

Gender Determination using Radio Morphometric Analysis of the Maxillary Sinus in Edentulous Individuals - A Cross Sectional Cone Beam Computed Tomography Study

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ABSTRACT:

Introduction: Sinus radiography has been extensively used in determination of the gender of existent, especially in forensic disquisition for mortal identification and gender determination of individualities. CBCT can give precise information about complex anatomical structures in edentulous individualities as it's characterized by rapid volumetric image accession with high resolution. **Objectives:** To measure length and width in axial view from the most anterior point to the most posterior end on the medial wall and width from the sinus medial wall to its most lateral portion in males and females of completely edentulous individual using CBCT sidexis software. **Materials and Methods:** Current study consists of 36 patients were divided into two groups, group I consisted of 18 males and group II consisted of 18 females, where maxillary sinus dimensions like maximum length) and maximum width were evaluated using CBCT scans in axial section respectively. **Results:** Males exhibited greater sinus length on right side, difference was not statistically significant. males had significantly greater left maxillary sinus length compared to females which were (statistically significant ($p < 0.05$). Although females showed a slightly higher mean width by using the unpaired t-test. **Conclusion:** The present study demonstrates that maxillary sinus length shows partial sexual dimorphism, with statistically significant difference observed on the left side, where males displayed lesser confines than females. still, no significant gender differences were observed in maxillary sinus range on either side.

Keywords: Gender Determination, Cone Beam Computed Tomography (CBCT), Radio morphometric analysis, Maxillary sinus, Edentulous Individuals

INTRODUCTION:

Identifying skeletal remains requires an ideology biological profile including age, ancestry, stature, and sex of the decedent.[1] Forensic identification of a person is always grueling and its multidisciplinary approach [2]. Maxillary sinuses in embryonic development, they appear at the end of alternate month and reach their adult sizes at age of about 15 times, when the endless teeth up to alternate molars completely erupt [3] The floor of the sinus is formed by the alveolar process of the maxilla. The roots of the canines, first, alternate and third molars, may elevate the sinus or perforate the bottom. Pneumatization is a physiologic process that do in all paranasal sinuses during the growth period, causing them to increase in

volume. Pneumatization of the sinus varies greatly from person to person and indeed from side to side [13]. As the endless teeth eruption, sinus pneumatisation to the alveolar lift becomes established and is always associated with the presence or absence of teeth, in aged individualities, due to lack of teeth (either naturally or due to dental extractions), it's seen prominently[4]. Sinuses remain indefectible, although skull and different bones may be seriously incinerated and act concrete attestations for forensic purposes. Next to pelvis, cranium is the most generally sexed part of the body because of its high resistance to adverse environmental conditions, performing in lesser stability of dimorphic characteristics as compared to the rest of the body [5].

The radiographic images taken could give acceptable measures of maxillary sinuses for use in morphometric analysis and forensic operations that cannot be approached by other means [6]. Radio morphometric analysis refers to the quantitative assessment like length, width and height parameters of anatomical structures using radiographic imaging ways.[12] CBCT, due to its exertion to produce detailed, accurate and fluently reproducible images it, replaces the traditional imaging modalities and is now included to visualise paranasal sinuses. It's now expanding its bodies in the forensic identification of individualities [7].

Rationale of Study:-

The maxillary sinuses are air- filled depressions which vary in size and shape [8]. The advanced radiographic ways like Cone Beam Computed tomography (CBCT), especially the axial and coronal sections, have been considered as subtle conception in forensic odontology [10]. Arathi Kannampurath et al stated Gender determination of cadaverous remains is an important forensic procedure in the identification process. Maxillary sinus remains complete indeed when the cranium and other bones may be poorly disfigured. Cone Beam Computed tomography (CBCT) can give precise information about complex anatomical structures in edentulous individualities as it's characterized by radio volumetric image accession with high resolution.[11]

The aim of study is to estimate the parameters of maxillary sinus using CBCT and to identify its recrimination in edentulous existent of males and female.

MATERIALS AND METHODS:

The present CBCT study is cross sectional analytical study with selected CBCT scans meeting the inclusion and exclusion criteria were analysed. The study was conducted in the Department of Oral Medicine and Radiology in our dental institution after obtaining the approval from institutional ethical committee MGV/KBHDC/IEC79/2024-25. The current study covered total of 36 participants consisting of 18 males along with 18 females. The length and width of maxillary sinus bilaterally (Right and Left) were determined using CBCT. In our study, only edentulous individuals between the age group of 20-50 years of either genders, fulfilling the inclusion and exclusion criteria were included in the study. The samples are divided using simple random Sampling technique. Then as per the sample size formula the sample was calculated.

I) Sample size:

The study included 36 CBCT scans of both gender patient ranging from 20-50 years and was divided into three main groups:

Group 1: CBCT Scan of Edentulous patients from above 18 years of age (n=18)

Group 2: CBCT Scan of Edentulous patients from above 18 years of age (n= 18)

II) Sample selection:

Inclusion criteria:

- CBCT scans clearly depicting completely edentulous of both maxillary and mandibular arch CBCT scan of patients above the age of 20 years in both males and female individual.

III)Statistical Procedures:

Exclusion Criteria:

- CBCT scans with low image quality, radiographic artifact, partial image.
- The exclusion criteria were less than 20 years of age because sinus development is completed by the age of 18-20 years, patients with the common cold or any previous history of sinusitis, patients with a prior history of any head and neck surgeries, female patients who are planning for pregnancy or already being pregnant.
- CBCT scans with bony pathology in region of interest like cysts, tumor, malignancy, developmental defects, inflammatory, infectious diseases, periodontal pathology etc.
- CBCT scans showing radiographic evidence of trauma and surgery in area of interest.

IV) Methodology:

- The present study retrospectively analysed 36 CBCT scans of patients who were referred for various other purposes for viewing the maxillary arch and were selected from the Department of Oral Medicine and Radiology.

- The images were evaluated in a darkened, quiet room and image contrast and brightness was adjusted to ensure optimal visualization.

- The selected CBCT scans will be divided into 2 different groups.

GROUP A:- 18 males with bilateral maxillary sinus length and width.

GROUP B:- 18 females with bilateral maxillary sinus length and width .

- The morphometric analysis of length and width in axial section can be evaluated and compared in these 2 age groups in edentulous patients.

- The position will be marked by using the measurement tool of proprietary CBCT software.

- The marking will be done from (maximum length).

- Length measured from the most anterior point to most posterior end on the medial wall of the bilateral maxillary sinus in axial view in males and females of edentulous individuals.

- The marking will be done from (maximum width).

- The width of the bilateral maxillary sinus is determined by measuring longest distance in an axial view from the

sinus medial wall to its most lateral portion in males and females of edentulous individuals.



Fig. (1). CBCT image showing measurements of right maxillary sinus length and width, left maxillary sinus length and width in axial section in sample of group I.

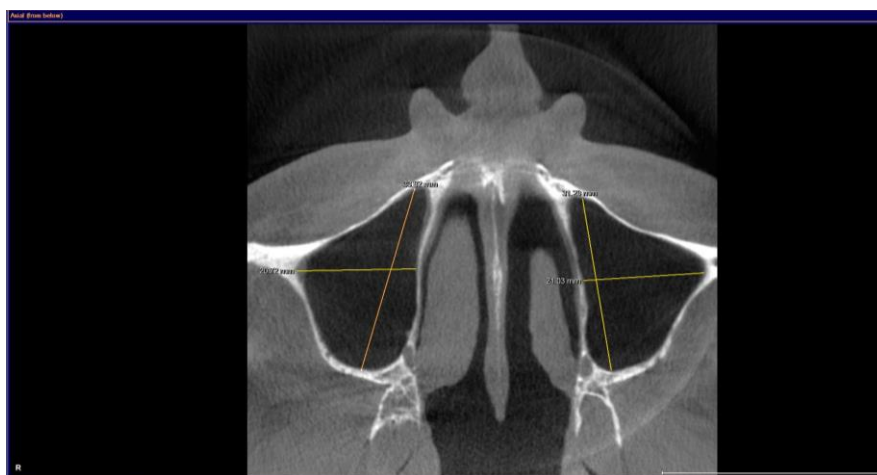


Fig.(2). CBCT image showing measurements of right maxillary sinus length and width, left maxillary sinus length and width in axial section in sample of group II

Study instruments/ Data collection tool Equipment:

1. The 3D X-ray data recorded using ORTHOPHOS XG 3D manufactured by SIRONA, Germany with field of view of 8cm x 8cm.
2. The data were visualized using, SIDEXIS Version 1.9.4497.23802(ID7) software.

V)Data Analysis and Methods:

- Type of data is continuous quantitative.
- Data collected will include various tables, graphical representation and statistical tests to achieve aims and objective of the study.
- Data is analysed by using descriptive statistics, The unpaired t-test .

RESULTS:

Males exhibited greater sinus length on the right side, the difference was not statistically significant. males had significantly greater left maxillary sinus length

compared to females which were (statistically significant ($p < 0.05$).

Although females showed a slightly higher mean width, the unpaired t-test revealed a t-value of -0.727 and a p-value of 0.472, which was not statistically significant ($p > 0.05$).

Table 1 presents the intergroup comparison of length of the maxillary sinus between males and females. The mean length of the right maxillary sinus in males was 33.45 ± 3.45 mm, whereas in females it was 30.84 ± 5.10 mm, showing a mean difference of 2.61 mm. However, the unpaired t-test revealed a t-value of 1.798 with a p-value of 0.081, which was statistically not significant ($p > 0.05$). This indicates that although males exhibited greater sinus length on the right side, the difference was not statistically significant.

On the left side, the mean maxillary sinus length in males was 33.44 ± 4.28 mm compared to 30.51 ± 3.12 mm in females, with a mean difference of 2.93 mm.

The unpaired t-test showed a t-value of 2.344 with a p-value of 0.025, which was statistically significant ($p <$

0.05). This finding indicates that males had significantly greater left maxillary sinus length compared to females.

Table 1: Intergroup comparison of length of maxillary sinus between males and females respectively

Length	Right maxillary sinus Mean (SD)	Left maxillary sinus Mean (SD)
Males	33.45 (3.45)	33.44 (4.28)
Females	30.84 (5.1)	30.51 (3.12)
Unpaired t test	t = 1.798	t = 2.344
P value, Significance	P=0.081 (NS)	P=0.025*

$p > 0.05$ – no significant difference

* $p < 0.05$ – significant difference

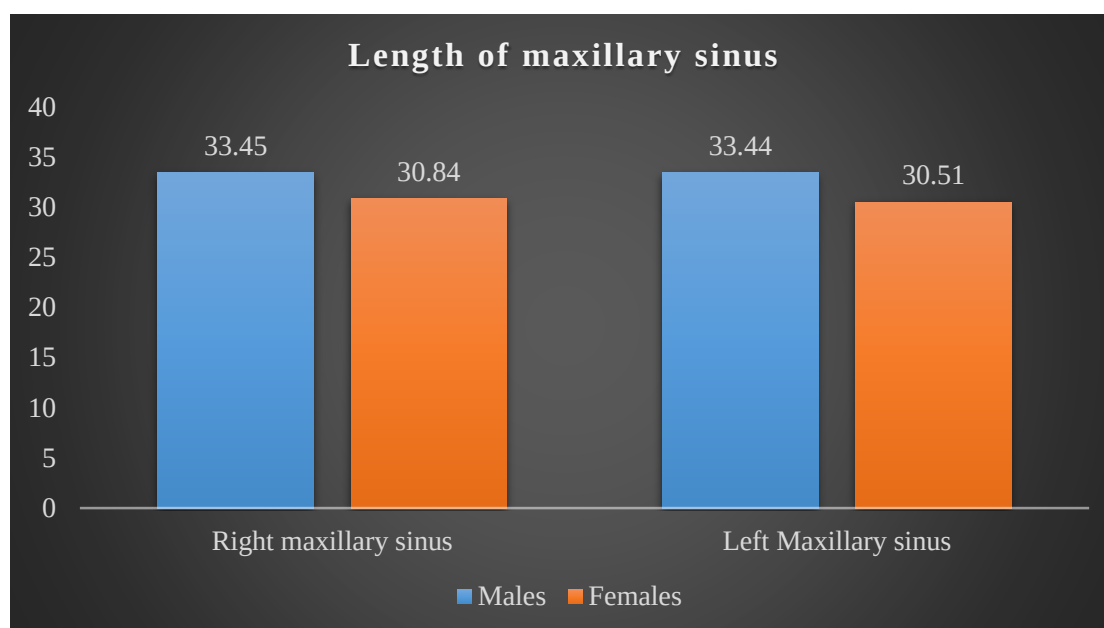


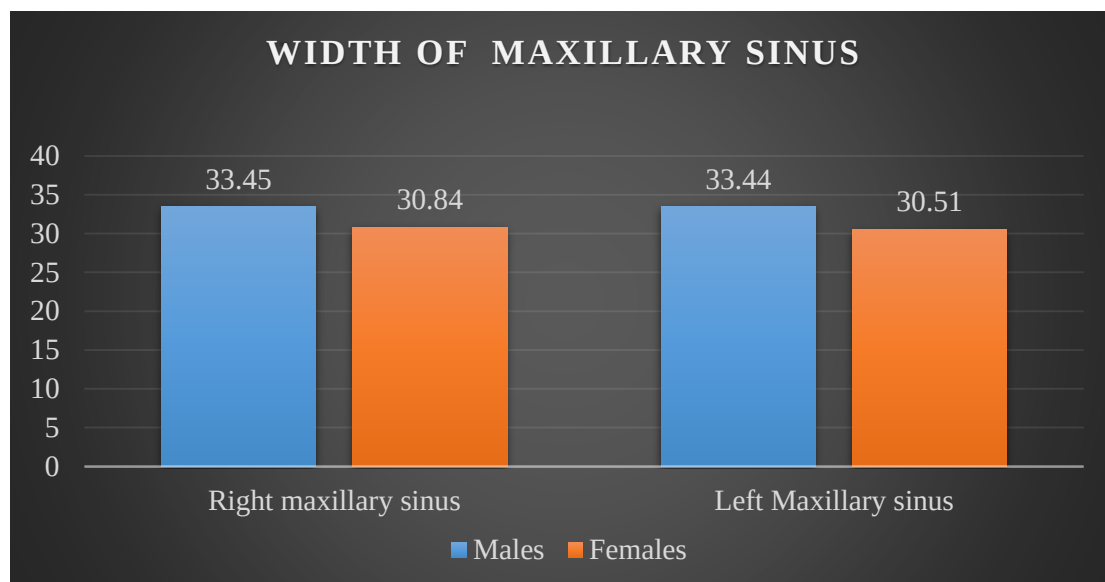
Table 2 shows the intergroup comparison of the width of the maxillary sinus between males and females. The mean width of the right maxillary sinus was 19.24 ± 3.58 mm in males and 18.40 ± 4.72 mm in females, with a mean difference of 0.84 mm. The unpaired t-test yielded a t-value of 0.602 and a p-value of 0.551, indicating no statistically significant difference between genders.

Similarly, the mean width of the left maxillary sinus was 18.18 ± 3.35 mm in males and 18.95 ± 2.97 mm in females. Although females showed a slightly higher mean width, the unpaired t-test revealed a t-value of -0.727 and a p-value of 0.472, which was not statistically significant ($p > 0.05$).

Table 2: Intergroup comparison of width of maxillary sinus between males and females respectively

Width	Right maxillary sinus Mean (SD)	Left maxillary sinus Mean (SD)
Males	19.24 (3.58)	18.18 (3.35)
Females	18.4 (4.72)	18.95 (2.97)
Unpaired t test	t = 0.602	t = -0.727
P value, Significance	P=0.551 (NS)	P=0.472 (NS)

$p > 0.05$ – no significant difference



DISCUSSION:

Kanthem RK et al, Studied gender determination using maxillary sinus concludes volume of the right maxillary sinus can be used as accurate individual parameter for gender determination.[9]

Neenu U et al, studied morphometric evaluation of anterior and maxillary sinus for determination of age and sex conclude morphometric evaluation of anterior and maxillary sinus are usefull fashion to determine age and sex [10] Iturralde- Garrote et al concluded qualitative conflation of available studies which assess the volumetric characteristics of the sinuses and their changes according to age.[13]

Lin Y et al, in there study concludes there's significant difference seen in the parameter of maxillary sinus lesser in males as compared to in ladies of dentulous existent. Pneumatization of sinus varies greatly from person to person and indeed from side to side. The expansion of the sinus is larger due to fully edentulous in an individual by a superiorly curving sinus floor. similar kind of study may help gender determination in forensic odontology.[12]

Sinus radiography has been extensively used in determination of the gender of the existent, especially in forensic disquisition for mortal identification and sex determination of individualities[9].

On the right side, although males showed a higher mean sinus length (33.45 ± 3.45 mm) than females (30.84 ± 5.10 mm), the difference was not statistically significant ($p = 0.081$). This suggests that right maxillary sinus length alone may not serve as a dependable parameter for gender determination in edentulous individualities. analogous findings were reported by Teke et al. who observed that certain sinus confines may show sexual dimorphism but fail to reach statistical significance, limiting their standalone individual value.[14]

In contrast, left maxillary sinus length showed a statistically significant difference ($p = 0.025$), with males demonstrating greater dimensions (33.44 ± 4.28 mm) compared to females (30.51 ± 3.12 mm).

and Sidhu et al., who reported that while nearly all sinus parameters are larger in males, not every parameter reaches statistical significance in every population¹⁵

Fernandes CL et al also emphasized that maxillary sinus confines can vary bilaterally and that combining multiple parameters enhances delicacy in gender determination.[16]

Likewise, edentulism itself may impact maxillary sinus morphology due to alveolar bone resorption and sinus expansion over time. Despite these changes, the sinus remains a fairly stable anatomical structure, making it precious tool in forensic identification, as stressed by Rai et al. [17]

A retrospective study lead by Tirumala Ravali et al. depicted that CT and MRI were precious individual tools in the evaluation of MS concluded that MS can be used in forensic anthropology for sex identification of the existent[18]. In our study demonstrates that maxillary sinus length shows partial sexual dimorphism in edentulous existent, with a statistically significant difference observed on the left side, where males displayed lesser confines than females.

The results indicated in our study have no statistically significant differences between males and females on either side, suggesting that maxillary sinus range alone may not be a dependable index of sexual dimorphism.

On the right side, the mean sinus width was slightly greater in males (19.24 ± 3.58 mm) compared to females (18.40 ± 4.72 mm), with a mean difference of 0.84 mm. However, this difference was not statistically significant ($p = 0.551$). This finding is in agreement with the study conducted by Teke HY et al. who reported that although males tend to have larger sinus confines, certain parameters similar as range may not demonstrate significant sexual dimorphism.[14]

Similarly, on left side, females exhibited a slightly higher mean sinus width (18.95 ± 2.97 mm) compared to males (18.18 ± 3.35 mm). Despite this reversal in trend, the difference was not statistically significant ($p = 0.472$). These findings are harmonious with those of

Uthman AT et al, who observed that not all sinus confines are inversely dependable for gender determination.

Another findings Image several contemporary studies (e.g., Sahlstrand- Johnson et al.) which set up that while sinus volume and height are excellent predictors of sex, range frequently fails to reach statistical significance. This reinforces the need for multivariate approach counting a combination of measures rather than a single parameter like range.[19]

Ayeesha Urooge study findings are harmonious with several former studies. CBCT frequently show statistically insignificant gender differences, except for occasional side-specific variations[20] also, other examinations using CT imaging Oguzhan Ekizoglu have demonstrated that although males tend to have slightly larger sinus confines, the differences aren't always significant for individual direct measures similar as range.[21]

LIMITATIONS:

The study was conducted on a fairly limited sample, which may affect the generalizability of the findings to the broader population. Further comprehensive parameters similar as height and surface area could give better results in gender determination. Being across-sectional study, it doesn't regard for age- related changes or longitudinal variations in sinus morphology. Although CBCT provides high- resolution imaging, combining it with other imaging modalities could enhance individual trustability.

CONCLUSION:

Within the limitations of the present study, it can be concluded that the maxillary sinus exhibits a degree of sexual dimorphism in edentulous individuals when assessed using CBCT imaging with a statistically significant difference observed on the left side, where males exhibited greater dimensions than females. However, no significant gender differences were observed in maxillary sinus width on either side. In conclusion, CBCT-based radiomorphometric analysis of the maxillary sinus serves as a valuable adjunct tool in forensic odontology, especially in edentulous individuals where other anatomical landmarks may be compromised, but it should be applied as part of a multifactorial approach rather than a standalone method.

AVAILABILITY OF DATA AND MATERIAL:

The authors have decided to make the data available if necessary

FUNDING:

None.

CONFLICT OF INTEREST:

We declare no conflict of interest, financial or otherwise.

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