

Evaluation of the Prevalence in Differences of the Nasal Cavity: A Computed Tomography Study

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Abstract

Original Research Article

Background: The nasal cavity is a vital structure for respiration, olfaction, and phonation. Anatomical differences are common, driven by genetic and environmental factors. These variations include septal deviations, turbinate hypertrophy, and accessory air cells. Such differences can alter airflow, mucociliary function, and disease susceptibility. Computed tomography (CT) is crucial for evaluating these differences. Assessing nasal cavity anatomy is essential for pre-surgical planning and managing sinonasal diseases. This study aimed to determine the prevalence and clinical significance of nasal cavity anatomical variations using CT scans. **Method:** This descriptive cross-sectional retrospective study was conducted at RSUTH, Nigeria. Ethical approval was obtained. The study analyzed 339 adult, non-contrast CT scans using RadiAnt Dicom software. Images were evaluated for the different anatomical patterns associated with the nasal cavity. Poor quality images and images of were excluded. **Results:** The most prevalent nasal cavity pattern was nasal septal deviation (68%), whereas the least prevalent was septal spur with choncha bullosa (2.4%). Other variants seen were agger cells more in the left nasal cavity of males and also haller cells were predominantly seen in the left nasal cavity of females. **Conclusion:** Knowledge of nasal cavity anatomical variations is crucial for ENT surgeons to ensure safe and efficient surgical procedures. Pre-operative evaluation of the nasal septum is essential for surgical planning, reconstruction, and optimal cosmetic outcomes.

Keywords: Nasal cavity, computed tomography, nasal septal deviation, anatomical variations.

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BACKGROUND

The nasal cavity forms the upper part of the respiratory tract. It is divided into two by a nasal septum. The septum constitutes superiorly perpendicular plate of the ethmoidal bone and inferiorly vomer, palatine bone and crest of maxilla along with septal cartilages. It is a relevant anatomical midline structure and forms a vital supportive foundation for the nasal cavity. The nasal cavity does essential physiological functions including air conditioning, olfaction and phonation (Sobiesk and Munakomi, 2023; Guo-She Lee *et al.*, 2005). Anatomically, the nasal cavity extends from the external nares to the choanae and is bounded inferiorly by the hard palate, laterally by the medial walls of the maxillary sinus, and superiorly by the nasal, ethmoid and sphenoid bones (Gibelli *et al.*, 2017). Although the gross features of the NC are well described, there is important population-level variation in internal nasal architecture driven by genetic, developmental, environmental and

hormonal influences. These variations may manifest as differences in septal alignment, turbinate size and pneumatization, presence of accessory air cells, and olfactory fossa depth and have direct clinical and forensic consequences because they modify airflow patterns, mucociliary function and susceptibility to sinonasal disease. There are morphological differences associated with the nasal cavity. These variations include differences in septal alignment, turbinate size and pneumatization, presence of accessory air cells and have direct clinical consequences because they modify airflow patterns, mucociliary function and susceptibility to sinonasal disorders. Significant nasal septal deviation can produce compensatory hypertrophy of inferior turbinate and concha bullosa of the middle turbinate at the contralateral side, exasperating the obstruction, or additionally causing hypoplasia of the ipsilateral turbinates. According to side, NSD can be classified as right-sided, left-sided or S-shaped variants (Cellina, *et al.*, 2020). Nasal septal deviation and other morphological

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variations play an important role in nasal congestion symptoms and sinonasal diseases. Therefore, evaluation of the nasal cavity is essential for pre-surgical planning, reconstruction, and overall cosmetic results. The assessment of the nasal cavity with computed tomography (CT) is of significant importance, as different forms may result in change in the drainage pathways from the nasal cavity and paranasal sinuses, resulting in obstruction and sinusitis. The aim of this study was to determine the prevalence of anatomical disparities in the nasal cavity using computed tomography (CT) scans, and to assess their clinical significance.

MATERIALS AND METHODS

This study was a descriptive cross sectional retrospective study conducted in the Radiology department of the Rivers State University Teaching Hospital (RSUTH), Nigeria between 2022-2024. Ethical approval was obtained from the ethical committee of the

Rivers State University Teaching Hospital, 339 adults, non-contrast computed tomographic films were used for this study. Images were studied for the different anatomical patterns associated with the nasal cavity, using the digital imaging and communications in medicine viewer for medical images (radiant dicom software) version 23 (Haak *et al.*, 2016). CT of the brain and paranasal sinuses were used in this study. Children and adults with poor quality images were excluded from the study.

ANGLE OF DEVIATION OF THE NASAL SEPTUM

The measurement of the nasal septal angle was done by measuring the angle between two lines. The first line runs from the maxillary crest (point A) to the junction point of the perpendicular and cribriform plate of ethmoid bone (point B). The second line was drawn to connect the junction point of the perpendicular and cribriform plate and the most prominent point of the deviated nasal septum (point C).

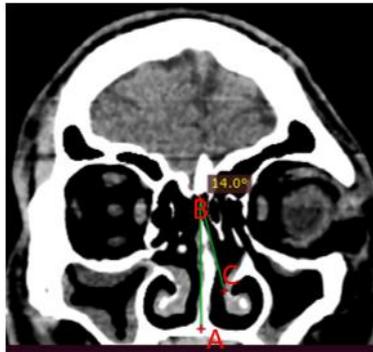


Fig. 1: Coronal image showing the measurement of the nasal septal angle deviation

Point A is the maxillary crest, point B is the junction point of the perpendicular and cribriform plate of ethmoid bone. Point c is the most prominent point of deviated nasal septum.

ANATOMICAL VARIATIONS OF THE NASAL CAVITY

It was observed that not all the subjects had straight nasal septum. The anatomical variations of the nasal cavity were carefully examined and the following variations were noted. It

- Nasal septal deviation:** In this study, it was observed that some of the subjects had nasal septal deviation to the right and left.

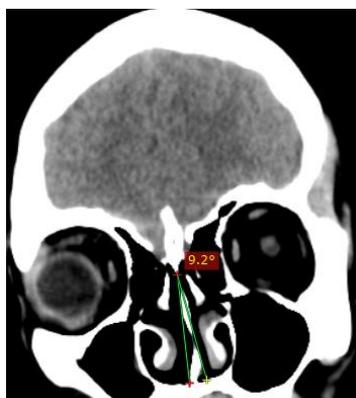


Fig. 2: Coronal image showing left nasal septal deviation

- b. **“S” shaped nasal septum:** This was another form of anatomical variation that was observed in this study.

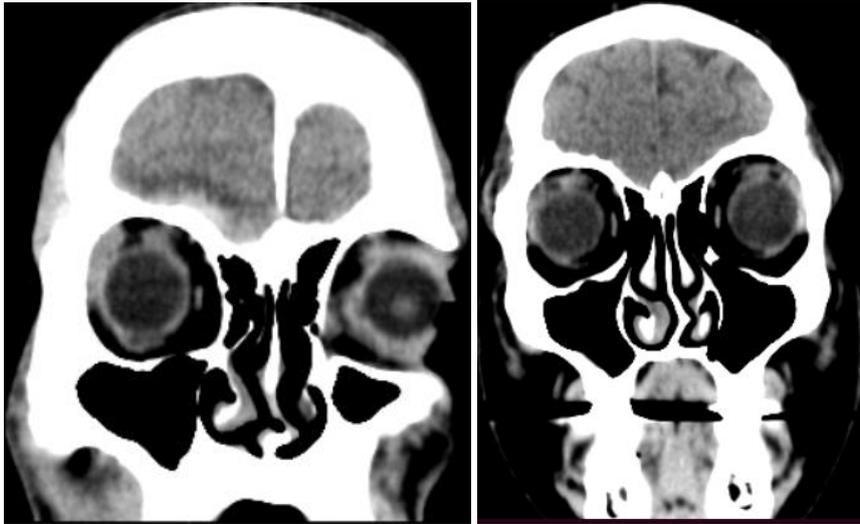


Fig. 3: Coronal image showing “S” shaped nasal septum

- c. **Agger nasi cells:** These are anterior ethmoidal air cells found in the lateral side of the nasal cavity, attached to the middle turbinate.

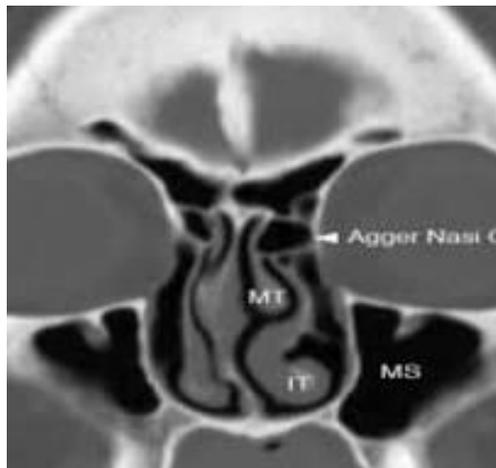


Fig. 4. Coronal image showing the presence of agger nasi cells

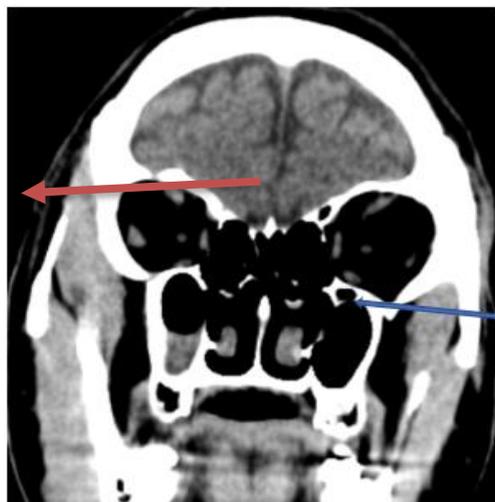


Fig. 5: Coronal image showing the presence of haller cells

- d. **Haller cells:** They are infraorbital ethmoidal air cells located on the floor of the orbit.

- e. **Nasal septal spur:** Nasal septal spur are small outgrowths of cartilage or bone on the nasal septum. In this study, we also observed the presence of nasal septal spur.



Fig. 6: Coronal image showing the septal spur with pneumatization



Fig. 7: Straight nasal septum

RESULTS

Data were analyzed using statistical package for the social science (SPSS version 23.0) and Microsoft

Excel 2020 enterprise edition. Results were presented in tables, percentage and bar charts.

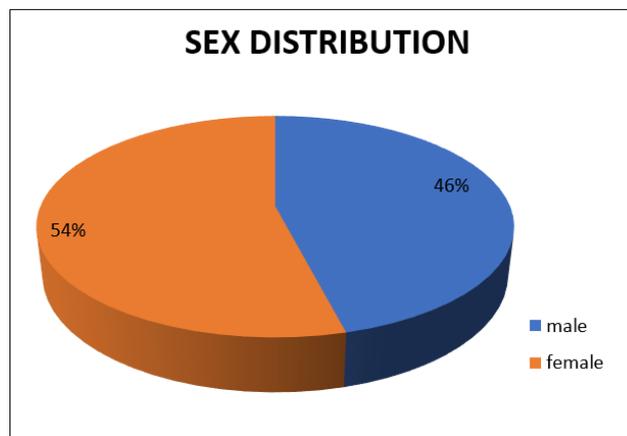


Fig. 8: Shows the sex distribution

Classification of angle of nasal septal deviation (NSD)

Type I (Normal) - naso septal angle $< 5^{\circ}$

Type II (Mild) NSD: naso septal between 5° - 10°
 Type III (Moderate) NSD: naso septal between 10° - 15°

Type IV (Severe) NSD: naso septal $> 15^{\circ}$
 (Periyasamy *et al.*, 2019)

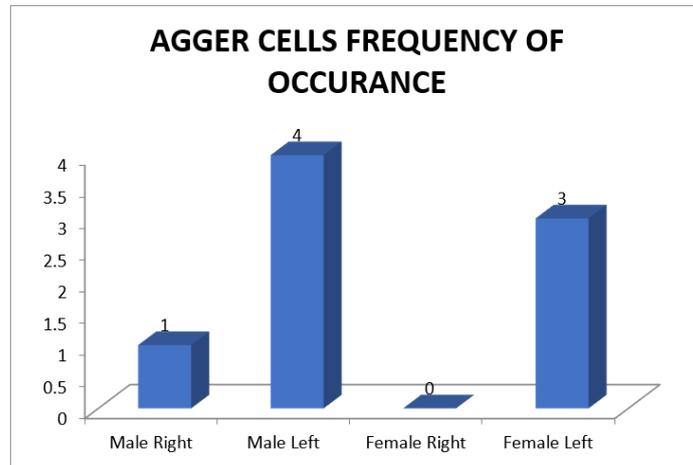


Fig. 9: Shows the frequency of agger cells

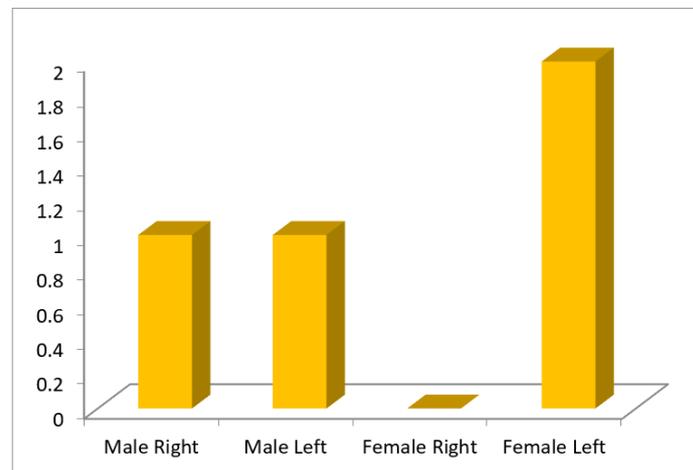


Fig. 10: Shows the frequency of occurrence of haller cells

Table 1: Angle of Nasal deviation

Angle of Deviation	%
$< 5^{\circ}$	10.0
$5-10^{\circ}$	34.2
$11-15^{\circ}$	40.6
$>15^{\circ}$	15.1

Table 1 shows the various degrees of nasal septal angle deviation. According to Periyasamy *et al.*,

(2019), most of our subjects in this study have moderate nasal septal deviation

Table 2: Septal Angles in Subjects with Nasal Septal Spur (Nss)

Angle of Deviation	%
$< 5^{\circ}$	0
$5-10^{\circ}$	20
$11-15^{\circ}$	33.3
$>15^{\circ}$	46.7

Table 2 shows the degree of nasal septum deviation in nasal septal spur. According to Periyasamy *et al.*, 2019 most of the subjects with nasal septal spur

had Type (IV) severe nasal septal deviation, followed by moderate degree of nasal septal deviation.

Table 3: Septal Angles in Subjects with Nasal Septum Pneumatization

Angle of Deviation	%
< 5 °	0
5-10 °	0
11-15 °	50
>15 °	50
TOTAL	100

Table 3 shows the degree of nasal septal angle deviation in subjects with septum concha bullosa (pneumatization). Subjects with septum pneumatization had moderate (type III) to severe degree (IV) nasal septum deviation.

DISCUSSION

Anatomical variants of nasal septum

It includes concha bullosa, spur, deviated nasal septum, thickening, and dislocation (Malpani and Deshmukh, 2022). In this present study, the following anatomical variants were observed; concha bullosa, septal spur, deviation, straight septa. The most prevalent was nasal septum deviation, followed by straight, septal spur and concha bullosa.

Nasal septal deviation

Nasal septal deviation-Nasal septum deviation implies displacement of the septal contour away from the midline (towards one side) of the nasal cavity (Koo, *et. al.*, 2017), and is identifiable in >50% of patients (Beale, *et. al.*, 2009). Nasal septal deviation could be right-sided, left-sided or S-shaped curvature. Deviation of nasal septum causes narrowing of one side of the nasal cavity, thereby resulting in nasal obstruction. According to Periyasamy *et. al.*, (2019), most of our subjects in this study had moderate nasal septal deviation. It is imperative to note that not all forms of deviated nasal septum always results in the development of nasal obstruction or chronic rhinosinusitis. Only tremendously severe deviated nasal septum appears to contribute to the etiology of chronic rhinosinusitis (Malpani and Deshmukh, 2022). Deviated nasal septum causes a decrease in the vital area of the osteomeatal unit predisposing to obstruction and related complications (Aramanim *et al.*, 2014).

Table 4: Evaluation of deviation of the nasal septum in different countries

Author(s)	Country	Study population	Deviated Nasal septum
Earwaker, (1993)	Australia	88	44
Baradaranfar and Labibi, (2007)	Iran	120	45
Adeel <i>et al.</i> , (2013)	Pakistan Asia	77	26
Al-Abri <i>et al.</i> , (2014)	Oman	360	80
Shpilberg <i>et al.</i> , (2015)	New York	192	98.4
Kaya <i>et al.</i> , (2017)	Turkey	350	89.7
Onwuchekwa <i>et al.</i> , (2017)	Nigeria	110	20.91
Abhishek <i>et al.</i> , (2017)	India	77	32
Simoes <i>et al.</i> , (2017)	Brazil	1005	80.7
Alshaikh <i>et al.</i> , (2018)	Saudi	291	38.8
Yazici (2018)	Turkey	225	55.1
Hadi <i>et al.</i> , (2018)	Iraq	75	72
Shokri <i>et al.</i> , (2019)	Iran	250	90.4
Kantun <i>et al.</i> , (2019)	Mexico	110	38.2
Ominde <i>et al.</i> , (2023)	Nigeria	336	40.5
Current study	Nigeria	339	65.8

Table 5: Prevalence of Anatomical Variations of Nasal Cavity in this Study

Variant	Frequency	%
Septal spur	18	5.3
Nasal septum with concha bullosa	8	2.4
Septal deviation	223	65.8
Straight septum	80	23.6
“S” shaped nasal septum	10	2.9

Nasal septum pneumatisation (Concha bullosa)

In this present study, the prevalence rate of nasal septal pneumatisation amongst Nigerians residing

in Rivers State was 2.4%. The reported incidence ranges from 0% (Yazici, 2019) to 4% (Gibelli *et al.*, 2018). In some cases, this pneumatisation may narrow the sphenoidal recess which limits access to the sphenoid ostium (Vaid *et al.*, 2015). There was no relationship between nasal septal pneumatisation and gender in this current study.

Nasal septum spur

Nasal septal spur (NSS) is a common anatomical variation that is usually associated with nasal septal deviation. If noticeable, NSS may hinder surgical access to the nasal cavity and also can narrow the middle meatus or ethmoid infundibulum (Beale, *et al.*, 2009). From this present study, the prevalence of NSS amongst Nigerians staying in Rivers State was 5.3%. This result is closely related to the result obtained by Alsubael and

Hegazy (2009), which was 7.0% amongst Saudi population. However, the prevalence rate from this present research differs from other studies done by Madani, *et al.*, (2021), 30.8%, Bagari *et al.*, (2019) reported 29.0% in Indians. Our result is also different from Perez-Pinas *et al.*, (2000), Turna *et al.*, (2014) and Chandel *et al.*, (2015) where the prevalence was, 18.0% in Spanish, 19.9% in Turkish and 11.6% in Indian populations respectively. These variations in prevalence rate may be due to racial, environmental or genetic factors. Moreso, in this present study there was no sexual dimorphism as regards the presence of NSS, this is not in agreement with of Bagari *et al.*, (2019) in Indians, who had higher prevalence of NSS in males compared to females ($P=0.008$) and left spurs were more frequent than the right ones.

Table 6: Prevalence of Nasal septal spur among different countries

Author(s)	Country	N	Septal spur
Earwaker, (1993)	Australia	800	3.25
Shpilberg <i>et al.</i> , (2015)	New York	192	32.3
Chandel <i>et al.</i> , (2015)	India	120	11.6
Alshaikh and Aldhuraish (2018)	Saudi	291	32
Shokri <i>et al.</i> , (2019)	Iran	250	34.8
Gungor and Okur (2019)	Turkey	320	43.8
Mohammed <i>et al.</i> , (2019)	Saudi	392	29.3
Nadwi <i>et al.</i> , (2019)	India	86	46.8
Ominde <i>et al.</i> , (2023)	Nigeria	336	11.9
Current study	Nigeria	339	5.3

CONCLUSION

Knowledge of the anatomical variations of the nasal cavity is very essential, because it will help surgeons especially E.N.T surgeon carry out safe and efficient surgical procedures with minimal or no complications. Therefore, pre-operative evaluation of the nasal septum is important in surgical planning, reconstruction, and overall cosmetic outcomes in patient.

Recommendation

Further comparative researches should be done using different ethnic groups and races.

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