Comparison of Maxillary Sinus Sizes in Patient with Maxillary Excess and Maxillary Deficiency

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Abstract

Objectives: The aim of this study was to compare the maxillary sinus sizes in patients with maxillary excess and maxillary deficiency.

Methods: 120 cephalometric and panoramic radiographs of 12-25 years old patients were studied. These radiographs were derived from patients with maxillary deficiency, normal, or excess. Each group consisted of 40 Patients, (20 female and 20 male). Different dimensions of maxillary sinus included maxillary sinus anterior posterior length (M.S.L), maxillary sinus height (M.S.H) and total maxillary sinus area (TMSA) were measured by digital lateral cephalometry and digital panoramic analysis. In AutoCAD program the lines were measured by mm and the area were measured (mm²). All input images into AutoCAD program converted to a unit scale to assess the minimal magnification error. Data were analyzed using T-test and ANOVA.

Results: TMSA was highest in the maxillary deficiency group following by the maxillary normal and maxillary excess groups which the differences were statistically significant (P value = 0.008). However no significant differences were noticed by panoramic image measurements (P value = 0.285). The mean of MSH was significantly higher in the maxillary deficiency group compared with the maxillary normal and maxillary excess groups, both in lateral cephalometry (P value < 0.001) and panoramic images (P value = 0.034). Regarding the MSL no significant differences were seen among the study groups both in lateral cephalometry and panoramic images.

Conclusions: According to the result of this study TMSA and MSH were significantly higher in maxillary deficiency group in comparison with the maxillary normal and excess groups.

Keywords: Maxillary Sinus, Malocclusion, Vertical Sinus Dimension, Horizontal Sinus Dimension

1. Background

The bony chambers which are surrounded by the bones around the nasal cavity and open into the nasal cavity are named “Paranasal Sinuses” (1). The maxillary sinus is the largest of the four paranasal sinuses (2) which is called “Antrum” or “Highmore Antrum” (3) which drains into the middle meatus of the nose and are located around nasal cavity. The base of pyramid-shape maxillary sinus is the lateral wall of nasal bone and zygomatic bone is its roof. Between the paranasal sinuses, the maxillary sinus plays a main role in the formation of facial contours (4, 5). The development of the maxillary sinus initiates at the ethmoid infundibulum in the third month of fetal life (6). After birth, the air pressure into the developing alveolar process enlarge the sinus (3). The maximum growth of sinus occurs at two time intervals: birth to 3 years of age and 7 to 12 years of age (7). The average volume of maxillary sinus at birth is 6 - 8 cm³, and it can be detected radiographically in a standard anteroposterior view by 5 months after birth (7). The floor of the maxillary sinus is constituted of the alveolar process of the maxilla (4, 8-10). Therefore, the maxillary sinus can encroach the alveolar process particularly when the maxillary first molars are missed over a long period of time (11). The invasion of maxillary sinus and occupation of residual alveolar space after extraction of one or more teeth may affect orthodontic treatment planning for malocclusion cases (12, 13). Therefore, knowledge of the development and size of the maxillary sinus may be critical for diagnosing and treating different cases of malocclusion (11). Jun et al. (5) studied relation of maxillary sinus aeration according to aging. He reported that development of the maxillary sinus continues till the third decade in male and second decade in female, and thereafter the size reduced. Some studies have reported no significant differences between left and right maxillary sinus sizes (2, 14). There are studies reporting correlation between size of sinus and the sex (1, 14). Endo et al. (11) evaluated the maxillary sinus size in different malocclusion classes by the use of lateral cephalometric radiographs and evaluated with WinCeph analysis software. He showed no relevancy be-
tween different malocclusions and size of maxillary sinus. Endo et al. (11) showed 12 to 16 years old patients with large cranial bases tend to have larger maxillary sinuses, but there is no significant association between maxillary sinus size and the A-N-B angle, also they reported no significant relevancy between maxillary sinus size and sex.

It could be theorized that development of maxillary sinuses, which have a closed association with the maxillary bone structure and the upper posterior teeth, could be affected by dental and skeletal malocclusions.

2. Objectives

The aim of this study was to compare the maxillary sinus sizes in patients with excess and deficiency of maxilla.

3. Methods

This is a retrospective study. 120 cephalometric and panoramic radiographs of 12 - 25 years old samples were selected from patients referred to dental school of Shahid Sadoughi university of Yazd these radiographs were belonged to subjects with maxillary deficiency, maxillary normal, and maxillary excess. Each group consisted of 40 Patients. The radiographs fulfilled the following selection criteria:

1- No syndrome or cleft lip or cleft palate.
2- No history of orthodontic treatment or maxillofacial surgery.
3- Fully erupted permanent dentition (except third molar).
4- No maxillary sinus pathology.

Images with poor quality or graphs with no clear maxillary sinus views were excluded.

The samples were divided into Max. Deficiency and Max. Excess according to Schwarz and McNamara index. According to Schwarz index mandibular length calculated according to length of cranial base. The normal value of A-PNS was considered to be 2/3 Go-Pog. The higher values considered Max. Excess and lower values considered Max. Deficiency. According to McNamara point A can be 1 mm anterior or posterior to the N-perpendicular line. More anterior is called Prognathism and more posterior is called Retrognathism. Also Cd-A distance was measured and compared with table.

Vertical measurements of S-PNS and N-ANS should be 51 - 55 in females and 56 - 60 in males. Higher values were considered as Max. Excess and lower ones as Max. Deficiency.

The samples were divided into three groups according to the geometry of the maxilla, each group consisted of 20 female and 20 male.

The measurement of maxillary sinus in digital lateral cephalometry and digital panoramic images were done using the method of Endo et al. (11) as follow:

1- An: The most anterior point of anterior wall of maxillary sinus
2- Po: The most posterior point of posterior wall of maxillary sinus
3- Su: The most superior point of superior wall of maxillary sinus
4- In: The most inferior point of inferior wall of maxillary sinus
5- Maxillary sinus anterior posterior LENGTH (M.S.L): this line was drawn from An to Po.
6- Maxillary sinus height (M.S.H): This line was drawn from Su to In.
7- Upper maxillary sinus area (UMSA): which defined by the area above maxillary plane that constructed from anterior nasal spin (ANS) to posterior nasal spin (PNS).
8- Lower maxillary sinus area (LMSA): which represents lower area of Maxillary sinus from palatal plane.
9- Total maxillary sinus area (TMSA): which represents summation of upper and lower maxillary sinus area.

In AutoCAD program the lines were measured in millimeters (mm) and the area were measured in square millimeters (mm²). All input images into AutoCAD program converted to a unit scale to access minimal magnification error. Lateral cephalograms of the subjects were traced and measured by one investigator (Figure 1 and Figure 2). In order to reduce measurement error, one week after the first analysis, all images were re-measured by the same investigator and finally average of each indicators was considered.

Statistical analysis were done for collected measurement by using statistical package for social sciences version 23 computer software. To compare between 2 groups, independent samples t-test, and among more than 2 groups ANOVA was used.

4. Results

According to the results of this study, the mean total maxillary sinus area (TMSA) of maxillary deficiency [U+060C] maxillary normal and maxillary excess groups in lateral cephalometry images were 1193.1, 1042.5, and 1006.7 mm², respectively. Therefore the mean TMSA in maxillary deficiency group had the highest value, followed by the maxillary normal and maxillary excess groups which this difference was significant (P value = 0.008). However, no significant difference was found by panoramic image measurements (P value = 0.285) (Table 1 and Table 2) (Figure 3).
The mean maxillary sinus height (MSH) of maxillary deficiency group in lateral cephalometry images were 41.5, 38.3, and 36.0 mm and in panoramic images were 39.9, 39.0, and 36.5 mm, respectively. These results revealed that mean value of maxillary sinus height was significantly higher in maxillary deficiency group than in maxillary normal and maxillary excess groups, both in lateral cephalometry (P value < 0.001) and panoramic images (P value = 0.034) (Tables 1 and Table 2) (Figure 4).
The mean maxillary sinus anterior posterior length (MSL) among maxillary deficiency, maxillary normal, and maxillary excess groups showed no significant differences in lateral cephalometry (P value = 0.823) and panoramic images (P value = 0.795) (Tables 1 and Table 2) (Figure 4).

Considering age, the mean of total maxillary sinus area (TMSA) and maxillary sinus height (MSH) were significantly different (P < 0.001) based on lateral cephalometry images. Results showed that group 3 was higher than first and second groups but the mean maxillary sinus length (MSL) showed no significant differences (P value = 0.068) in lateral cephalometry images. Based on panoramic images, the mean total maxillary sinus area (TMSA) and maxillary sinus height (MSH) were significantly different (TMSA, P value = 0.004 and MSH, P value = 0.016); however the mean MSL showed no significant differences in all study groups (P value = 0.497).

Regarding MSL, MSH, and TMSA, T-Test showed no significant differences in between genders both in lateral cephalometry and panoramic images while the average of each parameter in males was higher than in females (except MSH in panoramic images).

5. Discussion

Few studies on the association between maxillary sinus size and maxillary deficiency and maxillary excess. In this study, evaluation of maxillary sinus size was done based on digital lateral cephalometry and panoramic images.

The results of present study showed significant differences in MSH based on both lateral cephalometry and panoramic images. Maxillary deficiency group had the higher MSH than maxillary normal and maxillary excess. This finding was hard for the authors to explain, however the hereditary nature of malocclusion and environmental effects on sinus size could be the reason Urabi (15) who assessed the maxillary sinus dimensions in different malocclusions by digital lateral cephalometric images, showed that MSH in class III malocclusion was higher than other type of malocclusion in female. Endo et al. (11) also found that MSH in class III malocclusion was higher than other type of malocclusion in male, as confirmed by this study (Table 3), but difference was significant in this study. It might be explained by the difference in the type of classifications. In this study, samples were classified according to the geometry of the maxilla without considering mandible but other studies classified according to A-N-B angle and with considering maxilla and mandible.

The mean MSL were not significantly different among three groups, maxillary deficiency, maxillary normal and maxillary excess which was similar to Endo et al. (11) and Urabi (15) studies.

The mean TMSA in lateral cephalometric images of maxillary deficiency group had the highest values, followed by the maxillary normal and maxillary excess groups which were significantly different although with considering gender there was no significant difference between TMSA and geometry of maxilla. Endo et al. (11)
found no significant differences in size between the different classes of skeletal malocclusion and genders. Oktay (1), who researched the maxillary sinus areas on orthopantomographs of subjects with ideal occlusion and of patients with different angle malocclusions, and Urabi (15) showed that malocclusions had no effect on the maxillary sinus size. Oktay’s study (1), showed that females with class II malocclusion had larger maxillary sinus size than the other different classes of skeletal malocclusion while Urabi (15) found this results for male. These findings are inconsistent with this study.

Results of this study indicate that the mean TMSA and MSH increased with age. Ariji et al. (16) evaluated age changes in the volume of the human maxillary sinus by using computed tomography and showed that volume of maxillary sinus increased up to the age of 20 years, but then decreased. Degermenci (17) studied the age-related development of maxillary sinus in children and found that maxillary sinus volume measurements, were increased with age in both sexes until 16 years old. Lorkiewicz-Muszynska (18) who assessed development of the maxillary sinus from birth to age 18, showed that the maxillary sinus, present at birth, increased in size until the end of the 18th year. The growth pattern included changes in vertical, horizontal and anterior-posterior directions. Also Oktay (1) showed significant relation between age and maxillary sinus size and indicated that the size of the maxillary sinuses increased as age increased. These results came in conformity with the results concluded in this study.

Hopkin (19) who investigated the cranial base as an aetiological factor in malocclusions and Dibbets (20) evaluated morphological associations between the Angle
classes, both investigator reported that the cranial base dimensions tend to be larger in male than female and patients with larger cranial bases tended to have larger maxillary sinuses. Therefore male had a larger maxillary sinus size. Emirzeoglu et al. (2) evaluated volume of the paranasal sinuses in normal subjects using computer tomography images and showed a significant difference in the volume of maxillary sinus between male and female and males had larger size maxillary sinuses. Jalal (21) who estimated gender and age using spiral CT scanning of maxillary sinuses and foramen magnum found that the maxillary sinuses were significantly longer and higher in male than in female. Degermenci (17) and Endo et al. (11) however, found no statistically significant difference between the volumes of maxillary sinuses and sex. This study showed that male had larger maxillary sinus size than female (except MSH in panoramic images) but not significant as confirmed by Endo et al. (11) and Degermenci (17). Small sample size might be the reason of this difference.

5.1. Conclusion

According to the result of this study TMSA and MSH were significantly higher in maxillary deficiency group in comparison with the maxillary normal and maxillary excess groups.

References


Table 3. Mean and Standard Deviation of Maxillary Sinus Measurements in Male and Female

<table>
<thead>
<tr>
<th>Variables</th>
<th>Gender</th>
<th>TMSA (L.Cephalometry)</th>
<th>Maxilla</th>
<th>Excess</th>
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<td></td>
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<td>Deficient</td>
<td>Normal</td>
<td>Excess</td>
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<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
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<td>Female</td>
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<tr>
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</table>

*SD indicates standard deviation.*

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