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Morphometric analysis of sphenoid air sinus: A cross sectional cadaveric study among North Indian population

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ABSTRACT

The sphenoid air sinus is located inside the centre of the skull base is one of the major entry point for surgical interventions of diseases related to anterior and middle cranial cavity including the lesion of sellar area. ***Aim****: To estimate various morphometric parameters of sphenoid air sinus and distance from various anatomical landmarks in cadaveric heads among North Indian population group.The current observational anatomical study was performed on twenty-two adult (20 to 70 year old) formalin fixed cadaveric heads of both sexes of North Indian population group from the Department of Anatomy, SGT University, Gurugram, Haryana over a duration of 1 year from June 2021 to May 2022. Out of 22 cadaveric heads, 13 were of male & 9 cadaveric heads were of female sexes. Among the 44 samples (sagittal sections) the average dimensions of sphenoid air sinus (in mm) were in male 24.6 ± 5.68 to 21.7 ± 5.24 &18.4 ± 3.22 to 18.6 ± 4.38 and were in female 22.4 ± 5.74 to 22.8 ± 5.6 & 16 ± 3.76 to 17.5 ± 4.2 as A-P & vertical respectively. The range, mean with the standard deviation of various anatomical landmarks distances bilaterally among males & females cadaveric heads with't-value' and 'P-value' were measured. Significant difference was observed only for AP & vertical diameter of sphenoid air sinus male & female respectively. Detailed morphometry of sphenoid air sinus and distance from various anatomical landmarks are essential for the clinicians specially neuro & ENT surgeon to perform better surgical procedure for sellar& parasellar lession.*

Key words: Limen nasi, paranasal sinus, sellar lesion, subspinale, Trans-sphenoid approach

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INTRODUCTION

The sphenoid air sinus is located inside the centre of the skull base is one of the major entry point for surgical interventions of diseases related to anterior and middle cranial cavity including the lesion of sellar area [1, 2].It is known as the most variable structure among all the paranasal sinuses regarding extents & degree of pneumatization [3]. Also, morphological & morphometric variabilities of sphenoid air sinus have a potential role in trans-sphenoidal sinus surgeries [4]. Moreover, in chronic paranasal sinus disorders as well as pituitary gland neoplasm, functional endoscopic sinus surgeries (FESS) has considered as the gold standard [5].But because of its anatomical variations and degree of pneumatization lead to major complications while performing FESS procedure [1]. The body of the sphenoid bone gets pneumatized to form this sphenoid air sinus &pneumatization of cranial bones are very common [6]. Pneumatization occurs in various degrees and it might extent up to ACP (anterior clinoid process), foramen rotundum or pterygoid process. Anatomic variations of sphenoid sinus due to pneumatization have to be remembered by the surgeons while performing surgeries to present complications [6, 7].

Degrees of pneumatization may be of different types like conchal, Presellar, sellar& post sellar. It actually depends on the location of sinus in relation to sellaturcica [8]. So, for careful planning of trans-sphenoidal

surgery is only possible where the surgeon is well verged with anatomical variabilities of sphenoid air sinus.As, surgical intervention to the sphenoid sinus with endoscopic procedure is now a drop the treatment of choice to reduce the morbidity of the patients, so morphometric evaluation of anatomical landmarks related to sphenoid sinus will be a great help for the clinicians [9].Computed tomography scanning (CT scans) and MR imaging make easy access to detail study of sphenoid air sinus in the morden era to measure various parameters and also to find out degree of pneumatizations [10, 11]. But for sphenoid air sinus cadaveric study with sagittal sections of head will be an immense help for the surgeons to evaluate all related anatomical landmarks. Keeping this in the mind, the study has been undertaken on North Indian sagittal section of cadaveric heads to explore & evaluate morphometric parameters of sphenoid air sinus. This will be also provide a data base to clinicians for such complicated anatomical structure to avoid major complication while performing trans-sphenoidal as well as FESS procedures.

MATERIAL AND METHODS

The current observational anatomical study was performed on twenty-two adult (20 to 70 year old) formalin fixed cadaveric heads of both sexes of North Indian population group from the Department of Anatomy, SGT University, Gurugram, Haryana over a duration of 1 year from June 2021 to May 2022. Out of 22 cadaveric heads, 13 were of male & 9 cadaveric heads were of female sexes. Sagittal sections were made of all the cadaveric heads to expose the lateral wall of nose as well as sphenoid air sinus including associated areas. Nasal septum was carefully dissected to expose the sphenoid sinus & sphenoethmoidal recess to measure various morphometric parameters of sphenoid sinus including various distance of anatomical landmarks.

Sample size calculation: According to convenient sampling &taking the value as reference according to Bashar abuzayed et al. [12] the minimum number of sample size was calculated. The sampling formula is $N = z^2_\alpha \times p \times q / L^2$ where N is sample size; p is percentage; q = 1-p, Type of error α = 5%, Allowable error L= 12% of p. So, estimated sample size calculated was (N) 44.

Inclusion criteria: Only formalin-fixed adult cadaveric heads withoutany gross pathology and an intact nasal septum were utilized for the study.

Exclusion criteria: Pathologically deformed cadaveric specimens with evidence of gross abnormalities & disrupted or broken nasal septum were excluded from the study.

The specimens were anonymized, randomly coded and de- linked from any identity sources (ICMR National guidelines for bio- medical & health research involving human participants, ICMR, 2017, sec 5, Box 5.2) [13]. Among the cadaveric heads, mid sagittal region was exposed by proper dissection. Various morphometric parameters of Sphenoid sinus (SS) (displayed in Fig1) including the morphometry of some bony distances and angle were measured by the help of a digital vernier calliper in millimeters (mm) presented in Table-1.

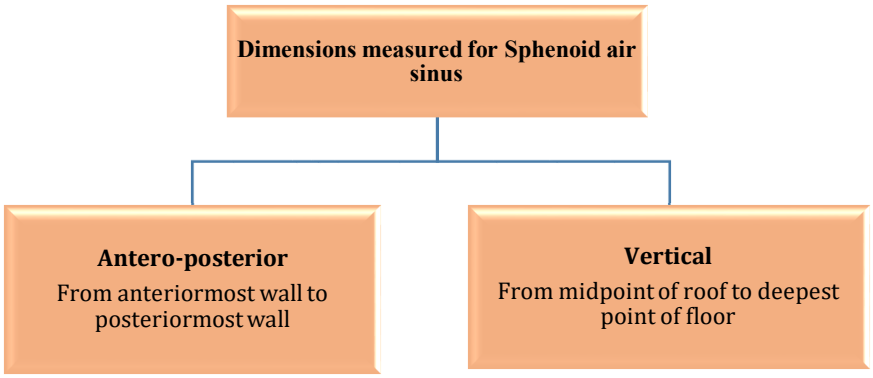

Fig 1: Morphometric parameters measured for the sphenoid Air sinus.

Distances from various anatomical landmarks	
Distance-1	Distance between the subspinale (inferior–posterior edge of the anterior nasal spine) and the anterior sphenoid sinus wall
Distance-2	Distance between the subspinale to anterior wall of sellar wall
Distance-3	Distance of the inferior end of the Sphenoid ostia from the limen nasi
Distance-4	Distance of the inferior end of the Sphenoid ostia from the midpoint of the roof of the choana

Table 1: Morphometric parameters measured as distances from various anatomical landmarks.

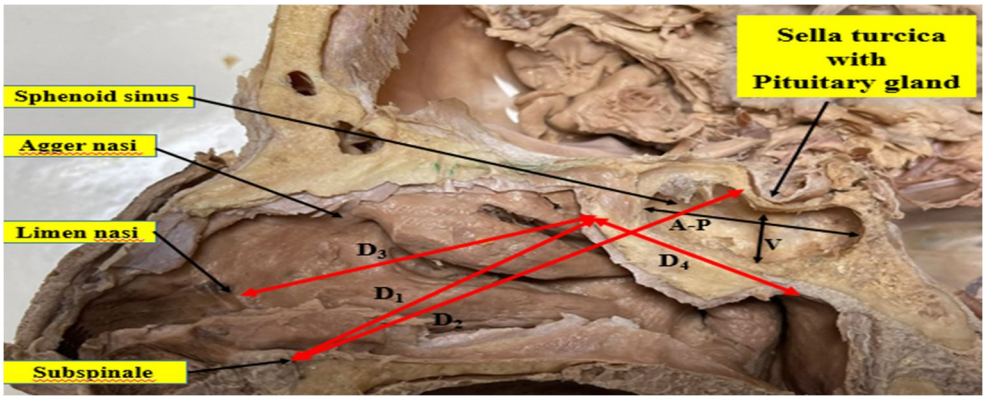

Fig 2. Sagittal section of male cadaver shows various dimension of sphenoid sinus (SS) and distances of various anatomical landmarks to SO

A-P: Anteroposterior diameter of sphenoid sinus, **V:** vertical diameter of sphenoid sinus, **D_1:** Distance between the subspinale & the anterior wall of SS, **D_2:** Distance between the subspinale to anterior wall of sella, **D_3:** Distance of the inferior end of the SO from the limen nasi, **D_4**: Distance of the inferior end of the SO from the midpoint of the roof of the choana.

Statistical analysis: The range, mean & Standard deviation of all parameters were calculated by using SPSS latest version (version 21) and unpaired t-test value as 't-value' was presented for comparison of data bilaterally. Apart from that P-value was calculated to detect the level of significance, P-value≤ 0.05 was considered as significant value. All parameters were measured twice to reduce error. The graphs and tables were created in Microsoft Excel and Microsoft Word 2013.

RESULTS

In the current observational study, 44 hemisected cadaveric heads were used to find out A-P diameter & vertical diameter of sphenoid sinus both the male and female which has been displayed in table-2. Measurements were displayed for both the sides &'t-value' along with 'P-value' both were presented in the table.

Dimension	Parameters	Right side		Left side			
		Range (In mm)	Mean ± SD (In mm)	Range (In mm)	Mean ± SD (In mm)	t-value	P-value
Male specimens sphenoid sinus	A-P	15.6-31.7	24.6 ± 5.68	16- 32.3	21.7 ± 5.24	2.31	0.02
	Vertical	13.3- 24.9	18.4 ± 3.22	13.3- 27.3	18.6 ± 4.38	0.12	0.9
Female specimens sphenoid sinus	A-P	11.3- 29.3	22.4 ± 5.74	13.2- 27.3	22.8 ± 5.6	-0.14	0.8
	Vertical	10.2- 20.6	16 ± 3.76	13- 25.2	17.5 ± 4.2	2.08	0.04

Table-2: The range, mean with the standard deviation of Sphenoid sinus (in mm) on both the gender & sides

The range, mean with the standard deviation of various anatomical landmarks distances bilaterally among males & females cadaveric heads with 't-value' and 'P-value' were exhibited in table-3.respectively.

Male specimens	Right side		Left side			
Distances	**Range (In mm)**	**Mean ± SD (In mm)**	**Range (In mm)**	**Mean ± SD (In mm)**	**t-value**	**P-value**
Subspinale to anterior wall of sphenoid sinus	45.4- 58.2	53.6 ± 3.4	45.6- 62.9	53.3 ± 4.1	0.16	0.87
Subspinale to anterior wall of sellaturcica	62.2- 76.3	70.9 ± 3.7	62.5- 78.3	71.3 ± 4.7	-0.24	0.80
Inferior end of Sphenoid ostia to limen nasi	47.4- 59	53.4 ± 3.2	46.3- 60	52.8 ± 3.6	1.71	0.05
Inferior end Sphenoid ostia to roof of choana	17.4- 33.1	25.9 ± 4.5	19.4-32.1	27.3 ± 3.9	- 2.075	0.04

Table3: The range & mean dimension with standard deviation of distance between the sphenoid sinus and various anatomical landmarks (in mm) on male cadaveric heads both sides

Female specimens	Right side		Left side			
Distances	**Range (In mm)**	**Mean ± SD (In mm)**	**Range (In mm)**	**Mean ± SD (In mm)**	**t-value**	**P-value**
Subspinale to anterior wall of sphenoid sinus	42.7- 61.6	51.7 ± 5.7	47.2- 62.7	53.6 ± 5	- 2.79	0.04
Subspinale to anterior wall of sellaturcica	59.2- 77.6	67 ± 5.7	62.5- 76.3	70 ± 4.6	-2.22	0.024
Inferior end of Sphenoid ostia to limen nasi	38.4- 57.6	51.7 ± 6	47.4- 56.8	51.2 ± 3.2	0.23	0.81
Inferior end Sphenoid ostia to roof of choana	19.1- 28.3	25 ± 3	19.9- 34.7	27.4 ± 4.2	- 2.35	0.019

Table 4: The range & mean dimension with standard deviation of distance between the sphenoid sinus and various anatomical landmarks (in mm) on female cadaveric heads both sides

RESULTS AND DISCUSSION

The sphenoid air sinus is an air filled cavity situated within the body of the sphenoid bone. Many significant anatomical structures surrounding the sinus, including the internal carotid artery in the lateral wall, the optic nerve at the superolateral, the pterygoid nerve (The Vidian Nerve) at the base and the pituitary gland lies on the roof of the sphenoidal air sinus [14]. The sphenoid sinus is useful for surgical access for a number of disorders of the anterior and middle cranial fossa, including lesions involving the sellar and parasellar area, particularly pituitary gland surgery [1, 2].Trans-sphenoidal surgery, which was first used in 1907, rapidly became a standard approach for treating intrasellar lesions [15]. The trans-sphenoidal approach with the help of an endoscope and an operating microscope is more efficient and related with fewer morbidity and mortality than to the alternative transcranial approach [16]. That is why, morphometry of Sphenoid air sinus and distance from various anatomical landmarks are essential for the clinicians specially neuro & ENT surgeon to perform better surgical procedure for sellar&parasellar lesion. In our present study, the anteroposterior (AP) diameter of male cadaveric heads sphenoid air sinus was significantly higher or the right side as compared to left side (P=0.02). Also, it was observed that there was a significant difference in vertical diameter of female cadaveric heads sphenoid air sinus on left sides (p= 0.04). The vertical diameter of sphenoid air sinus among present study it was 18.4 ± 3.22 to 18.6 ± 4.38 in male mm & in female it was 16 ± 3.76 to 17.5 ± 4.2, which was comparatively less among vertical diameter observed in Egyptian [17] & South Indian [19]population, where it was 20 mm&23± 6 to 21± 5 mm. Among the South Indian the dimension was slightly longer on the right side with statistical significance [19].

In the present study the vertical diameter of male cadaveric heads sphenoid air sinus and AP diameter of female cadaveric heads sphenoid air sinus of both sides were also measured but no statistically significant difference was observed on both the sides.

In the present study distance from various anatomical landmarks of both sides and both gender were also measured, in the male cadaveric heads the distance from SO to limen nasi& from SO to roof of choana right side was significantly higher than left side respectively (P= 0.05 & 0.04). And in female cadaveric heads distance from subspinale (S) to anterior wall of sphenoid sinus (SS) left side was significantly higher than right side (P= 0.04). The distance from subspinale to SS (62.3± 4.6 mm) & subspinale to anterior wall of sellaturcica (ST) (75.9± 6.3 mm) is higher among the Greek population [22] as compared to the present study. Also, the distance from SO to limennasi is greater among the South Indian [7, 23] population and it is less in the existing study of the North Indian population [9] as compared to the present study.

LIMITATION

To achieve more valid results for providing baseline data, the number of cadaveric heads can be increased as sample size. Also, as the sphenoid air sinus and various distances from the SO, the sphenoid sinus and anterior wall of the sellaturcica are the most important landmarks while performing the trans-sphenoidal approach for pituitary surgeries, radiological correlations can be included in the future.

CONCLUSION

The current cadaveric cross-sectional investigation of the sphenoid air sinus and various anatomical landmarks will serve as a preliminary data base from the North Indian population group. Also, detailed morphometry of this complicated region will be of immense help to Neuro and ENT surgeons in deciding on treatment modalities and performing surgical treatments for sellar lesions.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest. The research received no specific grant from any funding agency in the public, community, or non-for profit sectors.

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