Original Article

Computed Tomography Measurements of Paranasal Sinus at a Tertiary Care Center of Nepal

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Abstract

Background: Paranasal sinus is an anatomical structure located in head and facial bones. The proximity of the sinus with vital structures make them a very important. Variations in paranasal sinus has been suggested in literature. The present study was aimed to estimate the different measurements of paranasal sinus at a tertiary care center of Nepal.

Methods: A descriptive cross-sectional study was conducted at the Chitwan Medical College from January 2021 to July 2021. One hundred eight patients fulfilling the inclusion criteria participated in this study. Computed tomography scans were performed using Siemens 128 slice Somatom Definition Edge CT scan machine. The measurement of maxillary sinuses and its volume, the measurement of frontal sinus and sphenoidal sinus was done. All the data were entered into Microsoft Excel 2019 and then transferred to Statistical Package for Social Sciences version 21 for analysis. The data was analyzed using presented as frequency, percentages, mean and standard deviation

Results: In total 108 patients (72 (66.7%) males and 36 (33.3%) females) participated in this study. The mean age of patients was 40.74±17.93 years. The volume of maxillary sinus in male was greater in the left side (18.68±1.34 cm^3) than the right side (17.66±2.21cm^3)). Whereas the volume in both right and left side of female maxillary sinus was similar. The anteroposterior diameter of the frontal sinus was greater on the left side of male (1.01±1.42 cm) than in the female (0.81±0.42 cm). Fourteen participants had unilateral non-pneumatized frontal sinus while 13 had bilateral non-pneumatized frontal sinus.

Conclusion: The volume of maxillary sinus was higher in male than in female suggesting that variation do exists in our region too. This study also observed the difference in the measurement of frontal sinus in the same individual.

Keywords: Computed tomography; frontal sinus; maxillary sinus; paranasal sinus; sphenoidal sinus.

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INTRODUCTION

The paranasal sinuses (PNS) are air filled spaces present in the facial bones. The PNS aid important role in the development of facial structures, provide warmth and humidification to inspired air, add resonance of voice and weight of skull.[1-3]

These sinuses incept mostly after birth and show complex structural design, due to which they are subjected to developmental anatomical variation. These variations can occur in the same person, among gender and different ethnic groups. The end result of such variations has shown narrowing of passage of osteomeatal channels, impaired drainage and of the PNS and ultimately predisposing to sinusitis. In addition, other structures like the nasal septum also exert influence in growth and of PNS. Septal deformity has been shown with deformities of the lateral nasal wall, and altering the voice of individual.[2] Apart from this the root of maxillary premolars and first molar come to lie in the inferior wall of the maxillary sinus. Sometimes dental infection can also travel to the maxillary sinus. Literature have also suggested for the odontogenic cause of maxillary sinusitis.[3]

Knowledge of these variations are of great importance to the oral and maxillofacial surgeons, radiologists, endoscopic surgeons for perioperative evaluation so that vital structures such as orbit, brain and neurovascular bundles located in the region, can be protected and preserved. Although there are only few studies published related to maxillary sinus[4], some dimensions of the maxillary sinus were not obtainable and the information related to other sinuses are lagging among Nepalese. This study was planned to estimate the different measurements of paranasal sinus at a tertiary care center of Nepal.

MATERIALS AND METHODS

This was a descriptive cross-sectional study, conducted at the Department of Radiology, Chitwan Medical College (CMC) from January 2021 to July 2021. Before starting the study, ethical clearance for this study was obtained from Institutional Review Committee (IRC) of CMC (Ref: CMC-IRC/077/078-063). Based on the study of Sahlstrand-Johnson et al, sample size was calculated using formula $n=Z^2\sigma^2/d^2$(n=sample size, z=1.96 at 95% confidence interval, standard deviation=5.3[5] and margin of error=1mm). The sample size was calculated to be 107.91 and a total of 108 patients were taken into study. A convenience sampling method was used.

Patients above 18 years of both genders, referred for CT of head but without pathological findings of PNS were included in the study. Patients with history of sinus pathology or trauma, facial asymmetry or septal deviation were excluded. In addition, patients who had undergone surgical procedures of sinuses, pediatric age group patients with ongoing development of sinuses, expectant and nursing mothers and CT scans with artifacts which affect the proper visualization of the anatomical landmarks of interest were also excluded from the study.

Before starting the study, the written consent was taken from the study participants. The demographics of the patients were recorded in a predesigned proforma, when patients were scheduled to undergo CT scan. CT was performed using Siemens 128 slice Somatom Definition Edge CT scan machine. Acquisition parameter included: Tube voltage:120kVp, Effective mAs-92 KV, Detector collimation:128x0.3 mm, scan time-7.13s, rotation time-1.0s, Delay-2s. The slice thickness was 3.0 mm, Pitch-0.8. The images were sent to console and evaluated with Syngo. via software where multiplanar images were reconstructed to obtain the different measurements. No CT scan was performed only for research purpose.

The measurement of maxillary sinuses and its volume (Figure 1), the measurement of frontal sinus was done as described by Sahlstrand et al[5], while the measurement of sphenoidal sinus was done as described by Wu et al.[6] The given value for every measurement were taken by principal investigator to avoid interrater variations. All the data were entered into Microsoft Excel 2019 and then transferred to Statistical Package for Social Sciences (SPSS) version 21 for analysis. The data was analyzed using presented as frequency, percentages, mean and standard deviation.

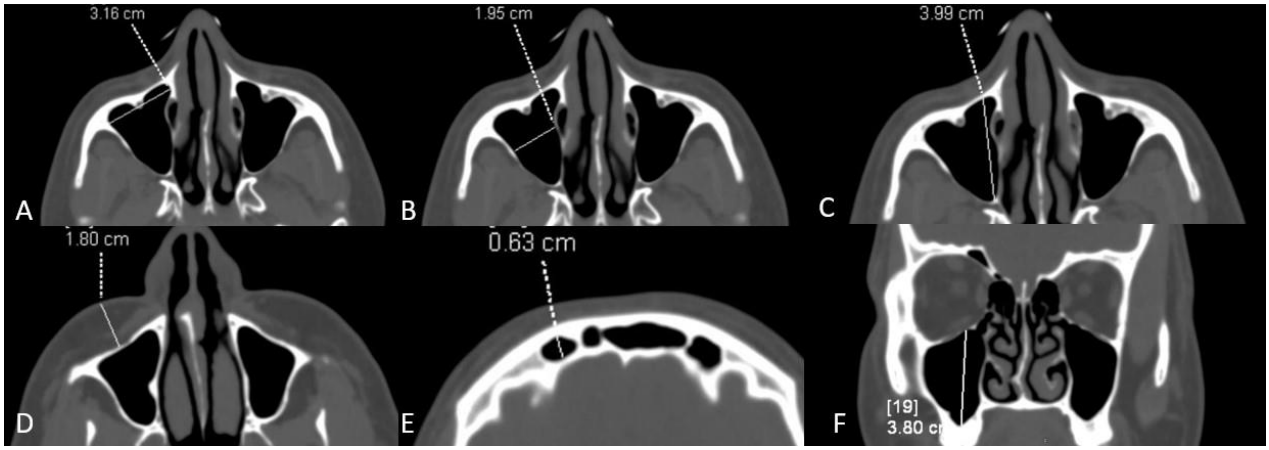

Figure 1: Measurements of different dimensions of paranansal sinus. A; maximum width of maxillary sinus, B; the width at the middle of the maxillary sinus, C; maximum depth (anteroposterior diameter of the maxillary sinus, D; the thickness of the soft tissue between the anterior wall of the maxillary sinus at the canine fossa and the skin surface, E; the depth of the frontal sinus, F; the maximum height of the maxillary sinus.

RESULTS

A total 108 patients participated in this study. Among them 72 (66.7%) were males and rest were females. The mean age of patients were 40.74±17.93 years. Nearly half of the patients were from the Khas ethnicity while 5 (4.6%) were from the Newar ethnicity (Table 1). Table 2 showed the different measurements taken of the PNS and these measurements were compared with male and female. Among males the volume of maxillary sinus was greater in the left side (18.68±1.34 cm^3) than the right side (17.66±2.21cm^3)). Whereas the volume was though smaller than male, both sides of female maxillary sinus was similar. The anteroposterior diameter of the frontal sinus was greater on the left side of male (1.01±1.42 cm) than in the female (0.81±0.42 cm).

In the frontal sinus few participants had non-pneumatized frontal sinus. Fourteen participants had unilateral non-pneumatized frontal sinus while 13 had bilateral non-pneumatized frontal sinus (Table 3).

Table 1: Demographic details of patients

Particulars		Frequency	Percent
Gender	Male	72	66.7
	Female	36	33.3
Age	Mean±S.D. (Years), 40.74±17.93		
Ethnicity	Khas	51	47.2
	Adiwasi .Janajati	41	38.0
	Newar	5	4.6
	Madhesi	11	10.2

Table 3: Status of non-pneumatized frontal sinus (n)

Frontal sinus	Right (n)	Left (n)	Bilateral (n)
Non-pneumatized	7	7	13

Table 2: Comparison of different measurement of paranasal sinus between male and female

Measurements of different paranasal sinus	Male Mean±S.D.	Female Mean±S.D.
Maxillary sinus		
Volume (Right)	17.66±2.21(cm^3)	13.81±2.38(cm^3)

Volume (Left)	18.68±1.34 cm^3	13.80±3.30(cm^3)
Craniocaudal diameter (Right)	3.95±0.54 cm	3.29±0.52 cm
Craniocaudal diameter (Left)	3.90±4.80 cm	3.31±0.46 cm
Anteroposterior diameter (Right)	3.65±0.41 cm	3.49±0.27 cm
Anteroposterior diameter (Left)	3.60±0.42 cm	3.51±0.36 cm
Width (Right)	2.93±0.46 cm	2.80±0.50 cm
Width (Left)	2.91±0.47 cm	2.74±0.45 cm
Width at the middle of the maxillary sinus (Right)	1.96±0.32 cm	1.89±0.34 cm
Width at the middle of the maxillary sinus (Left)	2.02±0.33 cm	1.89±0.25 cm
Thickness of the anterior wall at canine fossa (Right)	0.25±0.35 cm	0.18±0.07 cm
Thickness of the anterior wall at canine fossa (Left)	0.25±0.32 cm	0.17±0.05 cm
Soft tissue thickness between the anterior wall of maxillary sinus at the canine fossa and the skin surface (Right)	1.25±0.39 cm	1.28±0.35 cm
thickness of soft tissue between the anterior wall of maxillary sinus at the canine fossa and the skin surface (Left)	1.25±0.38 cm	1.30±0.33 cm
Frontal sinus		
Anteroposterior diameter) (Right)	0.75±0.46 cm	0.74±0.66 cm
Anteroposterior diameter) (Left)	1.01±1.42 cm	0.81±0.42 cm
Thickness of anterior wall (Right)	0.20±0.15 cm	0.17±0.09 cm
Thickness of anterior wall (Left)	0.20±0.15 cm	0.18±0.09 cm
Thickness of the orbital floor (Right)	0.16±0.04 cm	0.16±0.04 cm
Thickness of the orbital floor (Left)	0.16±0.04 cm	0.17±0.06 cm
Sphenoidal Sinus		
Line 1: The distance of sphenoid ostium to the roof of sphenoid sinus	0.80±0.28 cm	0.90±0.28 cm
Line 2: The distance to the bottom of sphenoid sinus	0.92±0.31 cm	0.83±0.19 cm
Line 3: The distance to the posterior wall of (SS)	2.59±2.54 cm	2.33±0.51 cm
Line 4: The distance from the bottom of sella to the anterior wall of sphenoid sinus	1.92±0.27 cm	1.93±0.34 cm
Line 5: The skull base length from the anterior wall of sphenoid sinus to the sella	1.34±0.34 cm	1.32±0.36 cm
Line 6: The longest horizontal distance of sphenoid sinus	2.90±0.76 cm	2.94±0.60 cm

DISCUSSION

In the past, traditional methods such as conventional radiography, was used to examine PNS. However, they had several limitations like superimpositions and unable to detect all the margins. After the introduction of CT scan in 1970, it gained popularity as a fast, readily accessible imaging technique providing the ability to provide finer details of soft and hard tissue and even the mucous membrane of the sinus. As previously explained, the sinus has a lot of variations in its architecture and owing to these variations they come across several pathologies.[7] With CT scanning of PNS, it has been easy to rule out if any variations are present and has been a boon to the operating surgeons for preoperative planning. Thus, the CT scan has become an important diagnostic tool for the management of patients with sinonasal disease.[2, 5, 8] Thus a thorough understanding and knowledge related to the sinus anatomy and its variations has to be known before doing any surgical interventions.[9]

The maxillary sinus is first PNS to develop and is the largest among all the PNS. It is also said that the growth and development of facial bone and the maxillary sinus is proportional to each other.[10, 11] In this study, the volume of maxillary sinus was estimated. The volume of maxillary sinus was greater in male than in female suggesting sexual dimorphism between the two genders. Similar findings were also reported by other author too.[4, 5, 12-14]

In a study done by Muthukumaravel et al[13], the size of maxillary sinus was smaller than the present study. The variation noticed in both studies may be the result of sample size as the earlier study was done in 200 CT scans each gender having 100 CTs. However, in the present study the equal number of CT between both genders was not done.

Among the PNS, the frontal sinus is the most anteriorly and superiorly located sinus. It is absent during the time of birth. It is also the last one to develop and its full size is attained in puberty.[15, 16] The primordia of frontal sinus begin in the 26th week of intra-uterine life by the development of middle meatus mucosa toward the developing frontal bone. Till 6-8 weeks, this primordium is surrounded by a small portion of cartilaginous nasal capsule.[17] Eventually after the age of six they can be observed radiographically.[17, 18] The growth of frontal sinus then becomes stable at about 20 years of age.[18] The shape of frontal sinus varies and that the variation do exists in the same individual and with other.[18] In this study variation between the same individual in the right and left side was only observed in the measurement of the anteroposterior diameter in both gender. The measurement of the anteroposterior diameter of frontal sinus in the male was longer than in the female. This was in contrast to the findings as reported by Sahlstrand-Johnson et al in which the authors reported the difference in the measurement of the anterior wall thickness between the right and left side.[5]

Frequently the frontal sinus also do not pneumatize. Non-pneumatization of frontal sinus have been reported by various other authors too.[5, 16] This can either be unilateral or bilateral.[16] In the present study too, unilateral and bilateral pneumatization was observed supporting the previous study.

Similar to other paranasal sinus, the sphenoid sinus also has variations. In sphenoid sinus, the sphenoid ostium is the important anatomical landmark. It is also the safest point of entry into the sphenoid sinus. This is due to the fact it lies in close approximation to vital neurovascular structures. Hence operating surgeons in this region have to be careful during surgery.[19]

In the present study we did not observe major difference in the measurement of sphenoid sinus between male and female. The line 1 was slightly longer in the female while line 2 and 3 was longer in the male. This may signify sexual dimorphism between male and female. However, to stress out on this, an elaborative, multicentric study is needed in the future. In a similar study, taking the 6 landmarks, except for line 4 which was higher in this study, rest all the measurements were higher.[6] In another study, Halawi et al also reported the distance from spheoid ostium to the roof of the sphenoid sinus as 11.18±2.60 mm which was longer than our observation.[20] This may be due to geographical differences between the later 2 studies and the present study.

The study also has limitations. The first limitation was that the convenience sampling. The other limitation was the small number of sample used and the study would have been better if an equal number of CT were allotted based on the genders.

CONCLUSIONS

The volume of maxillary sinus was higher in the male than in the female suggesting that variation existed in

our region too. This study also observed the difference in the measurement of frontal sinus in the same individual. This also signifies that the sinus surgeons should be careful and should also know about the variation in the same individual.

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