A computed tomographic study of the relationship between the root apex of the maxillary tooth and the inferior wall of the maxillary sinus

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Ⅰ. Introduction

An anatomical description and the relationship between the root apex of the maxillary tooth and the inferior wall of the maxillary sinus are essential for diagnosing sinus pathoses and planning a proper dental implant. The topography of the inferior wall with the maxillary root apices varies according to an individural's age, size and the degree of pneumatization of the maxillary sinus and the state of dental retention[1]. The first and second molar roots are most commonly in close proximity to the inferior wall of the maxillary sinus. Occasionally the projecting roots are usually separated from it by various bone thicknesses, but they are sometimes separated by the sinus mucosa alone.

Curved-layer panoramic radiograph represents a well-defined outline of both maxillary sinuses on one film. But panorama is radiographic method for examining the curved layers of the jaws by "blurring out" structures not in a preselected plane[2]. So it is inadequate and impractical for precise morphometric assessments. Moreover it presents a particulary distorted view for such assessments.

The CT solves these limitations of the panoramic radiograph by providing multiplanar views with low magnification. The 3-dimensional reconstruction allows greater accuracy of measurements and an improved visualization of the anatomical situation of the inferior wall with the maxillary root apices[3,4].

The aim of this study was to identify the relationship between the inferior wall of the sinus and the roots of the maxillary teeth and to compare panoramic radiographs and CT images.

Ⅱ. Material and methods

200 patients(51 males, 65 females, average age 36.9 years) were used in this study. CBCT(Cone Beam Computerized Tomography, i-CAT™, ISI, USA) was used to image all the subjects.

The panoramic radiographs were ontained by the orthopantomograph OP100®(Image instrumen tarium, Finland).

Positional relationships between the inferior wall of the maxillary sinus and maxillary molar roots

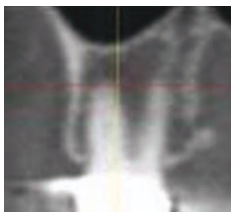
The vertical relationship between the inferior wall of the maxillary sinus and the roots of the maxillary molars were classified into 5 categories (Fig. 1).

Type Ⅰ: The inferior wall of the sinus was located above the level connecting the buccal and palatal

root apices.

Type II : The inferior wall of the sinus was located below the level connecting the buccal and palatal rood apices, without an apical protrusion over the inferior wall of sinus.

Type III : An apical protrusion of the buccal root apex was observed over the inferior wall of the sinus.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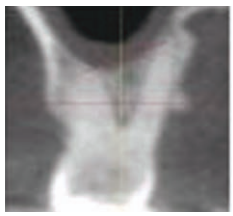
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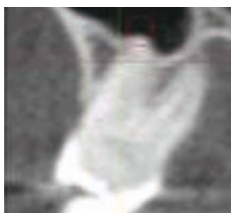
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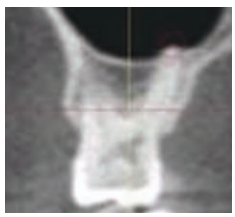
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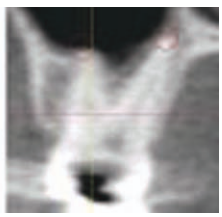
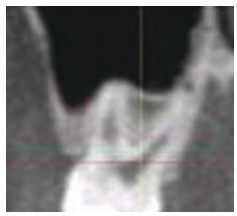

Type V

Fig. 1. Vertical Relation

Type IV : An apical protrusion of the palatal root apex was observed over the inferior wall of sinus.

Type V : An apical protrusions of the palatal and buccal root apices were observed over the inferior wall of sinus.

The horizontal relationship between the inferior wall of the maxillary sinus and the roots of the maxillary molars were classified into 3 categories (Fig. 2).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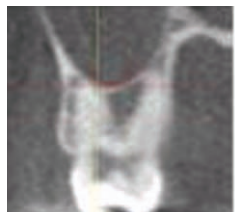
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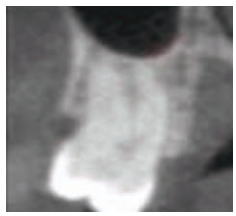
Type 3

Fig. 2 . Horizontal Relation

Type 1 : The alveolar recess of the inferior wall of the sinus was located more towards the buccal side than towards the buccal root.

Type 2 : The alveolar recess of the inferior wall of the sinus was located between the buccal and palatal roots.

Type 3 : The alveolar recess of the inferior wall of the sinus was located more towards the palatal side than towards the palatal root.

Comparison of panoramic radiographs and CT images between the inferior wall of the maxillary sinus and maxillary molar roots

Only teeth of 80 whose root apices were clearly imaged in both panoramic radiographs and CT images were included in comparison.

III. Results

Positional relationships between the inferior wall of the maxillary sinus and maxillary molar roots

The vertical relationship between the inferior

wall of the maxillary sinus and the roots of the maxillary molars were classified into 5 categories. At the first molar, Type I was observed in 81 out of 200 cases (40.5%) (Table 1), Type V was observed in 48 cases (24.0%), and Type II, TypeIII and IV were observed in 35 (17.5%), 18 (9.0%) and 18 cases (9.0%), respectively. At the second molar, Type I was predominant (98case, 49.0%) (Table 1).

Table 1. Vertical Relationship

	1st molar	2nd molar
Type I	81(40.5%)	98(49.0%)
Type II	35(17.5%)	23(11.5%)
Type III	18(9.0%)	38(19.0%)
Type IV	18(9.0%)	5(2.5%)
Type V	48(24.0%)	36(18.0%)
SUM	200(100.0%)	200(100.0%)

The horizontal relationship between the inferior wall of the maxillary sinus and the roots of the maxillary molars were classified into 3 categories. At the first molar, Type 2 was most common in 182 cases (91.0%) (Table 2). At the second molar, Type 2 also was most common in 147 cases (73.5%) (Table 2).

Table 2. Horizontal Relationship

	1st molar	2nd molar
Type 1	12(6.0%)	39(19.5%)
Type 2	182(91.0%)	147(73.5%)
Type 3	6(3.0%)	14(7.0%)
SUM	200(100.0%)	200(100.0%)

Comparison of panoramic radiographs and CT images between the inferior wall of the maxillary sinus and maxillary molar roots

Comparison of panoramic radiographs and CT images between the inferior wall of the maxillary sinus and maxillary molar roots was classified Same/Difference. At the first molar, 41 out of 80 cases were same (51.3%) (Table 3), and at the second molar, 29 out of 80 cases were same (37.2%) (Table 3).

Table 3. Comparison of Panorama and CT

	1st molar	2nd molar
Same	41(51.3%)	29(37.2%)
Different	39(48.7%)	51(62.8%)
SUM	80(100.0%)	80(100.0%)

Ⅳ. Discussion

Immediate placement of implants following extraction has been suggested by investigators to take advantage of the present osseous dimensions and to minimize further osseous resorption[5]. Clinicians conducting immediate placement of implants in posterior teeth, particularly should take into consideration the amount of protrusion of teeth roots into the sinus. And a periapical or periodontal infection of the upper posterior molars can spread to the maxillary sinus[6], and endodontic therapy or an extraction of these teeth can result in penestration. Moreover, it is known that the relationship between the dental roots and the inferior wall of the sinus can influence the movement of an orthodontic tooth[7,8].

There are some reports on the relationship between the root apex of the maxillary tooth and the inferior wall of the maxillary sinus. Kwak et al[1]. suggested 5 vertical relationships and 3 horizontal relationships in CT images only, finding that the most frequent vertical relation ship was a sinus floor that was not contacting the teeth roots. And the most frequent horizontal

relationship was a sinus recess that was located between the buccal and palatal roots. In this study, these results were identified. In the vertical relationship, Type I was most common and in horizontal relationship, Type 2 was most frequent. Eberhardt et al[9]. reported that the average distance from the root apices of the maxillary premolar and molar to the inferior wall of the maxillary sinus ranged from 0.83mm on the mesiobuccal root of the second molar to 7.05mm on palatal root of the first premolar. These were identified with the result in this study that Vertical Type III occurred more often in the second molar than in the first molar. In this study, Horizontal type 2 was almost common in both first molar and second molar, but Horizontal type 1 was signi ficantly increased in second molar. The result represents maxillary sinus floor that was close to maxillary second molar had tendency to be located on buccal side than that close to first molar. And this coincided in the result that Vertical Type III in second molar was more frequent than in first molar. These findings may have clinical applications in the area of oral and maxillofacial diagnoses as well as in surgical treatment.

This study compared the relationship of the sinus floor to tooth roots imaged by both panoramic radiography and CT. Freisfeld et al[10]. described 3 types of vertical relationships and examined them in panoramic radiographs and CT images, finding significant differences between the 2 imaging techniques in cases of roots that projected on the sinus cavity. Freisfeld at al. found that out of 129 roots, 64 seemed to penestrate into the maxillary sinus in the panoramic radiographs, but only 37 roots showed penestration in the CT. Bouquet at al[11]. found that out of 30 third-molar roots that projected on the sinus in panoramic radiographs, 7 did not penestrate the sinus in CT images. Arbel Sharan et al[12]. reported that only 39% of the teeth roots that projected on the sinus cavity in panoramic radiographs showed protrusionon the sinus with CT and the panoramic radiographs showed a statistically significant 2.1 times longer root projection on the sinus cavity in comparison to the root protrusion length into the sinus measured by using CT images. Indeed, when compared panoramic radiographs with CT images, only 44.2% were same and in first molar were more accurate than in second molar. (This considered that when panorama taking, second molar had tendency to be located farther from image layer, so the images were blurred and distorted.) The clinician observing maxillary molar roots in the panoramic radiograph should be aware that an average of only 44.2% of these roots were realized.

Ⅴ. Conclusion

The result of the study were following.

1. The most frequent vertical relationship was a sinus floor that was not contacting the teeth roots.

2. The most frequent horizontal relationship was a sinus recess that was located between the buccal and palatal roots.

3. When the results of the Panoramic view and CT image were compared, 44.2% of the results agreed with each other.

Maxillary sinus floor that was close to second molar had tendency to be located on buccal side

than close to first molar. And CT was more adequate and practical than the frequently used panoramic view. When immediate placement of implants, these findings may be helpful.

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Abstract

전산화 단층촬영법을 이용한 상악동 아래벽과 상악 대구치 치근사이 위치관계

정성순, 유인순, 궁화수, 김현철, 이상철

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상악동 아래벽과 치근단과의 관계는 상악동 질환을 위한 진단 뿐만 아니라 상악 치아의 근관 치료, 치근단 수술, 발치, 교정치료 그리고 임프란트 식립에도 중요하다. 현재 상악동 아래벽과 치근단과의 관계는 일반적으로 파노라마 방사선 사진을 통해 평가되고 있다. 하지만 기계적 특성에 의한 상의 왜곡이 발생하고, 상악 치아와 상악동 아래벽에 대한 입체적 관찰이 불가능하다. 반면 전산화 단층 촬영법은 상악 치아와 상악동과의 관계를 3차원적으로 관찰 가능하므로 많은 치과 연구에서 상악치아와 상악동과의 관계를 연구하기 위한 수단으로 사용되어 왔다. 본 연구는 400개의 치아를 전산화 단층촬영법을 통해 상악동 아래벽과 치근단과의 수직적, 수평적 관계를 분류하고, 각 분류별 상악동 아래 점막의 비후 정도를 평가하였으며, 파노라마 방사선 사진과 비교하였다. 상악 대구치 치근단과 상악동 아래벽의 수직적 관계는 5개의 유형으로 나누었으며, 수평적 관계는 3개의 유형으로 나누었다. 이중 파노라마 방사선상과 전산화 단층촬영상 모두 명확한 160개의 치아를 선택하여 파노라마 방사선상과 전산화 단층촬영상을 비교하였다. 수직적 관계에서는 상악 제1대구치(40.5%)와 상악 제2대구치(49%) 모두 제1형(협구개측 치근의 치근단을 연결한 선보다 상악동 아래벽이 상방에 위치하는 경우)이 가장 많았으며, 수평적 관계에서는 상악 제1대구치(91.0%)와 상악 제2대구치(73.5%) 모두 제2형(상악동 최하방부가 협측 치근과 구개측 치근 각각의 연장선 사이에 위치하는 경우)이 가장 많았다. 파노라마 방사선상과 전산화 단층촬영상의 비교에서는 상악 제1대구치에서는 51.3%, 상악 제2대구치에서는 36.3%가 일치하여 파노라마상에서 상악 제1대구치가 상악 제2대구치보다 정확하게 위치관계가 반영되었다. 이러한 결과는 치과치료에서 많은 참고사항이 될 것으로 생각된다.