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Prevalence of sinonasal anatomical variations and their effect on chronic rhinosinusitis in Al-Ramadi Teaching Hospital, Ramadi City, Iraq

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Abstract

Anatomical variations (AVs) of the nose and paranasal sinuses (NPS) are quite common findings on CT scans. However, their effect on chronic rhino-sinusitis (CRS) is still controversial. The objectives of this study is to estimate the prevalence of AVs of the NPS on CT scans and to assess the association between multiple versus single variant and CRS. A cross-sectional study was conducted in the Al-Ramadi Teaching Hospital during the period from January 1, 2018, to March 31, 2019. We reviewed the CT scans of the patients with suggestive symptoms and signs of CRS. Out of 203 CT scans, there were 153 (75.4%) scans associated with AVs of the NPS (group A). Seventy-eight with and 75 without radiological features of sinusitis. While group B (n=50 24.6%) were not detected any variants, 24 with and 26 without features of sinusitis. There was no statistically significant difference between the two groups (p-value>0.05). There were 11 AVs detected. The septal deviation of 63% was the commonest one. Most of the AVs of the NPS were multiple (2 or more) 99 (64.7%). Forty-nine (49.5%) of them were associated with features of sinusitis. There was a statistically significant difference (p-value <0.05) between those with multiple and those with single AVS concerning the radiological features of sinusitis. In conclusion; AVs of the sinonasal region were common findings on CT scans. A deviated nasal septum is the commonest AVs. Most of our patients contain more than 2 AVs, and they were more vulnerable to sinusitis.

Keywords: Anatomical variations, CT scan of nose and paranasal sinuses, FESS, Nose, Paranasal sinuses

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Introduction

During embryological life, the body has a flexible manner in the development of various parts regarding the size and shape of their constituents. Owing to this manner, anatomic variations (AVs) will have occurred [1]. These variations may be due to faults in the timing of embryological development or the persistence of normally obliterated parts. Anyhow, many or most of them run in a benign behavior, but some result in diseases [1].

AVs of the sinonasal region are considered a cause of osteomeatal complex (OMC) obstruction that is seen easily on the computerized tomography (CT) scan [2]. In this complex region, there are a lot of AVs like deviated nasal septum, Concha bullosa, paradoxical middle turbinate, Haller cell, Onodi cell, and pneumatization of the middle turbinate, superior turbinate, Crista gale, nasal septum, and uncinate process. It is of the utmost importance to diagnose these variations preoperatively to avoid sinister orbital or intracranial complications during functional endoscopic sinus surgery (FESS). The gold standard diagnostic tool of these variations is a CT scan of the nose and paranasal sinuses (NPS) [2].

There are many scientific articles tackle this important issue [2-16]. These investigations showed that the prevalence of AVs in the sinonasal region is high. Besides, there is an ethnic difference [11]. Some AVs are common, and others are rarely seen. However, there is no consensus among otolaryngologists that all AVs of the sinonasal region predispose to chronic rhinosinusitis (CRS). A prior study reported that there is no association between these AVs [17]. Moreover, individuals with three or more AVs are associated with limited sinus disease [18]. A recent study by Azgaonkar et al. [19] from India reported that maxillary and ethmoids sinuses were affected by 65% and 50% respectively, with obstructed OMC in 32% and prominent bulla in 48%. Frontal and sphenoid sinuses were least diseased in 10% and 2% respectively. Maxillary sinusitis caused by enlarged agger in 87%, while anterior ethmoiditis is due to enlarged agger (100%), bulla (89%), and frontal cells (51%).

To our kind knowledge, there is no investigation studied the effect of multiple versus single AVs on the CRS. Hence, we aimed to determine the prevalence of the AVs of the NPS at Al-Ramadi Teaching Hospital, Ramadi City, Iraq. The other aim was to evaluate the association of multiple versus single variants with CRS.

Material and methods

This cross-sectional study was conducted at Al-Ramadi Teaching Hospital, Ramadi city, Iraq**.** The study covered a period from January 1, 2018, to March 31, 2019. Patients from any age group whom were attending the Otorhinolaryngology outpatient clinic with symptoms and signs suggesting CRS and sending them to the radiological department for a CT scan of the NPS were enrolled in the study. Patients with previous mid-facial trauma, extensive nasal and sinonasal disease, and those with previous surgery were excluded from this study. The study was approved by the University of Anbar, Ethical Approval Committee [reference number: 132, Date: 22-12-2019].

The studies were performed on Philips Brilliance CT 64-slice and Toshiba Aquilion 64 scanners with a FOV of 14–16 cm and a slice thickness of 0.625 mm. The axial plane was the inferior orbital meatal plane (anthropologic plane). Coronal and sagittal reconstructions were post-processed.

The age and gender of all participants were recorded. The CT scans of the patients were examined independently by an otolaryngologist and radiologist authors. They look for AVs like deviated nasal septum (>3mm at the level of OMC), Concha bullosa was defined as being present when more than 50% of the vertical height (measured from superior to inferior in the coronal plane) of the middle turbinate was pneumatized, Onodi cells (most posterior ethmoid cell), Haler cells (ethmoid air cells located lateral to the maxillo-ethmoidal suture along the inferomedial orbital floor), Paradoxically bent middle turbinate (inferomedially curved middle turbinate edge with the concave surface facing the nasal septum) and any changes suggestive of CRS in the sinonasal region.

When there is a discrepancy between the results, a formal discussion between them was happening to reach the final accuracy of the data. The patients were divided into two groups: group A with and group B without AVs. Each group subdivided into two groups with or without radiological features of sinusitis. A descriptive analysis of the data with a comparative study between the two groups and those with single or multiple AVs concerning their effects on the sinusitis was done using Microsoft office excel 2007 and Minitab 17. The prevalence of anatomic variants of the NPS calculated for each group. The results for the two groups compared using the Fisher exact test. For all comparisons conducted in this study, a p-value < 0.05 was considered a statistically significant difference.

Result

A 229 patient with clinical features suggestive of CRS were referred by Otolaryngologists to the Department of Radiology/CT unit. CT scans of the NPS were done for all patients. Twenty-six excluded owing to they didn't fill the inclusion criteria (17 with an extensive nasal and paranasal disease, 6 with previous surgery, and 3 with previous mid-facial trauma). The remaining 203 were studied, 119 (58.6%) females and 84 (41.4%) males (M: F ratio 1:1.4). The patients' ages ranged from 14 to 78 years (30.52 ± 11.37 years). Of these 203 patients in **Table 1**, 153 (75.3%) had AVs in their NPS (78 with and 75 without radiological features of sinusitis). Fifty patients (24.6%) didn't show any AVs (24 with radiological signs of sinusitis and 26 was normal). There is no statistically significant difference between the two groups (*p*-value=0. 6092 and Fisher exact probability = 0.7466) **Table 1**.

Table 1.

CT scan of 203 patients with or with AVS and with or without sinusitis.

Group	Features	N	Frequency %	Incidence rate	P-value
A	AVs with sinusitis	78	38	75.4	0.6092
	AVs without sinusitis	75	37		
B	No AVs with sinusitis	24	12	24.6	
	No AVs without sinusitis	26	13		
Total		203	100		

Fisher exact probability = 0.7466

Table 2, showed 267 AVs from a 153 CT scan of the NPS. The most common one from the 11 AVs was nasal septal deviation 63% and the least were pneumatized Crista Galli and pneumatized inferior turbinate 2% for each.

Table 2.

The 267 AVs of the NPS detected in 153 CT Scans.

Anatomic Variant	N	Frequency %
Nasal septal deviation	97	63%
Agger nasi cell	41	27%
Paradoxically bent middle turbinate	37	24%
Concha bullosa	35	23%
Nasal septal spur	23	15%
Infraorbital-ethmoidal (Haller) cell	9	6%
Pneumatized superior turbinate	8	5%
Sphenoethmoidal (Onodi) cells	6	4%
Partially pneumatized middle turbinates	5	3%
Pneumatized crista Galli	3	2%
Pneumatized inferior turbinate	3	2%

Table 3.

Frequency of the single and multiple AVs of the NPS in a 153 CT scan.

Variable		N	Frequency %
Single AVs		54	35.3
Multiple AVs	2	88	57.5
	3	7	4.6
	4	4	2.6
	Total	99	64.7%
Total		153	100

Most of the CT scans of the NPS with multiple AVs, 99 (64.7%) [88 with two, 7 with 3, and 4 with 4] and 54 had one variant Table 3. Nineteen (35.2%) patients with single AVs had sinusitis, while 49 (49.5%) with multiple AVs associated with radiological signs of sinusitis. There was a statistically significant difference between them (p-value=0. 0266) Table 4.

Table 4.

The 153 CT scans of the NPS with single and multiple AVs and with and without sinusitis.

Variable		Sinusitis		Without sinusitis		P-value
		N	%	N	%	
Single variant		19	35.2	35	64.8	0.0266
Multiple variants		49	49.5	50	50.5	

Fisher exact probability= 0.125

Figure 1, Shows one of our patients without AVs and clear sinuses (Panel A), while (Panel B) another patient without AVs and right maxillary sinusitis. And figure 2 shows one of our patients with a large left Concha bullosa and clear sinuses (Panel A). While (Panel B) with septal deviation to the left and there is a mucosal thickening of both maxillary and ethmoid sinuses.

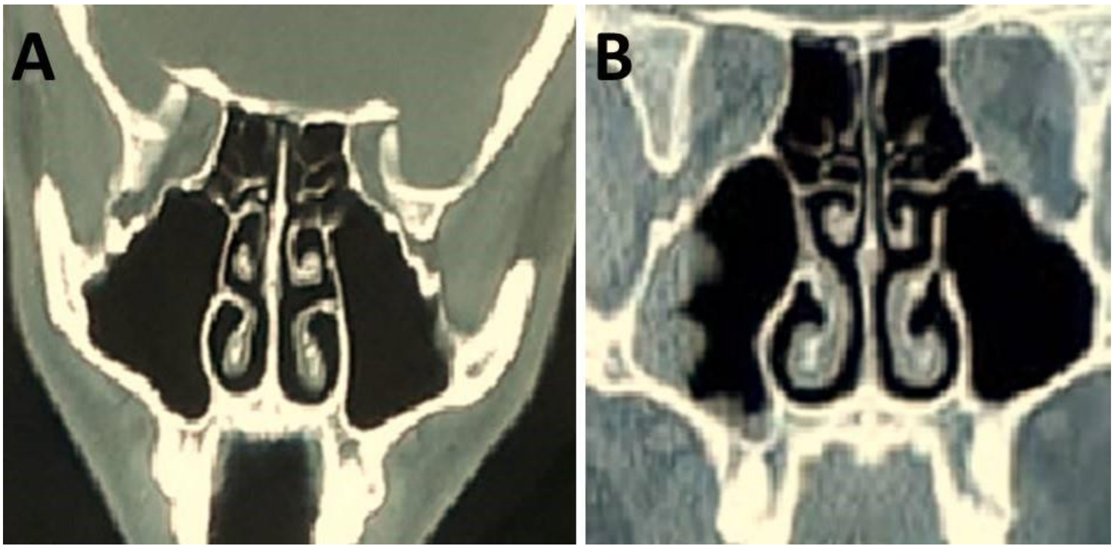

Figure 1.

Coronal CT scan of the NPS (A) with no AVs and no sinusitis, (B) without AVs and with sinusitis.

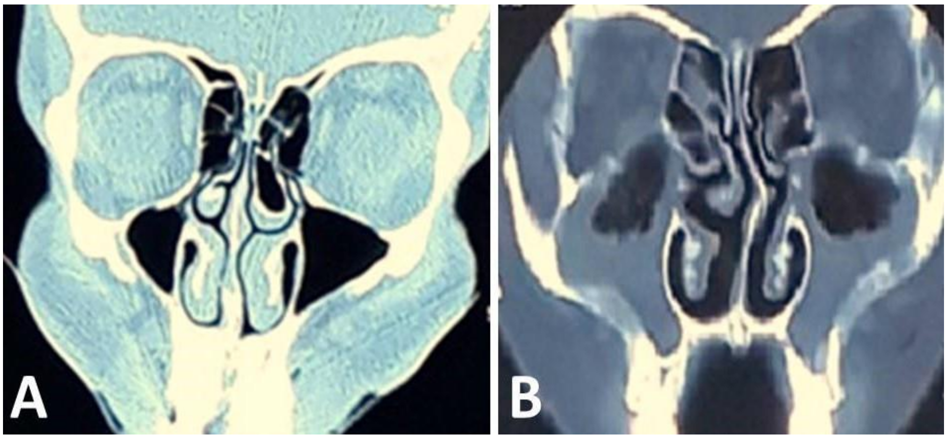

Figure 2.

Coronal CT scan of the NPS (A) large left Concha bullosa and the appeared sinuses look clear, (B) Septal deviation to the left and there is mucosal thickening of both maxillary and ethmoid sinuses.

Discussion

AVs of the NPS are a quite common in daily clinical practice [2, 3]. The reported rate varied from 51.9-92.9% in previous kinds of literature [3, 4, 10, 13]. Our prevalence rate of AVs was in between this range. The variation between these studies may attributed to the difference in the definition of certain variations like septal deviation and the type of population studied.

The strength of this study was the classification of the CT scans into two groups, group A with and group B without AVs. Comparison between the 2 groups was done regarding the presence or absence of radiological findings of the sinusitis. The study found that there was no statistical difference between the two groups (*p*-value=0.6092). This confirms that the AVs of the NPS may not the sole cause of sinusitis. However, it may have aggravated sinus infections if associated with other reasons like allergic rhinitis, previous attacks of acute rhinitis and sinusitis, etc. However, AVs of the NPN may be a possible cause of sinusitis per se if the variations are multiple or extensive such as large concha bullosa, which obstructs the OMC [20]. Our study revealed that sinusitis occurred when there were two or more AVs in comparison with a single variant (*p*-value<0.05).

Septal deviation is a common variant, but its presence per se doesn't suggest causing a problem to the patient [4]. Calhoun defined nasal septal deviation as any deviated septum reaching the lateral nasal wall structures and found them to be a significant cause in individuals with sinus symptoms (*p*-value = 0.01) [21]. Elahi et al. and Yousem et al. [22, 23] used the angle between the septum and midline as a reference to the severity of the deviation. And they found that the severity of mucosal sinus disease is directly proportional to the degree of the septal angle. However, the assessment of septal deviation using septal angles can be problematic.

It is seldom to see septal deviation with a true angle, and a septal deviation may be started with an angle, then it curves back to the midline, therefore, it has a negligible effect on the surrounding structures. Moreover, the small nasal cavity can be affected more with a small septal deviation than a large nasal cavity with a large deviation. While the study by Caughey et al. [2] used the width of each nasal cavity at the level of the OMC. However, this way was suggested by Yousem et al. as an appropriate method for assessment of the deviated nasal septum [23].

In the present study, the septum is considered deviated when there is a 3 mm or more deviation from the midline at the level of OMC. Therefore, the rate of septal deviation and its impact on sinus disease vary from one study to another.

The importance of the Onodi air cells (sphenoethmoidal cells) is their close relation to the optic nerve and internal carotid artery. Preoperative recognition on CT of the NPS is of utmost importance in preventing damage to these vital structures and entry to the middle cranial fossa during functional endoscopic sinus surgery (FESS) [15] A wide range in the prevalence of Onodi cells was reported (10%–98%) in previous studies [15]. Our study reported only 4% among the studied patients.

AVs of the NPS among different populations were studied by Badia et al. [11]. In their study, they examined 100 CT scans of Chinese subjects and compared them with 100 Caucasians. The study showed that there was a statistically significant difference between the 2 ethnic populations.

The convexity of the middle turbinate if turned laterally, called paradoxical middle turbinate. It may lead to impaired ventilation of the paranasal sinuses as it causes middle meatus narrowing. CRS might be the result of such pathology. Our result of the paradoxically bent middle turbinate (24%) was higher than the other studies [2, 3, 10, 16].

Concha bullosa is defined as enlargement of the nasal middle turbinate due to entrapment of air inside it. There are 3 types: lamellar, bulbous, and extensive. It is one of the commonest variations involving the sinonasal area. The prevalence of Concha bullosa was varied among various studies in a range from 9.5-55.4% [2, 3, 11, 13-17], [19, 20]. The variability was attributed to the difference in the definition by previous researchers and ethnic differences in different populations. Our prevalence was much lower than Alrumaih et al. [3] and higher than Badia et al. [11]. Due to its location, Concha bullosa might results in nasal obstruction, impaired sense of smell, and obstruct the anterior paranasal sinuses leading to sinusitis.

Agger nasi cells are the most anterior ethmoidal air cells. They are located in the lateral nasal wall and bordered the frontal recess. Excessive enlargement of them leads to the narrowing of the frontal recess with the consequence of frontal sinusitis. The range of the prevalence of the agger nasi among prior studies was so wide. The prevalence of the agger nasi by Alrumaih et al. study [3] was 96.5%, while, our prevalence (27%) was similar to Caughey et al., [2].

Haller cells (infra-orbital ethmoidal air cells) are one type of ethmoid air cells found on the medial side of the orbital floor near to and above the ostium of the maxillary sinus. However, if they are enlarged might lead to impaired drainage of the sinuses due to obstruction to the infundibulum and maxillary ostium and might resulting in recurrent or CRS. Moreover, Haller cells may cause persistent headaches without any evidence of mucosal disease on conventional and endoscopic nasal examinations. Therefore, if Haller cells are found on a coronal CT scan, can explain the patient's symptoms [24]. The present study showed that the prevalence of Haller cells was 6%. This finding was slightly more than Badia et al., [11]. but it was much less than Alrumaih et al., [3].

AVs of the NPS are a complex subject. They may be unilateral or bilateral. Also, the presence of one variant on one side might accompany another variant on another side. Therefore, it is necessary to study the CT scan on each side separately, with a concentration on the associated pathology to give the best option of treatment to the patient whether medical or surgical [3]. Moreover, the presence of such variants doesn't mean that they cause CRS as it has appeared in the current study **Figure 2 A**.

The limitation of the study was not comparing the effect of each AVs especially the common variants like septal deviation, agger nasi cells, and concha bullosa in the causation of CRS.

Conclusion

AVs of the NPS was a common finding, but it was not necessitated to cause CRS. The septal deviation was the commonest variation in this study. Multiple variants were more common than a single one. Two or more AVs were a predisposing factor for CRS.

Conflict of Interest

The authors declare that there is no conflict of interest.

References

1. Sikka A, Jain A. Bilateral variation in the origin and course of the vertebral artery. Anat. Res. Int., 2012; 2012.
2. Caughey RJ, Jameson MJ Gross CW, Han JK. Anatomic risk factors for sinus disease: fact or fiction? Am. J. Rhinol. 2005;19:334–339.
3. Alrumaih RA, Ashoor MM, Obidan AA, Al-Khater KM, Al-Jubran SA. Radiological sinonasal anatomy: exploring the Saudi population. Saudi Med. J. 2016;37:521.
4. Mendiratta V, Baisakhiya N, Singh D, et al. Sinonasal anatomical variants: CT and endoscopy study and its correlation with extent of disease," Indian J. Otolaryngol. Head Neck Surg. 2016;68:352–358.
5. Karki S, Pokharel M, Suwal S, Poudel R. Prevalence of Anatomical Variations of the Sinonasal Region and their Relationship with Chronic Rhinosinusitis. Kathmandu Univ Med J. 2016;56:342–346.
6. Kaygusuz A, Haksever M, Akduman D, Aslan S, Sayar Z. Sinonasal anatomical variations: their relationship with chronic rhinosinusitis and effect on the severity of disease-a computerized tomography assisted anatomical and clinical study. Indian J. Otolaryngol. Head Neck Surg. 2014;66:260-266.
7. Shpilberg KA, Daniel SC, Doshi AH, et al. CT of anatomic variants of the paranasal sinuses and nasal cavity: poor correlation with radiologically significant rhinosinusitis but importance in surgical planning. Am. J. Roentgenol. 2015;204:1255-1260.
8. Sonone J, Solanke PS, Nagpure D, et al. Effect of Anatomical Variations of Osteomeatal Complex on Chronic Rhinosinusitis: A Propective Study," Indian J. Otolaryngol. Head Neck Surg. 2019;71:2199-2202.
9. Hadi HH, Al-Bayati HA, Al-Gazali SSN. Prevalence of normal anatomical variations in the region of paranasal sinuses in patients with chronic rhinosinusitis. Med. J. Babylon 2018;: 243–250.
10. Aramani A, Karadi RN, Kumar S. A study of anatomical variations of osteomeatal complex in chronic rhinosinusitis patients-CT findings. J. Clin. diagnostic Res. JCDR 2014;8:KC01.
11. Badia L, Lund VJ, Wei W, et al. Ethnic variation in sinonasal anatomy on CT-scanning. Rhinology 2005;43:210.
12. Jun H, Kim, et al. The relationship between anatomic variations of paranasal sinuses and chronic sinusitis in children. Acta Otolaryngol. 2006;126:1067-1072.
13. Mazza D, et al. Paranasal sinuses anatomic variants: 64-slice CT evaluation.," Minerva Stomatol. 2007;56:311–318.
14. Mamatha H, Shamasundar NM, Bharathi MB, Prasanna LC. Variations of ostiomeatal complex and its applied anatomy: a CT scan study. Indian J Sci Technol. 2010;3:904–907.
15. Kaya M, Çankal F, Gumusok M, et al. Role of anatomic variations of paranasal sinuses on the prevalence of sinusitis: Computed tomography findings of 350 patients. Niger. J. Clin. Pract. 2017;20:1481-1488.
16. Adeel M, Rajput MSA, Akhter S, et al. Anatomical variations of nose and para-nasal sinuses; CT scan review. J. Pak. Med. Assoc. 2013;63:317.
17. Devaraja K, Doreswamy SM, et al. Anatomical Variations of the Nose and Paranasal Sinuses: A Computed Tomographic Study. Indian J. Otolaryngol. Head Neck Surg.2019;71:2231–2240.
18. Wu J, Jain R, Douglas R. Effect of paranasal anatomical variants on outcomes in patients with limited and diffuse chronic rhinosinusitis. Auris Nasus Larynx 2017; 44: 417-421.

19. Azgaonkar SP, Dutta M, Kudalkar UN, et al. The Anatomic Variations of the Nose and Paranasal Sinuses and Their Effect on Chronic Rhinosinusitis in Adult Patients. Indian J. Otolaryngol. Head Neck Surg. 2020:1–7.
20. Albayrak E, Güleryüz G. Konka Büllozanın Septal Deviasyon ve Sinüs Patolojileri ile İlişkisi. Çağdaş Tıp Derg.2014;3:182–186.
21. Calhoun KH, Waggenspack GA, Simpson CB, et al. CT evaluation of the paranasal sinuses in symptomatic and asymptomatic populations. Otolaryngol. Neck Surg. 1991;104:480-483.
22. Elahi MM, Frenkiel S, Fageeh N. Paraseptal structural changes and chronic sinus disease in relation to the deviated septum. J. Otolaryngol. 1997;26:236–240.
23. Yousem DM, Kennedy DW, Rosenberg S. Ostiomeatal complex risk factors for sinusitis: CT evaluation. J. Otolaryngol. 1991;20:419.
24. Wanamaker HH. Role of Haller’s cell in headache and sinus disease: a case report. Otolaryngol. Neck Surg. 1996;114:324–327.