

Original Research Article

Evaluation of Morphology and Prevalence Of Palatogingival Grooves on Affected Maxillary Anterior Teeth using Cone-Beam Computed Tomography

Abstract

Background: Palatogingival groove (PG), a developmental anomaly, originates in cingulum and extends to varying distances apically. It is an ideal pathway for oral bacteria to invade periodontal tissues causing periodontal damage, pulp necrosis, apical periodontitis and endo-periodontal deformity which is not easily perceived until sinus tract infection appears in mouth. **It presents a challenge to most clinicians as it requires an interdisciplinary approach to diagnosis and treatment planning.**

Aim and objective: To evaluate the prevalence and characteristics of palatogingival grooves (PGs) in maxillary anterior teeth on CBCT.

Material and methods: CBCT examinations of 707 teeth in 120 patients (Female-41, Male-79) were evaluated retrospectively. Maxillary central incisors, lateral incisors and canine were investigated for the presence or absence of **PGs and PG type** using the Gu classification (type I, II, or III). **3D CBCT image** were used for evaluation of PGs. Radiographic features of PGs were noted and differences were evaluated and results were obtained. Differences was considered significant for $p \leq 0.05$.

Results: The PGs were observed in 61 teeth. Type 1 PG is found more prevalent in males (30.37%) than in females (12.19%) followed by type 2 (male-12.65%, females-4.87%) and type 3 (male-3.75%). Higher prevalence for Type 1 PG was seen in the lateral incisor followed by central incisor and canine and had a male predominance. Type 2 PG showed equal prevalence for lateral & central incisor and male predominance. Type 3 PG showed higher prevalence for lateral incisors and male predominance.

Conclusion: Prevalence of PGs was found to be 8.62%. PG facilitate bacterial colonization leading to periodontitis, pulp necrosis and endo-periodontal lesion **in an apparently normal tooth** which pose challenges in **its diagnosis and management for survival of tooth**.

Keywords: Palatogingival groove, developmental anomaly, Gu classification, Endo-periodontal lesions, CBCT, survival of tooth.

Introduction

Palatogingival groove (PG) or radicular lingual groove(RG) is a developmental anomaly during which an infolding of the inner enamel epithelium and Hertwig's epithelial root sheath create a groove that passes from the cingulum of maxillary incisors and extends to varying distances in an apical direction within the root.^[1,2] Lack of knowledge of morphology of the root canal system, PGs and its variations may result in failure of endodontic treatment.^[3,4] PG is typically found on the lingual surface of maxillary incisor teeth.^[5-7] Among the incisors, the maxillary lateral incisors are the foremost commonly affected teeth.^[8,9] **PGs are not clinically seen except the cingulum and the cemento-enamel junction appear irregular and distorted within the region of the groove making them difficult to diagnose clinically.**^[4]

Conventional radiography is a non-invasive clinical means for obtaining a 2-dimensional outline of the root canal morphology. However, it is limited in providing details about anatomic variations, therefore Cone-beam computed tomographic (CBCT) imaging has been widely employed in the field of endodontics. CBCT imaging helps to visualize the communication between the pulp and periodontium, determine the depth and length of the PGs, and elucidate the internal anatomy of the root canal system, therefore, helps in successful endodontic treatment. CBCT also has an ability to inspect small structures and variations as well as high resolution and lower radiation exposure.^[10]

Hence, the purpose of this study was to radiographically evaluate the morphological characteristics and the prevalence of PGs in maxillary anterior teeth on CBCT.

Methods and material

The study was conducted in the Department of Oral Medicine and Radiology. The study protocol was approved by the Institutional Ethics Committee (SDKS/PG/STRG/OMR3/Dated 21.12.2020). For this retrospective study, the CBCT scans of anterior maxillary teeth which were undertaken to evaluate the anterior region for endodontic and surgical intervention purposes were utilized for this study.

Low-quality image scans with scattering or insufficient accuracy of bony borders in the anterior region, errors/distorted images, and patient movement artifacts were excluded. Anterior teeth with dental caries, direct or indirect restorations, rotation, impaction, or

congenital malformations were also excluded from the study. Evidence of bone disease, skeletal asymmetries or trauma, congenital disorders, or anamnesis of previous surgical procedures and syndromic patients were excluded.

Maxillary central incisors (CI), lateral incisors (LI), and canines (CN) were investigated for the **presence or absence of PG and PG type using the Gu classification (type I, II, or III)**^[11]. **3D CBCT scans** were used for the evaluation of PGs. The examiners were calibrated to acknowledge PGs and to identify the affected teeth and surrounding structures. The examiners only evaluated the radiographs and were blinded to other patient data during the radiographic examination. Data from CBCT evaluation of 707 teeth (central incisor-231 teeth, lateral incisor – 236 teeth, canine- 240 teeth) was analyzed retrospectively. The final diagnosis and radiographic condition of **affected maxillary anterior tooth** was obtained by consensus among the examiners. The data was recorded and analyzed using statistical software “STATA” version 10.1, 2011 (StataCorp LP, Texas, USA).

Descriptive statistics were used **to calculate** quantitative variables by mean and variance and qualitative variables by frequency and percentages. Test of significance and p values are used for inferential statistics. Difference was considered significant for a value of $p \leq 0.05$.

Results

In the present study, 707 teeth in 120 patients (Males-79, Females-41) were evaluated retrospectively as per Gu classification [Fig 1]. Type 1 PG was found in 24 males and 5 females, Type 2 PG was found in 10 males and 2 females, and Type 3 PG was found in only 3 males (Graph 1). Out of total screened teeth, PGs were found in 61 teeth. Type 1 PG was found in 38 teeth, Type 2 PG in 20 teeth and type 3 in 3 teeth (Graph 2).

Type 1 PG is more prevalent in males (30.37%) than in females (12.19%) followed by type 2 (male-12.65%, females-4.87%) and type 3 (male-3.75%). A Higher prevalence for Type 1 PG was seen in the lateral incisor followed by central incisor and canine and had a male predominance (Graph 3). Type 2 PG showed equal prevalence for lateral & central incisors and had a male predominance (Graph 4). Type 3 PG showed a higher prevalence for lateral incisors and male predominance (Graph 5).

The prevalence was higher in maxillary lateral incisors than in other teeth for both sexes. For male, it was 12.65% and for females, it was 9.75%. Two bilateral cases of PGs were found, one in lateral incisor and the other in canine. There was no statistically significant difference found between the sex ($p=0.30$).

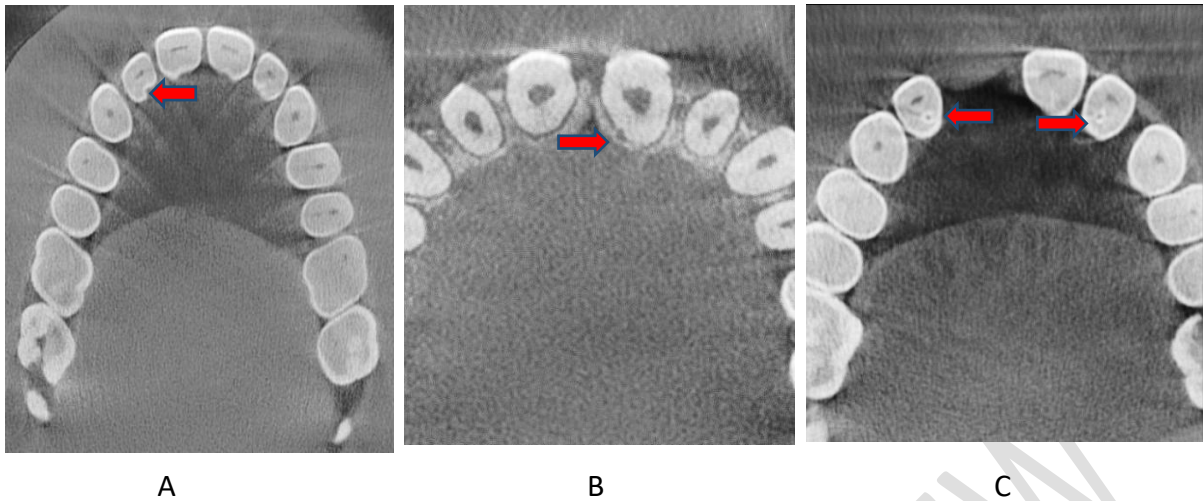
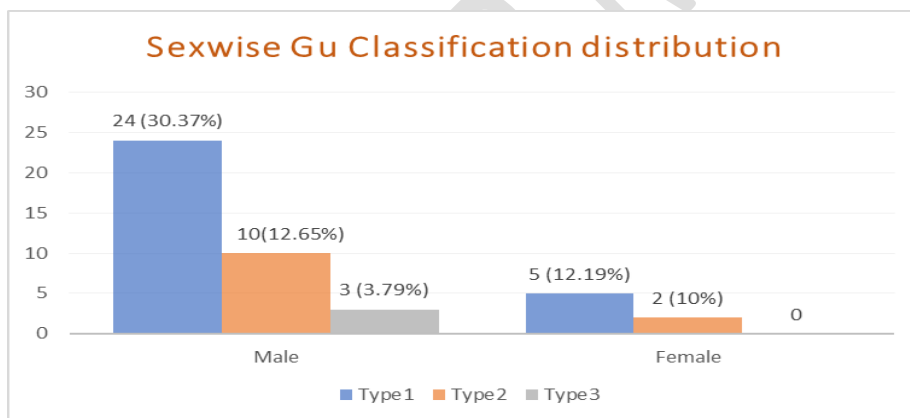
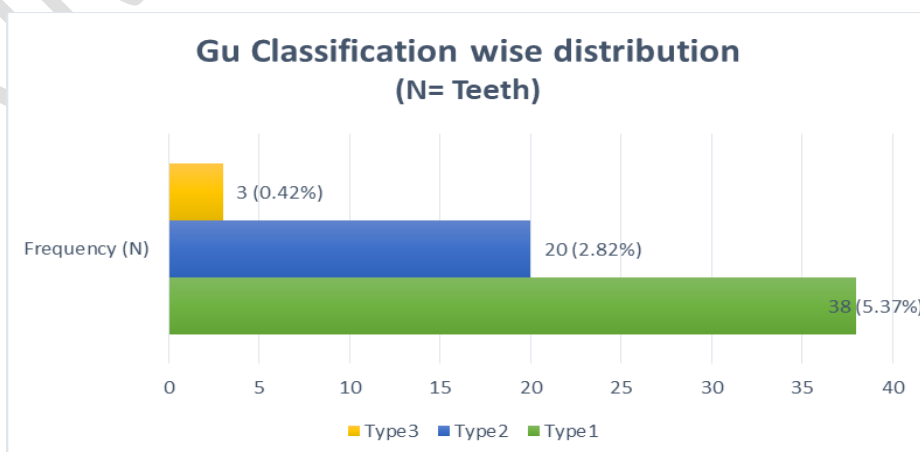


Figure 1: Radiographic image scans showing Gu classification Type 1 (A), Type 2 (B) and type 3 (C).

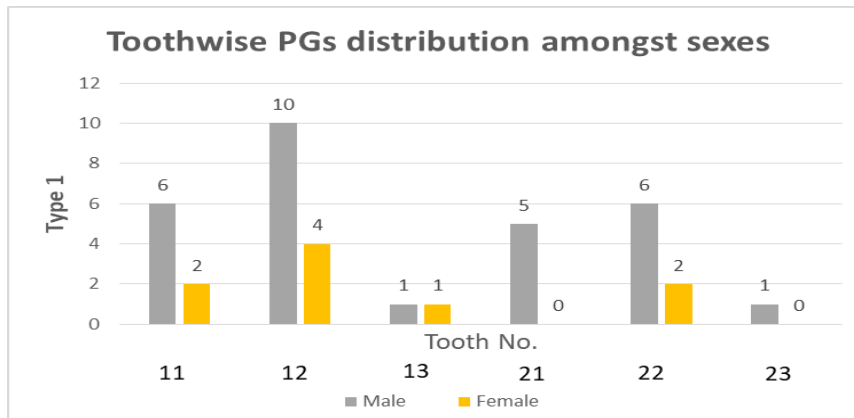
Graph-1: Sex-wise Gu classification distribution of Palatogingival Groove



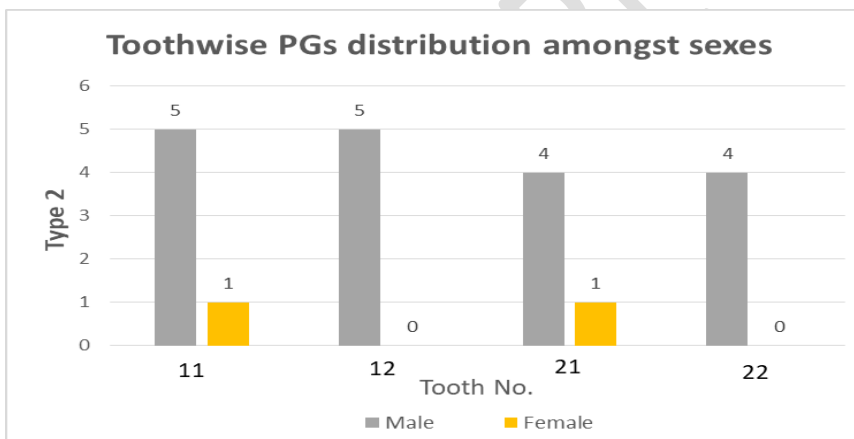
Graph 2: PGs Gu classification distribution in teeth



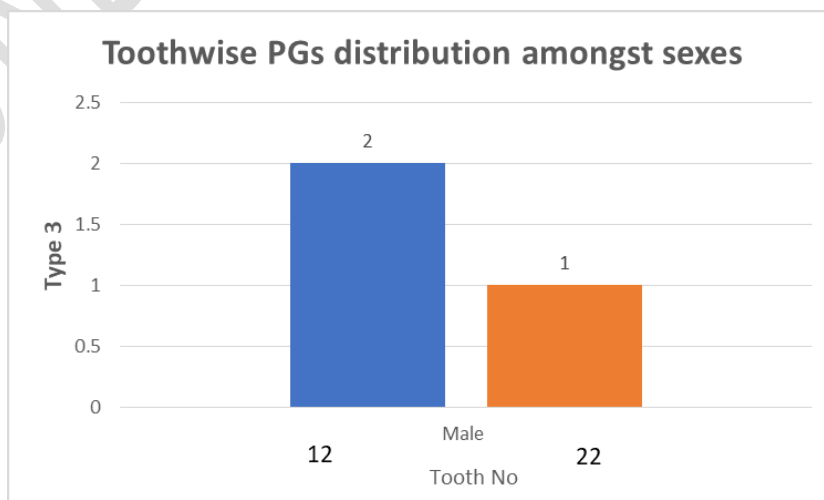
Graph 3: Tooth-wise Type 1 PG distribution amongst the sexes



Graph 4: Tooth-wise Type 2 PG distribution amongst the sexes



Graph 5: Tooth-wise Type 3 PG distribution amongst the sexes



Discussion

The maxillary anterior region and teeth show various morphologic and anatomic anomalies, including **globulomaxillary cyst**, cleft palate, congenital absence of a tooth, supernumerary tooth, dens invaginatus, Eagle's talon, peg-shaped lateral incisor, germination, fusion, accessory root, and palatogingival grooved incisors.^[5, 6]

Clinically, patients with PG may have a pathologic lesion and often complain of dull intermittent or acute pain or mobility of the teeth, pain on percussion, pus discharge with sinus tract formation, and gingival swelling. In most of cases, patients may have no symptoms and no history of dental caries, trauma, or discoloration of the teeth. Cases with advanced lesions along deep grooves frequently show no response to thermal or electric pulp vitality testing. If the pulp is primarily infected, a teardrop-like radiolucency may be observed in a radiograph and misdiagnosed as a possible fracture. This can be the rationale why PGs are difficult to diagnose sometimes clinically.^[7]

Evaluation of PGs has been performed in vitro using photographs and micro-computed tomography and in vivo using the clinical examination.^[12] **The complex anatomy of PG calls for detailed knowledge of the dental root's internal morphology for the successful planning of endodontic therapy.**^[13]

Periapical radiographs provide 2-D images of anatomic structures, and the superimposition of adjacent tissues may obscure the true nature of these anomalies and the extent of periodontal damage. CBCT is especially useful in endodontics for the identification of anatomic features and variations of the root canal system and also demonstrate the dimensions of groove and extent of invagination, its communicating nature, the site of bifurcation, the volume of bone loss, and thus, the approximate amount of graft required for filling the defect.^[13]

Gu^[11] demonstrated that PGs could be detected in axial, coronal, and sagittal sections of images, which prompted the detection of PGs using CBCT in this study. Different classifications of PGs have been suggested according to their location, origin, and termination. Recently, Gu^[11] classified PGs into 3 types according to the degree of severity based on micro-computed tomography studies viz type I, type II, and type III. **Type I- Groove not beyond coronal third of root, Short groove. Type II- Groove long extends beyond coronal third, shallow groove with normal canal. Type III- Groove long extends beyond coronal third, deep groove with complex canal system.**

A recent study by Arslan et al^[14] examined CBCT images of 416 patients (age 8–68 years) in a Turkish population and their study reported that the PG incidence in the lateral incisors (2.3%) was higher than the central incisors (0.6%). Prevalence for PGs for males was 6.9% and for females was 1.02% whereas the prevalence of PGs for males is 30.37% and for females 12.19%, **in the present study.**

The study conducted by Akshoy et al^[4] on 191 patients on CBCT in turkey reported only type 1 PGs and prevalence was 4.18% whereas **present study found** a prevalence 5.37% for type 1.

Everett & Kramer^[15] and Kogon^[16] conducted a study on extracted teeth and reported PG prevalence of 2.8% and 4.6% respectively.

Withers et al^[8] reported 8.5% PG prevalence and was predominantly found in the maxillary lateral incisors with 93.8% prevalence. A clinical study by Bacic' et al^[9] divided the subjects into two groups comprising young adults (age 20–22 years) and adults with periodontal disease (age 35–50 years) and reported PG incidences of 1.01 and 0.79%, respectively. Pe'cora and da Cruz-Filho^[17] and Hou and Tsai^[18] reported 25 teeth with PGs and prevalence of 44.6% respectively.

The clinical study was conducted by Shrestha D et al^[2] in Nepal on 231 patients. The study reported prevalence for type 1 with female predilection (56.6%) and for males it was 43.3% whereas **the present study showed prevalence of 30.37% for type 1 PG with male predilection and for females, it was 12.19%.**

Previously, teeth with PGs were usually extracted because of the complicated endo-periodontal damage and hopeless prognosis. Over time, many attempts had been made to treat and save these teeth by various therapeutic options like scaling and root planning, periodontal regeneration, guided periodontal tissue regeneration, endodontic surgery, and intentional replantation.^[19,20]

Treatment modalities depend on the severity of the endo-periodontal lesion because the periodontal environment and root canal system have complex communications and therefore, root canal therapy (RCT) alone is not effective. Therefore, the prognosis of a tooth with a PG depends mainly on the severity of the periodontal involvement because of its extent, depth, and accessibility of the groove. Moreover, the depth of PG is the main factor affecting the complexity of a root canal system and root contour, and eventually alters the treatment methodology employed i.e RCT and periodontal surgery.^[21,11]

CBCT images allowed the best visualization of the depth of the grooves and also the complications involved in treating the condition. The key to achieving long-term favorable results in the treatment of PG is an accurate diagnosis, elimination of grooves, and thorough infection control. Intentional replantation is an efficient therapeutic approach for this sort of deformity and can improve the prognosis, particularly in type II and III PGs. Clinicians' awareness and understanding of the peculiarities of PGs may help to avoid improper diagnosis and treatment of patients.^[10]

Conclusion

Limited data are available in the **literature regarding evaluation of PGs in maxillary anterior teeth using CBCT. CBCT provided precise diagnostic information and helped in mapping of PGs.** Type I was the most common PG type. The frequency of PGs was higher in males than in females and was higher in maxillary lateral incisors which were 12.65% for males and 9.75% for females for type 1. The prevalence of PGs in this study was found to be 8.62%. As the morphology of PGs pose challenges in its diagnosis and treatment to most clinicians, it requires an interdisciplinary approach in the treatment planning. PGs were a relatively infrequent anomaly of teeth in this population, but when present, clinicians should

understand the clinical features of these root variations and plan the treatment according to these variations.

Limitations

A limitation of this study is the utilization of various field of view (FOV) sizes within the CBCT unit. The use of different FOV sizes for imaging single or multiple quadrants, scattered radiation can affect the quality and standards of the images. Further studies need to be conducted to check the quality of images with fixed FOV sizes.

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Conflict of Interest:- There is no conflict of interest in this study.

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