

Original article:

**Anatomical variations of the middle Turbinate among adult Sudanese Population
-A Computed Tomographic Study**

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Abstract:

Objectives: This study aimed to determine the prevalence of the anatomical variations of the middle turbinate among adult Sudanese population which include Concha Bullosa (CB) and Paradoxical middle turbinate (PMT) and their relationship with age and sex. **Methods:** The study population involved 29 males (47.5%) and 32 females (52.5 %) with a mean age of 37 years. Exploration was done in the radio-diagnostic department of Ribat University Teaching Hospital, Khartoum- Sudan in the period from January to September 2018. Patients were scanned on slice collimation of 1mm thickness with a slice thickness of 4 mm. Computed Tomography (CT) scans were retrospectively reviewed for the presence of CB and PMT coronal planes, bony windows and reported the results in the datasheet. Statistical analysis was performed using SPSS and compared with previous results on similar studies. **Result:** In the current study, the prevalence of the CB was 22.9%, observed bilaterally in 6 cases (9.8%), unilaterally in 8 (13.1%). PMT was present only in 3 cases (4.9%) all of them were unilateral. **Conclusion:** Computed Tomography (CT) may easily identify such uncommon anatomic variations of the osteomeatal region, determination of these variations aids in providing a better surgical orientation and avoiding or minimizing the possible complications.

Keywords: Computed tomography scans, Concha bullosa; Paradoxical middle turbinate, Middle turbinate; Paranasal sinuses, Ethmoidal cells.

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Abbreviations: CT, PNS, MNM, CB, PMT, DNS.

CT- Computed Tomography, PNS- Paranasal Sinuses, MNM- Middle nasal meatus, DNS- Deviated nasal Septum, CB- Concha Bullosa, PMT- Paradoxical Middle Turbinate, pneumatised middle turbinate) and PMT

Introduction

From the lateral wall of the nasal cavity, there are three nasal conchae (turbinate bones old name called

by Otorhinolaryngologist) projecting downwards¹. The nasal turbinates are important anatomical structures within the nasal cavity². While the inferior one is a separate bone, the others are parts of the ethmoid bone. Their position and relationship to other important anatomic landmarks are extremely important especially in non-invasive endoscopic skull base and ENT (ear, nose, and throat) surgical procedures³.

Concha bullosa is the most common anatomic

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variation of the osteomeatal complex region that is seen in the middle turbinate (MT)

Concha bullosa (CB):

CB is hypertrophy and pneumatization of the nasal turbinate, occurring most often in the middle turbinate and rarely noticed in the inferior or superior turbinates^{4,5}. It can be uni- or bilateral and if it is unilateral then it is usually accompanied by a contralateral septal deviation⁶. Pneumatizations of all three turbinates, superior, middle and inferior (panconchabullosa) is extremely rare⁷⁻⁹. The supreme nasal concha of Santorini is a rare anatomic variant and the supreme concha bullosa was not previously reported¹⁰.

According to the location and shape of pneumatization; three variations of Concha bullosa are seen like lamellar form (pneumatization of the vertical lamella of the concha), bulbous form (pneumatization of the inferior segment) and the extensive form which is a massive pneumatization of both the lamellar and inferior parts¹¹.

The medial part of the ethmoid bone forms the middle concha. As it elongates in the nasal cavity, anterior-superior stabilization is provided by the cribriform plate of ethmoid whereas the lamina papyracea provides posterior and lateral stabilization. The bony structure which gives attachment to the lamina papyracea is called the basal lamella. Basal lamella divides the ethmoidal air cells into the anterior and posterior groups. Pneumatization of the middle concha is an extension of the normal pneumatization of the ethmoidal air cells¹¹⁻¹³.

Although there is an association of CB with sinusitis, there are also studies against this argument. It is not the existence of concha bullosa but its size was held responsible for the occurrence of sinusitis¹⁴. Later in following studies, sinusitis was not associated with CB, but CB is emphasized as a possible cause of sinusitis due to forming mucosal contact and obstruction in the osteomeatal complex region¹⁵.

The paradoxical middle turbinate (PMT):

PMT refers to an inferomedially curved middle turbinate edge with the concave surface facing the nasal septum which usually occurs bilaterally¹⁶. However, it is not associated with any change in the normal middle turbinate attachments. This anatomic variant alone can lead to significant narrowing of the

middle nasal meatus (MNM) and impedes the normal drainage of paranasal sinuses due to osteomeatal complex obstruction and thus resulted in sinusitis or other mucosal diseases of sinus, especially the large ones¹⁷.

Material and methods

Study design:

An observational, analytical cross-sectional study of adult Sudanese patients depending on their age and sex was conducted to determine the prevalence of clinically significant anatomical variations of the middle turbinate. The study was conducted in Khartoum, Sudan during the period from January to September 2018.

Study sample:

The study population involved 29 males (47.5%) and 32 females (52.5%) with a mean age of 37 years. Exploration carried out in the radio-diagnostic department of Ribat University Teaching Hospital, Khartoum- Sudan.

Inclusion criteria:

Patients who presented with signs and symptoms attributed to nasal sinuses after clinical examinations and subjected to radiological investigation.

Exclusion criteria:

Patients with congenital deformities, previous surgery, trauma or malignancy of the nose, paranasal sinuses were excluded from the study.

Data collection techniques:

Patients were scanned on slice collimation of 1mm thickness with a slice thickness of 4mm. The age and sex were recorded, CT scans were reviewed in coronal planes in bony windows and the results were reported in the datasheet.

Data analysis:

Statistical analysis was performed using SPSS version then it was presented and described by using the text, table charts, and figures.

Ethical clearance: Not needed, Retrospective case study

Result

Samples:

This study consisted a total of 61 patients of which 29 (47.5%) were males and 32 (52.5%) were females

(Table 1). The subjects were assigned to seven age groups (age ranges from 10-80yrs) with an average age of 37 yrs (Table 2). This study encountered anatomical variations of the middle turbinate among adult Sudanese population which include CB (pneumatized middle turbinate) and PMT (medially curved middle turbinate).

Table 1. Gender distribution among the study group

Percent	Frequency	Gender
47.5	29	Male
52.5	32	Female
100	61	Total

Table 2. Age distribution among the study group

Percent	Frequency	Age groups
21.3	13	10-20
24.6	15	21-30
11.5	7	31-40
24.6	15	41-50
11.5	7	51-60
3.3	2	61-70
3.3	2	71-80

Concha Bullosa:

Out of 61 cases studied, CB was seen in 13 (22.9%) cases (Table 3). The prevalence of unilateral CB (13.1%) was more frequent as compared to bilateral (9.8%), (Table 4). It was found in higher proportion in females (25.0%) as compared to males (20.7%), (Table 5). Regarding age most cases of bilateral CB (3 cases) were found in 41-50 yrs age group. Moreover, most cases of unilateral CB (4 cases) were found in 10-20 yrs age group, while there was no CB in (51-60) and (61-70) age groups (Table 6). Figures (1&2) showing different types of CB on coronal CT images.

Paradoxical Middle Turbinate:

Out of 61 cases studied, PMT was present only in 3 cases (4.9%) all of them were unilateral, Table (3&4). It was found in 2 females (6.3%) and 1 male (3.4%), (Table 5). Regarding age, PMT was found equally in 21-30 yrs, 31-40 yrs and 41-50 years age groups with 1 case (1.6%) for each, and was absent in the rest (Table 6). Figures (3&4) showing PMT on coronal CT images.

Table 3. Presence of Concha Bullosa & Paradoxical Middle Turbinate (PMT) among the study groups

Percent	Frequency	Anatomical variant of the Middle Turbinate
22.9	14	CB
4.9	3	PMT

Table 4. Presence of Concha Bullosa & Paradoxical Middle Turbinate (PMT) based on laterality

PMT n(%)	CB n(%)	Pattern
0	6 (9.8)	Bilaterally
3 (4.9)	8 (13.1)	Unilaterally

Table 5. Presence of Concha Bullosa & Paradoxical Middle Turbinate (PMT) based on gender

Female (n=31)		Male (n=29)		Pattern
PMT n(%)	CB n(%)	PMT n(%)	CB n(%)	
0	4 (12.5)	0	2 (6.9)	Bilaterally
2 (6.3)	4 (12.5)	1 (3.4)	4 (13.8)	Unilaterally
2 (6.3)	8 (25.0)	1 (3.4)	6 (20.7)	Total

Table 6. Presence of Concha Bullosa & Paradoxical Middle Turbinate (PMT) based on age

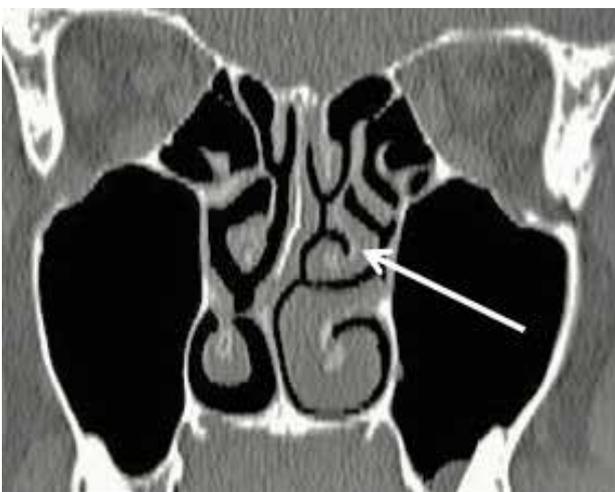
Age groups	Bilaterally n(%)		Unilaterally n(%)		Total n(%)	
	CB	PMT	CB	PMT	CB	PMT
10-20	0	0	(46.6)	0	(46.6)	0
21-30	(23.3)	0	(11.6)	(11.6)	(34.9)	(11.6)
31-40	0	0	(23.3)	(11.6)	(23.3)	(11.6)
41-50	(34.9)	0	(11.6)	(11.6)	(46.5)	(11.6)
51-60	0	0	0	0	0	0
61-70	0	0	0	0	0	0
71-80	(11.6)	0	0	0	(11.6)	0



Figure (1): Coronal CT showing right Extensive Concha Bullosa (star) with Deviation of Nasal Septal DNS (left).



Figure (2): Coronal CT showing bilateral concha bullosa, right lamellar form (arrow) and left extensive concha bullosa (star)



Figure(3): Coronal CT showing Paradoxical Middle Turbinate(PMT) on the left side (arrow)

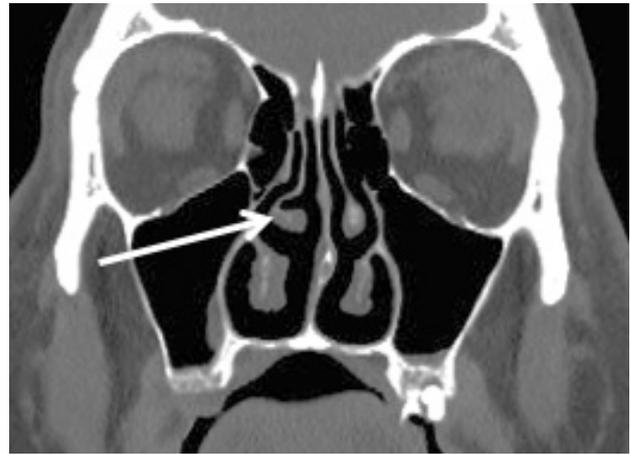


Figure (4): Coronal CT showing Paradoxical Middle Turbinate(PMT) on the right side (arrow)

Discussion

In the present study, the frequency of anatomical variations of the middle nasal turbinate which include CB (pneumatized middle turbinate), PMT (medially curved middle turbinate) was determined. Pneumatization of the middle concha is divided into three groups: lamellar type - the pneumatization of the vertical lamella of the concha; bulbous type -pneumatization of the bulbous segment (an inferior portion of the turbinate); extensive CB- pneumatization of both the lamellar and bulbous parts¹¹. The true concha bullosa is produced following pneumatization of both portions (vertical lamina and inferior bulb) of the middle nasal concha¹⁹. Lamellar pneumatization and conchal Pneumatization were included as a criterion in our study. Its prevalence rate was (22.9%), which matches closely to prevalence of (24%) reported²⁰. But less when compared to the result reported by another study in(35%) subjects²¹. High prevalence was reported (42.6%) and (53.6%)^{22,11}. Low prevalence of (9.5%) and (11%) were reported^{23,24}. The reported prevalence of CB varies widely from 4-80% in several studies¹⁹. Such a wide range of incidence is due to the criteria of pneumatization adopted.

Paradoxically curved middle concha in the present study was found only in 3 patients (4.9%). This finding matches closely to incidence of (5.3%) reported²⁵. Whereas it is lower than that of (13.97%),(15%) and (16.3%) reported by authors ^{26,20,27}. Greater prevalence rate of 26.1% and 25.3% were observed in other studies^{11,28,29}.

Conclusions

Computed tomography (CT) is the investigation of choice for evaluating the anatomical variations of the nasal cavity and paranasal sinuses. Determination of these variations aids in providing a better surgical orientation and avoiding or minimizing the possible complications during any operative procedures. In the present study concha bullosa is the most common occurrence in the nasal cavity, but the paradoxical middle turbinate is rarely encountered anatomical variant.

Recommendations:

- 1) The CT scan should not be used exclusively to diagnose chronic sinusitis or to determine the need for surgery. Rather, it should be used to provide clinical data to the endoscopic examination and assist in directing surgical treatment to the affected areas.
- 2) It is important for the radiologist to know the anatomical variations of the paranasal sinus region to consider their possible pathological consequences.
- 3) Further studies of anatomical variations with a larger number of patients and clinical disease correlations are needed for more reliable and accurate results.

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Conflicts of Interest

The authors declare that they have no conflicts of interest

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Authors' contribution:

Idea owner of this study: .. Dr. Gisma Ahmed Madani, Kamal Badawi,

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References:

1. Chummy S. Head and neck and spine. In: McMinn R, editor. Last's Anatomy Regional & Applied. 9th ed. London, Elsevier 1998; 475-476.
2. Ozcan KM, Selcuk A, et al. Anatomical variations of nasal turbinates. *J Craniofac Surg*, 2008; **19**(6): 1678-1682. <https://doi.org/10.1097/SCS.0b013e318188a29d>
3. Märu N, Rusu MC., et al. Variant anatomy of nasal turbinates: supreme, superior and middle conchae bullosae, paradoxical superior and inferior turbinates, and middle accessory turbinate. *Rom J Morphol Embryol*. 2015; **56**(3): 1223-6. PMID: 26662164
4. Lloyd GA. CT of the paranasal sinuses: study of a control series in relation to endoscopic sinus surgery. *J Laryngol Otol* 1990; **104**(6): 477. <https://doi.org/10.1017/S0022215100112927>
5. Pochon N, Lacroix JS. Incidence and surgery of concha bullosa in chronic rhinosinusitis. *Rhinology*. 1994; **32**(1): 11.
6. Ceylan S, Bora F, Batmaz T et al. Complex Concha Bullosa. *Otolaryngology*. 2012; **2**(1): 109. <https://doi.org/10.4172/2161-119X.1000109>
7. San T, San S, Gürkan E, et al. Bilateral triple concha bullosa: a very rare anatomical variation of intranasal turbinates. *Case Rep Otolaryngol*. 2014; **1**:851508. <https://doi.org/10.1155/2014/851508>
8. Fidan V. Panconchabullosa: new definition in the literature. *J Craniofac Surg*. 2012; **23**(3): 253-254. <https://doi.org/10.1097/SCS.0b013e31825186b6>
9. Ozturan O, Yenigun A, et al. Conchae bullosis': a rare case with bilateral triple turbinate pneumatizations. *J Laryngol Otol*. 2013; **127** (1): 73-75. <https://doi.org/10.1017/S0022215112002514>
10. Nicoleta M, Mugurel C, et al. Variant anatomy of nasal turbinates: supreme, superior and middle conchae bullosae, paradoxical superior and inferior turbinates, and middle accessory turbinate. *Rom J Morphol Embryol*. 2015; **56**(3): 1223-1226.
11. Bolger WE, Butzin CA, et al. Paranasal sinus bony anatomic variations and mucosal abnormalities: CT analysis for endoscopic sinus surgery. *Laryngoscope*. 1991; **101**: 56-64. <https://doi.org/10.1288/00005537-199101000-00010>
12. Zinreich S, Albayram S, et al. "The ostiomeatal complex and functional endoscopic surgery". In: Som P, editor. Head and Neck Imaging. 4th ed. St Louis: Mosby 2003; 149-173.
13. Stammemberger H. "Functional Endoscopic Sinus Surgery". Philadelphia: B. C. Decker 1991; 161-169
14. Yousem DM, Kennedy DM et al. Osteomeatal complex risk factors for sinusitis: CT evaluation. *J Otolaryngol*. 1991; **20**: 419-424.
15. Scribano E, Ascenti G, et al. The role of osteomeatal unit anatomic variations in inflammatory disease of the maxillary sinuses. *Eur J Radiol*. 1997; **24**: 172-174. [https://doi.org/10.1016/S0720-048X\(96\)01073-X](https://doi.org/10.1016/S0720-048X(96)01073-X)
16. Neskey D, Eloy JA, et al. Nasal, septal, and turbinate anatomy and embryology. *Otolaryngol Clin North Am*. 2009; **42** (2): 193-205. <https://doi.org/10.1016/j.otc.2009.01.008>
17. J Earwaker. Anatomic variants in sinonasal CT. *Radiographics* 1993; **13**(2):381-415. <https://doi.org/10.1148/radiographics.13.2.8460226>
18. Zinreich S, Albayram S, 197 et al. The ostiomeatal complex and functional endoscopic surgery. in: Som P, editor. Head and Neck Imaging. 4th ed. St. Louis: Mosby. 2003; 149-73.
19. I. Pérez-Piñas, J. Sabaté, A. Carmona, et al., "Anatomical Variations in the Human Paranasal Sinus Region Studied by CT. *Journal of Anatomy*. 2000; **2**:221-227. <https://doi.org/10.1046/j.1469-7580.2000.19720221.x>
20. Lloyd GAS, Lund VJ, Scadding GK. Computerised tomography in the preoperative evaluation of functional endoscopic sinus surgery. *Journal of Laryngology and Otolology*. 1991; **105**: 181-185.
21. A. R. Talaiepour, A. A. Sazgar and A. Bagheri, Anatomic Variations of the Paranasal Sinuses on CT Scan Images. *Journal of Dentistry, Tehran University of Medical Sciences*. 2005; **2**: (4): 142-146.
22. Maru YK, Gupta V. "Anatomic variations of the bone in sinonasal CT. *Indian Journal of Otolaryngol and Head Neck Surgery*. 2001; **53**: 123-128.
23. Badia L, Lund VJ, Wei W, Ho WK. Ethnic variation in sinonasal anatomy on CT-scanning. *Rhinology* 2005; **43**: 210-214.
24. Dua K, Chopra H, Khurana AS, Munjal M. CT scan variations in chronic sinusitis. *Indian Journal of Radiology and Imaging* 2005; **15**: 315-320. <https://doi.org/10.4103/0971-3026.29144>
25. S Lerdlum and B Vachiranubhap. "Prevalence of Anatomic Variation Demonstrated on Screening Sinus Computed Tomography and Clinical Correlation. *Journal of the Medical Association of Thailand*. 2005; **88** (4): 110-115.
26. Liu X, Zhang G and Xu G. Anatomical variations of the Osteomeatal complex and their correlation with chronic sinusitis CT evaluation. *Zhonghua Er Bi Yan Hou Ke Za Zhi* 1999; **34**(3):143-146.
27. F. Kasapoglu, S. Onart and O. Basut, Preoperative Evaluation of Chronic Rhinosinusitis Patients by Conventional Radiographics, Computed Tomography and Nasal Endoscopy. *Kulak Burun Boğaz İhtisas Dergisi*. 2009; **19** (4): 184-191.
28. A. Tonai and S. Baba, Anatomic Variations of the Bone in Sinonasal CT, *Acta Otolaryngologica*. 1996; Supplement, **525**:9-13.
29. Tewari, S., Gupta, C., Palimar, V., & Kathur, S. Morphometric analysis of infraorbital foramen in South Indian dry skulls. *Bangladesh Journal of Medical Science*. 2018; **17**(4), 562-566. <https://doi.org/10.3329/bjms.v17i4.38316>