



# Cone-Beam Computed Tomographic Evaluation of Radicular Grooves in Maxillary Anterior Teeth in a Selected Iranian Population

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## ABSTRACT

**Introduction:** The region of maxillary anterior teeth is susceptible to numerous anomalies such as radicular groove (RG). RG usually begins by the cingulum of the tooth and proceeds to the root surface in various lengths and depths. This anomaly can prone the tooth to periodontal and endodontic pathosis. The aim of this study was to evaluate the prevalence of RG in maxillary anterior teeth in an Iranian population using cone-beam computed tomography (CBCT). **Methods and Materials:** A total of 552 CBCT images of maxillary anterior teeth were randomly selected from the archive of a radiology clinic in Shiraz, Iran. Eighteen hundred maxillary anterior teeth met the inclusion criteria. The variants including patient's gender, tooth type, presence or absence and unilateral or bilateral incidence of RGs, their types, and mesiodistal location of RGs were analyzed using the *Chi-square* test. **Results:** RGs were diagnosed in 0.5% of central incisors, 2.6% in lateral incisors and 0.16% in canines. The prevalence of RGs in maxillary incisors and maxillary anterior teeth were calculated 1.58% and 1.11%. Statistical analysis showed that there was no significant relationship between gender and the presence, symmetry and location of RGs, but different tooth types had significant differences in the presence of RGs. **Conclusion:** In this cross sectional study the prevalence of RG had higher frequency in lateral incisors in comparison with canines and central incisors. CBCT is very useful in RG cases and is beneficial in RG diagnosis and treatment planning.

**Keywords:** Cone-Beam Computed Tomography; Dental Anomalies; Radicular Groove

## Introduction

The radicular groove (RG) is an infrequent anomaly of maxillary anterior teeth that originates around the cingulum of tooth proceeding disto-apically along the root trunk in various lengths [1-3]. Although RGs etiology is not clear, but researches considered its origin as: *i-* enfolding of inner enamel organ and Hertwig's epithelial root sheath *ii-* genetic mutations [4-7]. Other RG terminologies are the palatogingival groove, the palatal groove, the radicular lingual groove and the distolingual groove [8-10]. The situation of maxillary lateral incisors is more susceptible to embryologic threats [11, 12]. Consequently, higher incidence rate of developmental anomalies such as cleft palate, supernumerary teeth and peg shaped maxillary lateral incisors, may occur [13-15]. Therefore, RGs mainly occur in maxillary lateral and central incisors, and in maxillary canines which is less prevalent [3, 11, 16].

While Bacic *et al.* [10], classified RGs according to their location. Kogon [3] classified RGs based on their location, origin and termination. The most recent RGs classification was done by Gu [17], which divided RGs into three categories based on micro-computed tomographic studies as follows: type I, short grooves (RG is in the coronal third of the root); type II, long and shallow grooves (RG extends beyond the coronal third of the root, with simple canal); type III, long and deep grooves (RG extends beyond the coronal third of the root leading to a complex root canal system) (Figures 1A to 1C) [17].

RGs may be asymptomatic, however, they could result in periodontal pathology, in addition to secondary pulpal involvement, if RG belongs to Gu's type III classification [10, 17].

Via the attachment loss of RGs, accumulation of bacterial plaque and calculi results in inflammatory reaction that initiates periodontal pockets as well as severe localized periodontitis [18,

19]. Moreover, the defected area is not easily accessible for patients or even the professional to clean and control oral hygiene [20, 21].

Ethnicity, different study methods and ways of sampling affect RG's prevalence in different ethnic groups [1, 17, 22].

There are several methods in evaluating RGs; clinical examinations and conventional radiographs are such methods that unfortunately cannot provide adequate information on details of RG [3, 19, 23]. Cone-beam computed tomography (CBCT) is a three dimensional noninvasive method that provides useful information on head and neck structures by limiting the beam dose that a patient is exposed to [24, 25].

The aim of this study was to evaluate the prevalence of RG in maxillary incisors of an Iranian population using CBCT. To the best of our knowledge, no other study has been carried out with such an aim.

## Materials and Methods

High quality CBCT images of 1800 maxillary permanent anterior teeth of 552 patients were gathered by convenient sampling of an oral and maxillofacial radiology central clinic in Shiraz, Iran. The images consisted of 600 central incisors, 600

lateral incisors and 600 canines. These patients were referred to this clinic for different problems such as complex endodontic conditions or evaluations for implants from 2015 to 2017. Consequently, unnecessary exposure to beams was avoided. The CBCT images were prepared by a NewTom VGI (QR S.r.l-Verona-Italy) device with the voxel size of 200  $\mu$ m (medium resolution), exposure time of 1.8 sec, 110 kVp, 4 mAs, field of view of 6 cm $\times$ 6 cm to 15 cm $\times$ 15 cm, focal spot of 0.3 mm and the section thickness was 0.3 mm.

The inclusion criteria were having bilateral anterior tooth. Some features that could exclude the images from the study were: open apex, extensive crown restorations, presence of posts or canal obturations in the root canal, impact or primary anterior teeth, internal or external resorptions, deep and extended caries and clefts.

The images were evaluated by a dentist and an endodontist using NTT Viewer software program (version 4.6.5, NTT Software Corporation, Yokohama, Japan) using axial, coronal and sagittal plans. Those depressions were diagnosed as RGs that were extended beyond cemento-enamel junction and were visible in at least five sections to make sure dental pits are not mistaken with RGs. After eight weeks, fifty CBCT images were randomly chosen and evaluated again.

**Table 1.** RG prevalence regarding to tooth type and gender

| Variables  |                                     | Teeth total number | Prevalence of RGs | P-value |
|------------|-------------------------------------|--------------------|-------------------|---------|
| Tooth type | Permanent maxillary central incisor | 600                | 3(0.5%)           | <0.001  |
|            | Permanent maxillary lateral incisor | 600                | 16(2.6%)          |         |
|            | Permanent maxillary canine          | 600                | 1(0.16%)          |         |
| Gender     | Female                              | 184                | 11(5.97%)         | 0.569   |
|            | Male                                | 116                | 6(5.17%)          |         |

**Table 2.** RG prevalence in maxillary anterior teeth according to Gu's classification

| Tooth type                          | Teeth total number | Type of RG |         |          |
|-------------------------------------|--------------------|------------|---------|----------|
|                                     |                    | III        | II      | I        |
| Permanent maxillary central incisor | 600                | 0 (0%)     | 0 (0%)  | 3 (100%) |
| Permanent maxillary lateral incisor | 600                | 0 (0%)     | 8 (50%) | 8 (50%)  |
| Permanent maxillary canine          | 600                | 0 (0%)     | 0 (0%)  | 1 (100%) |

**Table 3.** RG prevalence in male and female, and bilateral/unilateral incidence

|                       | Female     | Male      |
|-----------------------|------------|-----------|
| Unilateral RG         | 10 (5.43%) | 4 (3.45%) |
| Bilateral RG          | 1 (0.54%)  | 2 (1.72%) |
| Total RGs' prevalence | 11 (5.97%) | 6 (5.17%) |

**Table 4.** RGs mesiodistal location according to the tooth type

| Tooth type                          | Location  |          |           |
|-------------------------------------|-----------|----------|-----------|
|                                     | Mesial    | Palatal  | Distal    |
| Permanent maxillary central incisor | 2 (66.6%) | 0 (0%)   | 1 (33.3%) |
| Permanent maxillary lateral incisor | 1 (6%)    | 15 (94%) | 0 (0%)    |
| Permanent maxillary canine          | 0 (0%)    | 0 (0%)   | 1 (100%)  |



**Figure 1.** A) Unilateral palatal RG of maxillary left lateral incisor (Type I); B) Bilateral palatal RG of maxillary lateral incisors (Type I); C) Bilateral palatal RG of maxillary lateral incisors (Type II)

Patient's gender, tooth type (central incisors, lateral incisor or canine), location of RG, bilateral or unilateral RG incidence and type of RGs according to Gu's classification (Type I, II or III) were evaluated in the present study

#### Statistical analysis

Statistical analysis was performed by SPSS software (version 22, SPSS, Chicago, IL, USA) using the *Chi-square* test to evaluate presence/absence, relevance to gender, tooth type and RG type.

#### Results

CBCT images were examined on each reviewer (a dentist and an endodontist). After a two-week interval the CBCTs were examined again. Intra observer reliability of the reviewer was calculated by test-retest method, Cohen's Kappa value was 0.93. If there was any doubt, the oral and maxillofacial radiologist was consulted for the final decision. A total number of 552 CBCT images of maxillary anterior teeth were examined and 1800 maxillary anterior teeth passed the inclusion criteria. The rest were excluded from the study. Amongst the included teeth, 20 teeth revealed RGs in their structures. Tables 1 to 4 show the results.

Totally, 5.6% of patients had affected teeth, and the 1% that showed RGs bilaterally in their maxillary anterior teeth in lateral incisors. The remaining patients (4.6%) had RGs unilaterally. RGs were diagnosed in 0.5% of the central incisors, 2.6% in lateral incisors, and 0.16% in canines.

The prevalences of RGs in maxillary incisors and maxillary anterior teeth were calculated at 1.58% and 1.11%. Statistical analysis shows that the prevalence of RGs was significantly different between maxillary anterior teeth. Thus; lateral incisors had the highest incidence rate ( $P < 0.01$ ). Also, there was no significant relationship between males and females regarding the presence or absence of RGs ( $P = 0.569$ ).

Results showed that Gu's type I classification had the highest prevalence of 60% amongst the teeth with RGs (12 out of 20 teeth

with RG), Type II had 40% of RGs (8 out of 20 teeth), and there were no Type III.

The present study showed that 75% of teeth with RGs had the groove on their palatal aspect and RGs were located in the proximal sides in only 25% of these teeth. On the contrary to central incisors and canines that RGs were always found on their mesial or distal aspect, the lateral incisors RGs were dominantly seen on their palatal surface (94% of lateral incisors).

#### Discussion

Evaluating teeth structure and anomaly is important to conduct proper dental treatments [26]. RG is an anomaly that can induce endodontic and periodontal problems [27-30]. Due to basic role of anterior teeth in esthetics, biting and speech, it is essential to study RGs to prevent unfavorable outcomes [31].

Studies have utilized different methods to study RGs as follows: clinical examination [10, 32], serial sections and scanning via electron microscopes [33], *in vitro* studies on extracted teeth [11, 23], micro-CT [17] and CBCT [1]. The shortcomings of *in vitro* studies are tooth structure destruction as missing details in clinical examinations, while using CBCT as a diagnostic tool avoids the mentioned disadvantages [17, 34]. Furthermore, CBCT is the most practical method in studying RGs, which is noninvasive, three dimensional, high resolution and it doesn't expose the patient to too much conventional CT beams [1, 24].

In the present study the prevalence of RG among men and women were calculated 5.17% and 5.97%, respectively, but the statistical analysis showed that there were no significant differences between two genders for the presence of RG. In accordance to our study, the study by Shrestha *et al.* [32] showed higher frequency of RG in women. However, Hakan *et al.* [1], reported higher prevalence of RG in men. These differences might be related to ethnicity, sampling methods and the size of study samples.

For the first time, Lee *et al.* [2], presented the fact that RGs might occur bilaterally. The preset study showed that unilateral cases (4.6%) are dominantly more common than bilateral ones (1%). In line with Hakan *et al.* [1], that had reported unilateral and bilateral incidence of RGs 3.6% and 0.5%. It can be stated that bilateral incidence usually occurs in lateral incisors.

The prevalence of RG varies in different researches. In the present study, the prevalence of RG was calculated 1.11 % in maxillary anterior teeth and 1.58% in maxillary incisors. Statistical analysis showed that there were significant differences between tooth types in the presence of RG, and the prevalence of this anomaly had the highest frequency of 2.6% in lateral incisors, the prevalence was 0.5% and 0.16% in maxillary central incisors and canines, respectively. Hakan *et al.* [1], used CBCT to evaluate RGs and reported the prevalence of 2.3% for lateral incisors and 0.6% for central ones, and reported the lateral incisors as the most susceptible maxillary tooth to RGs. Shrestha *et al.* [32] conducted a clinical study on 1362 maxillary anterior teeth in 2014 and stated that 6.06 % of maxillary anterior teeth, 0.88% of lateral incisors and 0.2% of canines had RGs in their structure. Bacic *et al.* [10], evaluated 1081 patients clinically and reported that 1.01% of patients had this anomaly in their teeth. Kogon *et al.* [3], used a dissecting microscope to examine 3168 extracted central and lateral maxillary incisors. The results showed that the prevalence of RGs was 4.6%, 5.6% and 3.4% in maxillary incisors, maxillary lateral incisors and maxillary central incisors, respectively. These differences in various studies can be due to applying different methods and devices or differences in population, variations in sampling methods or other unknown reasons.

The present study revealed that RGs mostly occur on the palatal aspect of the teeth with 75% of cases, and 94% of the affected lateral incisors grooves occur on their palatal surfaces. While all the affected central incisors and canines showed the anomaly on their proximal sides. In line with our results, the study by Kogon *et al.* [3] reported that RGs were found on the mid palatal surfaces of 62% of the lateral incisors and 45% of central incisors. However, Bacic *et al.* [10] reported mesial and distal aspects of the affected teeth to be more susceptible to RGs.

CBCT imaging has its own disadvantages such as high cost and higher radiation dose than conventional radiographs, hence its usage should be limited to cases that previously had been examined clinically by periodontal probes and are suspicious for the presence of RGs [1].

## Conclusion

The prevalence of RGs has been calculated 1.58% in Iranian population and it is essential to study RGs to prevent unfavorable

outcomes. CBCT scanning should be utilized to diagnose the RG anomaly in dubious cases after accurate clinical examinations to achieve best clinical success.

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Conflict of Interest: 'None declared'.

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