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ORIGINAL ARTICLE

Prevalence of Palatal Radicular Groove in upper Lateral Incisors: A CBCT study at Isfahan Azad dental school

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Abstract

Background: Palatal root grooves are developmental anomalies often found in maxillary incisors, originating around the cingulum and potentially extending along the root. Recognizing these grooves is crucial for identifying patients at higher risk for periodontal and endodontic issues, enabling more effective treatment in dental practices. This study aimed to assess the prevalence of palatal grooves in the lateral maxillary teeth among patients referred to the Radiology Department at Azad University in Isfahan, using CBCT, due to limited existing research in Iran.

Materials and Methods: This descriptive-analytical cross-sectional study examined 150 CBCT images of 300 lateral maxillary teeth. The scans were obtained from the anterior maxillary teeth of patients referred to the Radiology Department of Isfahan Azad Dental School within the age range of 11 to 60 years from October 2023 to August 2024. Available scans were analyzed in axial and sagittal views. The data were recorded and analyzed using an independent t-test ($\alpha = 0.05$).

Results: The prevalence of palatal grooves in the lateral maxillary teeth was 18.7%. Of these, 71.4% were unilateral, and 28.6% were bilateral. 85.7%of grooves were Type I, and 7.1% showed Type II and III.

Conclusion: According to results, palatal root grooves, primarily unilateral and classified as Type I, are common anomalies in maxillary lateral incisors, occurring in 18.7% of the studied Iranian population. Their prevalence emphasizes the need for thorough clinical and radiographic evaluations to reduce risks of periodontal and endodontic complications. Cone-beam computed tomography (CBCT) is recommended for accurate detection and treatment planning.

Keywords: Radiography; Cone beam computed tomography; Prevalence; Maxilla

Introduction

Palatal root grooves were first defined by Black in 1908 as a type of developmental anomaly primarily observed in maxillary incisors. These grooves start at the cingulum and extend toward the root in varying degrees (1-3). Although the precise etiology is unclear, previous studies indicate that genetic factors might contribute to their development. It is believed that during the formation of teeth, the inner enamel and Hertwig's Epithelial Root Sheath (HERS) come together, resulting in the development of grooves (4-6). Various articles refer to palatal grooves by different names, such as developmental palatal groove, palatal-

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gingival groove, singular-radicular groove, radicular-lingual groove, disto-lingual groove, and vertical groove (7-10). Palatal root grooves are primarily located on the palatal side of anterior maxillary teeth, especially in lateral incisors (12-18).

Various classification systems exist for palatal grooves. One classification by Bacic et al. is based on the groove's position (mesial, distal, and midpalatal) (8), while Kogan's classification is based on the groove's point of origin and termination (3). In 2011, Gu categorized grooves based on the degree of severity obtained from micro-computed tomography into three groups: Group 1 includes short grooves located in the coronal third of the root, Group 2 consists of long grooves extending beyond the coronal third, and Group 3 includes long and deep grooves extending beyond the coronal third (19). The first group is typically asymptomatic, while the second and third groups significantly contribute to plaque accumulation and calculus formation (4). These grooves are often inaccessible and difficult to clean, leading to localized progressive periodontal inflammation (8, 19). This periodontal destruction allows bacteria to gain a rapid access to the pulp chamber through lateral canals or even via the apical foramen, resulting in secondary pulpitis (20-23).

Numerous studies have been conducted in this field; for instance, the study by Alkahtany et al. (31) highlights the prevalence of radicular grooves in maxillary lateral incisors in a Saudi population, reporting an incidence rate of 4.9%. Most of these grooves were unilateral (61.5%) and primarily classified as type I (69.2%), followed by type II (15.4%) and type III (15.4%). This data emphasizes the importance of studying population-specific prevalence rates to better understand the clinical significance of radicular grooves and improve diagnostic approaches. Traditionally, the only treatment for teeth with these grooves is tooth extraction; however, today conservative treatments have been used with favorable outcomes (4, 5, 7, 12, 24, 25, 26). Mild root grooves are usually managed with periodontal therapy, while shallow grooves can be restored with restorative materials (27, 28). In cases of deeper and more complex grooves, additional interventions may be necessary, including root canal treatment, periodontal curettage, and cauterization, with or without guided tissue regeneration and replantation. Extraction is recommended for non-restorable teeth (11-13, 27, 29).

The early identification of palatal root grooves is essential to prevent complications such as progressive periodontal inflammation, pulp necrosis, and tooth loss. Early diagnosis enables clinicians to intervene promptly with preventive and conservative treatments, potentially avoiding more invasive procedures or extractions (24, 26). Various approaches have been utilized to evaluate root grooves. Clinical examinations and conventional radiographs were traditionally employed for the identification of root grooves; however, they often provided insufficient information regarding grooves extending beneath the gums and jawbone. In some cases, surgical intervention is required for accurate diagnosis. Cone-beam computed tomography (CBCT) offers a non-invasive alternative, providing precise information for examining tooth morphology, canal anatomy, and root grooves (19). Thus, this study aimed to determine the prevalence of palatal root grooves in lateral maxillary teeth among patients referred to the Radiology Department at Azad University, Isfahan, Iran, using CBCT. By analyzing the frequency and distribution of palatal root grooves, this study offers clinicians valuable insights for improving early diagnosis and treatment planning in dental practices. (19).

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Materials and Methods

This descriptive-analytical cross-sectional study was approved by the Ethics Committee of the Khorasgan Islamic Azad University Faculty of Dentistry with the ethics code IR.IAU.KHUISF.REC.1403.068. The inclusion criteria for the study were the presence of a high-quality, bilateral CBCT scan from the anterior maxilla. Cases with extensive crown restoration, root filling, internal and external resorption, cleft lip and palate, high lateral tooth impaction, and deep caries were excluded from the study. This descriptive-analytical cross-sectional study examined 150 CBCT of 300 lateral teeth from patients at the specialized Radiology Department of Khorasgan Dental School, selected randomly from the archive using a systematic random sampling method. Patient records were assigned numerical identifiers, and every nth record was selected based on a random starting point, ensuring unbiased selection. All CBCT scans were obtained from patients who visited the Radiology Department for various reasons, such as comprehensive endodontic treatment or implant therapy, during the years 2021-2023 using CBCT Galileos (Sirona, Germany, Bensheim). The exposure time was 1.8 seconds, kVp 115, mAs 4, voxel size ranged from 0.15-0.3 mm (medium resolution), and FOV ranged from 6 cm × 6 cm to 15 cm × 15 cm, with a focal spot of 0.3 mm and slice thickness of 0.3 mm. Arslan's protocols from 2014 were applied in this study (2).

The lateral teeth in each scan were individually examined in axial and sagittal sections using On Demand software to identify the palatal grooves. For each patient, the following data were recorded: gender, presence or absence of developmental grooves, unilateral or bilateral occurrence, and the type of palatal groove classified into Types I, II, and III (Figure 1) (19).

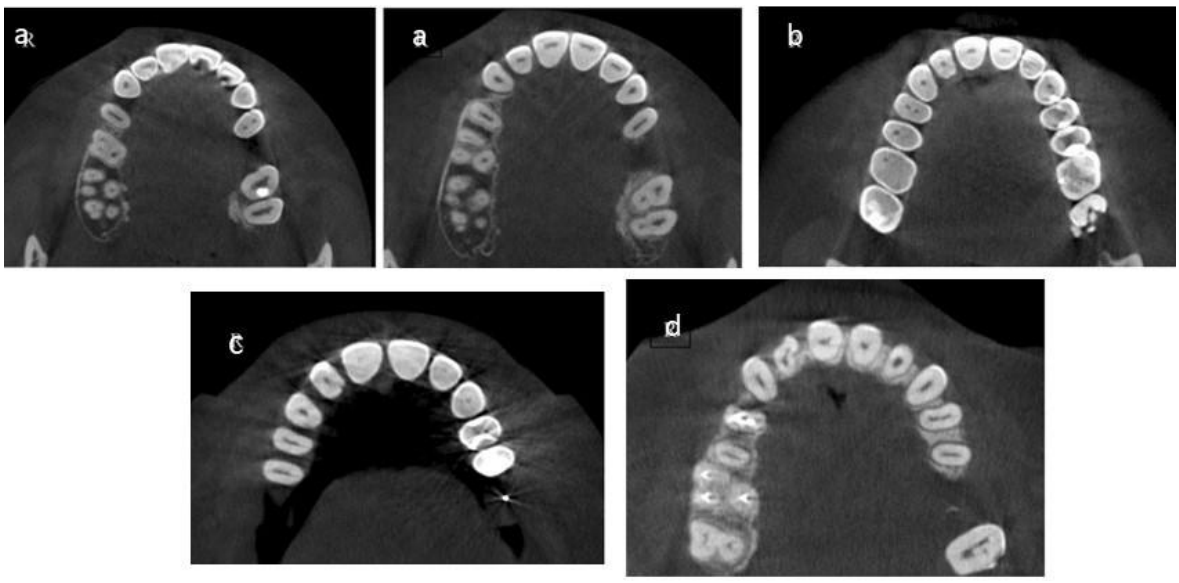

Figure1. a) Bilateral Type I Palatal Groove. b) Unilateral Type I Palatal Groove c) Unilateral Type II Palatal Groove d) Unilateral Type III Palatal Groove

Results

The present study aimed to determine the prevalence of palatal grooves in the lateral teeth of patients at the Azad University Dental School in Isfahan. The frequency distribution of variables has been reported, and Chi-square, Fisher's exact test, and binomial tests have been used.

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In the distribution of palatal groove prevalence by gender, 64.3% were female and 35.7% were male.

The investigation conducted at Isfahan Azad dental school demonstrated that the prevalence of palatal radicular grooves in maxillary lateral incisors among the patient population was 18.7% (95% Confidence Interval: 14.2% to 23.2%).

According to Table 1, in the distribution of palatal groove prevalence based on unilateral or bilateral presence, 71.4% were unilateral (95% CI 59.3% to 83.5%) and 28.6% were bilateral (95 %CI 16.5% to 40.7%).

Table 1. Frequency and Percentage Distribution by Unilateral or Bilateral Presence

Type	Frequency	Percentage
Unilateral	20	71.4
Bilateral	8	28.6
Total	28	100

In the prevalence of palatal grooves by type, 85.7% were Type I (95% CI: 76.3% to 95.1%), and both Type II and Type III grooves each had a prevalence of 7.1% (95% CI:0.2% to 14%). (Table 2).

Table 2. Frequency and Percentage Distribution by Type

Type	Frequency	Percentage
Type I	24	85.7
Type II	2	7.1
Type III	2	7.1
Total	28	100

According to Table 3, 24.0% of females exhibited palatal grooves, while 76.0% showed no grooves. In contrast, 13.3% of males showed palatal grooves, with 86.7% having none.

The significance level for Fisher's Exact Test was 0.142, which is greater than 0.05. Therefore, with 95% confidence, the null hypothesis of no relationship between the prevalence of palatal grooves and gender is accepted, indicating no significant relationship exists.

Table 3. Descriptive Statistics of Gender Relation to Prevalence of Palatal Grooves

Variable	Male	Female	P value
Prevalence of palatal groove	10 (13.3%)	18 (24%)	0.142
Absence of the palatal groove	65 (86.7%)	57 (76%)	

The significance level of the binomial test is 0.036, which is less than 0.05. Therefore, with 95% confidence, the null hypothesis stating that the unilateral ratio is equal to 0.5 is rejected. The unilateral ratio is greater than 50% (Table 4).

Table 4. Binomial Test for Unilateral or Bilateral Presence of Palatal Grooves

Type	N	proportion in the sample	P value
unilateral	20	0.71	0.036
bilateral	8	0.29	0.182

The significance level of the chi-square test was <0.001, leading to the rejection of the null hypothesis that the proportions of Types I, II, and III are equal. The proportion of Type I is significantly higher than that of Types II and III, with Type I accounting for approximately 86% of the sample (Table 5).

Table 5. Chi-Square Test for Equality of Proportions of Types I, II, and III Palatal Grooves

Types	N	Proportion in the sample	P value
Type I	24	0.86	34.571
Type II	2	0.07	2
Type III	2	0.07	<0.001

Discussion

Periodontal destruction and endodontic infections can result from the presence of developmental grooves, particularly those located on the palatal side of maxillary lateral incisors (23). An appropriate diagnostic test and thorough clinical evaluation play a

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crucial role in diagnosing and treating endodontic issues. Previous studies have reported the prevalence of palatal grooves to vary widely, ranging from 2.2% to 30%. Various methods have been employed to assess the prevalence of these developmental grooves, including laboratory techniques like imaging and micro-CT, alongside clinical examinations, radiographic images, and CBCT in clinical settings, yielding different results (2, 3, 12, 18). New methods, such as CBCT, provide high-resolution three-dimensional images with enhanced information about internal canal anatomy and the external root anatomy, including the extent of palatal grooves (11). Despite its potential weaknesses, such as increased radiation exposure and susceptibility to artifacts, CBCT's advantages outweigh these limitations in studies like ours. The high-resolution imaging provided by CBCT enables a detailed, non-invasive assessment of the root morphology, allowing for accurate identification of palatal grooves even in areas that may not be visible with traditional radiographs. Additionally, CBCT provides a three-dimensional perspective, enabling the assessment of grooves and their relationship with surrounding structures, a capability that is absent in traditional two-dimensional radiographs and clinical examinations. While radiation exposure is a concern, the ability to obtain comprehensive data with a single scan minimizes the need for multiple traditional radiographs, thereby reducing cumulative radiation exposure in the long run. Furthermore, modern CBCT technology incorporates dose-reduction protocols that help mitigate radiation risks**.** Traditional periapical radiographs generate two-dimensional images that are susceptible to distortion and inherent noise, which affects the accurate assessment of root morphology. Thereby, in the present study, CBCT was used to examine maxillary lateral teeth (30).

Our study found that 18.7% of maxillary lateral incisors exhibited palatal grooves, which aligns closely with other studies. The prevalence of palatal grooves in Saudi Arabia was reported to be 4.9% by Alkahtany et al. (31). Arslan et al. and Aksoy et al, respectively, revealed a prevalence of 2.3% and. 2.2% in a Turkish population (2). In India, Varun et al. found a prevalence of 3.7% (32), and Ghahramani et al. reported a prevalence of 1.58% in the Shiraz population (33). The variation in prevalence rates may be attributed to ethnic and genetic factors in the studied populations. Furthermore, sample size can influence prevalence rates. In our study grooves were mostly unilateral and Type I, which is in accordance with previous studies.

In the present study, CBCT, only two patients had Type II and two had Type III grooves. The exclusion of patients with extracted or endodontically treated teeth in the present study may have introduced a potential bias to the research, as it is more likely that these teeth might have had the more severe grooves. Consequently, our study may underrepresent the true prevalence of deeper grooves (Types II and III). This may limit the generalizability of our results, as it might not represent the true severity of grooves in the population**.**

Females constituted 64.3% of patients presenting with palatal grooves. This prevalence may be attributable to a greater likelihood of women visiting dental clinics rather than males. However, there was no significant difference in the prevalence of palatal grooves between genders, which is consistent with findings by Aksoy et al. (34). Our study predominantly identified unilateral grooves, with a prevalence of 71.4%, aligning with the study of Alkahtany et al (31).

The results of the present study indicate that the palatal groove was not a rare finding in the studied population. Dentists should always consider the possibility of this and other developmental anomalies during examinations and treatment planning. Palatal grooves are clinically significant due to their

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propensity to create areas for plaque and calculus accumulation, as well as potential periodontal problems and pulp lesions.

Conclusion

In conclusion, 18.7% of the studied population showed developmental palatal grooves in their maxillary lateral incisors. This developmental anomaly was predominantly of Type I and presented unilaterally. Given the clinical significance of palatal grooves in the development of periodontal and endodontic complications, dental practitioners need to remain vigilant in assessing these grooves during routine examinations. Early identification of palatal grooves can facilitate timely intervention, prevent potential complications and improve long-term dental outcomes.

Conflict of Interests:

The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial, or non-financial in this article

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