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Morphological analysis of palatogingival grooves in an Iraqi population: a retrospective cone-beam computed tomography study

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Abstract

INTRODUCTION. The palatogingival groove is a developmental anomaly of maxillary anterior teeth that may heighten susceptibility to periodontal and endodontic diseases. This study examined the prevalence and morphological features of the palatogingival groove in an Iraqi population utilizing cone beam computed tomography.

MATERIALS AND METHODS. This retrospective study assessed cone beam computed tomography scans from 500 patients (250 males and 250 females) collected between 2020 and 2025. Only high-quality image of both maxillary anterior teeth was used. Any image with restorations, root canal treatment, resorption, deep caries, or artifacts. Two calibrated examiners independently evaluated the presence of the palatogingival groove, tooth distribution, laterality, and morphology in accordance with Gu's classification.

RESULTS. The palatogingival groove was found in 7.8% of patients, and it was more common in males (5.8%) than in females (2%). The maxillary lateral incisors were the most affected (7.4%), while the central incisors and canines were the least affected (0.2% each). Bilateral the palatogingival groove was noted in 1.2% of cases, occurring solely in lateral incisors. All grooves were categorized as Type I. There was a very high level of agreement between observers (κ = 0.92).

CONCLUSIONS. The palatogingival groove is a fairly common anatomical difference in Iraq, mostly affecting the maxillary lateral incisors and showing up as unilateral Type I grooves. Recognizing this anomaly is important for making an accurate diagnosis and planning treatment.

Keywords: palatogingival groove, cone beam computed tomography, maxillary anterior teeth, anatomical variation, Iraqi population

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Морфологический анализ небно-десневых борозд у населения Ирака: ретроспективное исследование с использованием конусно-лучевой компьютерной томографии

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Резюме

ВВЕДЕНИЕ. Небно-десневая борозда (palatogingival groove, PGG) представляет собой аномалию развития передних зубов верхней челюсти, способную повышать предрасположенность к заболеваниям пародонта и эндодонтической патологии. Целью настоящего исследования явилось изучение распространенности и морфологических особенностей небно-десневой борозды в иракской популяции с использованием конусно-лучевой компьютерной томографии.

МАТЕРИАЛЫ И МЕТОДЫ. В рамках ретроспективного исследования были проанализированы снимки конусно-лучевой компьютерной томографии 500 пациентов (250 мужчин и 250 женщин), полученные в период с 2020 по 2025 г. В анализ включались только изображения высокого качества, содержащие оба передних зуба верхней челюсти. Из исследования исключались изображения с реставрациями, эндодонтическим лечением, признаками резорбции, глубоким кариесом или артефактами. Два калиброванных исследователя независимо оценивали наличие небно-десневой борозды, распределение по зубам, латерализацию и морфологические характеристики в соответствии с классификацией Gu.
РЕЗУЛЬТАТЫ. Небно-десневая борозда выявлена у 7,8% пациентов, при этом чаще у мужчин (5,8%), чем у женщин (2%). Наиболее часто поражались верхние латеральные резцы (7,4%), тогда как центральные резцы и клыки поражались значительно реже (по 0,2%). Двусторонние борозды отмечены в 1,2% случаев и выявлялись исключительно на латеральных резцах. Все выявленные борозды были отнесены к типу I. Отмечен высокий уровень согласованности между исследователями (к = 0,92).
ВЫВОДЫ. Небно-десневая борозда является относительно распространенной анатомической вариацией в иракской популяции, преимущественно локализующейся на латеральных резцах верхней челюсти и чаще проявляющейся в виде односторонних борозд типа I. Выявление данной аномалии имеет важное значение для точной диагностики и планирования лечения.

Ключевые слова: небно-десневая борозда, конусно-лучевая компьютерная томография, передние зубы верхней челюсти, анатомическая вариация, иракская популяция

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INTRODUCTION

The palatogingival groove (PGG) is a developmental anomaly of indeterminate etiology, typically appearing on the palatal surface of maxillary incisors [1]. Previous research shows that the percentage of people with PGG teeth varies from 0.93% to 44.6% across different groups [2]. PGGs are most common in lateral incisors, although they can also be seen in central and canine teeth [3]. PGG usually starts in the central fossa or cingulum and moves along the root surface at different angles, depths, and distances. It is only detected in the crown of the teeth in very uncommon situations [4]. In the literature, PGG can be put into distinct groups. Bacic et al. divided PGGs into three groups: mesial, distal, and midpalatal [4]. Other researchers conducted a subsequent study that categorized PGGs according to their origin, location, and conclusion. Gu used microcomputed tomography to divide PGGs in extracted teeth into three categories based on the groove's depth and width [5]. The researcher also shown that PGGs can be identified in the axial portions of the images. Arslan et al. employed cone beam computed tomography (CBCT), a noninvasive and therapeutically significant technology, to examine the configurations of the grooves in accordance with the Gu classification [6]. Most of the latter PGG studies have confirmed the CBCT and Gu categorization [7–10].

Bacteria prefer to settle down in PGGs and produce plaque and calculus, which can lead to localized periodontitis [1]. Some studies have used standardized periodontal markers to show how PGGs and periodontal disease are related [7; 8]. Zhang et al. used CBCT to study how much bone loss happens around teeth using PGGs. This implies a potential association between PGGs and periodontal damage. They also looked at how different types of PGG are linked to bone loss around the teeth. This is because CBCT can see how far a PGG goes without getting in the way of the gums and alveolar bone that are next to it. That cannot be achieved with periodontal probing. The researchers have found that different types of PGGs can cause different amounts of bone loss [7].

Teeth with PGGs may be a sign of periapical disease. Some people believe that primary pulp infection could occur if there are deep grooves that extend into the pulp cavity. Accessory foramina or isthmuses may link the pulp cavity to the periodontium [7]. Some people believe that primary pulp infection could occur if there are deep grooves that extend into the pulp cavity. Accessory foramina or isthmuses may link the pulp cavity to the periodontium [7]. Previous research has investigated the existence of periapical lesions in teeth with PGG; however, these studies were limited by small sample numbers [9–11]. No previous entries have discussed the populace of Iraq. The study aimed to utilize CBCT to determine the prevalence of PGG on the anterior teeth of individuals in Iraq.

MATERIALS AND METHODS

This research was executed at the College of Dentistry, University of Tikrit, Iraq. The ethical committee of the college of dentistry gave its approval for the study protocol (Ref. no. 10, issued on September 30, 2025). We looked through the dental records of 500 patients (n = 500: 250 males, 250 females) to see if they met the requirements for inclusion. From 2020 to 2025, all CBCT

images were taken with a CBCT machine (Carestream, Germany) from patients who were sent to the radiology department for different reasons, such as complicated endodontics cases or implant evaluations. The voxel size varies from 0.15 to 0.3 mm, and the slice thickness measures 1.0 mm. This retrospective study followed the guidelines set out in Arslan et al. [6].

The criteria for inclusion were the availability of high-quality CBCT images and the presence of bilateral maxillary anterior teeth. Any case with "extensive coronal restorations, root canal fillings, and posts, internal/external resorption, cleft lip and palate, impacted teeth in the maxillary anterior region, and deep caries was excluded". Two specialist dentists (one a periodontologist and the other an endodontist) then looked at the cases that were included on their own. An oral radiologist was consulted when there was a disagreement. We used RadiAnt (version 2025.1: Poland) software to look at the axial, sagittal, and coronal sections of the CBCT images. For each patient, the following information was collected: "age and gender, whether or not they have PGG, and whether the PGG is bilateral or unilateral". According to Gu's classification, the type of PGG was noted [5]: type I, II, or III. The Gu's classification. Type I: "short groove (not beyond the coronal third of the root). Type II: long and shallow groove (beyond the coronal third of the root). Type III: long and deep groove (beyond the coronal third of the root), associated with complex root canal system".

RESULTS

Regarding the Kappa test, the two inspectors showed good agreement between them (κ = 0.92) with respect to the recognition of PGG on CBCT images. The total number of 500 patients with CBCT images of the maxillary anterior area according to the inclusion criteria were inspected.

The PGG was occurred in 7.8% of all cases, 11.6% of males and 4% of females, according to Table 1, Figs 1–3, there was only one case with PGG found in the central incisor and canine, and the majority of PGG was in the lateral incisor as in Table 2, Fig. 4 and 5, bilateral PGG was found in 6 cases of lateral incisors 1.2% (5 male, 1 female, Fig. 6). Only type I PGG was identified in this study.

Table 1. Incidence of the palatogingival groove in examined patients (*n* = 500)

Таблица 1. Частота встречаемости небно-десневой борозды у обследованных пациентов (*n* = 500)

Gender	Number of patients			*p*-value
	with PGG	without PGG	total	
Male	29 (5.8%)	221 (44.2%)	250	0.002
Female	10 (2%)	240 (48%)	250	
Total	39 (7.8%)	461 (92.2%)	500	

Table 2. Incidence of the palatogingival groove among the 6 maxillary anterior teeth

Таблица 2. Частота встречаемости небно-десневой борозды среди 6 передних зубов верхней челюсти

Tooth type	Value
Central incisor	1 (0.2%)
Latera incisor	37 (7.4%)
Canine	1 (0.2%)
Total	39 (7.8%)

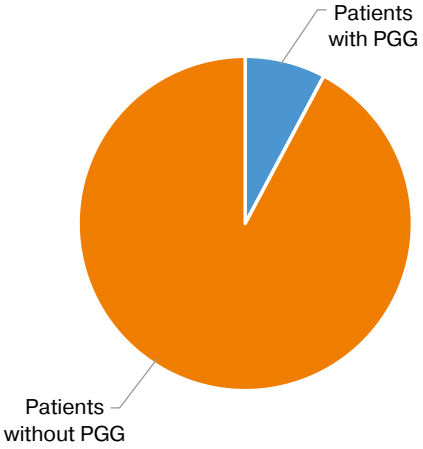

Fig. 1. Incidence of the palatogingival groove on maxillary 6 anterior teeth in examined patients (*n* = 500)

Рис. 1. Частота встречаемости небно-десневой борозды на 6 передних зубах верхней челюсти у обследованных пациентов (*n* = 500)

Fig. 2. Axial view of the palatogingival groove in lateral incisor (green arrow)

Рис. 2. Аксиальный вид небно-десневой борозды на боковом резце (зеленая стрелка)

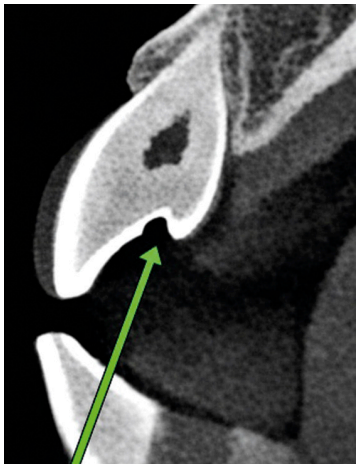

Fig. 3. Sagittal view of the palatogingival groove in lateral incisor (green arrow)

Рис. 3. Сагиттальный вид небно-десневой борозды на боковом резце (зеленая стрелка)

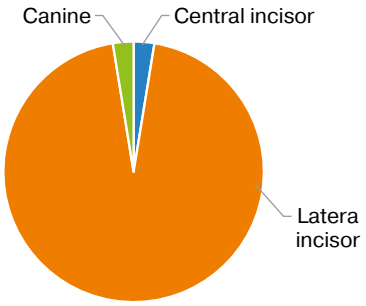

Fig. 4. Incidence of the palatogingival groove among the central incisor, lateral incisor, and canine

Рис. 4. Частота встречаемости небно-десневой борозды среди центральных резцов, боковых резцов и клыков

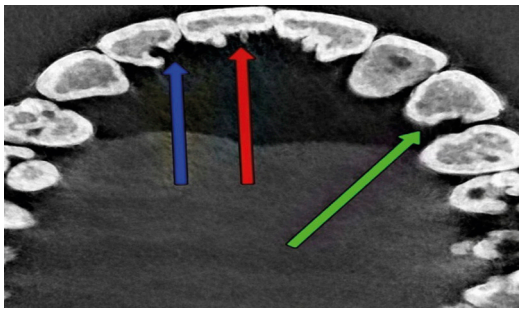

Fig. 5. CBCT images of a patient with palatogingival groove: blue arrow – lateral incisor, red arrow – central incisor, green arrow – canine

Рис. 5. Снимок компьютерной томографии пациента с небно-десневой бороздой: синяя стрелка – на боковом резце, красная стрелка – на центральном резце, зеленая стрелка – на клыке

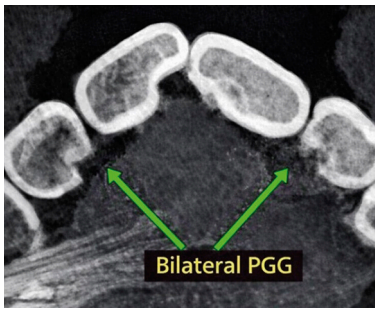

Fig. 6. Bilateral palatogingival groove in lateral incisor

Рис. 6. Двусторонняя небно-десневая борозда на боковом резце

DISCUSSION

PGGs can cause periodontal tissue loss that can lead to endodontic infections. The grooves are on the palatal side of the maxillary incisors [7]. A comprehensive diagnostic assessment of clinical manifestations is essential for effective endodontic diagnosis and treatment. Previous studies analyzed the prevalence of PGGs in diverse populations, producing results that vary considerably from 2.2% to 30%. Various techniques, such as photography and in vitro microcomputed tomography, were utilized to assess the prevalence of PGGs. Clinical examination, radiographic examination, and CBCT were used in vivo tests. The results are different [3; 4; 6; 11–14].

CBCT offers three-dimensional (3D) high-resolution precise images, with more data about the maxillofacial region, including the internal canal anatomy and external root structural features [15–17], including the PGG extent [10–13].

Despite its many benefits, CBCT has certain drawbacks, such as a higher radiation dose and the potential for artifact creation [8]. It is well known that traditional periapical radiographs generate two-dimensional images with unavoidable geometric distortion and noise, which impairs the accuracy of root canal morphology examination. In order to determine whether radicular grooves are present on maxillary lateral incisors, we decided to use CBCT in this study [10–13].

The current study found that 7.4% of upper lateral incisors had PGGs, which was marginally different from the 7.3% incidence found in a previous CBCT study conducted in the Indian population by Varun et al. [18]. According to Aksoy et al. [11] and Arslan et al. [6], the incidence in the Turkish population was 2.3% and 2.2%, respectively. Genetic and ethnic differences in the sample may be the cause of this variation in PGG incidence. Additionally, the incidence rate in various studies may be impacted by the sample size. The current data revealed that most detected PGGs were type I PGG was the only classification detected. This is in agreement with the previous study of Aksoy et al. [11].

Regarding the central incisor the incidence of PGG was 0.2% only one time; this was slightly different than the study of Withers et al. in 1981 who found the prevalence of PGG was 0.28% in young adults in the United States [19] while the study of Aljuailan et al. in the Saudi population found the percentage of PGG was 1.1 [2].

The PGG was identified in 0.2% of canines in only one tooth. The CBCT-based study done by Ghahramani et al. also identified a single maxillary canine with a PGG, reporting a prevalence of 0.1% to 0.16% in canines in the Turkish population [10], on the other hand the studies by Arslan et al. [6] in the Turkish population and the study by Aljuailan et al. [2] in the Saudi population found no PGG in the maxillary canine.

Our study showed that bilateral PGG exists in 1.2%, and in lateral incisors only, this was slightly different than the study of Withers et al., who found the prevalence of PGG was 1.7% in young adults in the United States [19], while the study of Alkahtany et al. found the percentage of bilateral PGG was 38.5 in Saudi Arabia [9].

According to the available data, type I PGG was the most frequently found classification, and the majority of detected PGGs were unilateral. This is consistent with earlier reports [6; 13; 14].

Our retrospective CBCT study found only Type I PGGs in all of the maxillary teeth we inspected. This may be attributable to the association of deeper root grooves with periodontal and endodontic symptoms, necessitating extraction and endodontic intervention [20; 21]. We did not include patients who had missing or endodontically treated maxillary lateral incisors in our study. So, we might not identify those deeper grooves (Type II & III), and only sound maxillary anterior teeth were included, which are most commonly related to the shallow groove configuration (Type I).

The majority of the patients with PPG were males 5.8% and female 2%, this comes in accordance with the study done by Zhang et al. in Chinese population [7], on the other hand the study of Aksoy et al. found the female cases were the majority of cases [11]. While the studies of Aljuailan et al. [2] in Saudi Arabia and the study of Withers et al. [19] done in the U.S shows a non-significant difference between the sex in relation to the incidence of PGG.

The occurrence of PGG in the current Iraqi cohort (7.8%) was significantly greater than that observed in adjacent populations, including the Turkish population (2.2%) [11]. There could be a number of reasons for this difference. First, the different ethnic groups in the two areas may have different genetic predispositions that cause the Hertwig's epithelial root sheath to fold in [22]. Second, differences in methods, like the high resolution of the CBCT scans used in this study, probably made it possible to find shallow Type I grooves that are often hard to identify in studies that use two-dimensional radiography [22]. Finally, the 100% prevalence of Type I grooves in our findings indicates that although the anomaly is common in Iraq, it frequently manifests in its mildest morphological form, potentially being overlooked in other clinical surveys [13].

One of the limitations of the current retrospective study was the exclusion of many CBCT images because they contained artifacts from nearby crowns or restorations. These artifacts will make it impossible to identify PGGs, so we may have to exclude some cases of PGGs that we were unable to identify. Furthermore, many cases with RCT in anterior teeth that may have been brought on by infection from PGGs have been excluded. Finally, because of its limitations, we do not advise using CBCT as the only technique to detect PGG. To accurately diagnose this anomaly, a thorough clinical examination should be carried out prior to any radiographic evaluation.

According to our research, PGGs are common in the Iraqi community. Therefore, when performing a clinical examination and planning a course of treatment, clinicians should always take into account the existence of this groove as well as other anatomical variations. Because they encourage the buildup of calculus and plaque, which results in periodontal and pulpal pathosis, PGGs are clinically significant.

CONCLUSION

The prevalence of PGG was 7.8% in the upper anterior teeth of the Iraqi population, particularly the upper lateral incisor. This anatomical variation only occurs on one side (unilateral) as Type I. PGG and other anatomical variations should always be taken into account by clinicians during clinical examination and treatment planning. The prevalence of Types II and III may be underestimated because teeth with endodontic treatment are not included.

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