CLINICAL STUDY ON KOREAN POSTERIOR MAXILLAE RELATED TO DENTAL IMPLANT TREATMENT

Du Han Lee, DDS, MSD, Seong Hyun Lee, DDS, Ju Hong Hwang, DDS, Jeong Keun Lee, DDS, PhD*

Department of Dentistry, Ajou University School of Medicine

Abstract

Purpose of study: The purpose of this study was to provide adequate diagnostic guideline for the maxillary sinuses prior to dental implant treatment for edentulous posterior maxillary areas. For this purpose, our procedure involves the estimation of the remaining alveolar bone height, the examination of the anatomical variation in the maxillary sinuses (e.g. sinus septum), and the evaluation of the incidence of preoperative pathological conditions in the maxillary sinuses.

Materials and methods: We selected 189 patients to undergo computerized tomography (CT) in order to account for the posterior maxillary anatomy found in patients of Korean ethnicity. We evaluated the following using Dentascan software: Remaining alveolar bone height, incidence of sinus septum, and rate of preoperative pathologic conditions in the maxillary sinus. The average amount of remaining alveolar bone height was analyzed using the student's t-test for differences according to anatomical site, and the ANOVA was used for the differences according to age group with the level of significance set at 0.05.

Results: Alveolar bone heights of upper first premolar, second premolar, first molar, and second molar was 12.24 mm, 10.37 mm, 7.16 mm, and 7.15 mm, respectively with statistical significance ($P < 0.05$). Incidence of sinus septum as an anatomic variation was 17 out of 189 cases (9.0%).Incidence of mucosal thickening as a pathologic variation was 82 out of 189 cases (43.4%).

Conclusion: In treatment planning of posterior maxillary edentulous area of Koreans, the consideration of augmentation surgery for maxillary sinus is required in maxillary molar area before dental implant installation, and preoperative screening of the asymptomatic maxillary sinuses can be regarded as a reasonable preoperative procedure in the planning of dental implant treatment on the posterior maxillary edentulous area.

Key words: Posterior maxilla, Maxillary sinus, Alveolar bone height, Sinus septum, Mucosal thickening

I. Introduction

The local anatomical condition of the edentulous alveolar ridges in the posterior maxilla is usually not favorable for implant placement. The dual resorption found inside and outside of the maxillary sinus area endangers the longevity of the dental implants in this region. In addition, poor bone quality of this region is an influencing factor on the prognosis of the dental implants. Furthermore, the high occlusal force of this region complicates the situation more. It is important to gain anatomical information on the operation site during the surgical planning stages when preparing for dental implant treatment, which allows for optimal dental implant treatment. The following preoperative information is important including: alveolar bone height and width, the avoidance of vital anatomy, such as maxillary sinus or inferior alveolar nerve,[1-4] and the existence of preoperative antral pathologic conditions.

Radiographic evaluation of remaining alveolar bone is fundamental to adequate treatment planning. The

panoramic evaluation is a popular method for evaluation of remaining alveolar bone height, and is a technique using metal balls of known diameter are mounted in the radiographic stent providing the information on the original height of the remaining bone.[5,6] However, image distortion and incorrect width information are disadvantages of panoramic radiography in treatment planning. A dependency on CT is most evident in the edentulous posterior maxillary area, where thick fibrous soft tissue masks the thin alveolar ridge. Estimated available bone height as viewed on panoramic radiographs is usually incorrect due to the distortion produced by magnification. The area of fixture length provided by panoramic radiography alone significantly underestimates the length as to what is determined during surgery.[7] A comparative study using reformatted dental CT and panoramic radiography revealed an overestimate in the amount of available bone height on panoramic radiography.[8]

As a physiological process throughout the developmental stages, pneumatization of the maxillary sinus occurs until the volume reaches 12-15 cm^3.[9] Aside from developmental pneumatization, the expansion phenomenon of the maxillary sinus occurs with the loss of posterior teeth. The dimension of the available bone height in posterior maxillary edentulous area is greatly reduced with this type of pneumatization from the inside and alveolar resorption from outside. As a rule, a complicated pattern of reduced available bone height makes it difficult to standardize dental implant treatment protocol in this area. Anatomic variations of the maxillary sinus limit the length of dental implant in the posterior maxillary edentulous areas, which give rise to the sinus graft technique.[10,11] Elevating the Schneiderian membrane is difficult in the pathologic maxillary sinuses or when we encounter a sinus septum. Dependency on preoperative CT evaluation becomes more evident when we consider Schneiderian membrane elevation. Furthermore, a detailed evaluation of remaining alveolar bone height is an advantage of CT over the panoramic radiograph. It is well known that the most influencing factor in the success rate of dental implant treatment on the posterior maxillary area is the remaining alveolar bone height.[12-14]

The aim of this study was to provide adequate diagnostic guidelines for the maxillary sinuses prior to dental implant treatment for edentulous posterior maxillary areas by estimating the remaining alveolar bone height, by examining anatomic variation of the maxillary sinuses such as sinus septum, and by evaluating the incidence of preoperative pathologic conditions in the maxillary sinuses.

Ⅱ. Materials and Methods

We selected 189 patients to undergo reformatted computed tomography in order to evaluate their remaining alveolar bone height in the posterior maxillary edentulous area, the rate of septum in maxillary sinuses, and the presence of preoperative antral pathologic conditions. We used Dentascan software (GE Medical system, Milwaukee, WI) to evaluate the remaining alveolar bone height from upper first premolar through the upper second molar (Fig. 1). We

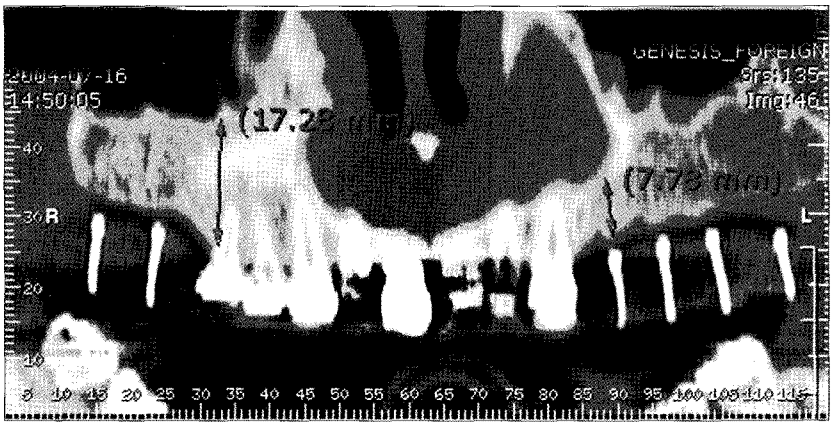

Fig. 1. Measurement of the available alveolar bone height.
Measurement of the available alveolar bone height was done by the calibration function of the Dentascan software.
(A) In dentulous area, the height of the alveolar bone was measured from the alveolar bone level to the anatomically limited structures, such as floor of the sinus, to the direction of the long axis of teeth.
(B) In edentulous areas, it was measured with the aid of radiographic stent in which radiopaque parallel pins were embedded, by the same method as in (A) to the direction of the radiopaque pin.

Table 1. Age distribution of the patients

Decade	Number
1st	0
2nd	1
3rd	8
4th	22
5th	66
6th	57
7th	28
8th	6
9th	1
Total	189

Table 2. Remaining alveolar bone height

Site	Amount (mm)
First premolars	12.24±5.99
Second premolars	10.37±5.09
First molars	7.16±4.28
Second molars	7.15±4.27

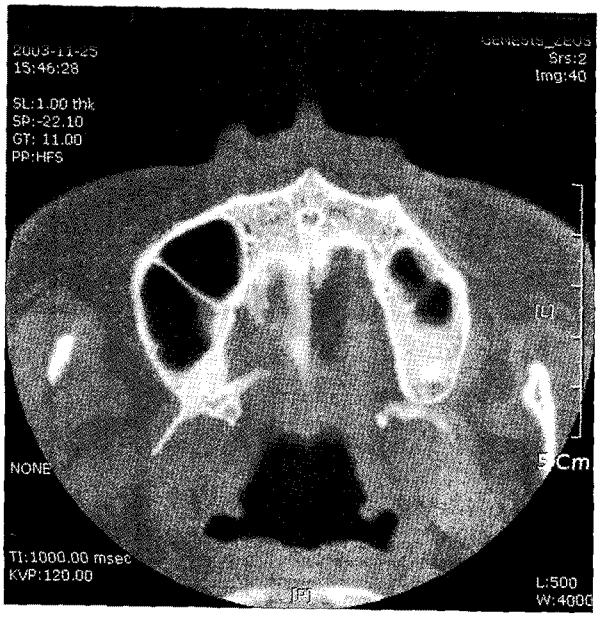

Fig. 2. Typical sinus septum on the axial view of the CT.

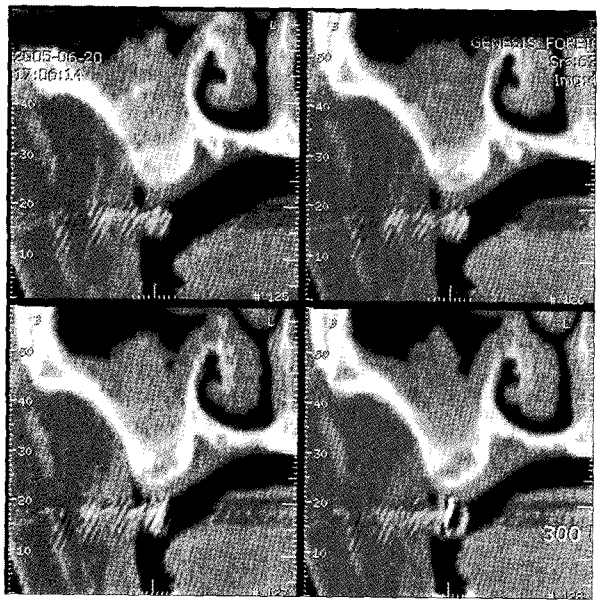

Fig. 3. Pathologic change of the right maxillary sinus on the coronal view of the CT.

evaluated the amount of bone height according to patient age (Table 1) and teeth sites (Table 2). We analyzed the frequency in anatomic variations in the the maxillary sinuses (Fig. 2), with the preoperative pathologic condition confirmed on the CT (Fig. 3). The average amount of remaining alveolar bone height was analyzed using the student's t-test for differences according to sites, and the ANOVA was used for the differences according to age groups, setting the level of significance at 0.05.

Ⅲ. Results

1. Amount of remaining alveolar bone

The age distribution of patients varied as displayed in Table 1 without a significant difference in the amount of remaining alveolar bone, according to age group. A difference in alveolar bone height was evident in the data revealed in Table 2, with statistical significance ($P < 0.05$).

2. Anatomic and pathologic variations

There were 17 cases of sinus septum out of a total189 patients (9.0%), with 2 cases of more-than-two septum (1.1%) and 15 cases of 1 septum (7.9%).The main preoperative CT finding was thickening of the sinus mucosa. There was a relatively high ratio of mucosal thickening with 82 cases (43.4%).

Ⅳ. Discussion

Anatomic variation in the posterior maxillary edentulous area makes it impossible to generalize and to standardize the dental implant treatment protocol in this area. Beside the usual alveolar bone resorption as a result of periodontal disease, pneumatization of the maxillary sinus complicates the fixture installation of this area. The amount of alveolar bone height is determined by complicated factors, but there is a report on ethnic variation evidencing Asians have greater alveolar bone loss compared to non-Asians.[15] Our report is the first one on the remaining alveolar bone height of Koreans. Advancing of age, if not accompanied with the loss of teeth, does not significantly influenced morphometric characteristics of the maxilla in other ethnic groups,[16] and this was also evident in our study, for there was no age difference among remaining alveolar bone height.

On the other hand, the site of teeth origin significantly affected the remaining amount of alveolar bone in this area. Remaining bone height is known to be an influencing factor on the success of dental implants reporting that dental implants shorter than 9mm has a 16% lower survival rate compared to those implants longer than 10 mm.[17] The remaining alveolar bone heights were over 10 mm in premolar area but those of first molar and second molar were 7.16 mm and 7.15 mm respectively in this study, indicating that other techniques need to be sought in order to overcome this anatomical problem. To date, sinus grafting techniques are the only safe and accepted method[18,19] to increase alveolar bone height recording success rates to around 90%.[11,20,21]

The presence of septal bone in the sinus complicates the course of the sinus grafting. Elevation of the Schneiderian membrane and infracture of the bony window is hindered across a septum, in which case two separate bony windows are formed and infractured respectively medial and lateral to septum and membrane elevation is performed from both sides. Other techniques to overcome the antral septum is the outfracture technique in which the bony window is moved out of the operation field. In our study the incidence of the septum was relatively low, compared to previous studies.[22-25] This low incidence may reflects low occlusal stress, for chewing hard food is related to dense hard bone and the sinus septum often disappears with lost teeth.[26]

Elevation of Schneiderian membrane is one of critical procedures in the sinus grafting technique. The inflamed sinus mucosa renders a problem in this procedure because it is vulnerable to perforation and is susceptible to postoperative infection of graft materials. Chronic inflammation of maxillary sinus coincides with thickening of the sinus mucosa and can be identified with imaging modalities, such as CT. In our radiographic review of the 189 CT scans, we found 82 cases of mucosal thickening, recording a relatively high score of 43.4% during the screening test. Asymptomatic mucosal thickening must be diagnosed and treated if possible, in patients subject to antrum-intervening surgery such as sinus graft. Preoperative CT evaluation of asymptomatic maxillary sinuses is justified by this result.

Ⅴ. Conclusion

In this study encompassing 189 preoperative Korean patients for dental implant in posterior maxillary edentulous area, we evaluated the remaining alveolar bone height, anatomic and pathologic variations with the results as follows

1. Alveolar bone heights of upper first premolar, second premolar, first molar, and second molar was 12.24 mm, 10.37 mm, 7.16 mm, and 7.15 mm, respectively with statistical significance ($P < 0.05$).
2. The incidence of sinus septum as an anatomic variation was 17 out of 189 cases (9.0%).
3. The incidence of mucosal thickening as a pathologic variation was 82 out of 189 cases (43.4%).

With these results it is concluded that the require-

ment for augmentation surgery for maxillary sinus is confirmed in maxillary molar area before dental implant installation, and preoperative screening of the asymptomatic maxillary sinuses can be considered a reasonable preoperative procedure in the planning of dental implant treatment on the posterior maxillary edentulous area.

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저자 연락처
우편번호 443-721
경기도 수원시 영통구 원천동 산 5
아주대학교 의과대학 치과학교실
이 정 근

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Jeong Keun Lee
Department of Dentistry, Ajou University School of Medicine
San 5, Wonchon-dong, Yeongtong-gu, Suwon 443-721, Korea
Tel: 82-31-219-5333 Fax: 82-31-219-5329
E-mail: arcady@ajou.ac.kr

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