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# 2018년 8월 박사 학 위논문 

상악동 거상술시 해부학적 고려사항

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김 지 형

# 상악동 거상술시 해부학적 고려사항 

 Anatomical consideration for sinus lift2018년 8월 24일

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# 이 논문을 치의학 박사학위신청 논문으로 제출함 

2018년 4월

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## 목 차

ABSTRACT ..... iii
I. Introduction ..... 1
II. Material and Methods ..... 3
III. Results ..... 6
IV. Discussion ..... 9
V. Conclusion ..... 12
Reference ..... 13

Lists of figures
Figure 1. Setting the lowest point of finus floor in 3D


Figure 2. Measure the perpendicular distance of posterior superior alveolar artery(PSAA) from the lowest point of sinus floor3
Figure 3. PSAA inside the bone (intraosseous) ..... 4
Figure 4. PSAA below the Schneiderian membrane ..... 4

Figure 5. PSAA on the outer cortex of the lateral sinus wall4
Figure 6. Classify sinus floor shape into 2 type ........... 10

Figure 7. Slice 3d structure according to $3 \mathrm{~mm}, 5 \mathrm{~mm}, 7 \mathrm{~mm}$, 10 mm height from the sinus floor12
Figure 8. 3D reconstructed sinus volume models ..... 12

## 초록

## 상악동 거상술시 해부학적 고려사항

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## I 서론

상악골의 후방 부위는 치아의 상실로 인한 상악동 재함기화로 인한 유 용한 골량의 부족 그리고 골질이 좋지 못한 부위이다. 이러한 부위에 임 플란트 수술을 할 때 임상의는 상악동 증강술이 요구된다. 본 연구에서는 상악동 거상술시에 고려해야 하는 후상치조동맥의 위치, 상악동 측벽의 두께, 상악동 중격의 유무와 중격의 높이 그리고 상악동 거상량에 따른 상악동의 부피를 평가하고자 한다.

## II 재료 및 방법

상악동 거상술을 받기 위해 내원한 환자들중 CT 를 촬영하고 CT 소견 에서 염증이나 증식의 증거가 없는 46 명의 환자를 대상으로 하였다. 남 성 20 명, 여성 26 명을 대상으로 평균 나이는 57.3 세로 18 세에서 85 세 이었다. 2007 년 5 월부터 2016 년 8 월까지 조선 대학교 치과 병원을 방 문하여 치료를 받은 환자를 대상으로 하였다. CT 스캔 데이터를 3D 모델 로 재건 후, 상악동저에서 부터 상악동의 형태에 따라 상악동저에서 후상 치조 동맥까지의 거리를 측정하고, 후상 치조 동맥의 외측 분지 바로 아 래의 상악동 외벽 두께를 측정 하였다. 그리고 후상 치조 동맥 분지의 위

치를 측정하기 전에 3 D 모델에서 상악동 바닥의 가장 낮은 지점을 설정 한 후 제 1 대구치 부위에서 상악동 가장 낮은 지점으로부터 거리를 측정 하고, 상악동 중격의 유무 및 중격의 높이를 측정하였다. 상악동 부피를 측정하기 전 상악동 형태에 따라 좁은형 $(\mathrm{N})$ 과 넓은 형 $(\mathrm{B})$ 으로 구분하였 다. 상악동의 부피 측정 및 거상술시 필요한 이식재의 부피 측정을 위해 상악동 바닥에서 $3 \mathrm{~mm}, 5 \mathrm{~mm}, 7 \mathrm{~mm}, 10 \mathrm{~mm}$ 의 높이에 따라 3 차원 모델을 재구성한 후 부피를 통계적으로 평가하고 분석하였다.

## III 결과

상악동저에서 후상 치조 동맥 가지의 수직 거리 평균은 5.56 mm 에서 21.29 mm 까지 11.34 mm 이었다. 상악동 외측벽 두께의 평균은 0.40 mm 에 서 2.04 mm 범위의 0.90 mm 이었다. 상악동 중격은 $27.1 \%$ 에서 존재 하였 으며, 평균 높이는 13.93 mm 이었다. 부비동 바닥에서 3 mm 높이의 부 비동 부피는 B 형의 평균치는 $0.37 \mathrm{~cm}^{3}$ 이고 N 유형의 평균치는 $0.19 \mathrm{~cm}^{3}$ 이었다. N 형은 B 형보다 유의하게 작았고 P 값은 0.00050 으로 0.05 보다 작았다. 5 mm 의 경우 평균 체적은 B 형이 $0.82 \mathrm{~cm}^{3}, \mathrm{~N}$ 형이 $0.56 \mathrm{~cm}^{3}$ 로 두 그룹간에 유의한 차이가 있었다. $(\mathrm{P}=0.00075) 7 \mathrm{~mm}$ 의 경우 평균값은 B 형이 $1.47 \mathrm{~cm}^{3}, \mathrm{~N}$ 형이 $1.06 \mathrm{~cm}^{3}$ 으로 p 값이 0.05 미만이었다. ( $\mathrm{P}=0.00048$ ) 높이가 10 mm 인 경우 B 형의 평균은 $2.81 \mathrm{~cm}^{3}$, N 형의 평균은 $2.13 \mathrm{~cm}^{3}$ 이었고, 또한 p 값은 0.05 미만이었다.

## IV 결론

상악동저에서 후상 치조 동맥 외측 가지의 수직 거리의 평균은 5.56 mm 에서 21.29 mm 까지 11.34 mm 이었다. 외측벽 두께의 평균은 0.40 mm 에서 2.04 mm 범위의 0.90 mm 였고, 상악동 부피(높이 $3 \mathrm{~mm}, 5 \mathrm{~mm}, 7$ mm 및 10 mm )의 경우 상악동의 형태 유형에 따라 유의미한 차이를 나

타내었으며 평균 부피는 각각 3 mm 에서 $0.27 \mathrm{~cm}^{3}, 5 \mathrm{~mm}$ 에서 $0.67 \mathrm{~cm}^{3} 7$ mm 에서 $1.23 \mathrm{~cm}^{3}, 10 \mathrm{~mm}$ 에서 $2.42 \mathrm{~cm}^{3}$ 이었다. 후상치조 동맥의 평균적 인 위치와 외측벽 두께, 평균적인 상악동 거상량에 따른 부피는 상악동 거상술 수술시 3 차원 CT 정보를 갖지 않은 상태에서 2 D 이미지를 통해 삼차원 해부학적 정보를 유추하는데 도움이 될 수 있을 것으로 사료된다.

## I. Introduction

Treatments involving implants have become common in the treatment of tooth loss in the maxillary posterior area.

However, bone quality in this area is poor, and bone volume is often not sufficient because of the presence of the maxillary sinus. Consequently, this area is notoriously difficult to treat using implants. Maxillary sinus floor elevation has been regarded as a successful and predictable approach for augmentation of the posterior maxilla and provides adequate bone volume for implant placement.(1) Understanding the vascular anatomy of the maxillary sinus is also critical to avoid hemorrhage and membrane perforation. Blood vessels with large diameters may impose more serious risk of bleeding during the surgery.(2) Assessment of the maxillary sinus anatomy is important to avoid unnecessary complications due to the close anatomical relationship of the PSAA with the maxillary sinus.(3) (4) Perforation of the membrane may occur while reflecting the membrane or preparing the window to access the sinus cavity. Technical and anatomical factors such as the presence of sinus septum, lateral wall thickness, and the angle between the lateral and medial walls have been implicated in membrane perforation.(5) The difference in the thickness of the lateral
wall in different areas may be related to the position of the adjacent structures such as the buttress of the zygoma, maxillary tuberosity, and the canine eminence.(6) Cone beam computerized tomography (CBCT) is a relatively new radiographic technique that provides multiplanar imaging of the dentoalveolar region with the possibility of using less radiation dose in comparison with medical CT. Measurements taken with this technique have been proven to be both accurate and reliable. (7) The purpose of the current study was to assess the thickness of the lateral wall using CBCT scans and investigate the influence of the side of maxillary sinus, age and sex on thickness of the lateral wall. It also provides information about the anatomy of the location of the PSAA and maxillary sinus volume according to the height.

## II. Materials and Methods

The study design underwent formal review and received approval from the institutional review board of our institution. The retrospective study group was planned according to Sample Size Estimation Simple Random Sampling and consisted of 46 CBCT scans of 20 males and 26 females ( 92 sinuses) obtained. Patient ages ranged from 18 to 85 years. Digital images were taken using an Hitachi CBCT scanner (Hitachi, Japan). 3D reconstructions were created by reformatting the axial CBCT scans on Mimics (18.0.0.025) software (Materialise, Belgium). A written informed consent form, which is routinely obtained from each patient prior to imaging in our faculty, also included a clause for the use of images in this research. Before measurements were made, the orientation of the images was determined for each patient. at first, we found the lower point of sinus floor by 3D analysis. On coronal scans, evaluation was made between where the artery was seen. The distance between the lower border of the artery and the lower point of sinus floor (A), bone height from the sinus floor to the top of the alveolar ridge (B), and lateral wall thickness (C). (Fig. 1)

Locations of the artery were classified with 3 types;
a. intraosseous (Figure 2), b. below the membrane (Figure 3), and c. on the outer cortex of the lateral sinus wall (Figure 4).

For intra-examiner calibration and determination of reliability and reproducibility of the measurements, the images were evaluated a second time by the same observer. Additionally, in the selected sagittal section, a built in digital caliper made the following measurements in millimeters. The below the PSAA level was chosen to be the level where the lateral window augmentation ends. Volumes were measured by determining the differences in Hounsfield values expressed on CT. In other words, the volume of the empty space within the maxillary sinus was determined using presurgical CT scan according to the height from the sinus floor ( $3 \mathrm{~mm}, 5 \mathrm{~mm}, 7 \mathrm{~mm}, 10 \mathrm{~mm}$ ). Sinus was reconstructed to the 3D model and measured the volume.

SPSS 15.0 (Statistical Package for Social Sciences, IBM, New York, USA) for Windows 2007 (Microsoft, New Mexico, USA) was used for statistical analysis of the results. Prior to the study, all parameters were evaluated with the

Kolmogorov-Smirnov test, and the data were found to be normally distributed. Simple Random Sampling Sample Size

Estimation was done. While evaluating the data using descriptive statistical methods, parameters with normal distribution for the comparison of quantitative data were evaluated using one-way analysis of variance, the Tukey test, and Student's t-test. Qualitative data were evaluated using the Chi-square test. The Pearson correlation was used to assess potential correlations between parameters. Intra-observer agreement was calculated using the intraclass correlation coefficient. Signicance was accepted at $\mathrm{p}<0.05$.

## III. Results

The mean age of the study participants was 57.3 years. The PSAA was observed in 91.3 \% of all sinuses; $30.4 \%$ of arteries were intraosseous, 51.1 \% were below the membrane, and only $9.8 \%$ were on the outer cortex of the lateral sinus wall. The artery diameters ranged from 0.62 to 1.62 mm with a mean value of $0.92 \pm 0.22 \mathrm{~mm}$. The artery diameters were mostly $\leq 1 \mathrm{~mm}$ ( $69.0 \%$ ). The percentages of artery diameters $\leq 1 \mathrm{~mm}$ were $70 \%$ and $68 \%$ for the right and left sinuses, respectively, a difference that was not statistically significant ( $\mathrm{p}>0.05$ ). No significant correlation was found between the presence of the artery and age/gender ( $\mathrm{p}>$ $0.05)$. A statistically signicant difference was found between locations of the artery and age ( $\mathrm{p}<0.05$ ). Although the prevalence of an PSAA below the membrane was signicantly higher in females ( $57.7 \%$ ) than males ( $37.5 \%$ ), the prevalence of an intraosseous PSAA was signicantly higher in males ( 40 \% ) than females ( 26.9 \%) and the PSAA was located on the outer cortex of the lateral sinus wall higher in males (15 \% ) than females(5.8 \%) bot there was no statistically signicant difference ( Table 1; p > 0.05).

The mean distance from the artery to the lower point of sinus floor was $11.34 \pm 3.37 \mathrm{~mm}$ (A), and the bone height from the sinus floor to the top of the alveolar ridge (B) was 9.09 $\pm 4.11 \mathrm{~mm}$. The Lateral sinus wall thickness(C) was $0.90 \pm 0.28 \mathrm{~mm}$. A statistically signicant difference was found between the mean distance from the artery to the lower point of sinus floor and sex ( $\mathrm{p}<0.05$ ). The mean distance of male ( $12.17 \pm 3.90$ ) is longer than that of female( $10.7 \pm 2.77$, $\mathrm{P}=0.04$ ). No statistically significant difference was observed between gender and the bone height from the sinus floor to the top of the alveolar ridge ( $B$ ) ( $p>0.05$; Table 2) .

The prevalence of sinus septa was $27.1 \%$ and the mean height of sinus septa was 13.93 mm . There was no statistically significant difference between prevalence of sinus septa and other values

The average volume of the maxillary sinus was $19.87 \pm 6.55$ $\mathrm{cm}^{3}$. According to the sinus floor shape in the 3D reconstructed sinus model, maxillary sinus was classified with $u$-shape broad type(B) and $v$-shape and narrow type( $N$ ). When compared the sinus volume of 3 mm height from the sinus floor, B type's average was $0.37 \mathrm{~cm}^{3}$, and N type's average was $0.19 \mathrm{~cm}^{3}$.

And N type was smaller than B type significantly. ( $\mathrm{P}<0.005$ ). In case of 5 mm , average volume was $0.56 \mathrm{~cm}^{3}$ in N type, $0.82 \mathrm{~cm}^{3}$ in B type and p -value was 0.001 also shows the significant difference in two groups. In case of 7 mm , the average was $1.47 \mathrm{~cm}^{3}$ in B type, $1.06 \mathrm{~cm}^{3}$ in N type respectively, And also p -value was $<0.001$. In case of 10 mm height, B type's average was $2.81 \mathrm{~cm}^{3}$. N type's average was $2.13 \mathrm{~cm}^{3}$, also p -value was 0.0007 .
IV. Discussion

Sinus augmentation is a method with high predictability for placing successful dental implants into atrophic posterior maxilla. (8) Knowledge of the anatomic structure of the area is important for this procedure. In the present study, we were able to observe the presence and location of the PSAA with CBCT scans. The artery was observed in $91.3 \%$ of the 92 sinuses and located inner surface of the lateral wall( $81.5 \%$, below the membrane $51.1 \%$ and intraosseous $30.4 \%$ ). The success rate for identifying the artery was higher than that reported by Güncü et al. (9) (64.5 \% ), Elian et al. (10) (52.9 \% ), Mardinger et al. (11) ( $55 \%$ ), and Kim et al. (12) (52 \% ). The lateral sinus wall thickness was $0.90 \pm 0.28 \mathrm{~mm}$ and ranging from 0.4 to 2.04 . On the contrary, sex did not seem to affect lateral wall thickness. Because of these factors, each case must be evaluated independently to reduce the number of membrane perforations and consequent complications. The find ings from the present study might help the clinician Percentiles overcome the pitfalls during maxillary sinus augmentation by illustrating the anatomic patterns of the lateral wall.(6) The management of the lateral wall during sinus augmentation via
lateral approach has been emphasized because its thickness may influence the integrity of the Schneiderian membrane. (3)

Results from this study demonstrate that mean lateral wall thickness was $1.96 \pm 0.72 \mathrm{~mm}$. Yang et al.(13) found thicker mean lateral wall thickness in patients with complete edentulism (1.75 $\pm 0.80 \mathrm{~mm}$ ) This difference might be attributed to either the measuring reference used to determine lateral wall thickness (i.e., anatomic landmarks or inclination of the line following the lateral wall anatomy) or the race of the patients. (13) Neiva et al. showed, in white skulls, that mean lateral wall thickness was thinner than that found in the present study ( $0.91-0.43 \mathrm{~mm}$ ). In other words, instruments used to record the data might be the cause of this disparity.(14) Furthermore, it is noteworthy that these findings demonstrated that the presence of teeth adjacent to the edentulous span is related to mean lateral wall thickness. In general, repneumatization could be affected the lateral wall thicknees in edentulous maxillary molar areas. For example, in cases where bone volume is not sufficient because of the pneumatization of the maxillary sinus, maxillary augmentation has been introduced as a means to augment bone volume.(15) A wide range of bone graft materials has been used in maxillary augmentation. Numerous studies
have reported that allogenic bone, xenogenic bone, and synthetic bone can be used safely and successfully.

Ariji et al reported the volume of maxillary sinus and The volume ranged from 4.56 to $35.21 \mathrm{~cm}^{3}$ (mean: $14.71 \pm 6.33$ $\left.\mathrm{cm}^{3}\right)(16)$ and our result is $16.87 \pm 6.55 \mathrm{~cm}^{3}$. these findings demonstrated that our result and measuring method can be acceptable. Narrow type of maxillary sinuses were significantly smaller than Broad type in all the measurements.

## V. Conclusion

For the location of posterior superior alveolar artery, the average of distance was 11.34 mm ranging from 5.56 mm to 21.29 mm . The average of lateral wall thickness was 0.90 mm and ranging from 0.4 mm to 2.04 mm . In case of segmented sinus (height of $3 \mathrm{~mm}, 5 \mathrm{~mm}, 7 \mathrm{~mm}$ and 10 mm ), the Narrow type sinus volume was smaller than the Broad type. The average position of the posterior superior alveolar artery, the wall thickness of the lateral wall, and the average volume of the maxillary sinus will be helpful to the clinician in the maxillary sinus lift. Therefore, clinicians should consider these anatomic landmarks during the surgery.

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Figures
Fig. 1


Fig. 2


Fig. 3


Fig. 4


Fig. 5


Fig. 6


Fig. 7


Fig. 8


## Tables

Table. 1 Posterior superior alveolar artery localization according to age and gender

|  |  | Abscence | Intraosseous | Below the <br> membrane | On the outer <br> cortex | p value |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- |

Table. 2 Location of the posterior superior alveolar artery(PSAA), and laterla wall thickness measurements according to gender

|  | Total | According to gender |  |  |
| :--- | :--- | :--- | :--- | :--- |
|  | Mean $\pm$ SD | Female <br> Mean $\pm$ SD | Male <br> Mean $\pm$ SD | p value |
| A | $11.34 \pm 3.37$ | $10.70 \pm 2.77$ | $12.17 \pm 3.90$ |  |
| B | $9.09 \pm 4.11$ | $8.66 \pm 4.30$ | $9.64 \pm 3.84$ | 0.28 |
| C | $0.90 \pm 0.28$ | $0.86 \pm 0.23$ | $0.95 \pm 0.33$ | 0.14 |

(A: From sinus floor to PSAA, B: From sinus floor to top of the alveolar ridge, C: Lateral wall thickness)
Table. 3D segmented volume according to the shape of the maxilalry sinus

|  | Total | According to type |  |  |
| :--- | :--- | :--- | :--- | :--- |
|  | Mean $\pm$ SD | Broad <br> Mean $\pm$ SD | Narrow <br> Mean $\pm$ SD | p value |
| total $\left(\mathrm{cm}^{3}\right)$ | $16.87 \pm 6.55$ | $19.29 \pm 6.98$ | $15.10 \pm 5.65$ | $* 0.002$ |
| $3 \mathrm{~mm}\left(\mathrm{~cm}^{3}\right)$ | $0.27 \pm 0.26$ | $0.37 \pm 0.34$ | $0.19 \pm 0.14$ | $* 0.001$ |
| $5 \mathrm{~mm}\left(\mathrm{~cm}^{3}\right)$ | $0.67 \pm 0.40$ | $0.82 \pm 0.49$ | $0.56 \pm 0.26$ | $* 0.001$ |
| $7 \mathrm{~mm}\left(\mathrm{~cm}^{3}\right)$ | $1.323 \pm 0.56$ | $1.47 \pm 0.69$ | $1.06 \pm 0.36$ | $* 0.0005$ |
| $10 \mathrm{~mm}\left(\mathrm{~cm}^{3}\right)$ | $2.42 \pm 0.86$ | $2.81 \pm 1.07$ | $2.13 \pm 0.51$ | $* \ll 0.001$ |

