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Factors associated with sinus membrane thickness in the posterior maxilla

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Factors associated with sinus membrane thickness in the posterior maxilla

Directed by Professor Ik-Sang Moon

A Master's Thesis

submitted to the Department of Dentistry

and the Graduate School of Yonsei University

in partial fulfillment of the requirements for the degree of

Master of Dental Science

So-Ran Song

June 2016

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This certifies that the Master's thesis

of So-Ran Song is approved.

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무엇보다 먼저 저를 치주과 의사로 이끌어 주시고 이 논문이 완성되기까지 자상한 지도와 격려로 이끌어주신 문익상 교수님께 깊은 감사와 존경의 마음을 드립니다. 아울러 바쁘신 와중에도 저의 논문을 검토해주신 허종기 교수님과 이동원 교수님께 감사 드립니다.

사랑과 믿음으로 키워주신 부모님, 부족한 저를 항상 아끼고 배려해 주시는 시부모님, 착하고 사랑스런 동생 소형이 덕분에 긴 학창시절과 수련을 무사히 마칠 수 있었습니다. 치주과 의국생활의 길잡이가 되어 주셨던 모덕경, 손선보, 어연호, 이청운 선생님과 3 년간 동고동락한 최재용 선생님, 그리고 더 많이 도와주지 못해 아쉬운 마음이 남는 이해석, 박찬호, 유재현, 남기창 선생님과의 추억도 가슴깊이 남아있습니다.

치주학을 전공하고자 문익상 교수님을 처음 만나 뵙던 그 순간이 아직 기억 속에 생생합니다. 어느덧 시간이 흘러 의국을 떠나고 학위를 마무리하게 되었지만 교수님의 가르침을 언제 어디서나 가슴 깊이 간직하고 선배님들께 누가 되지 않는, 학교의 명예를 드높이는 제자가 되겠습니다.

끝으로 항상 옆에서 힘이 되어주는 사랑하는 남편과 저에게 무엇보다 큰 기쁨과 희망인 딸 채원이에게 이 논문을 바칩니다.

2016년 6월

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ABSTRACT

Factors associated with sinus membrane thickness in the posterior maxilla

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(Directed by Professor Ik-Sang Moon, D.D.S., M.S.D., Ph.D.)

The aim of this study was to analyze the factors associated with mucosal thickness in the maxillary sinus of individuals referred for dental implant placement in the posterior maxilla. One hundred and fifty-two cone beam computed tomography (CBCT) scans of patients who were scheduled to receive dental implants were studied. CBCT was used to evaluate periodontal conditions and Schneiderian membrane

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thickness. Other factors that were examined included age, gender, smoking, time since the removal of the last tooth, and the season in which the of the CBCT scan were acquired.

Periodontal bone level (p = 0.027) and gender (p = 0.009) were the factors that influenced the sinus membrane thickness. No statistically significant association was seen between membrane thickness and age, smoking, time since the removal of the last tooth, presence of periapical lesions, previous root canal treatment in the region of interest, or the seasons in which the scan was acquired.

We showed that gender and periodontal bone loss were significantly associated with the thickness of maxillary sinus membranes. This finding indicates that treating periodontal inflammation might reduce the size of the membrane. Overall, CBCT imaging can be regarded as a valuable diagnostic method to evaluate areas that are difficult to examine, such as maxillary sinuses and periodontal areas, before implant surgery.

Key words: Maxillary sinus membrane, dental implant, periodontal bone

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Factors associated with sinus membrane thickness in the posterior maxilla

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I. INTRODUCTION

Sinus augmentation is a conventional, well-documented procedure (Nkenke and Stelzle, 2009; Zijderveld et al., 2009) that allows the rehabilitation of the atrophic posterior maxilla by using osseointegrated dental implants. However, perforation of the sinus membrane is the most common complication associated with sinus augmentation; it occurs in approximately 20% of all cases (range: 0–58%) (Nkenke and Stelzle, 2009; Pjetursson et al., 2008). To avoid these complications, cone beam computed tomography

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(CBCT) is valuable in the evaluation of maxillary sinuses.

Recently, CBCT was introduced for maxillofacial and dental imaging (Harris et al., 2012). CBCT has several advantages over CT. CBCT emits lower levels of radiation and provides higher resolution images. The machine is inexpensive and is reliable for evaluating maxillary sinus and periodontal structures (Harris et al., 2012). Because the maxillary sinus is a significant anatomical structure in dental practice and CBCT is a useful diagnostic image modality in dentistry, the use of CBCT in visualizing anatomical variations and lesions in maxillary sinuses is being recognized increasingly (Pelinsari Lana et al., 2012).

In some studies, CBCT was used to find pathological signs within the maxillary sinus. In most studies, mucosal thickening was common; it ranged between 40% and 60% (Vogiatzi et al., 2014). However, the association between odontogenic pathology and an increase in the thickness of the maxillary sinus membrane is controversial (Vogiatzi et al., 2014). In a few reports, correlations have been found between the clinical findings of posterior maxillary teeth and mucosal findings of the maxillary sinus with CBCT. Janner et al. (2011) found that sex influenced mucosal thickness. Phothikhun et al. (2012) reported that severe periodontal bone loss was significantly associated with thick maxillary sinus membranes. Furthermore, periapical lesions are correlated with increases in mucosal thickness (Bornstein et al., 2012; Lu et al., 2012; Vallo et al., 2010).

However, many studies have observed the case that teeth were existing state, and in a few studies, membrane thickness after tooth extraction was examined (Janner et al., 2011;

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Yoo et al., 2011). Therefore, the purpose of the present study was to investigate the thickness of maxillary sinus membrane above the area of tooth extraction in patients who were referred for dental implant placement in the posterior maxilla using CBCT.

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II. MATERIALS AND METHODS

1. Patient Selection

Patients who planned dental implants in the posterior maxilla (defined as the second premolar, first molar, and second molar sites) between January 1, 2011 and November 30, 2014 in the Department of Periodontology at Gangnam Severance Dental Hospital were included. All individuals underwent CBCT prior to receiving their dental implants. Patients who had previously received a dental implant or undergone bone grafting in the posterior maxilla were excluded.

The study was approved by the Institutional Review Board at the Gangnam Severance Hospital, Yonsei University in Seoul, South Korea.

2. Imaging Procedures

The exams were performed by using the Pax-Zenith 3D CBCT system (Vatech Korea, Seoul, Korea). The operating parameters were set at 5.5 mA and 105 kV. The exposure time was 30 seconds, and the field of view (FOV) was 9 × 12 cm. Image analyses and measurements were performed by using Ez3D-i software (Vatech Korea), which provided axial, coronal, and sagittal views through multiplanar reconstructions of 0.5 mm slices.

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3. Evaluation of the Images

Evaluation of Sinus Membrane Thickness

Maxillary sinus membrane thickness was measured (in mm) at the point of maximum thickness perpendicular to the underlying bone of the edentulous site for which the implant placement was scheduled. The maximum thickness in each sinus was recorded. If the margin of sinus membrane was unclear or beyond the field of view, that case was excluded.

Evaluation of Odontogenic Factors

The area adjacent to the edentulous area was evaluated for these criteria.

(1) Presence of periapical lesions (Lofthag-Hansen et al., 2007) :

The presence of periapical lesions was determined from the panoramic and cross-sectional views. A periapical lesion was recorded if the lamina dura was invisible and periapical radiolucency was seen around the root apex. (Radiolucency indicated bone destruction.)

(2) Presence of previous root canal treatment :

A root canal filling was recorded when radio-opacity was seen within the root canal spaces.

(3) Periodontal bone level (mm) :

Coronal CBCT slices were used to determine periodontal bone level, which was measured as the perpendicular distance (in mm) from the marginal bone level of an

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adjacent tooth to the maxillary sinus. We selected a slide that was cut in the middle of the tooth. For a tooth with a furcation involvement, we measured the distance from the margin of the furcation to the sinus floor. If there were teeth on both sides of an edentulous area, periodontal bone level was determined by the shortest distance between them.

Evaluation of Additional Clinical Parameters

The electronic medical records of Gangnam Severance Dental Hospital were reviewed to determine which parameters influence the thickness of the Schneiderian membrane. The following parameters were examined.

(1) Age

(2) Gender

(3) Smoking (smoking, not smoking)

(4) Time since extraction (months)

(5) Season in which image was obtained (spring, summer, autumn, winter)

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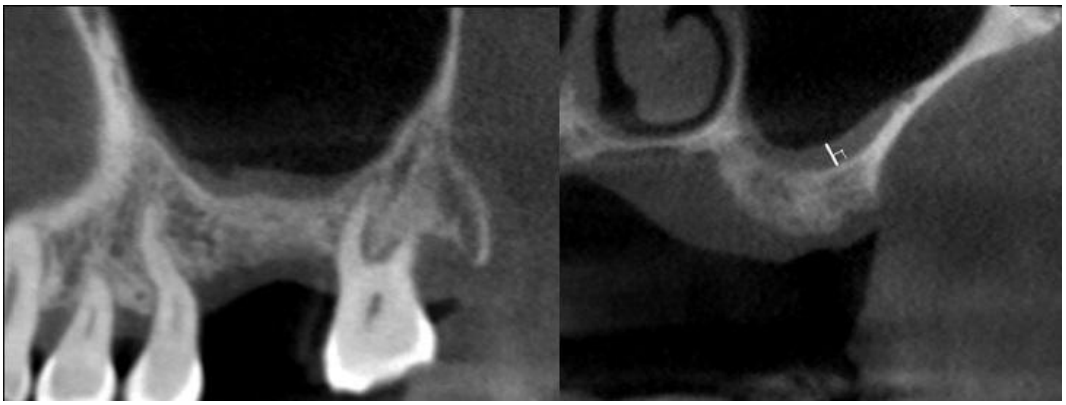

Fig 1. a) The cone beam computed tomography image of a maxillary sinus with a thick membrane (sagittal slice). b) The thickness of the sinus membrane was evaluated in cross sectional view.

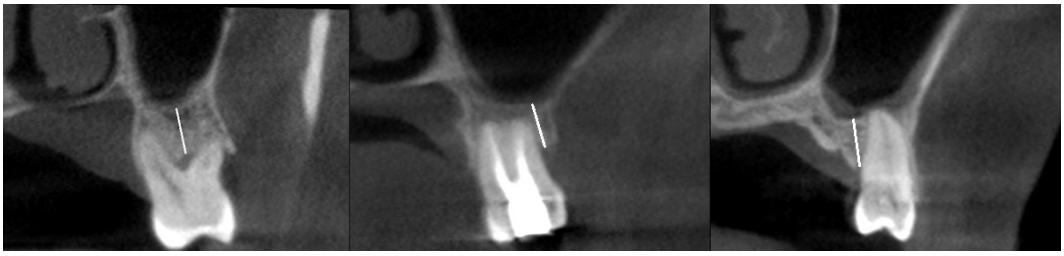

Fig 2. Measurement of the periodontal bone level

4. Statistical Analysis

All statistical analyses were performed by using the IBM SPSS Statistics (Version 20.0; IBM Corp., Armonk, NY, USA) software package. Univariate and multivariate linear regression models were used to evaluate the impact of each of the parameters on the mean value for the thickness of the maxillary sinus membranes. Data were first analyzed descriptively for frequency distributions. Because the original data were skewed,

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the response variable (thickness of the Schneiderian membrane) was log-transformed to obtain a normal distribution for further analysis.

All parameters with a *p*-value of 0.2 or less in the univariate analysis were included for further analysis in a multivariate linear regression model. Statistical differences were considered significant at $p < 0.05$.

III. RESULT

A total of 152 patients (age, 30–77 years; mean, 54.33 ± 8.507 years) were included; 85 (55.9%) were male and 67 (44.1%) were female. The thickness of the Schneiderian membranes varied widely, with a minimum value of 0.16 mm and a maximum value of 20.00 mm. The average sinus membrane thickness was 3.57 ± 2.48 mm.

Two factors were associated with thick maxillary sinus membranes. We observed a higher prevalence of mucosal abnormalities in males than in females ($p = 0.009$). Periodontal bone loss was also a factor that influenced sinus membrane thickness ($p = 0.027$). No statistically significant association was seen between membrane thickness and age ($p = 0.267$), smoking ($p = 0.346$), time since the removal of the last tooth ($p = 0.070$), presence of periapical lesions ($p = 0.684$), previous root canal treatment in the region of interest ($p = 0.336$), and the season in which the CBCT was taken ($p = 0.234$ - 0.962; Table 1).

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Table 1. Univariate analysis of potential affecting factors of thickness of the maxillary sinus membrane

Factor		coefficient	*p*-value
Age		.008	.267
Gender(male vs female)		.298	.018
Smoking		-.037	.643
Time since extraction		-.007	.070
Season	summer vs spring	.010	.962
	autumn vs spring	.127	.521
	winter vs spring	.225	.234
Periapical lesion		-.077	.684
RCT state		-.166	.336
Periodontal bone level		-.028	.050

Table 2. Multivariate analysis of potential affecting factors of thickness of the maxillary sinus membrane

Factor	coefficient	*p*-value
Gender (male vs female)	.322	**.009**
Time since extraction	-.007	.067
Periodontal bone level	-.030	**.027**

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IV. DISCUSSION

Sinusitis is the major cause of thick membranes in symptomatic individuals. The relationship between dental infections and maxillary sinusitis is well established. Sinusitis of odontogenic origin has traditionally been considered to account for 10% to 12% of sinusitis cases (Mehra and Jeong, 2009). However, the cause of thick sinus membranes among asymptomatic individuals is not clear. A high prevalence of thick membranes in the maxillary sinuses of asymptomatic patients has been reported (Vallo et al., 2010). We also showed that the thickness of the mucosa varied greatly among individuals; thickness values ranged from 0.16 mm to 20.00 mm (mean= 3.57 ± 2.48 mm).

There have been studies that a thickness of less than 2mm was a normal variant in the asymptomatic ethmoidal sinus (Rak et al., 1991). Hence, in many studies, membrane thickness of more than 2 mm was considered abnormal (Vogiatzi et al., 2014). In the present study, mucosal thickness was more than 2 mm in 56.62% of the maxillary sinuses. This result corresponds with previous research (Janner et al., 2011; Pazera et al., 2011; Schneider et al., 2013).

In previous studies, several different factors were identified as potential local or systemic influences on the thickness of the Schneiderian membrane. Many authors

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indicated that a higher prevalence of thick membranes was seen in males than in females (Havas et al., 1988; Janner et al., 2011; Phothikhun et al., 2012; Schneider et al., 2013; Yoo et al., 2011). In the present study, males also had thicker maxillary sinus membranes than did females. Aimetti et al. (2008) reported that gingival thickness can reliably indicate maxillary sinus membrane thickness. Gingival phenotype was associated with the thickness of healthy Schneiderian membranes; thicker membranes were found in individuals with thick gingival tissue than in those with thin gingival tissue. Aimetti et al. reported that variations in sinus mucosal thickness were associated with the connective tissue layer and that periodontal phenotypes also depended on the thickness of the lamina propria. Thus, the thickness of the maxillary sinus membrane seemed to be genetically thick tendency in male like gingival phenotype.

The presence of periodontal lesions has also been associated with an increase in mucosal thickness (Brullmann et al., 2012; Phothikhun et al., 2012; Vallo et al., 2010). In these studies, maxillary sinus membranes above unextracted teeth were studied. In our own study, the focus was on the edentulous area and periodontal state of adjacent teeth, which were assumed to influence the thickness of the Schneiderian membrane. Yoo et al. (2011) also reported the relationship between the thickness of the mucous membrane after tooth extraction and periodontal disease in adjacent teeth. They found that the mucous membrane was thicker in the periodontal disease group than in the normal group, but the difference was not statistically significant. In that study, a mucous membrane was considered thick if it was thicker than 2 mm. However, the present study used the

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thickness of the membrane itself as the result. Also, unlike in previous studies, in this study the distance from the periodontal marginal bone to the maxillary sinus floor was calculated. If the maxillary posterior teeth were far from the sinus floor, periodontal inflammation would not greatly affect the maxillary sinus membrane. Therefore, it seems valuable to determine the distance from which periodontitis can affect the maxillary sinus.

We did not investigate the reason for tooth extraction in this study. However, if the periodontal condition of the adjacent teeth is not good, the condition of the extracted site also will not be good. Therefore, the reason for tooth extraction might be the periodontitis. In this study, although the average time elapsed since extraction was 10.03 months, the mean thickness of the maxillary sinus membranes was 3.57 ± 2.48 mm. Periodontal disease of the adjacent teeth may have influenced the inflammation level in the sinus mucosa, even if the extraction itself relieved some of the existing inflammation.

No significant relationship was found between age and the thickness of the maxillary sinus membrane. Perhaps because many of our patients were elderly (mean age = 54.33), differences in mucosal thickness among age groups was hard to find. Moreover, we found that periapical lesions and previous root canal treatment were not associated with the thickness of the maxillary sinus membrane. The reasons for this may be that a low number of teeth (n = 6) with apical lesions were included in this study and the good state of root canal treatment.

The findings from this study have several clinical implications. Thick Schneiderian membranes were common among patients requiring dental implant surgery. More than

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half of the individuals in our study had thick maxillary sinus membranes. Therefore, a proper radiographic evaluation should be performed before sinus augmentation surgery. We also showed that periodontitis was significantly associated with the thickness of maxillary sinus membranes. Thus, periodontal treatment should be performed before surgery to reduce the inflammation of maxillary sinus membranes.

Because this was a retrospective study, there were limitations. The sinuses could not be clinically examined, and clinical data on the odontogenic factors could not be obtained. In the future, prospective studies that include large populations are needed to determine the factors that affect the thickness of maxillary sinus membranes.

V. CONCLUSION

This study showed that periodontal bone level and gender were significantly associated with the mucosal thickness of maxillary sinuses. Hence, treating periodontal inflammation might reduce the thickness of the sinus membrane. Overall, CBCT imaging can be regarded as a valuable diagnostic method to evaluate areas that are difficult to examine, such as maxillary sinuses and periodontal areas, before implant surgery.

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국 문 요 약

상악 구치부의 상악동막 두께와 관련된 인자 연구

송 소 란, D.D.S.

연세대학교 대학원 치의학과

<지도교수: 문 익 상, D.D.S., M.S.D., Ph.D.>

이 연구의 목적은 상악 후방 부위의 임플란트 치료를 위해 내원한 환자의 CBCT를 이용하여, 상악동막의 두께와 관련된 인자를 분석하고자 함이다.

본 연구를 위해 152명의 CBCT를 분석하였다. 상악동막의 두께와 치성 요소 및 나이, 성별, 흡연 여부, 발치 후 경과기간, CBCT 촬영 시 계절을 평가하였다.

상악동막의 두께 증가에 영향을 미치는 요소는 치조골 높이와 성별로

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통계학적인 유의성이 관찰되었다. ($p < 0.05$)

따라서, 본 연구를 통하여 치주치료가 상악동막의 두께 감소에 영향을 미칠 것으로 사료된다. 또한, CBCT는 임플란트 수술 전 인접치와 상악동의 해부학적 평가에 유용한 진단학적 방법으로 여겨진다.

핵심 되는 말 : 상악동막, 임플란트, 치조골