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The Increase in Thickness of Maxillary Sinus Mucosa and Its Relationship with Odontogenic Factors in Panoramic Images of Patients

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A B S T R A C T

Introduction: Odontogenic infections are one of the common causes of maxillary sinusitis. The aim of this study was to evaluate the increase in maxillary sinus thickness and its relationship with odontogenic factors in panoramic images.

Materials & Methods: This retrospective cross-sectional study examined 1246 sinuses. The images recorded odontogenic factors such as periapical lesions, dental caries, root canal treatment, periodontal lesions, and implants. Their relationship with the increase in the thickness of maxillary sinus mucosa was evaluated. The data was analyzed with SPSS16 statistical software and chi-square, as well as the significance level ($P < 0.05$).

Results: Among the examined panoramic images, 468 showed an increase in the thickness of the sinus mucous membrane. There was a significant relationship between dental caries, periapical lesions, root canal treatment, and periodontal diseases with an increase in the thickness of the sinus mucosa ($P = 0.001$). There was no significant relationship between the presence of the implant and the increase in maxillary sinus mucosa thickness ($P=0.057$).

Conclusion: The results of this study significantly correlate the increased thickness of the maxillary sinus mucosa with odontogenic and inflammatory lesions.

Keywords: Maxillary Sinus, Panoramic Images, Odontogenic, Periapical

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Introduction

The maxillary sinus is a pyramid-shaped cavity located in the maxilla. Its average volume is 12.5 ml, and it is connected to the nasal cavity by a bone (1). One of its main functions is reducing the overall weight of the skull (2). The maxillary sinus is covered with a respiratory mucous membrane that firmly adheres to the periosteum (also known as the Schneiderian membrane). The mucosa of a healthy maxillary sinus is usually not visible on radiographs, and its thickness does not exceed 1 mm (3,4). Mucous thickening of more than one mm can be considered pathologic (4). After puberty, the lower wall of the maxillary sinus lowers and becomes the same level as the nasal floor; as a result, odontogenic inflammatory factors can affect the mucosa due to the small distance between the teeth's root and the sinus floor (5, 6). Mucous thickening, a defense reaction of the maxillary sinus, is an inflammatory process that results from the hypertrophy of epithelial cells (7). This process can be caused by odontogenic infections such as periapical abscesses, periodontal problems, trauma, improper implant placement, paranasal sinusitis, chemicals, allergies, and bronchial asthma (8). Due to the proximity of the roots of the posterior maxillary teeth to the floor of the sinus and the fact that the maxillary bone is spongy, pathogens and bacteria can easily enter the sinus cavity (9, 10).

This increase in sinus thickness (mucositis-sinusitis) can be seen in patients without clinical symptoms or accompanied by clinical symptoms such as headache and secretions, and the possibility of finding one as an incidental finding in panoramic images is high (11). The increase in maxillary sinus thickness can be seen in asymptomatic people with different radiographic techniques, which has a prevalence of 8-29% (6). Although a slight increase in sinus thickness is often asymptomatic and considered a normal radiographic finding, an increase in thickness greater than two mm can be considered maxillary sinusitis (12). Sinusitis with odontogenic origin is the cause of 10-12% of sinusitis (9). Sinus diseases with odontogenic origin require special considerations because they are different in terms of pathology-microbiology and treatment compared to normal sinusitis (4). In the study of Longhini et al., rapid treatment of sinusitis was reported following dental treatments in patients whose sinusitis treatment had failed previously (10). Most sinus infections of dental origin are caused by dental caries, although periodontal diseases have also been observed as an etiology in some cases (13).

A panoramic radiograph is one of the radiographic images that can be used to evaluate the maxillary sinuses. An increase in the thickness of the maxillary sinus can be an incidental finding in panoramic images, because in most patients, panoramic radiographic images are prescribed to examine the teeth (6, 8). It should be noted that panoramic radiography is the most common method for evaluating the relationship between the roots of the maxillary posterior teeth and the maxillary sinus and provides the possibility of imaging anatomical structures at a relatively low cost. Therefore, the present study was conducted with the aim of investigating maxillary sinus thickness and its relationship with odontogenic factors in Ilam City.

Materials and methods

Study Design

In this cross-sectional study, all panoramic radiographs of patients aged 18–70 years referred to the radiology department of the dentistry clinic of Ilam University of Medical Sciences during 2021 were investigated. A digital panoramic device (Papaya Genoray model, Germany) was used to make panoramic images. Inclusion criteria were the presence of at least one tooth in the posterior area (premolar and molar teeth) and an age of above 18 years old (because sinus maturation continues until 18 years old). The radiographs in which the distance between the sinus and the posterior teeth was more than 10 mm, the sinus was not fully formed or matured or had hypoplasia, and other structures such as the hard palate were superimposed on the sinus were excluded.

Sample Size

The sampling method is the census. A total of 1246 sinuses were examined, out of which 641 sinuses were excluded because they did not meet the conditions for the study.

Measurements & Validity and Reliability

Demographic form

M Demographic variables included in this study were decay, peri-apical lesions, non-odontogenic root canal treatment, periodontal disease, and implants.

Panoramic Imaging

A panoramic image by the Planmeca Proline EC device (Finland) with time=18s, voltage (kVp)=64-68, and mA=8-10 (current) was done. Panoramic images saved in JPEG format were investigated (Figure 1). Images that met the inclusion criteria were examined in terms of increased thickness (defined as more than a one mm increase in the thickness of the mucous membrane of the sinus floor or the presence of a mucous retention cyst) and the presence of caries in the posterior teeth, periodontal lesions, periapical lesions, root canal treatment, and implants. A researcher, who had received the necessary training from an oral and maxillofacial radiologist, conducted the examinations in a calm, semi-dark environment on a fixed monitor (HP computer screen). To avoid errors, the images were re-examined by a maxillofacial radiologist under the same conditions. The presence of odontogenic lesions was recorded in radiographs with increased thickness of maxillary sinus mucosa. Panoramic images were examined regarding root canal treatment in posterior teeth, placement of implants in the posterior maxilla region, and the presence of dental caries and periodontal diseases. Bone resorption was evaluated for periodontal disease, and bone resorption was diagnosed if the distance between the CEJ and the alveolar crest was more than two mm.

Ethical consideration

The ethical considerations included compliance with the ethics code (IR.MEDILAM.REC.1400.243), ensuring integrity in the library collection and data reporting, obtaining written informed consent from all participants in accordance with the Declaration of Helsinki, and adhering to principles for conducting interventions involving human subjects.

Statistical and Data Analysis

All panoramic radiography information, including demographic factors, was documented in a checklist created by the researcher and entered into SPSS V.16. Statistical analyses were presented in two descriptive and analytical sections. In the descriptive section, the mean attitude as the main variable was presented across different groups, and all demographic characteristics of images were reported based on descriptive criteria. The studied variables were analyzed using chi-square. All tests were conducted at a 0.05 significance level.

Results

In this research, 1246 panoramic radiographs were examined, of which 605 radiographs met the inclusion criteria. Among the 605 radiographs examined, an increase in the thickness of the mucosa was observed in 468 cases. In 120 cases, periapical lesions and in 159 cases, root canal treatment were observed in posterior teeth. In 146 cases, periodontal lesions and in six cases dental implants were observed in the posterior maxilla. In 447 cases, dental caries of at least one posterior tooth was visible, and in 65 cases, sinus thickness was increased due to non-odontogenic factors (Table 1).

Table 1. Investigating the frequency of variables with increased thickness of maxillary sinus mucosa.

Variable		Frequency	Percentage
Increase in thickness	Yes	468	77.4

	No	137	22.6
Decay	Yes	447	73.9
	No	158	26.1
Peri-epic lesions	Yes	120	19.8
	No	485	80.2
Non-odontogenic	Yes	65	10.7
	No	540	89.3
Root canal treatment	Yes	159	26.3
	No	446	73.7
Periodontal disease	Yes	146	24.1
	No	459	75.9
Implant	Yes	5	0.8
	No	600	99.2

The chi-square test between odontogenic and non-odontogenic factors with increased thickness of maxillary sinus mucosa is presented in Table 2. There is a strong link ($P < 0.05$) between tooth cavities, periapical lesions, root canal treatment, and periodontal diseases getting worse as the thickness of the sinus mucosa rises, among other things. The presence of the implant did not significantly increase the thickness of the maxillary sinus ($P=0.049$).

Table 2. chi-square test between odontogenic and non-odontogenic factors with increased thickness of maxillary sinus mucosa.

Factor	χ^2 Value (Chi-square)	df	P-value
Dental caries	16.24	1	0.001
Periapical lesions	14.76	1	0.001
Root canal treatment	7.52	1	0.006
Periodontal disease	13.56	1	0.001
Non-odontogenic causes	10.83	1	0.001
Dental implant	3.84	1	0.049

Figure 1. Normal sinus (left picture) and increased thickness of maxillary sinus mucosa (right picture).

Discussion

The aim of this study was to investigate the relationship between odontogenic factors such as dental caries, periapical lesions, periodontal disease, etc., and the increase in the thickness of the maxillary sinus mucosa. Each of these factors was examined in posterior teeth that are related to the sinus. The present study's results indicate that the presence of odontogenic factors, caries, root canal treatment, periapical lesions, periodontal disease, and

occasionally non-odontogenic factors can lead to an increase in the thickness of the maxillary sinus mucosa. However, the presence of implants did not significantly increase the thickness of the maxillary sinus mucosa, possibly due to the limited number of panoramic radiographs showing implants in the posterior areas. If dentists can diagnose the increase in the thickness of the sinus mucosa in panoramic radiographs and its connection with dental disease during the routine examinations, the patient can be made aware of the problem in a timely manner and prevent it from becoming chronic. On the other hand, studies have shown that some chronic sinusitis that had not responded to usual treatments for years has been resolved by treating underlying dental pathologies.

The study by Kuligowski et al. looked at how odontogenic factors affected the thickness of the maxillary sinus mucosa in CBCT images and found that these factors can make the maxillary sinus mucosa thicker, which was similar to our present study (13). Similarly, Yusufoglu et al. showed that there was a significant relationship between maxillary sinusitis and periapical lesions as well as dental restorations. They also found that periapical lesions increase sinus mucosa thickness by increasing lesion size and proximity (12). Ezzedini Ardakani et al. demonstrated a significant relationship between the presence of periodontal disease and the increase in the thickness of the maxillary sinus mucosa (14). The results of this study were consistent with the present study. Researchers Aksoy and Kaan looked into the link between the presence of odontogenic factors in CBCT images and the thickening of the maxillary sinus mucosa. They found that there was a strong link between the two. The result of this study was also consistent with the current study, although the type of examined radiographs was different (15).

Furthermore, the results of the studies of Mir Beigi et al. (16) and Kock et al. (17), who investigated the prevalence of maxillary sinus floor mucositis in patients with various types of bone loss and periodontal disease in panoramic digital radiographs, showed that the presence of bone loss and periodontal disease is related to the increase in the thickness of the maxillary sinus mucosa, which was in line with the present study; however, they had a smaller population (200) and a smaller number of variables. The studies show that odontogenic factors play a big role in making the maxillary sinus mucosa thicker. Knowing about this relationship at the right time can greatly assist the treatment of sinusitis.

The study's strength was the assessment of sinus thickness through panoramic radiographs, which are inexpensive and readily available. However, the study's weaknesses include the small number of samples studied and the lack of access to patient CBCT, a procedure most patients avoid due to its high cost.

Conclusion

The results of this study showed that there was a significant relationship between the increase in the thickness of the maxillary sinus mucosa and odontogenic factors, such as periapical lesions, root canal treatment, dental caries, periodontal disease, and non-odontogenic factors. Future studies should examine the implant variable with a larger statistical population to obtain more accurate results, and they should also use Cone Beam Computed Tomography (CBCT) radiography to achieve more accurate results.

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Conflict of interest

The authors declare that no conflict of interest exists.

Authors' contributions

Methodology, Investigation, Visualization, Project Administration: FA, FF, Conceptualization, Writing– Original Draft Preparation: MM, FF, Validation: MM, Formal Analysis: AS, NN, Resources, Data Curation, Writing– Review & Editing, Supervision: NN.

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