

THE STUDY OF THE THICKNESS OF THE ADJACENT MAXILLARY SINUS MUCOSA BY ROOTS TREATED IN CBCT

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ABSTRACT

Aim: The posterior maxilla region is proximal to the maxillary sinuses, on the other hand, many root canal treatments are performed in the maxillary posterior teeth area, thus the purpose of this study was to determine the thickness of adjacent maxillary sinus mucosa with the treated roots and also to study the effect of factors like the presence of apical periodontitis, the condition of root treatment, in CBCT images in north of Iran.

Materials & Method: In this cross-sectional study which was performed on 200 CBCT images of patients referred to an oral and maxillofacial radiology clinic, the relationship between the presence of apical periodontitis, the quality of root canal therapy, gender, and age of the patients was investigated by increasing the thickness of maxillary sinus mucosa. The data were collected and entered into SPSS V.23 software and analyzed by Chi-Square statistical analysis. $P < 0.05$ was considered significant.

Results: Increased thickness of mucosa was observed in 74.8 percent (247 cases). This increase was significantly more in men than women. A significant relationship was observed between the presence of apical periodontitis and increased thickness of mucosa, and also between incomplete root treatment and increased thickness of mucosa, whereas no significant relationship with the patients' age was observed. Furthermore, increased thickness of mucosa in teeth with root treatment was significantly more than in healthy teeth without root treatment.

Conclusion: The present study revealed that increased mucosal thickness is more prevalent among men, and the presence of apical periodontitis and on complete root treatment significantly lead to increased thickness of maxillary sinus mucosa.

Key words: Cone-Beam Computed Tomography, Maxillary Sinus, Periapical Periodontitis, Root Canal Therapy.

Introduction

The maxillary sinuses are of particular importance to the dentist because of their proximity to the teeth and their associated structures. Sinus disorders can cause symptoms similar the odontogenic diseases and abnormalities that occur inside and around the tooth can affect the sinus.¹

The apex of the premolar and maxillary molar teeth adjacent to the maxilla sinus causes the spread of dental lesions into the sinus. The low magnitude increase in maxillary sinuse mucosa in asymptomatic individuals has a prevalence of 8-29%.² This thickness is about 1 mm which is generally not seen in radiographic images and is considered as a normal finding. The thickness of the mucosa is considered as increased thickness if it is more than one millimeter and it can be of different origins.¹

Increasing the wall thickness of the maxillary sinus in patients with periapical infection is more common than those who have no history of periapical and periodontal infection,³ and has been introduced as an important indicator in the incidence of maxillary sinusitis.⁴ Studies have shown that periapical lesions and periodontal diseases increase the thickness of maxillary sinus mucosa about 58.58%.^{5,6} Also apical periodontitis, periodontal diseases, tooth extraction, and dental treatments are among the factors that increase the risk of major sinusitis.⁴

A recent study by Ehsani *et al.* revealed a significant relationship between root filling quality and apical periodontitis⁷ and a study by Brullmann and colleagues showed that patients with decayed teeth and root treatment

had more involvement in their maxillary sinus floor than those with healthy teeth and, the relationship between thickening of the maxillary sinus floor mucosa and maxillary posterior decayed tooth is significant.⁸

These studies show that the three-dimensional evaluation of maxillary posterior teeth and the determination of the thickness of the sinus mucosa can help to detect early and more efficient maxillary sinus involvement. In a study by Shahidi *et al.* an increase in mucosal thickness was seen in 40.3% of patients with an average thickness increase of 1.017 mm, 66.3% of patients had periodontal disease, and there was a significant relationship between periodontal disease, age, and gender of the patients.⁹ Khorshidi and colleagues also showed an increase in mucosal thickness of 1.8 mm in 56.4% of patients, and it was found that there was a significant relationship between increased mucosal thickness with incomplete root treatment and periapical radiolucency.¹⁰

The aim of this study was to evaluate the relationship between the thickness of the adjacent maxillary sinus mucosa and the treated roots using CBCT images in north of Iran. Also the effect of parameters such as apical periodontitis, clinical signs, age and gender on the increase in the thickness of the mucosa is investigated.

Materials & Method

This cross-sectional study was performed on 200 CBCT images that were referred to an Oral and Maxillofacial Radiology Clinic in Babol. All images were made using the CBCT Giano device (Newtom Verona Italy).

Sample size was determined 132 stereotypes based on the abnormal frequency of maxillary sinus mucosa (15-25%)^{11,9} with 95% confidence and 80% strength, and 200 stereotypes will be collected for more confidence.

The inclusion criteria for this study included:

- 1) Patients over 18 years of age.
- 2) Patients with maxillary CBCT in which maxilla and sinuses were observed bilaterally.
- 3) Patients with endodontic posterior teeth in maxilla.
- 4) Patients without prior surgery or acute trauma in maxilla.
- 5) Patients without history of allergy and sinusitis.

The checklist was prepared to check the age, gender, referral date, and medical history of the patients. The cases that were considered in the medical history were: the presence or absence of apical periodontitis, the root treatment status of posterior maxillary teeth in terms of complete or incomplete treatment, age, and gender. Information on sinusitis and allergy was recorded through a personal interview with the patients. Patients with benign mucosal cysts were also excluded. An oral and maxillofacial radiology specialist and a root treatment specialist as a viewer study the images together at a meeting and announce a single opinion. It is worth mentioning that a ruler in the NNT software is used in order to measure the thickness of the maxillary sinus mucosa. The presence or absence of increased mucosal thickness in the maxillary sinus floor in the cross-sectional, coronal and panoramic sections was investigated. In each case, the increase in the thickness of the mucosa was measured at the cross-sectional section and the highest rate was recorded.

Increasing the thickness of the mucosa was observed from the cross-sectional view and was considered normal thickness if mucosa was not seen. The thickening classification has been as follows:

Group 1: Thickness of zero or normal thickness (without increased thickness)

Group 2: Thickness between 0.1 and 2 mm

Group 3: Thickness between 1.2 and 4 mm

Group 4: thickness between 1.4 to 10 mm

Group 5: Thickness greater than 10 mm

The figure shows an image of a sample showing an increase in the thickness of the mucosa in the maxillary sinus. Also in order to assess the effect of gender and age on the increase in the thickness of the mucosa, the sex of the patients was recorded and the age of the patients was classified into three groups:

- 1) 18-40
- 2) 41-60
- 3) over 60 years.

The presence or absence of apical periodontitis and incomplete or complete root treatment are shown in the Table 1.

Parameter	Characterization
Apical Periodontitis	<ol style="list-style-type: none"> 1. Absence (normal periapical structure or small change in periapical structure) 2. Presence (changes in bone structure by decreasing the amount of minerals, apical periodontitis with a specific area of radiography, or severe or extensive periodontitis with marked and severe characteristics)
Canal Filling Length	<ol style="list-style-type: none"> 1. Appropriate- < 2mm has distance from radiographic apex 2. Inappropriate- > 2mm has distance from radiographic apex or it is located away from the apex
Canal Filling Density	<ol style="list-style-type: none"> 1. Appropriate (Density and uniformity of filling with channel walls) 2. Inappropriate (visible lateral space in filling, void in filling material, identifiable untreated canal)
Crown Filling Quality	<ol style="list-style-type: none"> 1. Appropriate (appropriate marginal matching, no sign of leakage) 2. Inappropriate (signs of overhang, inappropriate marginal matching, decay recurrence, temporary repair or no repair)

Table 1. The presence or absence of apical periodontitis and complete or incomplete root treatment

Data analysis was done using SPSS software version 23 and Chi-square test was used. *p* value values less than 0.05 were considered significant.

Results

Of 200 patients, 194 healthy teeth and 342 root treated posterior maxillary teeth were studied. Out of 342 rooted teeth, 12 of them had benign mucosal cysts and were removed from the set. Out of 330 teeth with treated root, 180 of them (54.5%) were for women and 150 (45.5%) for men. The age range of the subjects was 18 to 88 years, with an average of 44.98 ± 13.12 years. 83 sinuses (25.2%) had normal mucosal thickness (zero), in 148 sinuses (44.8%) the thickness of the mucosa was 0.1-2, in 35 sinuses (10.6%) the thickness of the mucosa was 2.1-4, in 43 sinus (13.1%) the thickness of the mucosa was 4.1-10, and in 11 sinuses (3.3%) the thickness of the mucosa was more than 10. [Table 2 & figure 1]

Variables		Number (%)
Sex	Female	180 (54.5)
	Male	150 (45.5)
Apical Periodontitis	Has	108 (32.7)
	Does not have	222 (67.3)
Mucosa Thickness	0	83 (25.2)
	0.1 - 2	148 (44.8)
	2.1 - 4	45 (13.6)
	4.1 - 10	43 (13.0)
	>10	11 (3.3)
Root Treatment Status	Incomplete	186 (56.4)
	Complete	144 (43.6)
Age	18 - 40	138 (41.8)
	41 - 60	150 (45.5)
	> 60	42 (12.7)

Table 2: Demographic data of the studied variables

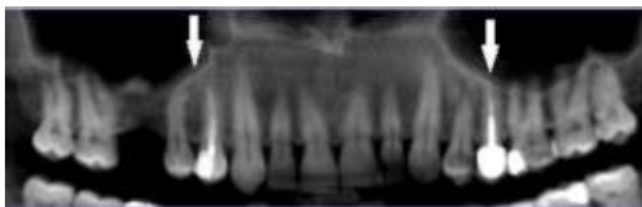


Figure 1: The shape of a panoramic image of CBCT shows an increase in the thickness of the mucosa in the maxillary sinuses. (Flash tip)

The difference in thickness of the sinus mucosa is presented separately in Table 3. As shown in Table 3, there is a significant difference in the thickness of the maxillary sinus mucosa between the two sexes, and the mucosal thickness of the men was higher than that of women ($p=0.001$).

For apical periodontitis, 108 teeth (32.7%) had no lesion and 222 teeth (67.3%) had lesion. Among patients with apical periodontal disease, only 40 cases (37%) had normal mucosal thickness and 179 cases (80.6%) showed increased thickness. [Table 2,3]

There was a significant relationship between the thickness of sinus mucosa and the presence of apical periodontitis in patients.

Variables		0	0.1 - 2	2.1 - 4	4.1 - 10	10 +	p-Value	Mean ± SD (Middle)
Sex	Female	61 (33.9)	74 (41.1)	16 (8.9)	23 (12.8)	6 (3.3)	0.001	2.208 ± 3.27 (1)
	Male	22 (14.7)	74 (49.3)	29 (19.3)	20 (13.3)	5 (3.3)		2.63 ± 2.97 (2)
Apical Periodontitis	Has	40 (37.0)	37 (43.3)	10 (9.3)	16 (14.8)	5 (4.6)	0.002	2.44 ± 3.42 (1)
	Does not have	60 (36.1)	111 (50.0)	35 (15.8)	27 (12.2)	6 (2.7)		2.38 ± 3.01 (1.5)
Root Treatment Status	Incomplete	37 (19.9)	88 (47.3)	30 (16.1)	27 (14.5)	4 (2.2)	0.045	2.45 ± 2.86 (2)
	Complete	46 (31.9)	60 (41.7)	15 (10.4)	16 (11.1)	7 (4.9)		2.33 ± 3.48 (1)
Age	18 - 40	42 (30.4)	62 (44.0)	14 (10.1)	15 (10.9)	5 (3.6)	0.434	2.04 ± 2.91 (1)
	41 - 60	31 (20.7)	67 (44.7)	23 (15.3)	23 (15.3)	6 (4.0)		2.76 ± 3.49 (2)
	> 60	10 (23.8)	19 (45.2)	8 (19.0)	5 (11.9)	0 (0.0)		2.27 ± 3.49 (2)

Table 3: The amount of sinus mucosa thickness differentiated according to different parameters in subjects with treated root.

The relationship between maxillary sinus mucosal thickness and root treatment status was statistically analyzed. The results showed that 186 patients (56.4%) had incomplete root treatment and 144 patients (43.6%) had complete root treatment. Of these, only 37 patients (19.9%) with incomplete root treatment had normal sinus mucosal thickness and in the other 149 patients (80.1%) increased mucosal thickness was observed. [Table 2,3]

In the group of patients with complete root treatment, 46 patients (31.9%) had normal sinus mucosal thickness, and the other 98 patients (68.1%) showed increased mucosal thickness. The value of p -value indicates that there was a significant relationship between incomplete root treatment factors and increased sinus mucosal thickness. Also, the association of age increase with maxillary sinus mucosal thickness was investigated using statistical analysis. In this

study, 138 patients (41.8%) were 18-40 years old, 150 patients (45.5%) were 41-60 years old, and 42 patients (12.7%) were over 60 years old. In total 156 patients (47.3%) had normal mucosal thickness and 174 patients (52.7%) showed increased mucosal thickness, there was no statistically significant relationship between age increase and increase in sinus mucosal thickness of patients ($p=0.434$).

194 untreated teeth were evaluated for the comparison of sinus mucosa thickness in teeth with treated and untreated root. Of the 194 teeth with untreated root, 138 sinuses (67%) had normal mucosa thickness (0), 46 sinuses (22.3%) had the mucosa thickness between 2.1 - 4, 7 sinuses (3.4%) had the mucosa thickness between 4.1 - 10, and none of them had the thickness of more than 10 mm. [Table 4]

Variables	0	0.1 - 2	2.1 - 4	4.1 - 10	10 +	p-Value	Mean±SD
Treated Root	83 (25.2)	148 (44.8)	45 (13.6)	43 (13)	11 (3.3)	0.001	2.4 ± 3.1
Untreated Root	138 (67)	46 (22.3)	15 (7.3)	7 (3.4)	0 (0)		0.7 ± 1.4
Total	221 (41.2)	194 (36.2)	60 (11.2)	50 (9.3)	11 (2.1)		

Table 4: Comparing the thickness of sinus mucosa in people with and without root treatment.

Of 330 teeth with treated root, the minimum thickness of the maxillary sinus mucosa was zero and the maximum thickness was 20 mm with the mean of $2.40 ± 3.15$, while in teeth with untreated root, the minimum thickness of the maxillary sinus mucosa was zero and the maximum thickness was 7 mm with the mean of $0.7 ± 1.4$ ($p=0.001$), and this difference was statically significant.

Discussion

In this study, the increase in sinus thickness was observed in more than half of the population. In normal mode, the thickness of the mucosa of the maxillary sinus floor is 0 to 1 mm which is not seen in CBCT images¹ but in this study, up to 20 mm thickness has been seen. In the present study, in all cases, the increased thickness of more than 1 mm was considered as a criterion which is in line with the study by Phothikhun *et al*⁴ and Nourbakhsh *et al*.¹² In the present study, the increase in the thickness of the mucosa was observed in 74.8% of the sinuses, which is a relatively high prevalence. These findings are consistent with the study by Bolger *et al*. who observed an increase in the thickness of the mucosa in 83.2% of the sinuses by using CT.¹³ Also, Brullmann and colleagues observed this increase in thickness in 73% of CBCT images.⁸

In the present study, a significant relationship was found between the increase in the thickness of the mucosa and the sex of the patients. It was found that the thickness of the

male was higher than that of the women, in agreement with similar studies in this area.^{4,13,14} Among the studies by Vallo and colleagues, Rak and colleagues, and Sheikhi and colleagues, it was argued that the prevalence of mucositis is higher in males.^{15,16,17} In contrast, the study of Shanbhag and his colleagues, and Mirbeigi *et al.* did not show a significant relationship between the prevalence of sinus mucositis and gender.^{18, 19} One justification for this difference can be due to differences in race and population studied.

According to the patients studied in this study, there was a significant relationship between the presence of apical periodontitis and increased sinus mucosal thickness, and it has been found that the presence of apical periodontitis plays an important role in increasing sinus mucositis. These findings are consistent with the study by Vallo *et al.* in which periapical lesions significantly raised the risk of increase in mucosa and showed that 80 percent of periapical lesions were associated with an increase in the thickness of the mucous membrane.¹⁵ Furthermore, this finding was in agreement with Lu *et al.* who found that there was a significant relationship between increased mucosal thickness and apical periodontitis.¹⁴

Ezaddini Ardakani and his colleagues also showed that the increase in the thickness of the mucosa in men was significantly higher and was significantly associated with periapical lesion.¹¹ Further research by Ericson and colleagues has confirmed that there is a significant relationship between periodontal disease and increased mucosal thickness.²⁰ These findings are consistent with Mattila *et al.*'s study on the significant relationship between increased mucosal thickness and periapical lesions⁶ while Janner and colleagues reported that there was no relationship between periodontal lesions and periapical lesions with maxillary sinus mucositis.²¹

The study of Shahidi and his colleagues also showed a significant relationship between increase in thickness of the mucosa and periodontal diseases, age and sex. The study also suggested that the most important factor in increasing the thickness of the mucosa is periodontal disease, although there was no significant relationship between the severity of periodontal disease and the increase in the thickness of the mucosa.⁹

Increased thickness of maxillary sinus mucosa in teeth with root treatment was significantly higher than healthy teeth without root treatment.

In the present study, there was a significant relationship between the root treatment type and the increase in the thickness of the mucosa, and the results showed that patients with incomplete root treatment showed more mucosal thickness than patients with complete root treatment. The study by Brullmann and his colleagues also suggested a significant relationship between the two parameters.⁸

Similarly, the results of the study by Nenzen *et al.* suggested the association of root treatment with the

increase in the thickness of the sinus mucosa of patients.⁵ The results of the study by Khorshidi and colleagues also showed that increased sinus mucosal thickness due to incomplete root treatment exists in 62.9% of patients, and the relationship between incomplete root treatment and periapical radiolucency with increase in mucosal thickness is significant.¹⁰ Although the study by Phothikhun *et al.* and Vallo *et al.* revealed that root treatment has not raised the risk of increase in mucosal thickness.^{4, 15}

The significant relationship between apical periodontitis and incomplete root treatment may prove that iatrogenic dental causes including root treatment can initiate periapical inflammation in sinus floor¹⁷ and following it will increase the thickness of the mucosa. Ehsani and his colleagues also reported a significant relationship between the quality of root treatment and the presence of apical periodontitis.⁷ Moreover, the study of Nenzen and colleagues revealed the cases of positional maxillary sinus mucositis adjacent to the teeth with periapical lesions removed by a successful root treatment.⁵

The cases mentioned in this study confirm that in case of inflammation around maxillary teeth, the probability of mucositis in the maxillary sinus is high. Therefore, CBCT images can be a good guide to finding the cause of mucositis and the involving root type.

The present study revealed that increased mucosal thickness is more prevalent among men, and the presence of apical periodontitis and incomplete root treatment significantly lead to increased thickness of maxillary sinus mucosa.

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