Radiological Study of Anatomical and Gender Variations of Maxillary Sinus in Adults

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Abstract

Background: Morphological measurements maxillary sinuses of human are known to exhibit sexual dimorphism. Maxillary sinus variables could be used successfully for sex identification by forensic experts. Radiograph of these sinuses is more precise, easier, accurate, reproducible method of knowing the morphological variations in both sexes by linear measurements.

Objective: The present study was attempted to document and evaluate the radiological measurements of adult maxillary air sinuses in both sexes and compare them to find out the differences in male and female.

Methods: This study was done in the department of anatomy of Rangpur medical college, Rangpur from January 2018 to December 2018. 100 plain X-ray films (50 male and 50 female) fulfilling the selection criteria were enrolled into this cross sectional, analytical study and these digital X-ray plates were collected from Hypertension and Research center, Rangpur. Protocol of the study was approved by ethical review board of Rangpur Medical College. The X-ray films were collected from adult persons aged 18 to 55 years. Plain X-ray of both antero-posterior (A/P) and lateral view (right) showing the skull with nasal cavity, orbit and paranasal sinuses were collected. The height and width of lower and total maxillary sinus were also measured by digital slide calipers and upper maxillary sinus area, lower maxillary sinus area and total maxillary sinus were also calculated.

Results: In this study maxillary sinus height and width/length and total sinus area in male were significantly higher than that of female. In male the mean ± SD of lower maxillary sinus width and area was also significantly higher in male than that of female. But the height of lower maxillary sinus had no significant difference in male and female though the value was higher in male than that of female. The value of upper maxillary sinus area was also found significantly larger in male than that of female. In case of maxillary sinus index the greater value in female made the result significant.

Conclusion: The air sinuses located in the pneumatic bone of the skull not only essential for functional point of view but also for sex differentiation. The morphological differences in the cranium between the two genders are determined mainly by the genetic factors more, so than nutritional, hormonal or muscular factors. Such aspects can explain why the maxillary sinuses are on average larger in male than that of female in this present study.

[M Abdur Rahim Medical College Journal, 2023 Jul; 16 (2):161-168]
[Former Dinajpur Medical College Journal]

Keywords: Maxillary sinus, air sinus

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Introduction

Historically, shortly after the discovery of the X-ray in 1895, the paranasal sinuses were frequently studied by plain radiograph. Normal sinuses are radiolucent, whereas when they are diseased, they show varying degree of opacity.[1] In antero-posterior view most of the paranasal sinuses are visible. Regarding the maxillary sinus, radiologically a pyramidal radiolucent area is seen below the orbit and lateral to the lower part of the nasal cavity, extending inferiorly into the alveolar process of the maxilla. The maxillary sinus is clearly seen in lateral view; it lies below the orbit and its relation to the roots of the teeth is obvious.[2] Maxillary sinus also exhibits variations in male and female. In male's maxillary sinus is higher and longer than females, that indicates males exhibit larger maxillary sinus than females. The mean value of maxillary sinus volume is significantly larger in males than females. Sex was successfully predicted by height of maxillary sinus. Ethnic variations are also found in case of linear measurements and volume of maxillary sinus.[3-5]

Paranasal sinuses are prone to great diversity of anomalies. It is important for surgeons to be aware of variations that may predispose patients to increased risk of intra operative complications and help to avoid possible complications and improve success of management. Thus, a better knowledge of normal pneumatization and development of maxillary sinuses through radiographic study is important to evaluate sinus disease and to propose an adequate treatment. As the conventional plain radiographs are the first one to be analyzed by the clinicians, so still important to know the anatomy, size and variants of maxillary sinus for specific population of both sexes.[6,7]

Methods

This study was performed in the department of Anatomy, Rangpur Medical College, Rangpur. This study was conducted from January 2018 to December 2018.This study was performed on plain digital X-ray films of adult maxillary air sinuses (both anteroposterior and lateral view) in both sexes. The study was approved by the Ethical Review Committee of Rangpur Medical College, Rangpur. This study was performed on 100 plain digital X-ray films (50 male and 50 female) of adult maxillary air sinuses. Sample was collected by convenient purposive sampling as per inclusion and exclusion criteria. Inclusion criteria includes apparently healthy adult male and female aged 18 - 55 years with no visible features of asymmetry in skull and patients who were willing to undergo PNS X-ray. Exclusion criteria includes-Pregnant female, adult persons with any congenital or acquired deformities of paranasal sinuses, adult persons with any surgical interventions of paranasal sinuses, any disease condition of paranasal sinuses, history of any type of systemic disorders such as- underlying bone diseases, nutritional and endocrinal diseases, Class III dental malocclusion patients, patients with posterior maxillary tooth extraction with no dental implant, Patients with having congenital syndrome involving craniofacial bones (cleft lip, cleft palate, hemifacial microsomy etc), history of orthodontic treatment or orthognathic surgery, trauma to nasomaxillary complex, mentally disabled patients, damaged or unclear X-ray films. 100 digital X-ray films were collected from the radiology department of a well-known diagnostic center of Rangpur (Hypertension and Research center, Rangpur). In case of female subjects help of a female attendance and in case of male subject help of a male attendance was taken for changing position. All X-ray were done by same radiology technician and in the same digital X-ray machine. The name of the machine was YZ- 200B 200mA Medical Diagnostic X-ray Machine (Appendix- V). DI-HT Fuji X-ray film was used to take images and the size of the X-ray film was 10 × 14 inch. Both views (anteroposterior and lateral) of the

PNS X-ray were included in the same X-ray plate. The data collected from the radiological studies were processed according to their distributions, central tendencies, and dispersions. Then results were prepared from these data in terms of ranges, frequency distributions, mean values, standard deviations (SD), percentage value etc. as applicable. Mathematical relationships between measurements of male and female were analyzed by unpaired Students 't' test. In all statistical analyses the level of significance was set as $p \leq 0.05$ at 95% confidence intervals. All the statistical analyses were done by using the SPSS software package for windows version 16.00.

Results

Table I: Comparison of measurements of lower of maxillary sinus width and height and area of lower and upper maxillary sinus area between male and female (n=100, male=50, female=50)

Variables	Male	Female	p value
Lower Maxillary sinus width (mm)	14.68 – 43.08 25.98 ± 6.22	14.98 – 37.66 23.31 ± 5.19	0.022 (S)
Lower maxillary sinus height (mm)	4.16 – 15.95 7.85 ± 2.14	4.26 – 14.91 7.51 ± 2.05	0.420 (NS)
Lower maxillary sinus area (mm^2)	88.5 – 687.12 210.59 ± 101.72	83.52 – 482.04 180.11 ± 84.05	0.106 (NS)
Upper maxillary sinus area (mm^2)	1395.58 – 3220.71 2096.4 ± 339.76	845.14 – 2396.37 1777.4 ± 283.69	0.000 (S)

Table I shows the mean ± SD of lower maxillary sinus height and width and lower maxillary sinus width, lower and upper maxillary sinus area in male and female. The mean ± SD of lower maxillary sinus width in male and female were 25.98 ± 6.22mm and 23.31 ± 5.19mm respectively. In male the mean ± SD of lower maxillary sinus width was higher than that of female and the difference was statistically significant (p=0.022).

The mean ± SD of lower maxillary sinus height in male and female were 7.85 ± 2.14mm and 7.51 ± 2.05mm respectively. In male the mean ± SD of height of maxillary sinus was higher than that of female but difference was statistically non-significant (p=0.420).

The mean ± SD of lower maxillary sinus area in male and female were 210.59 ± 101.72mm^2 and 180.11 ± 84.05mm^2 respectively. In male the mean ± SD of lower of maxillary sinus area was greater than that of female but the difference was statistically non-significant (p=0.106).

Table II: Comparison of maxillary sinus index between male and female (n=100, male=50, female=50)

Variables	Male	Female	p value
Maxillary sinus Index	0.94 – 1.38 1.14 ± 0.11	0.99 – 1.85 1.19 ±0.15	0.05(S)

Table II shows the mean ± SD of maxillary sinus index in male and female. The mean ± SD of maxillary sinus index in male and female were 1.14 ± 0.11 and 1.19 ± 0.15 respectively. In female the mean ± SD of maxillary sinus index was higher than that of male and the difference was statistically significant (p=0.05).

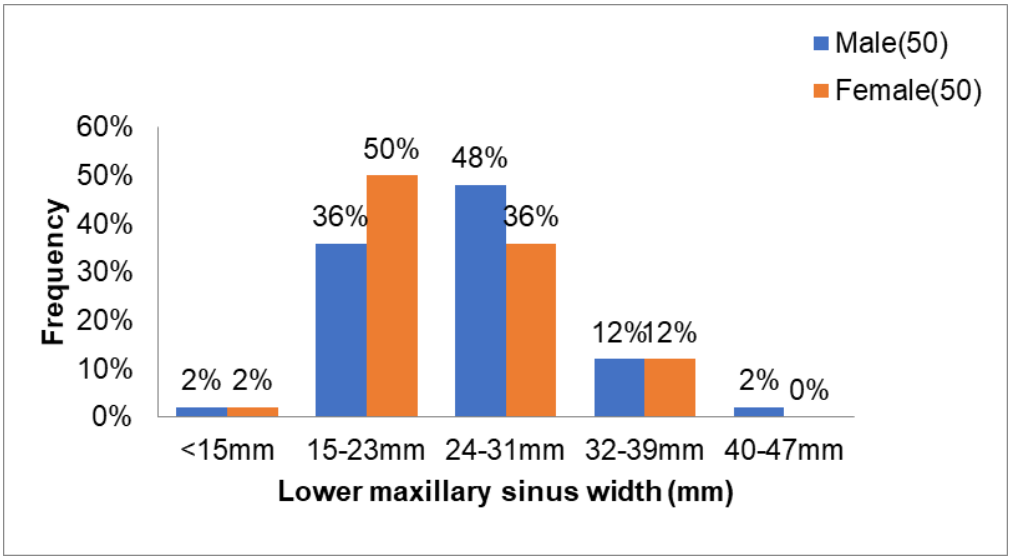

Figure 1. Distribution of lower maxillary sinus width in male and female

Figure 1 shows that most of the values of lower maxillary sinus width of male were in the range of 24-31mm (48%). The distribution of values of female was mostly below this range (50%). So, the difference of lower maxillary sinus width was significantly higher in male than that of female.

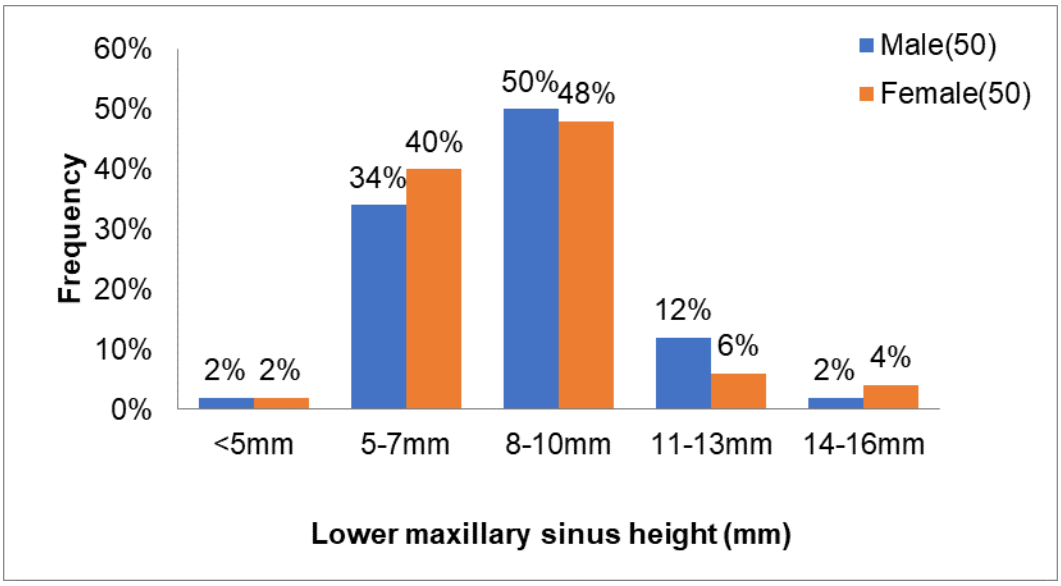

Figure 2**.** Distribution of lower maxillary sinus height in male and female

Figure 2 shows that the most of the values of lower maxillary sinus height of male (50%) and female (48%) distributed in the range of 8-10mm. In case of male, 36% and 14% value also distributed below and above this range respectively. In case of female, 42% and 10% value also distributed below and above this range respectively. The distribution of values of male and female below and above this range was more or less similar. So, the difference of lower maxillary sinus height between male and female was non-significant.

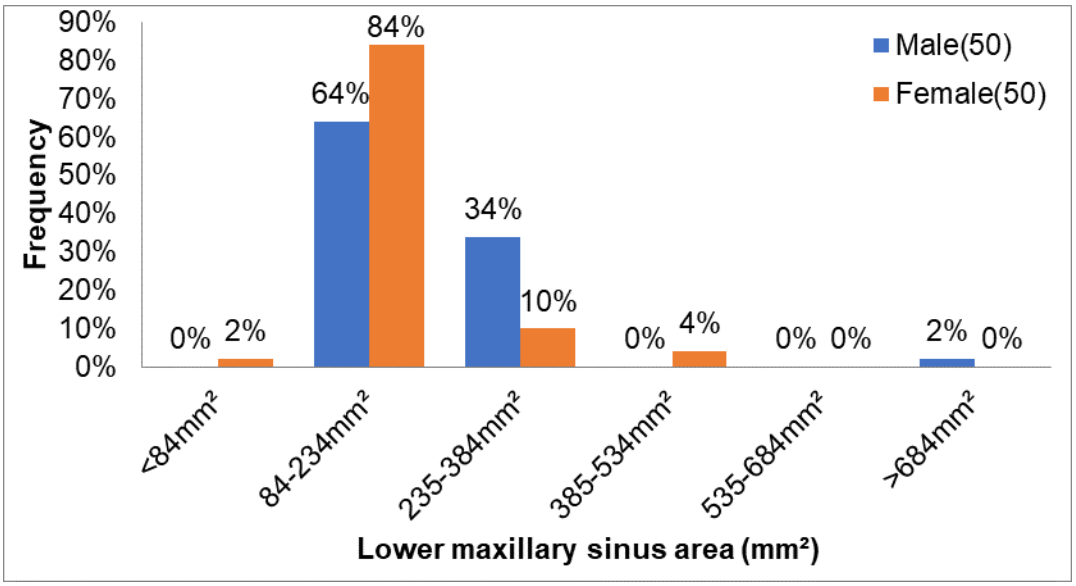

Figure 3**.** Distribution of lower maxillary sinus area in male and female

Figure 3 shows that the most of the values of lower maxillary sinus area of male (84%) and female (64%) distributed in the range of 84-234mm². 36% value of male and 14% value of female also distributed above this range. The distribution of values of male and female was more or less similar. So, the difference of lower maxillary sinus area between male and female was non-significant.

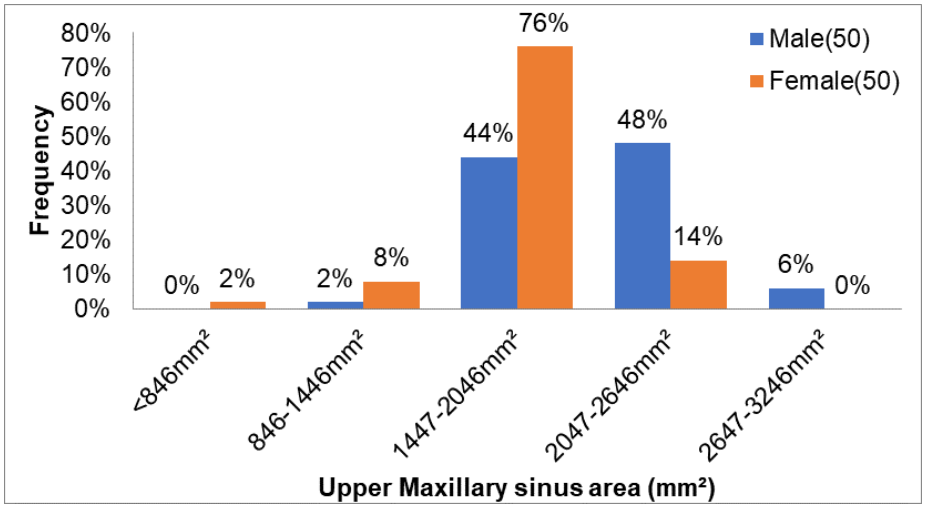

Figure 4. Distribution of upper maxillary sinus area in male and female

Figure 4 shows that most of the values of upper maxillary sinus area of male were in the range of 2047-2646mm² (48%). The distribution of value of female was mostly below this range (76%). So, the difference of upper maxillary sinus area was significantly higher in male than that of female.

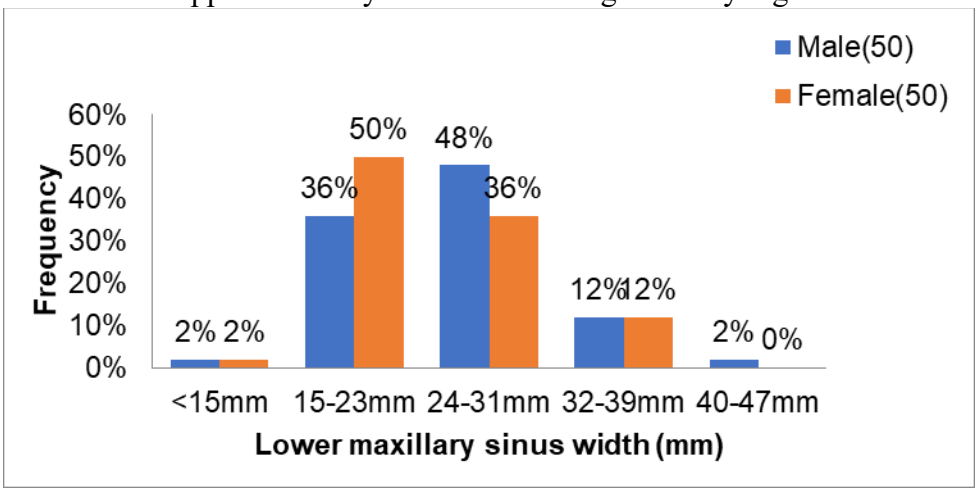

Figure 5. Distribution of maxillary sinus index in male and female

Figure 5 shows that most of the values of maxillary sinus index of male (28%) were in 0.94-1.14 and female (27%) was in the range of 1.15-1.34. 5% value of female also distributed above this level, whereas only 2% value of male distributed above this range. So, the difference of maxillary sinus index was significantly higher in female than that of male.

Discussion

In case of maxillary sinus, pneumatization of the sinus ends with the completion of eruption of third molars, by the age of 18-20 years. Henceforth, subjects included in the present study were above the age of 18 years. The maxillary sinus dimensions tend to stabilize after the second decade of life. Radiographic images provide adequate measurements for maxillary sinuses that cannot be approached by other means.[8] Thus, the maxillary sinus height, width, area and index were considered in this study. During adulthood, the shape and size of the maxillary sinus change especially due to loss of teeth. After the maximum growth period, the volume of the maxillary sinus decreases in both genders.[9] This is attributed to the fact that the loss of minerals in the bone matrix of the entire body structure surrounding the maxillary sinus in all directions contracts the maxillary sinus and results in decrease in the maxillary sinus volume. Regarding maxillary sinus width, highest value was observed in the present study in Bangladeshi male and females and lowest value was observed in Zulu of both sexes by Fernande.[10-12] He also found maxillary sinus height and width was higher in European than Zulu. In all the previous study including the present study, it was observed that width was greater than height except in Japanese male, Lebanese male and Indian male of Srinagar, where height was greater than width. In this study maxillary sinus index in female were higher than that of male and the difference was statistically significant.[13] In Khaitan et al, maxillary sinus index was significantly higher in female than male which is similar with this study. Sheikh et al, found that the height and width of maxillary sinus were larger in female than that of male with statistical non-significant difference, which was dissimilar with this study. Again, when lower maxillary sinus height and width in the present study was compared, it was observed that these variables were higher in males than females but reached a significant level in lower maxillary sinus width only.[14]

Conclusion

In the present study, basic differences of measurements of radiological variables of maxillary sinuses were present in male and female. In case of maxillary sinus, the measurements were also found significantly greater in case of male. Knowledge maxillary sinus anatomy and their variations is important for the diagnosis of acute and chronic sinus pathologies and for clinical and surgical procedures. In the forensic medicine, maxillary sinuses are important for establishing a reliable identification of unknown human remains based on comparison of antemortem and postmortem radiographies. So, the findings of the present study would be reliable enough and might help the surgeons and anthropologists of our country enable to improve their performances in this field.

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