Variant Anatomy of the Nasal Turbinates in Adult Nigerians

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Abstract

Objective: The variations of the nasal turbinates have been implicated in the pathogenesis of rhinosinusitis. Accordingly, this study aimed at elucidating the variations of the nasal turbinates in adults.

Methods: This retrospective study was conducted in the Radiology Department of a teaching hospital. Following ethical approval, brain CT scan images of 336 patients aged 20-99 years were used to study the nasal turbinates. Data were analyzed using Statistical Package for the Social Sciences (SPSS) version 23.0 (IBM SPSS Corp.; Armonk, NY, USA) and summarized in frequencies. Chi-square test was used to evaluate for gender and side differences in the frequencies of the variants. A *P*-value of $<.05$ was considered statistically significant.

Results: Concha bullosa (CB) was the commonest variant (28.6%) followed by the paradoxically curved middle turbinate (PMT) (14.3%) and inferior turbinate hypertrophy (14.3%). The least prevalent variants were pneumatized superior turbinate (6.5%) and hypoplastic inferior turbinate (4.5%). None of the variants showed a statistically significant gender difference ($P > .05$). Both CB and PMT showed a statistically significant side difference ($P = .001$).

Conclusion: The presence of the variants of the nasal turbinates in this study emphasizes on the need for preoperative imaging prior to functional endoscopic sinus surgery, which is becoming popular among otolaryngologists. This will ensure the successful restoration of sinus ventilation and drainage and minimize complications.

Keywords: Nose, turbinate, rhinosinusitis

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INTRODUCTION

The lateral wall of the nasal cavity (NC) has three projections called the turbinates or conchae, namely, superior, middle, and inferior turbinates. Sometimes a fourth (supreme) turbinate may exist lateral to the superior turbinate (ST).[1] The ST is located on the upper part of the NC, and the superior meatus that drains the posterior ethmoidal cells is located beneath the ST. The prevalence of ST pneumatization varies in different populations.[2–5] The middle turbinate (MT) forms the roof of the middle meatus, which drains the anterior sinus group (frontal, maxillary, and anterior ethmoid sinuses) via the anterior osteomeatal unit.[6] Extension of pneumatization from the frontal recess or ethmoidal air cells into the MT forms concha bullosa (CB) whose prevalence ranges between 11.7 and 75.9%.[7,8] A large CB has been significantly implicated in the pathogenesis of rhinosinusitis and limits the exposure of surgical field during the functional endoscopic sinus surgery (FESS).[9]

A paradoxically curved middle turbinate (PMT) abnormally curves toward the midline with its convex surface facing laterally toward the meatus instead of its smooth medial curvature.[10] The prevalence of PMT varies in different literature reports.[2,11] PMT is significantly allied with chronic rhinosinusitis (CRS) by altering nasal airflow dynamics and causing impingement of the infundibulum and middle meatus.[1] The inferior turbinate is the largest turbinate, and beneath, it is the inferior meatus which drains the nasolacrimal duct. The aeration of the inferior turbinate is rare.[1,3] Other rare variants of the inferior turbinates include hypertrophy, hypoplasia (14.6%), or bifid inferior turbinate.[1]

Rhinosinusitis is among the most common otorhinolaryngological disease caused by environmental pollution from oil and gas industrial activities as well as low socioeconomic status and overcrowding.[12,13] Computed tomography

(CT) is the gold standard imaging modality for accurate delineation of the complex anatomy of the sinonasal region.[14] This study aimed at using CT images of adult patients to elucidate the variants of the nasal turbinates in order to guide radiologists and surgeons during preoperative evaluation for safe FESS.

METHODS

This was a cross-sectional retrospective study conducted in the Radiology Department of a teaching hospital. Ethical approval was obtained from the Ethics Committe of Delta State University Training Hospital, EREC/PAN/2020/030/0371. Brain CT images taken using a 64 slice CT scanner (Toshiba Aquillon, 2009, Japan) and stored in the Picture Archiving and Communication System (PACS) unit of the Radiology Department were retrieved. These were images of 336 adult patients (199 males and 137 females) aged 20-99 years and taken between June 1, 2015 and June 30, 2020 for various reasons, such as suspected brain tumors, space-occupying lesions, stroke, and pulmonary embolism. CT images of patients below 20 years and poor-quality images with the presence of artifacts were excluded from this study. Moreover, images of patients with evidence of sinonasal pathologies, trauma, or previous sinus surgery were excluded. The nasal turbinates were identified on the lateral wall of the nasal cavity and studied in coronal and axial images for variants such as pneumatization, hypertrophy, hypoplasia, and PMT.

Statistical Analysis

Data were classified according to gender and analyzed using Statistical Package for the Social Sciences (SPSS) version 23.0 (IBM SPSS Corp.; Armonk, NY, USA) for frequencies of the variants. Chi-square test was used to evaluate for gender and side differences in the prevalence, and these were considered statistically significant at *P*-value of $<.05$.

RESULTS

We evaluated CT images of 336 patients, 199 males (59.2%) and 137 females (40.8%), with an average age of 53.29 ± 18.18 years. CB was the commonest variant (28.6%), followed by PMT and IT hypertrophy with an equal prevalence of 14.3%. ST pneumatization and IT hypoplasia were the least prevalent with frequencies of 6.5% and 4.5%, respectively. We did neither observe any IT pneumatization nor bifid IT (Figure 1). We report the pneumatization of the ST in 22 patients (6.5%). The prevalence of this variant on each side did not show any statistically significant gender difference ($P = .871, .591$) (Table 1). It occurred only unilaterally with a higher prevalence on the right (14, 63.6%) than the left (8, 36.4%) side. However, it did not show any significant association with side of existence ($P = .551$).

The prevalence of the CB was 28.6% (96 patients) with a higher frequency in females (43, 31.4%) than in males (53, 26.6%). It also predominantly existed unilaterally (56, 58.3%) than bilaterally (40, 41.7%). The prevalence of unilateral CB was significantly higher on the right (30, 53.6%) than on the left (26, 46.4%) side ($P = .001$). However, the gender differences were not statistically significant bilaterally ($P = .882$ and $.761$, respectively) (Table 1). The prevalence of CB varies in different study populations reported in literature (Table 2). PMT was observed in 48 patients (14.3%) and more commonly unilaterally (36, 75%) than bilaterally (12, 25%). We report a statistically significant association between PMT and side of existence ($P = .001$). Conversely, there was no significant gender differences on each side ($P = .491$ and $.765$) (Table 1). Table 3 shows the comparison of PMT in different study populations.

Forty-eight (14.3%) patients had hypertrophy of the inferior (IT) occurring unilaterally, more on the left (26, 54.2%) than on the right (22, 45.8%) side. We report no significant side difference in the prevalence of IT hypertrophy ($P = .160$). Likewise, there was no statistically significant gender difference in the prevalence of this variant on both sides ($P = .377$ and $.506$) (Table 1). Hypoplastic IT occurred unilaterally in 15 subjects (4.5%). Similarly, this variant did not show any significant association with side ($P = .676$). Its occurrence on either the right or left side was not associated with gender ($P = .507, .591$) (Table 1).

Main Points

- The morphological variants of the nasal turbinates varied from previously documented literature reports. It is therefore mandatory for radiologists and otorhinolaryngologists to identify these variants preoperatively for safe FESS.

DISCUSSION

The prevalence of pneumatized ST was 6.5% corresponding to the findings by Onwuchekwa and Alazigha[1] (6.4%) in the adult Nigerians of Rivers State. Our finding was higher than 1.7% documented by Sumaily et al.[4] in Saudi Arabia. On the contrary, higher frequencies have been reported in the American (26%), Turkish (13%), and Indian (20.2%) populations.[2,3,5] This perhaps suggests the impact of population, genetic, and racial differences in the occurrence of ST pneumatization. We report mainly a unilateral occurrence (100%) with a predilection to the right ST (63.6%). However, there was no statistically significant gender difference and side difference ($P \geq .05$). We, therefore, propose that there is no influence of gender or side on ST pneumatization.

The prevalence of CB was 28.6%, slightly lower than previous reports from the Nigerian population.[1,15] This may suggest the possible existence of genetic variation in people within the same geographical location. Furthermore, our findings varied from the reports from other countries implying the possibility of racial, geographical, and environmental influences on the occurrence of CB[8,10,11,16–19] (Table 2). The discrepancies in the prevalence of CB have also been accredited to the differences in the definition criteria.[15] Some authors define CB as the true pneumatization comprising the vertical lamina and the inferior bulb of the MT only, while others consider aeration of any size occurring on any part of the MT.[16,20] A lower prevalence suggests that only large pneumatization was considered.[19]

In our study, CB was more common unilaterally (58.3%) than bilaterally (41.7%). The unilateral CB was predominantly on the right (53.6%) compared to the left side (46.4%). Among the Egyptians studied by El-Anwar et al.,[10] CB was only observed unilaterally with all the cases occurring on the left side (100%). We report a statistically significant association between CB with the side of occurrence ($P = .001$). This may be attributed to the independent development of the craniofacial structures that exist on both sides, increasing the propensity of pneumatization on one MT more than the other. Congruent with the findings of Dawood,[19] we did not observe any significant association between CB and gender ($P > .05$), implying that gender had no influence on its occurrence. It is important for clinicians to be cognizant of the presence of CB, which, in most cases, is not pathological. However, large CB has been significantly associated with the pathogenesis of rhinosinusitis since it may deviate the uncinate process and narrow the middle meatus and infundibulum impeding drainage of the PNS.[21] Therefore, the prevalence of CB is higher in CRS.[14] Furthermore, a large CB limits the exposure of the surgical field during FESS.[9,16] Accumulation of pus within CB leads to the formation of a mucopyocele, which may be misdiagnosed as other nasal masses such as polyps.[14]

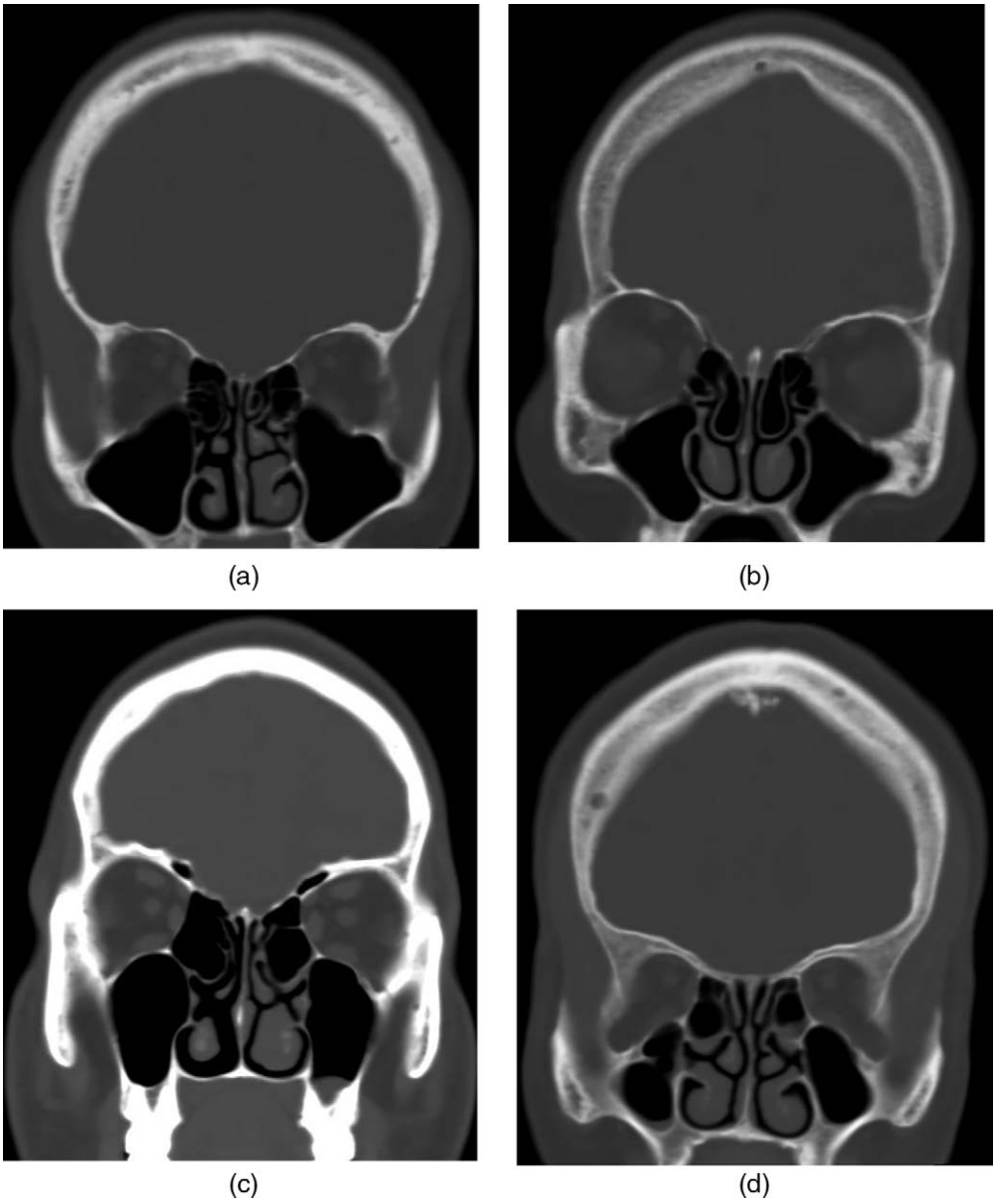

Figure 1. Coronal reformatted CT images showing the different variants of the nasal turbinates. (A) Left superior turbinate pneumatization. (B) Bilateral concha bullosa. (C) Left inferior turbinate hypertrophy. (D) Left paradoxical middle turbinate.

The prevalence of PMT in our study (14.3%) was higher than previously documented reports from Nigeria.[1,15] This shows the existence of intra-population variation ascribed to individual and genetic factors. Our finding was higher than the prevalence documented in Saudi Arabia, Iraq, India, and Pakistan.[4,9,18,22] On the other hand, scholars in Turkey, New York, and Egypt documented higher frequencies of PMT compared to our findings[2,10,21] (Table 3). The wide range of prevalence of this variant can be attributed to differences in race, geographical factors, and environmental factors.[10] PMT in our study was more prevalent unilaterally (75%) than bilaterally (25%), perhaps due to the independent embryonic development of the MT on either side. The prevalence for the right and the left unilateral PMT was equal (50%), and the side difference was statistically significant ($P = .001$), further supporting our certainty in the role of independent embryonic development in the self-determination of each MT shape. This variant did not show any significant gender difference ($P > .05$). PMT is significantly associated with CRS by altering nasal airflow dynamics and causing impingement of the infundibulum and middle meatus.[1] The size, degree of convexity, and combination with other variants determine the magnitude of obstruction and extent of the sinonasal disease.[8,9] In view of this, clinicians must be cognizant of the pervasiveness of this variant due to its role in the causality of sinonasal pathology.

We did not encounter any pneumatization of the IT, and this was parallel to literature reports that this variant is rare and is usually an incidental radiologic finding.[2] This is because the IT is an independent bone and not an extension of the ethmoid bone like the other conchae, hence rarely gets involved in extensive ethmoid sinus pneumatization.[3] Onwuchekwa and Alazigha[1] reported a very low prevalence of 0.9% in the Nigerian population studied in Rivers State. Likewise, low prevalence has been documented in America, Saudi Arabia, and Turkey.[2,3,23] The

Table 1. Variations of the Nasal Turbinates

Variant		Right		Left		Total Prevalence	
		N	%	N	%	N	%
ST pneumatization	Male	8	4	4	2	12	6
	Female	6	4.4	4	2.9	10	7.3
	Total	14	63.6	8	36.4	22	6.5
	P	.871		.591			
CB	Male	42	21.1	38	19.1	53	26.6
	Female	28	20.4	28	20.4	43	31.4
	Total	70	51.5	66	48.5	96	28.6
	P	.882		.761			
PMT	Male	16	8	17	8.5	25	12.6
	Female	14	10.2	13	9.5	23	16.8
	Total	30	50	30	50	48	14.3
	P	.491		.765			
IT hypertrophy	Male	15	7.5	17	8.5	32	16.1
	Female	7	5.1	9	6.6	16	11.7
	Total	22	45.8	26	54.2	48	14.3
	P	.377		.506			
IT hypoplasia	Male	5	2.5	4	2.9	9	4.5
	Female	2	1.5	4	2.0	6	4.4
	Total	7	46.7	8	53.3	15	4.5
	P	.507		.591			

Table 2. Comparison of the Prevalence of CB in Different Studies

Author	Country	N	CB (%)
Onwuchekwa and Alazi[1]	Nigeria	110	32.73
Shpilberg et al.[2]	New York	192	26
Gungor and Okur[8]	Turkey	132	75.9
El-Anwar et al.[10]	Egypt	86	8.1
Kantún et al.[11]	Mexico	110	20.9
Alrumaih et al.[16]	Saudi	121	55.4
Senniappan et al.[17]	India	138	57
Farhan et al.[18]	Pakistan	130	33.1
Dawood[19]	Iraq	300	61
Current study		*336*	*28.6*

CB, concha bullosa.

Table 3. Comparison of the Prevalence of PMT in Different Studies

Author	Country	N	PMT (%)
Onwuchekwa and Alazi[1]	Nigeria	110	1.8
Shpilberg et al.[2]	New York	192	15.6
Sumaily et al.[4]	Saudi	420	9.5
Shrestha et al.[9]	India	76	2.6
El-Anwar et al.[10]	Egypt	86	33.7
Oghenero et al.[15]	Nigeria	114	8.8
Farhan et al.[18]	Pakistan	130	12.3
Dawood[19]	Iraq	300	19
Alshaikh and Aldhurais[20]	Saudi	219	24.7
Karakurt et al.[21]	Turkey	118	19.4
Hadi et al.[22]	Iraq	75	15
Current study		*336*	*14.3*

PMT, paradoxical middle turbinate.

understanding of the existence of this variant is important to prevent radiological misdiagnosis since a large nasolacrimal duct may give an impression of a pneumatized inferior turbinate.[8]

The prevalence of IT hypertrophy in our study was 14.3% with no significant predilection for any gender ($P > .05$). Cury et al.[24] documented a higher prevalence of IT hypertrophy in Brazilian men (65.2%) than their female counterparts (34.8%). We observed only the unilateral occurrence of this variant; however, it did not show a statistically significant side difference ($P > .05$). We, therefore, suggest that IT hypertrophy is not influenced by gender or the side it occurs. Clinicians and otorhinolaryngologists need to be aware about the existence of this variant in our population, especially in cases of nasal obstruction. Prolonged obstruction due to IT hypertrophy causes mouth breathing that impacts negatively on the facial bones and the dental alveolar processes altering the craniofacial growth.[24]

Hypoplastic IT was observed in 4.5% of our study population, and this was lower than 14.6% previously documented among adult Nigerians of Rivers State; hence, it explicates the possible influence of geographical and environmental factors in the prevalence of this variant.[1] This variant occurred unilaterally but did not show any significant association with side or gender implying its fortuitous existence ($P > .05$).

The findings of this study will be expedient to radiologists, otolaryngologists, and neurosurgeons in the accurate evaluation of the patients with sinonasal disease prior to FESS and endoscopic skull base surgeries. FESS is gradually replacing the usual bilateral antral washouts, which were previously used to manage chronic sinusitis as well as destructive surgeries such as the Cadwell Luc's operation of the sinuses. Preoperative identification of the variants helps the surgeons to anticipate technical challenges and, therefore, obtain an informed consent from the patients.[18] Failure to identify these variants of the nasal turbinates may lead to surgical complications.

Limitations of Study

The sample size in the study was small, and the gender distribution was uneven.

CONCLUSION

The presence of the variants of the nasal turbinates in this study emphasizes on the need for preoperative imaging prior to FESS, which is becoming popular among otolaryngologists. This will ensure the successful restoration of sinus ventilation and drainage and minimize complications.

Ethics Committee Approval: Ethical committee approval was received from the Research and Ethics Committee of Delta State University Teaching Hospital (EREC/PAN/2020/030/0371).

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