The volumetric changes of the maxillary sinus according to missing the maxillary posteior teeth A study using computed tomography

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Ⅰ. Introduction

The developmental pattern of the maxillary sinus varies widely according to the individuals and age. Therefore, there are considerable variations in size and shape of the maxillary sinus[1,2]. Generally, it may increase in size after extraction of the maxillary teeth[3]. Providing normal values for the maxillary sinus size and their changes with extraction could be helpful in evaluating the presence of the abnormality[4].

In previous reports, Some researchers measured the volume of the maxillary sinuses on cadaveric materials, dry skulls[5,6]. and plain x-ray films[7].

Introduction of the CT scans has allowed exact estimation of the volume about this structure[8,9]. In this study, we evaluated the normal size of the maxillary sinus and the affection of extraction on the size of the maixillary sinus by using CT scans.

Ⅱ. Materials & Methods

This study was perfomed on CT scans taken from 43 patients (65 sinuses aged between 18 and 84 years. All patients were free of any signs of the maxillary sinus pathology such as fracture, inflammation, cysts or tumors.) These 65 sinuses were divided into two groups depending on dental status: group 1(without missing teeth, 39 sinuses) and group 2 (with one to three missing teeth, 26 sinuses with remaining alveolar bone thickness is less than 6 mm on maxillary sinus floor area and a longtime has passed after extraction). CT scan images were reconstructed by using the Simplant™ program (Materialize, Belgium). Maxillary sinus volumes were calculated.

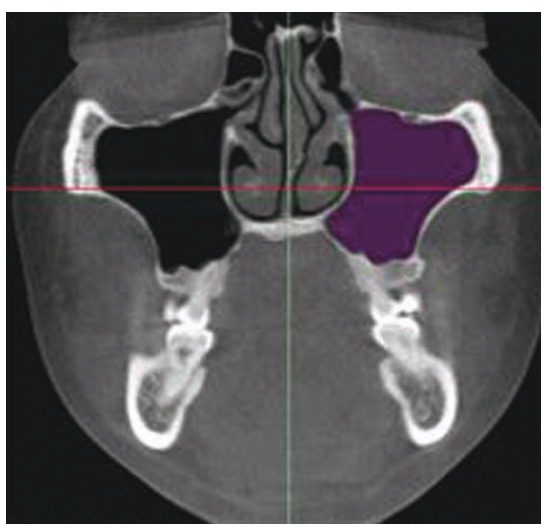

Fig. 1. coronal section of the CT scans

Total maxillary sinus volume from base to top(Fig. 1-4) and partial maxillary sinus volumes at the level of heights 5 mm, 10 mm from antral floor were evaluated(Fig. 5-7).

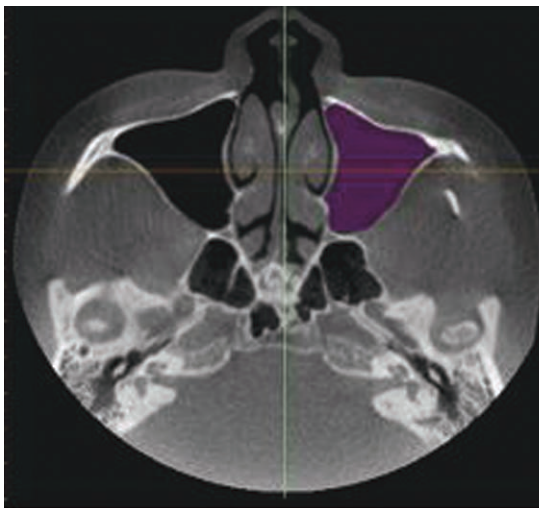

Fig. 2. axial section of the CT scans

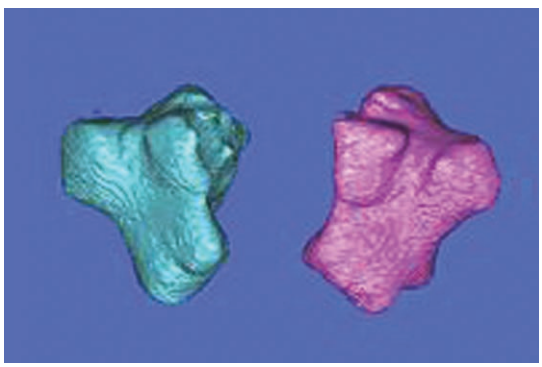

Fig. 3. 3-D reconstruction of the CT scans

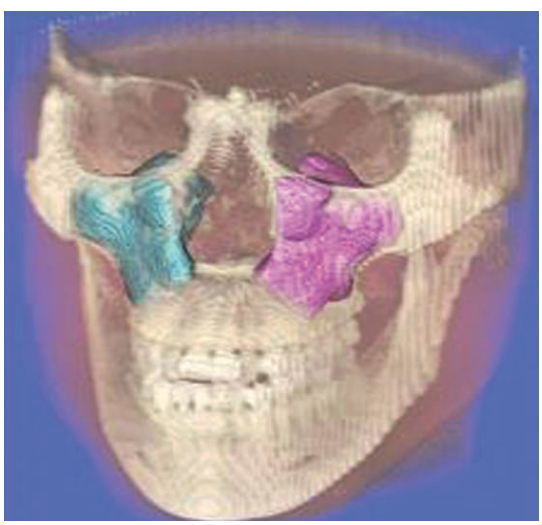

Fig. 4. 3-D reconstruction of the CT scans

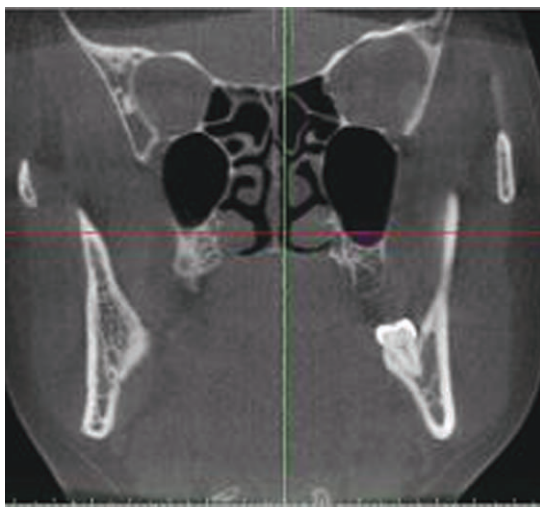

Fig. 5. coronal section of the partial maxillary sinus

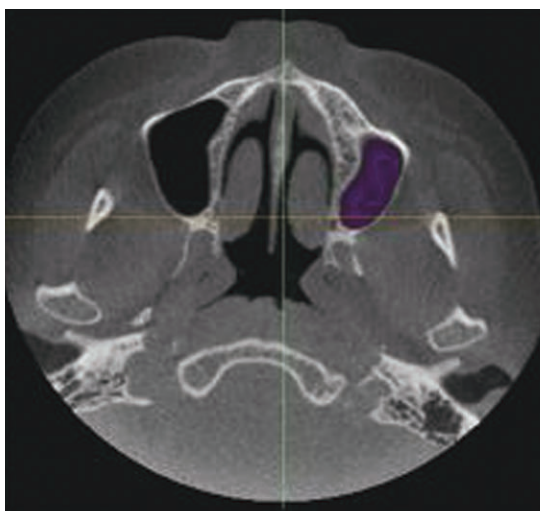

Fig. 6. axial section of the partial maxillary sinus

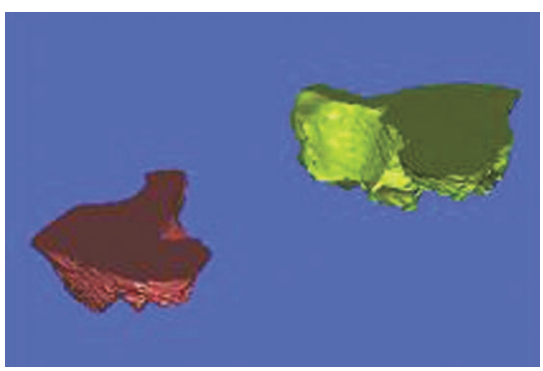

Fig.7. 3-D reconstruction of the partial maxillary sinus

III. Result

The mean volume of the total 65 sinuses was 18.25 ± 4.43cc. and The mean volume of the maxillary sinus in group1 was 18.14± 4.18cc, 18.74± 4.18 cc in group 2(Table 1).There were not singnificant difference between group 1 and group 2 (t-test, p value > 0.05). Volumes of the partial portion of the maxillary sinus, at the level of heights 5mm, 10mm from antral floor were 0.59± 0.22cc, 2.30± 0.55cc in group 1 and 0.72± 0.21cc, 2.61± 0.53cc in group 2(Table 2). There were statistically significant difference between group 1 and group 2 (t-test, p value < 0.05).

Table 1. total mean volume of the maxillary sinus

	group 1	group 2
volume	18.14±4.18cc	18.74±4.18cc
p-value	p>0.05	

Table 2. partial mean volume of the maxillary sinus

	at the level of heights from the antral floor	
	5mm	10mm
group 1	0.59±0.22cc	0.59±0.22cc
group 2	0.72±0.21cc	2.61±0.53cc
p-value	p<0.05	p<0.05

IV. Discussions

The maxillary sinus is often imaged because infectious and allergic diseases of the nasal cavity and paranasal sinuses[10]. Improved knowledge of normal development of maxillary sinus and their changes with extraction is important to allow sinus diseases to be evaluated and an adequate treatment to be proposed. The maxillary sinus develops in the 3rd month of fetal life. At birth, the volume of the maxillary sinus is 6 to 8 cm^3. After birth, the maxillary sinus continues to extend both laterally and inferiorly. Laterally, the maxillary sinus passes the medial orbital wall at 1 year of age and the infraorbital canal at 4 years of age. Inferiorly, it reaches the level of the hard palate at 9 years of age. It continues to grow downward and together with the pneumatization of the maxillary alveolar bone, reaching the level of the nasal floor at 12 years of age. The floor of the maxillary sinus finally extends 4 to 5 mm inferior to the nasal floor[11]. when it is reached maximum size, Various results, from 14 years of age to 25 years of age, have been reported[12,13]. The procedures for measuring the volume of the maxillary sinus have been changed with advances in medical techniques. For example, cadaveric skull measurements, plain radiographs to CT and MRIs. A disadvantage of measuring cadaveric skulls is in the inaccurate information about them, such as, measurements will be larger than true size because of the loss in cadavers of mucosa of the maxillary sinus and the other soft tissues[14]. The disadvantage of using plain radiographs is that the images may be different from actual size and that the boundary for the images of the maxillary sinus and adjacent structures overlaps and cannot be determined precisely[15,16]. CT scans efficiently distinguishes the maxillary sinus from the adjacent structures with a high resolution[17]. Therefore, it plays an important role in the diagnosis as well as the treatment of the maxillary sinus diseases. For that reason, CT scans has recently been used most frequently to estimate the maxillary sinus volume. Therefore we used a CT scans to measure the maxillary sinus volume, total mean maxillary sinus volume was

18.25± 4.43cc. The mean value of the maxillary sinus volume has been studied by several researchers.

Uchida et al.reported[18] the volume of the maxillary sinus, 13.6cc, Ariji et al. reported[6] that 14.7cc. These values are smaller compared with that in our study. Ikeda reported[19] that 20.5cc. In this way, The variation of reported results is supposed that the indivisual variation is great, mean value could be influenced by the quantity of the subjects. In addition, even if CT scans was adequately accurate, mesurements could be different by the reconstruction techniques[21].

Generally, maxillary sinus volume tends to be increased after loss of maxillary teeth[22]. The mechanism of this increase has been studied by several researchers. Acording to Chanavaz[23], in cases with early loss of maxillary teeth the maxillary sinus volume is expanded by a slight increased positive pressure in sinus. Kraut and Kessler[24] and Smiler et al[25]. reported that after tooth loss the periosteum of the Schneiderian membrane shows increased osteoclastic activity, resulting in resorption of the sinus floor and consequent expansion of the maxillary sinus.

In this study, the mean volume of the maxillary sinus in group 1 was 18.14± 4.18cc, 18.74± 4.18 cc in group 2. Because of individual variations, we cannot evaluate changes after extraction of the maxillary teeth. There was no statistically difference in the mean volume between group 1 and group 2, but significant differences in the volumes at the level of heights 5mm, 10mm from the antral floor between group 1 and group 2.

That is the site of maximum enlargement of the maxillary sinus is probab1y at its floor, since this region is most closely associated with the functional changes in the dentition. The extraction of maxillary teeth in this region serves to reduce the functional forces. The alveolar process is dependent upon the presence of teeth, regardless of whether or not they are active in mastications[26,27]. Rate of apposition of the bone is reduced as a consequence of the absence of functional stimulation. In addition, invaginated roots of the maxillary teeth are formed by septa in the sinuses. The removal of these teeth and the resorption of their supporting bony invaginations could contribute to enlargement of the maxillary sinus. In the previous study, Lee et al. reported volumes of the partial portion of the maxillary sinuses, at the level of heights 5mm, 10mm from the antral floor were 0.55 ± 1.41cc, 2.11 ± 0.88cc[13]. The mesurements were similar in this study, that results may be helpful to do implantation with bonegraft on the atrophic maxillary teeth area. Before the implatation, if the volumatic estimatation of the graft materials is possible, it may be useful reservation of the graft materials and decision doner site of the autogenous bone[28-30].

V. Conclusion

Previous reports and our results may be helpful to understand normal volumetric values of the maxillary sinus.

In this study, because of individual variations, when total volumes of the maxillary sinuses were mesured we could not evaluate changes after extraction of the maxllary teeth. But, when partial

volumes of the maxillary sinuses were measured, we could evaluate.

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Abstract

상악구치부 치아상실에 따른 상악동 부피 변화에 관한 연구

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개인별로 유전적 요소, 환경적 요소 및 과거 감염 병력등과 같은 외부 요소들로 인해 상악동의 발달 양상이 다르므로 그 크기와 모양에 있어 개인차이가 있다. 또 발치된 악궁에서는 상악동의 함기화로 인해 그 부피가 커진다는 보고가 있다. 상악동은 두개골내 공기를 포함하는 주요 구조물로 부비동을 평가하는 지표가 되므로 상악동 부피의 정상치와 발치에 따른 함기화의 정도등을 알아둔다면 비정상적인 상태를 평가하는데 도움이 될 것이다. 이전 연구에서는 두개골에 인상재를 주입하거나 방사선 사진을 통해 상악동 부피를 측정하였으나 건조된 두개골에서는 상악동 점막의 상실로 그 부피가 더 크게 측정되는 단점이 있고 일반적인 방사선 필름을 이용한 측정은 확대율에 따른 오차와 다른 구조물과의 중첩으로 상악동의 경계를 정확하게 판단하기 어려운 단점이 있다. 하지만 최근에는 높은 해상도를 가진 CT의 개발로 인해 상악동에 대한 정확한 분석이 가능하게 되었고 그로 인해 상악동 과 관련된 질환에 대한 진단과 치료에 있어 유용하게 사용될 수 있게 되었다. 본 연구에서는 3차원 CT영상 재구성 프로그램을 이용하여 상악동 부피의 평균치를 측정하여보았고 상악구치 상실 후 시간이 경과하여 잔존치조골 높이가 6mm 이하인 환자에 있어 상악동의 함기화로 인한 부피의 변화를 평가해보았다. 상악구치 상실이 있는 환자와 그렇지 않은 환자의 상악동 전체 부피의 평균치 및 상악구치 상실 후 함기화의 영향을 많이 받을 것으로 생각되는 상악동저부에서의 부피의 평균치를 비교해 보았으며 이때, 상악동 저부에서의 부피 측정치는 잔존 치조골량이 적은 경우 상악동 거상술을 동반한 임프란트 식립 전 필요한 골이식량과 자가골의 공여부를 결정하는데 그 유용성이 있을 것으로 생각된다.