooth position is presented in Table 4.

Discussion

The GT is the eruption path from the dental follicle to the gingiva for permanent teeth. It was emphasized that the prevention of normal tooth eruption may be closely related to the problems related to the GT. However, there are not enough studies on the GT. Evaluation of the GT with CBCT may help to more accurately predict possible eruption of permanent teeth (1, 2, 4, 19, 26, 27)

Although the GT is seen radiographically as a 1-3 mm diameter canal, it is often difficult to detect by clinicians on radiographs. In particular, the characteristic of the canal, the appearance of teeth germ in various densities, limits the detectability of the canal in coronal and sagittal sections (28). Therefore, we evaluated the canal on cross sectional and parasagittal sections in our study.

Tooth eruption is a complex process that takes place during normal growth and development and the timing may differ. The predictability of the eruption process and possible eruption alterations is important for orthodontists in terms of treatment timing and successful treatment. There are studies that the GT can be effective in eruption process (3, 4, 28, 29).

Nishida et al. (3) reported that any change in the GT may indicate eruption anomaly in permanent teeth. Oda et al also evaluated the frequency of GT in maxillary anterior teeth and mesiodens in individuals with normal or delayed eruption and reported that the frequency was significantly lower in individuals with delayed eruption. Koç et al. (28) and Gaeta-Araujo et al. (29) reported that the GT was less common in teeth with eruption disorders. The researchers found the detectability of the gubernaculum higher than in our study.

Although the mechanism of importance was not clearly elucidated in these studies, results were obtained suggesting that it may be associated with eruption anomalies. For this reason, it is important to reveal the viewability of the GT and its characteristics in different tooth groups and positions. In our study, we demonstrated the imaging features of the GT in various tooth groups.

We evaluated the incidence of the GT only in the permanent dentition period. Differences between studies may be due to the population characteristics studied, limited study data, and differences in imaging parameters. The inclusion of third molars in our study also causes statistical differences. The atypical positions of the third molars were thought to limit the detectability of the GT. Moreover, this study has limitations such as not following the clinical status of patients with the absence and presence of GT. Although this study is a pilot study in this sense, data on the characteristics of the GT, its relationship with tooth development stages and positions are presented to the literature. Further studies in larger populations are needed to elucidate the anatomy of the GT and its relationship with tooth eruption.

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TABLES

Table 1. Distribution of the study group in terms of gender and presence of GT

Gender	GT-without n %	GT-with n %	p
Female	221 (69.3)	98 (30.7) a	0.85
Male	104 (68.4)	48 (31.6) a	
Total	325 (69)	146 (31)	

a: Percentages with the same letter are not different. p>0.05

Table 2. Evaluation of the presence of GT according to the root development of the teeth

			Gubernacular Tract		Total
			None	Available	
Apex Development	None	n	30a	6a	36
		%	83,3	16,7	100,0
	Coronal 1/3	n	48a	42b	90
		%	53,3	46,7	100,0
	Middle 1/3	n	33a	16a	49
		%	67,3	32,7	100,0
	Apex 1/3 Immature Apex	n	69a	24a	93
		%	74,2	25,8	100,0
	Apikal 1/3 Mature Apex	n	145a	58a	203
		%	71,4	28,6	100,0
Total		n	325	146	471
		%	69,0	31,0%	100,0

a,b: Percentages with the same letter are not different. p>0.05

Table 3. Evaluation of GT characteristic in terms of all study groups and genders

Gender	Characteristic of GT					Total	p
	No Change n, %	Bending n, %	Contraction n %	Obliteration n %	Different in Eruption n, %		
Female	42, 28.8	18, 12.3	14, 9.6	14, 9.6	10, 6.8	98, 67.1	0.88
Male	21, 14.4	10, 6.8	4, 2.7	8, 5.5	5, 3.4	48, 32.9	
Total	63, 43.2	28, 19.2	18, 12.3	22, 15.1	15, 10.3	146, 100	

Table 4. Evaluation of the distribution of GT characteristic according to tooth position

Teeth Position	Characteristic of GT					Total	p
	No Change n, %	Bending n, %	Contraction n, %	Obliteration n, %	Different in eruption n, %		
Vertical	27, 18.5	8, 5.5	9, 6.2	12, 8.2	2, 1.4	58, 39.7	<0.001
Horisontal	2, 1.4	4, 2.7	1, 0.7	1, 0.7	7, 4.8	15, 10.3	
Mesioangular	25, 17.1	15, 10.3	7, 4.8	8, 5.5	6, 4.1	61, 41.8	
Distoangular	9, 6.2	1, 0.7	1, 0.7	1, 0.7	0, 0	12, 8.2	
Total	63, 43.2	28, 19.2	18, 12.3	22, 15.1	15, 10.3	146, 100	

Chi-Square test was performed.

Figure 1: Gubernacular tract characteristics a) no alteration, b) bending, c) contraction, d) obliteration, e) difference between erupted direction

