Original Article

Evaluation of the Effect of Apical Lesion on Mucosal Thickening and Thickness of Apical Bone Using Limited Cone-Beam Computed Tomography

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Abstract

Objective: The purpose of this study was to evaluate the effect of periapical lesion size on the degree of mucosal thickening of maxillary sinus and thickness of apical bone using cone-beam computed tomography. **Materials and Methods:** In Group 1 (teeth with apical lesions), diameter of apical lesion, width of apical bone, thickness of Schneiderian membrane; for Group 2 (teeth without apical lesions), width of apical bone in long axis of root and thickness of Schneiderian membrane were measured on coronal and sagittal images. **Results:** Mann–Whitney U-test revealed no significant difference between two groups regarding mucosal thickening and apical bone measurements ($P > 0.05$). Wilcoxon signed-rank test showed no significant difference between the measurements in sagittal and coronal slices ($P > 0.05$). **Conclusion:** Results of the present study showed that Schneiderian membrane near the maxillary premolars and molars with apical lesions is not significantly thicker compared to teeth without apical lesions.

Date of Acceptance: 23-May-2018

Keywords: *Apical, apical lesion, cone-beam computed tomography, maxillary sinus, Schneiderian membrane*

Introduction

Maxillary sinus is in very close proximity to maxillary posterior teeth because of anatomic localization. This close anatomic proximity provides a potential source for the spread of periapical and periodontal infection to the maxillary sinuses.[1,2] Accordingly, odontogenic infections play an important role in sinusitis formation. Bauer[3] first described this in his cadaver study and has shown that periapical inflammation may lead to changes in the sinus mucosa without causing perforation in the cortical bone of the sinus floor. He confirmed that mediators that cause infection and inflammation enter the bone trabecular spacing through blood vessels and lymphatics, thereby affecting the maxillary sinuses.[3] It was reported that etiology of 10%–12% of sinusitis cases are odontogenic factors such as apical periodontitis, periodontal disease, implants, or tooth extraction.[2] Some researchers reported that the floor of the maxillary sinus with the compact cortical bone would not allow the development of sinusitis by odontogenic infections.[4] However, other studies reported that, in the presence of sinus pneumatization or apical periodontitis, pathogens possibly penetrate the maxillary sinus floor from the soft-tissue space.[2,4,5]

Labial levator and orbicularis oculi muscles that adhere to the lateral wall of the maxillary sinus form the front wall of the maxillary sinus and can cause the transition of odontogenic infections to the maxillary sinus.[4,5] On the other hand, nonodontogenic factors such as age, gender, and allergy are thought to affect mucosal thickening.[6] There are many studies evaluating the maxillary sinus pathology in the literature.[2,6-13] However, to the best

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Access this article online

Quick Response Code:

Website: www.njcponline.com

DOI: 10.4103/njcp.njcp_307_17

How to cite this article: Kocak N, Alpoz E, Boyacioglu H. Evaluation of the effect of apical lesion on mucosal thickening and thickness of apical bone using limited cone-beam computed tomography. Niger J Clin Pract 2018;21:954-9.

of our knowledge, a limited number of studies have investigated the effect of teeth with apical lesions on sinus mucosal thickening.[2,8]

The primary aim of this study is to evaluate the effect of the apical lesion of maxillary teeth on the amount and type of mucosal thickening. Moreover, the effect of lesion diameter on the thickness of the apical bone and degree of mucosal thickening is evaluated.

Materials and Methods

This retrospective study included cone-beam computed tomography (CBCT) images of patients whose individual factors of gender, age, indication for scanning, and tooth type were recorded. The Clinical Research Ethics Committee of the Medical Faculty of Ege University approved this study (Approval no. 14-7.1/6).

Imaging procedures

The CBCT images were performed using a CBCT device CS 9000 3D Extraoral Imaging System (Kodak Dental Systems, Carestream, Rochester, NY, USA) in the Department of Oral and Dentomaxillofacial Radiology, Faculty of Dentistry, Ege University. All the images were recorded at 70 kVp and 10 mAs with a field of view of 5 cm × 3.7 cm, high-resolution bone algorithm, an axial slice thickness of 76 μm, and isotropic voxels. The images were examined in axial, sagittal, and coronal planes by a single observer.

Patient selection

The images of maxillary sinuses randomly selected from archives of the Faculty of Dentistry of Ege University were included in the study. The study was based on a retrospective evaluation of CBCT images of patients. Sixty premolar and/or molar teeth with apical lesions that met our inclusion criteria were included in the study. Sixty premolar and/or molar teeth without apical lesions were randomly selected and evaluated.

Images selected for this study had to meet the following inclusion criteria:

1. The maxillary sinus to be measured was visible from its floor to at least 6 mm in height.

The exclusion criteria for the images were as follows:

1. Images were unclear or incomplete
2. The presence of sinus pathology such as the mucocele, which rendered measurement impossible
3. Individuals with age below 18 years
4. Low-quality images
5. Images with artifacts[7,14]
6. The presence of dilacerated roots that cannot be linearly made measurement between maxillary sinus and part of the apical 1/3 root
7. The presence of severe apical periodontitis that can affect the amount of apical bone thickness.

Evaluation of the images

The lesion diameter, thickness of the apical bone, and degree of mucosal thickening were measured in teeth with apical lesions (Group 1). In teeth without apical lesions (Group 2), thickness of apical bone and degree of mucosal thickening were measured.

In both groups, premolar or molar was examined. In Group 1, teeth with apical lesions, which are endodontically treated or untreated, and in Group 2, teeth without apical lesions were studied. Bone-grafted sinuses and third molars were excluded from this study. The sagittal and coronal CBCT section images of the maxillary molar roots that have the largest apical lesions were selected for further analysis.[7]

In the coronal and sagittal section images of Group 1, measurements were performed on the teeth with apical lesion with having the largest lesion diameter and the closest relation to the maxillary sinus. Along the length of the line which is between the apical part of the 1/3 root and the maxillary sinus; lesion diameter measurements, bone thickness, and sinus membrane thickness measurements were performed, respectively [Figure 1].[7] In the coronal and sagittal section images of Group 2, along the length of the line which is between the apical part of the 1/3 root and maxillary sinus; bone thickness and sinus membrane thickness measurements were performed, respectively [Figure 2][7] (The lines of both groups are drawn parallel to the long axis of the apical part of 1/3 root).

Mucosal thickening types according to the Soikkonen and Ainamo[15] classification criteria were determined from the sagittal section images. The types of mucosal thickening were divided into five categories – normal: degree of mucosal thickening <2 mm; flat: smooth border mucosal thickening type; semispheric: polypoid style mucosal thickening type; mucocele-like: filling the sinus mucosal thickening type; and mix (flat and semispheric): including smooth and polypoid styles mucosal thickening type. Linear measurements performed in different mucosal thickening types were shown in Figure 3.

Statistical analysis

The data were statistically analyzed using SPSS 11.5 for Windows (SPSS Inc., Chicago, IL, USA). All data were first analyzed descriptively. Mann–Whitney U-tests were used for the evaluation of the degree of mucosal thickening and thickness of apical bone in Groups 1 and 2. In addition, the tests were used for the evaluation of the lesion diameter, a degree of mucosal thickening, and thickness of apical bone in the root canal-treated teeth (RCT+) and root canal-untreated teeth (RCT−). Wilcoxon signed-rank tests were used in the evaluation of the measurements made in the sagittal and coronal sections. Differences with values of $P < 0.05$ were considered statistically significant in both Mann–Whitney U-tests and Wilcoxon signed-rank tests.

Spearman's rank correlation tests were used to assess the correlation between the lesion diameter and thickness of apical bone with the lesion diameter and degree of mucosal thickening, and $r < 0.05$ was considered to be statistically significant.

Results

The demographic distribution of study population in the present study is as follows; 31 female and 29 male patients with a mean age of 39 ± 14.5 in Group 1; 34 female and 26 male patients with a mean age of 37.3 ± 13.9 in Group 2.

Group 1 included thirty premolar and thirty molar teeth with periapical lesion. Among these, 35 had root canal treatment (RCT) and 25 had no RCT. Group 2 consisted of 28 premolar and 32 molar teeth with no periapical lesion.

In terms of mucosal thickening type, when Groups 1 and 2 were examined, the most common type was, respectively, flat and normal [Figure 4].

The periapical lesion diameter has been found to be in the range 0.93–16.03 mm for Group 1. Distribution of lesion diameter is as follows: in teeth with RCT was between 0 and 5 mm in 32 teeth, >5 mm in 3 teeth, while the lesion diameter of teeth with no RCT was between 0 and 5 mm in 16 teeth and >5 mm in 9 teeth.

Groups 1 and 2 were compared using Mann–Whitney U-test in terms of the degree of mucosal

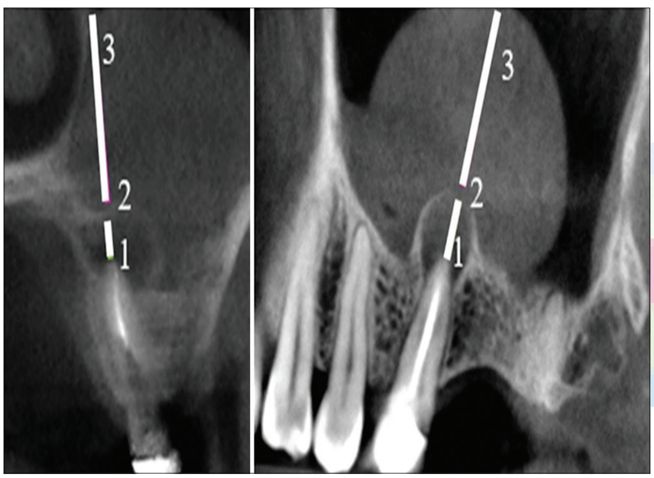

Figure 1: Linear measurements on teeth with apical lesions (1: lesion diameter; 2: apical bone thickness; 3: degree of mucosal thickening)

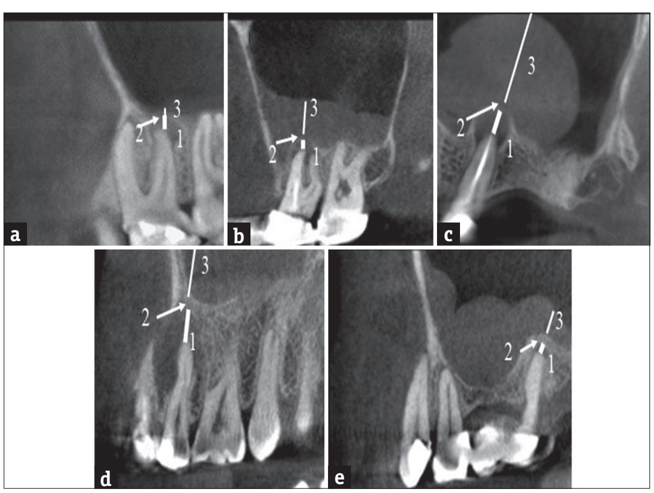

Figure 3: Demonstration of linear measurements in different types of mucosal thickening (a) normal; (b) flat; (c) semispheric; (d) mucocele-like; (e) mix (flat and semispheric) (1: lesion diameter; 2: apical bone thickness; 3: degree of mucosal thickening)

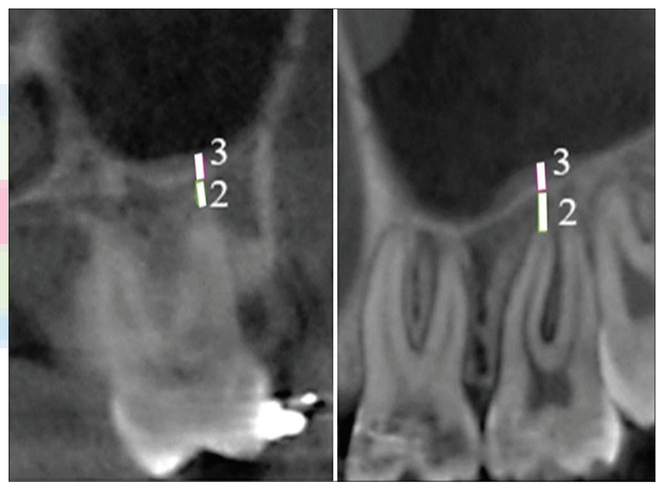

Figure 2: Linear measurements on teeth without apical lesions (2: apical bone thickness; 3: degree of mucosal thickening)

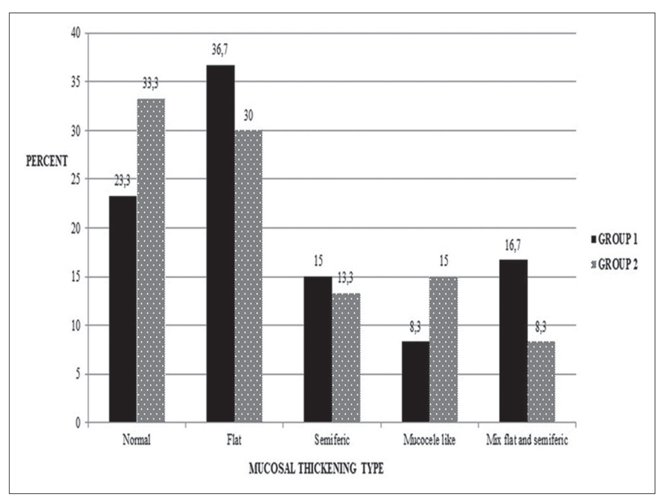

Figure 4: Types of mucosal thickening in Groups 1 and 2

thickening and thickness of apical bone in the sagittal and coronal sections, and no statistically significant difference was not found between the groups (thickness of apical bone: sagittal, $P = 0.715$; degree of mucosal thickening: sagittal, $P = 0.350$; thickness of apical bone: coronal, $P = 0.797$; degree of mucosal thickening: coronal, $P = 0.270$). Wilcoxon signed-rank test shows that the measurements made in sagittal and coronal sections were not statistically significant. (Groups 1 and 2, thickness of apical bone sagittal and coronal: $P = 0.033$; Groups 1 and 2, degree of mucosal thickening, sagittal: $P = 0.534$).

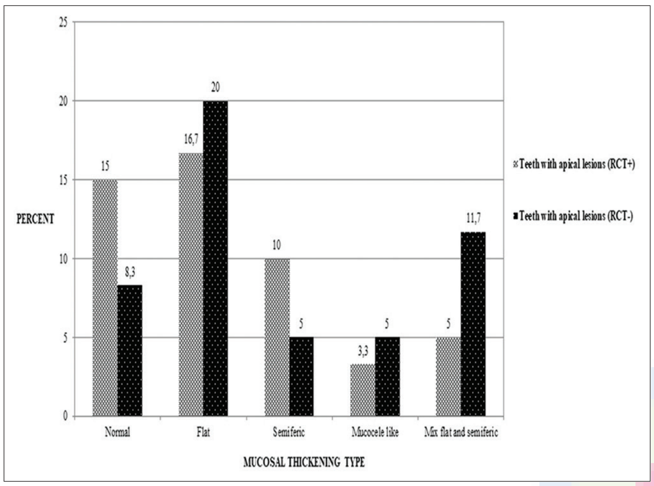

Figure 5: Distribution of teeth with apical lesions according to the presence of root canal treatment and types of mucosal thickening

Using Mann–Whitney U-test, in terms of thickness of apical bone and degree of mucosal thickening, no significant difference was found between RCT+ and RCT− (thickness of apical bone, sagittal: $P = 0.509$, coronal: $P = 0.964$; degree of mucosal thickening, sagittal: $P = 0.697$, coronal: $P = 0.758$).

When (RCT+) and (RCT−) teeth were evaluated, the lesion diameter was found to be statistically higher in (RCT−) teeth than that of the (RCT+) teeth (lesion diameter: sagittal, $P = 0.012$; coronal, $P = 0.005$). In addition, the lesion diameter in the premolar teeth was found to be greater than the molar teeth, but this difference was not statistically significant (lesion diameter: sagittal, $P = 0.433$; coronal, $P = 0.098$).

Regarding the presence of RCT, the most common type of mucosal thickening was flat in both groups [Figure 5].

In our study, Group 2 was found to be numerically greater in terms of thickness of the apical bone and degree of mucosal thickening than Group 1. However, in the Spearman's rank correlation test showed no correlation between the lesion diameter and the degree of mucosal thickening (sagittal section: $r = 0.129$, $P = 0.327$; coronal section: $r = 0.147$, $P = 0.262$) and

Table 1: Evaluation of the effect of tooth type on lesion diameter, thickness of apical bone, and degree of mucosal thickening in Group 1

	Premolar sagittal (mm)	Molar sagittal (mm)	Premolar coronal (mm)	Molar coronal (mm)
Lesion diameter	4.36	2.66	4.46	2.50
Thickness of apical bone	2.90	1.74	2.97	1.94
Degree of mucosal thickening	3.06	3.50	3.02	3.57

Table 2: Evaluation of the effect of gender on lesion diameter, thickness of apical bone, and degree of mucosal thickening in Group 1

	Female sagittal (mm)	Male sagittal (mm)	Female coronal (mm)	Male coronal (mm)
Lesion diameter	4.24	2.76	4.20	2.78
Thickness of apical bone	2.16	2.46	2.25	2.61
Degree of mucosal thickening	2.97	3.77	3.11	3.68

Table 3: Evaluation of the effect of gender on thickness of apical bone and degree of mucosal thickening in Group 2

	Female sagittal (mm)	Male sagittal (mm)	Female coronal (mm)	Male coronal (mm)
Thickness of apical bone	3.01	2.01	3.05	2.06
Degree of mucosal thickening	4.59	3.61	4.61	3.57

Table 4: Evaluation of the effect of tooth type on thickness of apical bone and degree of mucosal thickening in Group 2

	Premolar sagittal (mm)	Molar sagittal (mm)	Premolar coronal (mm)	Molar coronal (mm)
Thickness of apical bone	3.42	1.81	3.48	1.84
Degree of mucosal thickening	5.42	3.03	5.46	2.99

thickness of apical bone (sagittal section: $r = -0.139$, $P = 0.289$; coronal section: $r = 0.084$, $P = 0.524$).

Evaluation of the effect of tooth type and gender on lesion diameter, thickness of apical bone, and degree of mucosal thickening in Group 1 are presented in Tables 1 and 2.

Evaluation of the effect of gender and tooth type on thickness of apical bone and degree of mucosal thickening in Group 2 are shown in Tables 3 and 4.

Discussion

If bacterial inflammation is left untreated, it may spread toward the maxillary sinus and sinusitis may develop because of odontogenic infection, causing serious complications affecting the cranial structure and eyes.[7] Regarding the evaluation of periapical pathology, CBCT has proven to be more successful than conventional radiographies in previous investigations.[7,16,17] The studies of Low *et al*.[16] and Bornstein *et al*. demonstrated that[7] 25.9%–34% of roots with periapical lesions, either in the maxilla or mandible, were detected only in CBCT images. Moreover, Lofthag-Hansen[17] reported that mucosal thickening was seen more than 4 times as often in CBCT images, than in periapical images. Likewise Kasikcioglu and Gulsahi[18] reported that CBCT imaging was useful in showing the etiology and the borders of dental pathology regarding sinus involvement.

Therefore, in our study, the effect of apical lesions on the degree of mucosal thickening and thickness of apical bone was examined on CBCT images. To the best of our knowledge, a limited number of studies have evaluated the presence of mucosal thickening in relation to apical lesions.[2,7] However, the correlation between the lesion diameter and the thickness of apical bone and degree of mucosal thickening has not been investigated yet.

In the present study, the degree of mucosal thickening was found to be 3.38 mm in Group 1 (teeth with apical lesion) and 4.09 mm in Group 2 (teeth without apical lesion). Our findings are not in accordance with the results of a previous study stating that the presence of teeth with apical lesions increases the amount of mucosal thickening.[7] This can be explained as the role of several factors facilitating the spread of infection are also effective on mucosal thickening.[1,5] Furthermore, the number of teeth in this region and anatomic proximity, which is between the maxillary sinus and the apex of the root of posterior teeth, play an active role in facilitating mucosal thickening. Moreover, the increase in tooth loss with age, atrophy of the alveolar crest and sinus pneumatization may indirectly facilitate mucosal thickening.[6]

Our results agree with previous studies'[1,2] findings presenting an increase in the degree of mucosal thickening with bone resorption. In addition, it has also been reported that nonodontogenic factors facilitate mucosal thickening.[6] Owing to the porous structure of the maxillary bone, odontogenic infections in the palatal root of molars easily spread through the lateral wall of the maxillary sinus, which may lead to mucosal thickening.[4] This is because the roots of the molars are anatomically closer to the maxillary sinus than the roots of premolars. In our study, in the group of individuals having teeth with apical lesions, it has been identified that the degree of mucosal thickening in the molars (sagittal 3.5 mm; coronal, 3.57 mm) is greater than that in the premolars. Likewise in studies evaluating the association between the tooth type and mucosal thickening, the degree of mucosal thickening in the molars was found to be greater than that in the premolars.[9,13] In studies investigating the association between the presence of lesions and the tooth type, lesions are often found to occur in the first and second molar teeth[2,13] similar with the findings of the present study.

No significant difference in the thickness of apical bone was found between Groups 1 and 2. Systemic conditions of the patients such as chronic inflammatory diseases such as ankylosing spondylitis and arthritis may be considered to be the reason for differences between the results.[7,19,20] On the contrary, another study that evaluated the thickness of apical bone between the maxillary sinus and maxillary molars, stated that, in the presence of apical lesions, there is an increase in the thickness of the apical bone.[7]

Results of our study revealed that there is no correlation between the lesion diameter and the thickness of apical bone and degree of mucosal thickening. The difference between the findings of our study can be interpreted as the presence of both RCT+ and RCT− teeth in the study population. Accordingly, previous literature hypothesizes that RCT may initiate periapical inflammation in the sinus floor and instrumentation introduces bacteria into the sinus cavity.[4,21] Our results are in accordance with this hypothesis that mucosal thickening is found to be greater in RCT+ teeth than that in RCT− teeth numerically, but the difference was statistically significant.

In addition, our findings revealed that the lesion diameter of RCT− teeth was significantly greater than that of RCT+ teeth. As an outcome of successful endodontic treatment, a reduction in the diameter of the apical lesions was observed.[22] In our study, the thickness of apical bone was found to be numerically higher in RCT+ teeth with apical lesions than that in RCT− teeth with apical lesions, but this difference was not statistically significant. However, owing to the lack of similar studies on the topic, this finding cannot be compared with other study's results.

The main limitation of the present study is the lack of radiological follow-up of RCT teeth pre- and post-RCT. Thus, healing of the maxillary sinus pathologies could not be assessed. However, considering the amount of radiation dose given to the patient, the use of CBCT to evaluate endodontic treatment outcome is not ethical.

Conclusion

To prove the hypothesis, inflammation of maxillary premolar and molar teeth influences the thickness of apical bone and mucosal thickening. Further studies need to be conducted on larger populations.

Acknowledgment

We sincerely thank patients of Ege University, Faculty of Dentistry, who voluntarily participated in our study.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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