Clinical and radiologic factors affecting severity of dental implant-related maxillary sinusitis

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Clinical and radiologic factors affecting severity of dental implant-related maxillary sinusitis

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ABSTRACT

Clinical and radiologic factors affecting severity of
dental implant-related maxillary sinusitis

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Objective

The aim of this study was to identify factors affecting the severity of dental implant related sinusitis using a modified Lund-Mackay scoring system.

Materials and Methods

Fifty-one sinuses from 45 patients who were diagnosed with dental implant-related maxillary sinusitis were retrospectively evaluated. Their medical records were reviewed and computerized tomography scans were evaluated using modified Lund-Mackay scores. Factors that may affect severity of dental implant-related maxillary sinusitis were analyzed using multivariate linear regression analysis.

Results

Diabetes and sinus augmentation were independent factors that affected severity of dental implant-related maxillary sinusitis.

Conclusion

Patients with diabetes and sinus augmentation should be carefully evaluated and treated properly for a sinus infection before and after dental implants.

Key words: dental implants; maxillary sinusitis; diabetes mellitus; sinus augmentation

Clinical and radiologic factors affecting severity of dental implant-related maxillary sinusitis

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I. INTRODUCTION

Maxillary sinusitis is one of the most frequent diseases that occur in the paranasal sinuses. It has various causes and most of them are primarily rhinogenic, but in some cases, maxillary sinusitis maybe odontogenic in origin.[1, 2] The prevalence of odontogenic maxillary sinusitis is approximately 10-12% of maxillary sinusitis cases.[3] There are several well-known etiologic factors of odontogenic sinusitis, like dental extraction-related complication, dentigenous cyst, radicular cyst, dental carries and supernumenary tooth. But the most common cause for odontogenic sinusitis is a dental implant-related complication.[4] However, its incidence rate is relatively low, considering the number of dental implant surgeries performed. Despite much effort, characteristics of dental implant-related maxillary sinusitis are not yet clearly understood. Previous studies have reported that exposing a dental implant to the maxillary sinus does not increase the risk of maxillary sinusitis in canines.[5, 6] We sought to determine what factors may affect dental implant-related maxillary sinusitis and planned to evaluate its characteristics, especially the severity.

There are several methods for evaluating the severity of chronic rhinosinusitis (CRS). The Lund-Mackay staging system is a simple assessment system for

evaluating CRS. It includes symptom score, radiologic score and endoscopic evaluation. The radiologic score is especially widely used because of its simplicity and intuitiveness. Each sinus is assessed on a cross-sectional computed tomography (CT) image and categorized into the following three groups: completely clear, partly opaque, and completely opaque. The Lund-Mackay scoring system has been strongly recommended as a standard method for measuring the extent of CRS.[7, 8] A task force team on rhinosinusitis also recommends using this system for future outcomes research.[9]

The aim of this retrospective study was to determine the factors that might affect the severity of dental implant-related maxillary sinusitis. First, we evaluated the distribution of modified Lund-Mackay scores of patients. We then examined the association between modified Lund-Mackay scores and other factors that may affect the severity of the disease.

II. MATERIALS AND METHODS

1. Patient selection

This study was approved by the Institutional Review Board of Yonsei University Severance Hospital (4-2016-0629). A retrospective study was performed on patients diagnosed with dental implant-related maxillary sinusitis in the Department of Otorhinolaryngology at Severance Hospital from January 2005 to December 2015. The inclusion criteria were as follows: (1) patients who received dental implant with or without a sinus lift, (2) occurrence of sinusitis after a dental implant on the ipsilateral side, (3) diagnosis of maxillary sinusitis based on the American Academy of Otolaryngology Head and Neck Surgery criteria,[10] and (4) CT imaging for a maxillary sinusitis evaluation. Patients without CT imaging were excluded from the study.

Among 45 patients who met these inclusion criteria, 39 patients had maxillary sinusitis after dental implants on one side and 6 patients had the disease on both sides. The study was conducted on a total of 51 maxillary sinuses of dental implant-related maxillary sinusitis cases.

2. Evaluation of potential factors affecting severity of dental implant-related maxillary sinusitis

To evaluate the severity of dental implant-related maxillary sinusitis and assess other factors that may affect the severity of the disease, all of the patients' medical records were retrospectively analyzed. The assessments included the following parameters: age, sex, smoking, alcohol consumption, medical history (diabetes, hypertension, and allergic rhinitis).

The radiologic variables from CT findings (paranasal sinus CT, ostiomeatal unit CT, or cone beam CT) indicating dental and sinus pathology were listed according to set criteria. The criteria were, location and number of dental implant, sinus augmentation, penetration of maxillary sinus floor, perforation of the Schneiderian membrane of the maxillary sinus, exposed length of dental implant in maxillary sinus (less than 4mm or not), and number of the dental implants

penetrating sinus floors.

The Lund-Mackay scoring system (Table 1)[9] was used to assess the severity of sinusitis with little modification. We only evaluated the maxillary sinus and the ostiomeatal complex, which is directly adjacent to the maxillary sinus. The severity of maxillary sinusitis was scored from 0 to 2 (0 = no abnormalities, 1 = partial opacification, 2 = total opacification). The patency of the ostiomeatal complex on coronal CT images was scored from 0 to 2 (0 = no occlusion, 1 = partial occlusion, 2 = total occlusion). The severity of sinusitis was scored from 0 to 4 by adding the score of the maxillary sinus to the score of the ostiomeatal complex.

3. Statistical analysis

To identify the clinical and radiologic factors affecting the modified Lund-Mackay score, a multiple linear regression analysis was performed. First, a simple linear regression analysis was performed to select the independent variables, including a multiple linear regression model. This univariate analysis for selection of target independent variables was performed to avoid multiple linear regression model overfitting. Independent variables significant at p values less than 0.2 were included in the multiple linear regression analysis. Then, a multiple linear regression analysis was performed to adjust for confounding variables with an analysis of covariance. If the independent variable was a categorical value, such as diabetes, this variable was defined as a dummy variable, which equals 1 for patient who had diabetes and 0 for patient who did not. The level of statistical significance was $p < 0.05$. Statistical Package for Social Sciences for windows version 18.0 (SPSS Inc., Chicago, IL, USA) was used for the statistical analyses.

Table 1. Lund-Mackay CT scan assessment.

Paranasal sinuses
Maxillary (0, 1, 2)
Anterior ethmoid (0, 1, 2)
Posterior ethmoid (0, 1, 2)
Sphenoid (0, 1, 2)
Frontal (0, 1, 2)
Ostiomeatal complex (0, 2)*
Total
0 – With no abnormalities
1 – Partial opacification
2 – Total opacification

* 0: without obstruction; 2: obstructed

III. RESULTS

Patient characteristics are presented in Table 2. The age distribution was from 28 to 81 years. The median age was 61 years, with the most common incidence in the fifth and sixth decades (68.6%). Eight patients had diabetes and 15 patients had hypertension. Seventeen patients had allergic rhinitis. There were 14 smokers and 17 alcohol drinker. The most common symptom was mucopurulent rhinorrhea (71.1%).

The patients were treated in four different modalities: medical treatment using only antibiotics and a topical nasal spray (14 cases, 27.5%), dental care involving removal of an implant or grafted material (5 cases, 9.8%), unilateral functional endoscopic sinus surgery (FESS) after medical treatment (20 cases, 39.2%), and unilateral FESS with dental care (12 cases, 23.5%). Patients who underwent unilateral FESS with dental care were divided into two groups for treatment. Seven of them underwent implant extraction prior to FESS and the other 5 patients underwent extraction afterwards, due to persisting symptoms. Among the 32 patients who underwent unilateral FESS after medical treatment, 2 patients received revision surgery.

Table 2. Demographic information of patients.

Characteristics	Results
Numbers [1]	45 (51)
Age (years) [2]	61 (28-81)
Sex [3]	
Men	26 (50.1%)
Women	25 (49.9%)
Smoking [3]	14 (27.5%)
Alcohol intake [3]	17 (33.3%)
Diabetes [3]	8 (15.7%)
Hypertension [3]	15 (29.4%)
Allergic rhinitis [3]	17 (33.3%)
Symptoms	Muco-purulent rhinorrhea (n = 32), PND (n = 22), foul odor (n = 15), facial pain (n = 14), OAF (n = 8), headache (n = 5), epistaxis (n = 4), hyposmia (n = 2)
Treatment modalities [3]	
Conservative care only	14 (27.5%)
Conservative care with dental care	5 (9.8%)
FESS after conservative care	20 (39.2%)
FESS with dental care	12 (23.5%)

PND: postnasal drip, OAF: oroantral fistula, FESS: functional endoscopic sinus surgery

[1] Number of patients and number of involved sinuses in parenthesis.

[2] Median age and range in parenthesis

[3] Number of sinuses with the percentage in parenthesis

Table 3 shows the dental implant variables that were suspected to affect the severity of dental implant-related maxillary sinusitis. The second molar (n = 28) was the most common source, followed by the first molar (n = 27). Sinus floor augmentation was performed in 36 cases.

Perforation of the Schneiderian membrane of the maxillary sinus floor was identified in 34 cases. Inhomogeneous contents within involved maxillary sinus were noted in 15 sinuses, and 6 of them were identified as fungal pathogens by a pathologic examination (Table 4).

The distribution of the modified Lund-Mackay scores is shown in Figure 1. Sixteen (33.3%) of the pathogenic sinuses received a score of 1, 10 (21.6%) sinuses received a score of 2, 5 (10%) sinuses received a score of 3, and 20 (45.1%) sinuses received a score of 4.

Table 5 shows the final regression model affecting the Lund-Mackay scores. There was no multicollinearity among these factors. After controlling for smoking, a patient with diabetes had a poor Lund-Mackay score ($p = 0.001$), and a patient who underwent sinus augmentation for a dental implant had a poor Lund-Mackay score ($p < 0.001$). There was no statistically significant association between the modified Lund-Mackay score and age, sex, alcohol consumption, hypertension or allergic rhinitis. There was also no significant association between the modified Lund-Mackay score and variables such as location and number of dental implants, penetration of maxillary sinus floor, exposed length of dental implant in maxillary sinus, and number of the dental implants penetrating sinus floors.

Table 3. Dental implant variables.

Variables	Results
Site of dental implant	2nd molar (n = 28), 1st molar (n = 27), 2nd premolar (n = 24), 1st premolar (n = 20), canine (n = 8)
Involving 1st and 2nd molar [1]	35 (68.6%)
Not involving 1st and 2nd molar [1]	16 (31.4%)
Number of implants [2]	2.24 (0-5)
Sinus augmentation [1]	36 (70.6%)

[1] Number of sinuses with the percentage in parenthesis.

[2] The values are given as the average with the range in parenthesis.

Table 4. Complications of dental implant including radiographic parameters.

Variables	Results
Perforation of maxillary sinus floor [1]	
Not penetrated	10 (19.6%)
Bony penetration but preserved Schneiderian membrane	7 (13.7%)
Perforated Schneiderian membrane	34 (66.7%)
Exposed length of dental implant in sinus [2]	3.45 mm (0-11.87 mm)
0-4mm [1]	32 (62.7%)
≥ 4 mm [1]	19 (37.3%)
Number of penetrating dental implants [3]	0.57 (0-3)
Displaced implant material [1]	6 (11.8%)
Inhomogeneous content in CT [1]	15 (29.4%)

CT : computed tomography

[1] Number of sinuses with the percentage in parenthesis.

[2] Mean value of exposed length of dental implant in maxillary sinus and range in parenthesis.

[3] The values are given as the average with the range in parenthesis.

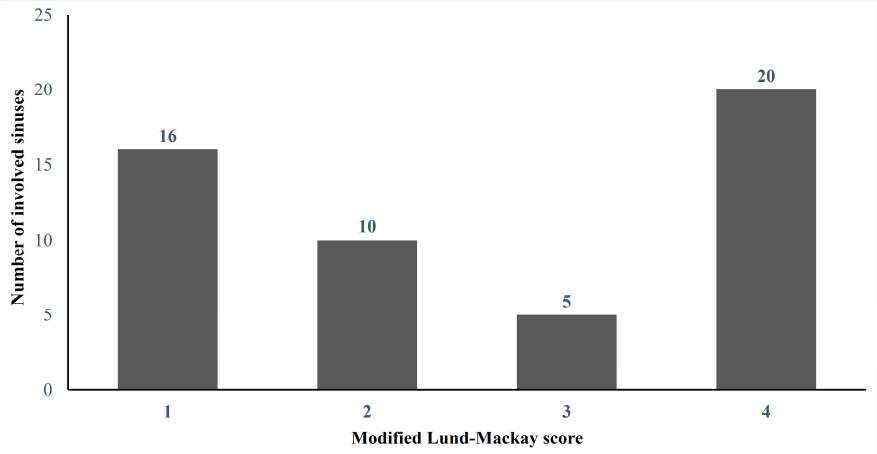

Figure 1. The distribution of the modified Lund-Mackay scores of dental implant-related sinusitis. Pathogenic sinuses received score of 1 to 4 and 20 (45.1%) sinuses received a score of 4 which means severe maxillary sinusitis.

Table 5. A multivariate linear regression model for the modified Lund-Mackay scores (n = 51).

	Parameter	Smoking	Diabetes	Sinus augmentation
Original model	B	0.157	0.407	0.465
(adjusted	SE	0.354	0.452	0.352
$R^2 = 0.285$)	*p*-value	0.208	0.003*	0.001*
Final model	B		0.444	0.354
(adjusted	SE		0.444	0.474
$R^2 = 0.275$)	*p*-value		0.001*	< 0.001*

B: standardized regression coefficient, SE: standard error, R^2: coefficient of determination

* A *p* value of < 0.05 was considered statistically significant

IV. DISCUSSION

There has been much effort to identify the characteristics of dental implant-related maxillary sinusitis. However, most of the previous studies have focused on assessing treatment modalities or looking for relationships between sinusitis and implant failure. To the best of our knowledge, this is the first report focusing on factors affecting the severity of dental implant-related maxillary sinusitis.

Our findings show that diabetes and sinus augmentation for dental implants are important factors affecting the Lund-Mackay score after adjusting for smoking. However, smoking was also an important factor for complications of dental implants. Previous studies have reported smoking and diabetes as an associated biological factors for peri-implantitis[11] and sinus complication.[12] In addition, implant failure was statistically higher in patients who were smokers.[13, 14]

In this study, diabetes was significantly associated with the severity of dental implant-related maxillary sinusitis. There have been many studies on the association between diabetes and dental implant failures, but only a few of them also examined the relationship between diabetes and dental implant-related maxillary sinusitis. Previous studies reveal persistent hyperglycemia in diabetic individuals inhibits osteoblastic activity,[15] but increases osteoclastic activity.[16] This may be the cause for marginal bone loss in patients with diabetes and who are treated with dental implants. Another study showed a significant difference in marginal bone loss between patients with and without diabetes.[17] In a study examining sinus augmentation, postoperative complications were associated with marginal bone loss.[18] Diabetes is also a well-known risk factor for fungal sinusitis. In our study, there were 6 cases of fungal maxillary sinusitis after dental implantation, with 2 of them being associated with diabetes.

Perforation of the Schneiderian membrane is a common complication of sinus augmentation. The reported incidence rate of the membrane perforation during sinus augmentation is 9.6-44%.[19-21] Even though it is widely known that perforation of the Schneiderian membrane due to a dental implant does not

increase the risk of sinusitis,[22] it may lead to the infiltration of particulate graft material into the sinus, subsequently leading to inflammation.[20] The incidence rate of acute sinusitis after sinus augmentation is up to 20%.[23,24] However, chronic maxillary sinusitis has been reported to occur only in 1.3% of patients undergoing sinus augmentation.[25]

Previous studies show that a slight perforation of the Schneiderian membrane caused by a dental implant generally heals spontaneously. According to a study by Jung et al., if the exposed length of a dental implant in the sinus is less than 4mm, the mucosa of the sinus fully covers the exposed portion of the implant. On the other hand, if the exposed length is greater than 4mm, the exposed portion will not be fully covered.[22] We evaluated the association between the exposed length of a dental implant in the sinus and the severity of sinusitis and found that there was no statistical significance.

The second and first molars area is the most commonly selected area for dental implantation.[4] Since the second and first molars are the closest teeth to the maxillary sinus floor, manipulation may easily lead to the spreading of infection from the teeth to the sinus. In this study, we presumed that there might be a relationship between the number of dental implants or the number of dental implants that penetrate the sinus floor and the severity of sinusitis, since the procedure may increase the risk of inflammation. However, there was no significant association between them.

Previous studies have suggested the following as possible causes of dental implant-related maxillary sinusitis: implant penetration into the maxillary sinus floor,[27-29] oroantral fistulas,[25] uncontrolled infection of grafted material,[27] and foreign body reaction by displaced graft material or a dental implant.[30-32] In the present study, 66.7% of involved sinuses showed implant penetration in to the maxillary sinus floor and 15.7% of the patients had an oroantral fistula. Seventy percent of the patients underwent a sinus augmentation prior to a dental implantation. There were only 6 cases (11.8%) of displaced implant material.

There are some limitations in this study. Since this study was designed as a retrospective study, there was a lack of unity in each patient's medical record

including CT exam (paranasal sinus CT ostiomeatal unit Ct, or cone beam CT). Performing of an objective evaluation and scoring each patient's severity of symptoms were difficult. In addition, endoscopic finding descriptions were not thorough enough to evaluate as a score. Therefore, it was impossible to compare the severity of symptom and the endoscopic findings with CT scans.

V. CONCLUSION

In conclusion, diabetes and sinus augmentation affect the severity of dental implant-related maxillary sinusitis. Therefore, patients with diabetes and those who need sinus augmentation before dental implantation may have more severe sinusitis than others after the procedure. As a result, careful evaluation and proper treatment of sinus infection are recommended for patients who have those factors, before and after dental implantation.

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osseointegrated implants. J Laryngol Otol 1990;104:333-4.

ABSTRACT (IN KOREAN)

치아 임플란트 후 발생한 상악동염의 중증도에 영향 미치는 요인들

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하 종 균

연구 목적

본 연구의 목적은 치아 임플란트 시술 후 발생한 상악동염의 중증도에 영향 미치는 요인을 확인하고자 하는 것이다.

재료 및 방법

임플란트 상악동염을 진단 받은 45명의 환자의 51개 부비동을 후향적으로 분석하였다. 각 환자의 CT 검사 결과를 Lund-Mackay score를 응용하여 중증도를 평가하였다. 다중 선형 회귀 분석을 이용하여 각 환자의 Lund-Mackay score에 유의미한 영향을 미치는 요인들을 확인하였다.

결과

당뇨와 상악동 거상술은 임플란트 상악동염의 중증도에 영향을 미친다.

결론

당뇨 환자 그리고 상악동 거상술을 받은 환자는 치아 임플란트 시술 전후로 주의깊은 평가가 필요하며 부비동염 발생시 적절한 치료가 필요하다.

핵심되는 말 : 임플란트, 상악동염, 당뇨, 상악동 거상