Original Research Article

Anatomical Variations of Paranasal Sinuses - A MDCT Based Study

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Abstract

Background: Pneumatisation of various bones around the nasal cavity results in the formation of paranasal sinuses. Varying degrees of pneumatisation result in multiple variations of paranasal sinuses some of which are important from clinical, pathological and surgical perspective.

Objective: Determining the prevalence of various sinonasal anatomical variations on multi-detector computed tomography.

Materials and methods: 852 patients with various symptoms of active rhinosinusitis were subjected to non-contrast enhanced CT examinations of the paranasal sinuses and nasal cavity. Multi-planar reconstructions were done in axial, coronal and sagittal plane and the reconstructed CT images were evaluated for the presence of anatomic variants of the sinonasal cavities and the prevalence of each variant was calculated.

Results: Deviated nasal septum (DNS) was the most common anatomic variant of the paranasal sinuses and nasal cavity seen in 724 patients (85%), if minimal septal deviation (<1 mm) was also taken into account. The second most common variant was prominent ethmoid bulla which was present in 392 of 852 patients (46%). Dehiscent lamina papyracea (0.9%) and pneumatised crista galli (11.7%) were the least commonly seen sinonasal anatomic variants.

Conclusion: Sinonasal anatomic variants are a rule rather than an exception, being present in a majority of population. These variations should be diagnosed and documented on CT examinations of paranasal sinuses to avoid any unforeseen complication during functional endoscopic sinus surgery and other skull base surgeries.

Key words

Anatomical variations, Paranasal sinuses, MDCT based study.

Introduction

Pneumatisation of various bones around the nasal cavity results in the formation of paranasal sinuses. Varying degrees of pneumatisation result in multiple variations of paranasal sinuses some of which are important from clinical, pathological and surgical perspective. Cross-sectional Imaging plays a pivotal role in their identification, especially after the advent of Multi-detector computed tomography (MDCT), which allows their accurate evaluation in various orthogonal and oblique planes due to various post-processing techniques like multiplanar reformation [1, 2]. The present study evaluates the role of MDCT in the identification of anatomical variations of paranasal sinuses and nasal cavity.

Materials and methods

The present study was retrospective in design with institutional review board approval. A total number of 852 consecutive unenhanced sinus CT examinations of patients were evaluated, who were referred because of various symptoms of active rhinosinusitis. Patients with a history of previous sinonasal surgery or sinonasal malignancy were omitted from the study. The main complaints were facial pain, headache, nasal obstruction, hyposmia, or purulent nasal discharge. The studies were performed on MDCT using 64 slice CT (Siemens Somatom Sensation) scanner with an FOV of 14–16 cm and a slice thickness of 0.625 mm. Topogram was used to determine the area to be scanned, cranially from the superior border of frontal sinus and caudally up to inferior border of maxillary sinus with the axial plane being inferior orbital meatal plane. Multiplanar reconstructions were done in axial, coronal and sagittal plane. The CT images were evaluated for the presence of anatomic variants of the sinonasal cavities and the prevalence of each variant was calculated.

Results

Out of total 852 patients evaluated on MDCT, 508 (59.6%) were males and 344 were females (40.4%) with a mean age of 40.3 years (age range, 14 to 78 years). Deviated nasal septum (DNS) was the most common anatomic variant of the paranasal sinuses and nasal cavity seen in 724 patients (85%). The second most common variant was prominent ethmoid bulla which was present in 392 of 852 patients (46%). The prevalence of various sinonasal anatomic variants in our study is as per **Table – 1**.

Discussion

Deviated nasal septum (**Figure - 1a**) was the most prevalent anatomic variant in our study, present in 85% of the subjects, if minimal septal deviation (<1mm) is also taken into account. Barring minimal septal deviation, the prevalence falls within the previously reported range in literature, of 19.4–79% [3–7]. Approximately, one third of the cases with nasal septal deviation had associated septal spur (28.2%). Prominent ethmoidal bullae accounted for the second most common sinonasal anatomical variation in our study with a prevalence of 46%, greater than the prevalence of 4–32.8% reported in literature. [5, 8]. This may be accounted by the subjective criteria used by us in evaluating the ethmoidal bullae, with no reference to size. The third most frequent variation was pneumatisation of sphenoid sinus extending posteriorly to the floor of the sella, with a prevalence of 42.3%. Variations with the reported prevalence in literature (13.4-77%) were likely due to different criterion used in defining post-sellar extension, with extension upto dorsum sellae (**Figure - 1b**) seen in 13.4% [9]. Sphenoid sinus extension into the postero-nasal septum (**Figure - 1c**) was the fourth most common variant resulting in its pneumatisation (39.9%). Another common sinonasal variant was Agger nasi cells (**Figure - 1d**), present in 36.6% of our patients, lying within the broad spectrum of 3-100%, as

reported by previous studies [3-5, 8, 10-12]. Concha lamella (**Figure - 2a**) defined as pneumatisation limited to vertical lamellar portion of middle turbinate was seen in 36.2% (9.6–46.2% previously reported) of subjects [5, 8, 13]. Concha bullosa (**Figure - 2a, b**) was defined as pneumatisation of the distal bulbous portion of middle turbinate and was found in 34.3% (14–67.5% previously reported) [3-7, 13-16] of patients in our study. Pterygoid process pneumatisation (**Figure - 2c**) was seen in 31.9% of patients, falling within the previously reported range of 29–43.6% in literature [17]. Anterior clinoid process (**Figure - 2d**) was pneumatized in 30% of our patients, which is in resonance with the prevalence of 4–29.3% reported in the literature [14, 17, 18].

Table - 1: Prevalence (%) of various sinonasal anatomic variants (n=852).

S. No.	Anatomical Variant	Prevalence (%)
1.	Deviated Nasal Septum	85.0(724)
2.	Prominent Ethmoidal Bulla	46.0(392)
3.	Pneumatisation posterior to floor of sella turcica	42.3(360)
4.	Extension of sphenoid sinus into posterior nasal septum	39.9(340)
5.	Agger nasi cell	36.6(312)
6.	Concha Lamella	36.2(308)
7.	Concha Bullosa	34.3(292)
8.	Pneumatised pterygoid process	31.9(272)
9.	Pneumatised anterior clinoid process	30.0(255)
10.	Nasal septal spur	28.2(240)
11.	Haller cell	27.2(232)
12.	Superior turbinate pneumatisation	20.2(172)
13.	Onodi cell	19.2(164)
14.	Pneumatised hard palate	16.0(136)
15.	Paradoxically bent middle turbinate	15.8(135)
16.	Uncinate cells	15.5(132)
17.	Pneumatised crista galli	11.7(100)
18.	Dehiscent lamina papyracea	0.9(8)

Haller (infra-orbital ethmoidal, **Figure - 3a**)) cells and Onodi (spheno-ethmoid, **Figure - 3b**)) cells were prevalent in 27.2% and 19.2% of subjects in our study, which is commensurate with the previously reported literature [3-5, 8, 10, 14, 15, 19]. Paradoxical middle turbinate, referring to infero-medial curvature of middle turbinate with concave surface towards nasal septum, was seen in 15.8% (0.7–40% previously reported) [3, 5, 14] in concordance with the previous studies. Uncinate cells (**Figure - 3c**) had a prevalence of 15.5% in our study, higher than 0.4–9% as reported in the literature [3, 5, 8]. Hard palate pneumatisation (maxillary sinus extension into its palatine process medially, **Figure - 3d**) was found in 16% of subjects in our study. Superior turbinate was pneumatised (**Figure - 4**) in 20.2 % of our patients, lower than the prevalence reported in literature, 27–57% [8, 13, 20]. Pneumatization of the inferior turbinates is a rare sinonasal anatomical variant with only few reported cases in literature. However, we did not come across any such case in our study. Pneumatisation of crista galli was seen in 11.7% (2.4–13% reported previously) [5, 21].

There are a colossal number of sinonasal anatomic variants, some being so common that they are more commonly seen in a large part of population. Some of them like Onodi cells, Haller cells, dorsum sella pneumatisation, anterior clinoid process pneumatisation and

lamina papyracea dehiscence acquire importance in patients planned to undergo functional endoscopic sinus surgery or other surgeries of the base of skull [10, 14, 19] and the operating surgeon should be made aware of the same. In nutshell, CT report of paranasal sinuses should diagnose and document these sinonasal anatomic variants to minimize surgical complications and hence don't bring catastrophe to operating surgeon, radiologist and the poor patient.

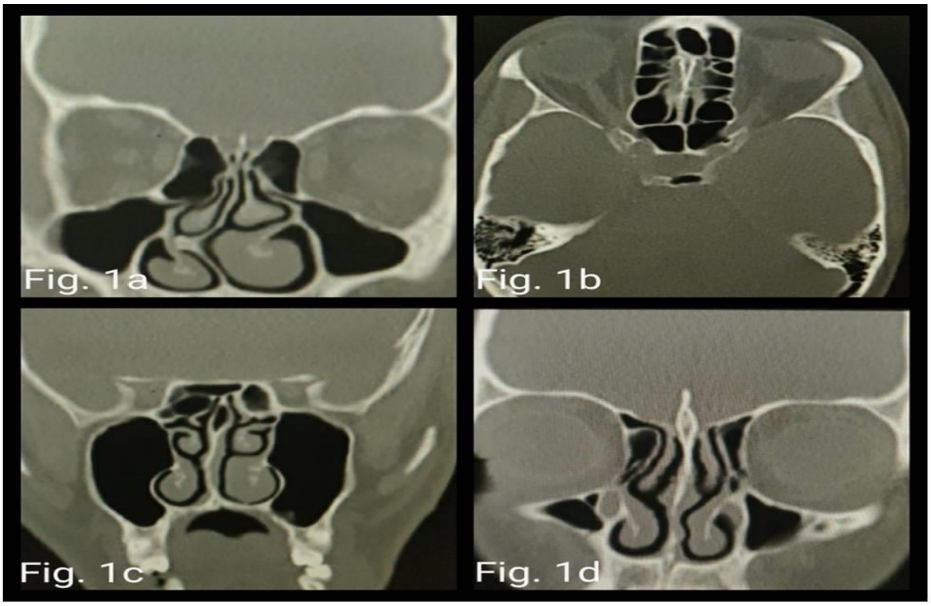

Figure 1:
(a) Coronal NCCT image showing deviated nasal septum towards right side with associated septal spur.
(b) Axial NCCT image showing aerated dorsum sellae.
(c) Coronal NCCT image showing aerated posterior nasal septum.
(d) Coronal NCCT image showing Agger Nasi cell on right side.

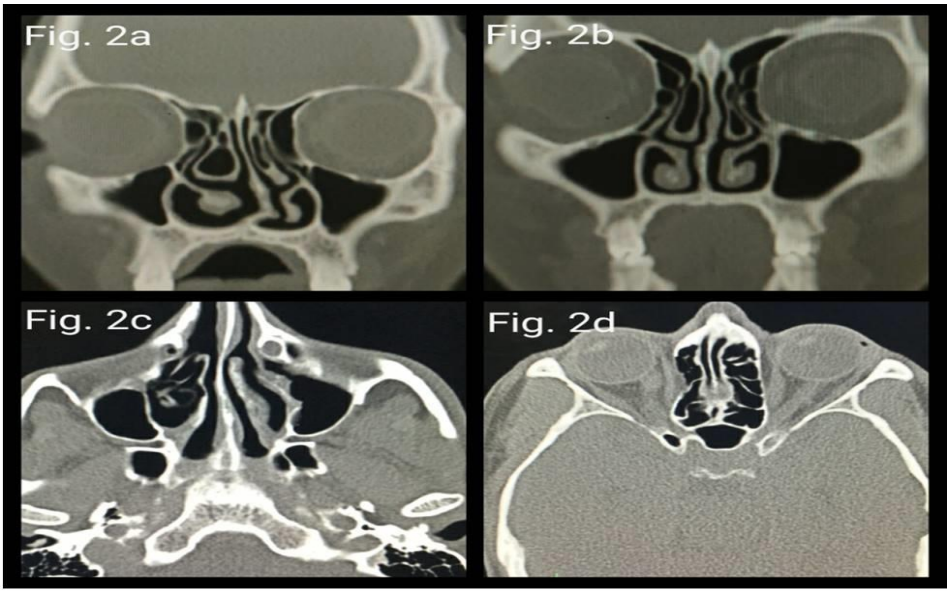

Figure 2:
(a) Coronal NCCT image showing Concha bullosa on right side with Concha lamella on the left.
(b) Coronal NCCT image showing bilateral Concha bullosa, right side dominant.
(c) Axial NCCT image showing bilateral pneumatised pterygoid processes.
(d) Axial NCCT image showing aerated anterior clinoid process on right side.

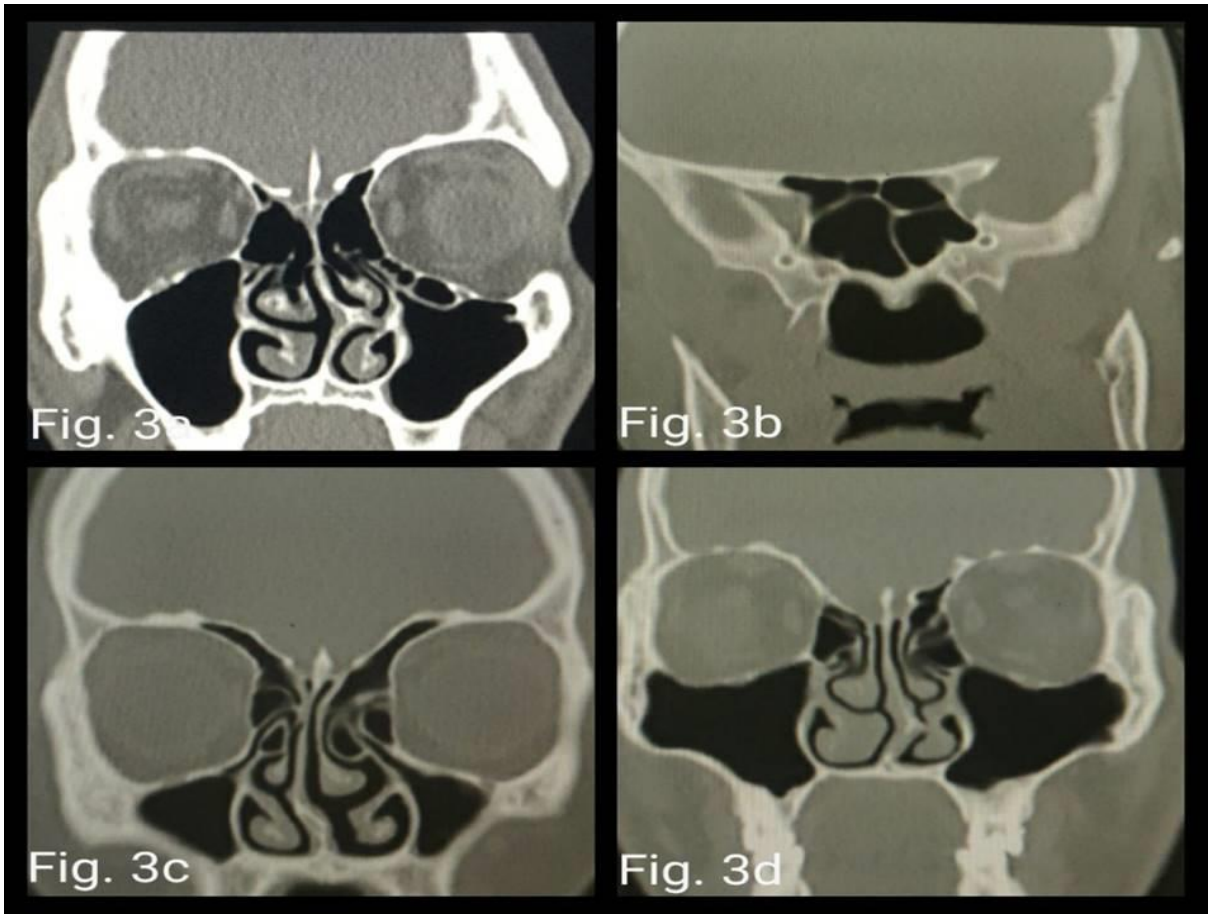

Figure 3:
(a) Coronal NCCT image showing Haller cells on left side.
(b) Coronal NCCT image showing Onodi cells.
(c) Coronal NCCT image showing Uncinate cells bilaterally.
(d) Coronal NCCT image showing aeration of hard palate billaterally.

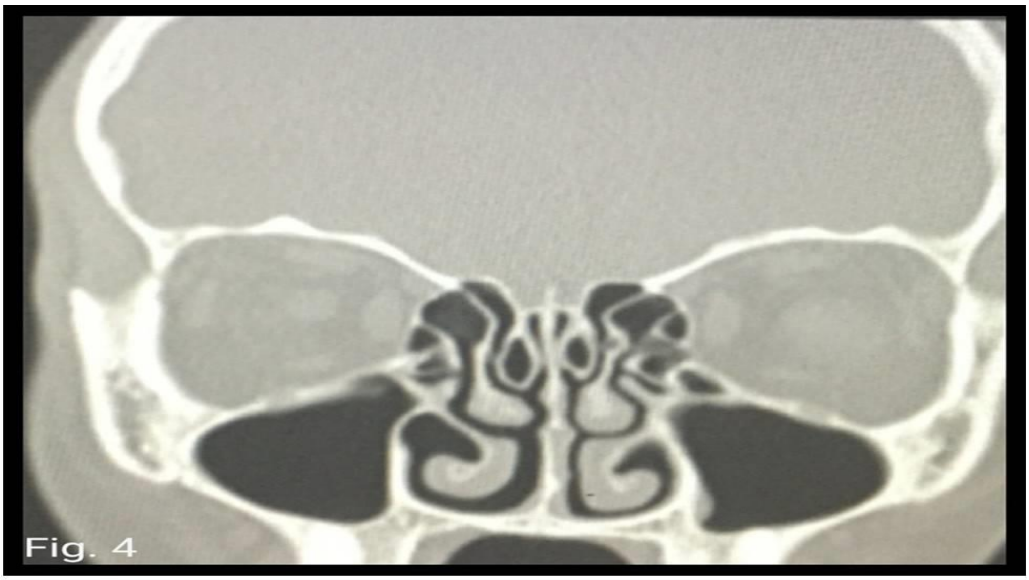

Figure 4:
Coronal NCCT image showing aeration of superior turbinates bilaterally.

Conclusion

Sinonasal anatomic variants are a rule rather than an exception, being present in a majority of population. These variations should be diagnosed and documented on CT examinations of paranasal sinuses to avoid any unforeseen complication during functional endoscopic sinus surgery and other skull base surgeries.

References

1. Kinsui MM, Guilherme A, Yamashita HK. Variações anatômicas e sinusopatias: estudo por tomografia computadorizada. Rev Bras Otorrinolaringol., 2002; 68: 645–52.
2. Riello APFL, Boasquevisque EM. Variações anatômicas do complexo ostiomeatal: achados tomográficos em 200 pacientes. Radiol Bras., 2008; 41: 149–54.
3. Azila A, Irfan M, Rohaizan Y, et al. The prevalence of anatomical variations in osteomeatal unit in patients with chronic rhinosinusitis. Med J Malaysia, 2011; 66: 191–194.
4. Stallman JS, Lobo JN, Som PM. The incidence of concha bullosa and its relationship to nasal septal deviation and paranasal sinus disease. AJNR, 2004; 25: 1613–1618.
5. Fadda GL, Rosso S, Aversa S, et al. Multiparametric statistical correlations between paranasal sinus anatomic variations and chronic rhinosinusitis. Acta Otorhinolaryngol Ital., 2012; 32: 244–251.
6. Beale TJ, Madani G, Morley SJ. Imaging of the paranasal sinuses and nasal cavity: normal anatomy and clinically relevant anatomical variants. Semin Ultrasound CT MR, 2009; 30: 2–16.
7. Smith KD, Edwards PC, Saini TS, Norton NS. The prevalence of concha bullosa and nasal septal deviation and their relationship to maxillary sinusitis by volumetric tomography. Int J Dent., 2010; 2010: 404982.
8. Sivasli E, Sirikçi A, Bayazýt YA, et al. Anatomic variations of the paranasal sinus area in pediatric patients with chronic sinusitis. Surg Radiol Anat., 2003; 24: 400–405.
9. Hamid O, El Fiky L, Hassan O, Kotb A, El Fiky S. Anatomic variations of the sphenoid sinus and their impact on trans-sphenoid pituitary surgery. Skull Base, 2008; 18: 9–15.
10. Kantarci M, Karasen RM, Alper F, et al. Remarkable anatomic variations in paranasal sinus region and their clinical importance. Eur J Radiol., 2004; 50: 296–302.
11. Eweiss AZ, Khalil HS. The prevalence of frontalcells and their relation to frontal sinusitis: a radiological study of the frontal recess area. ISRN Otolaryngol., 2013; 2013: 687582.
12. Mathew R, Omami G, Hand A, et al. Cone beam CT analysis of Haller cells: prevalence and clinical significance. Dentomaxillofac Radiol., 2013; 42: 20130055.
13. Braun H, Stammberger H. Pneumatization of turbinates. Laryngoscope, 2003; 113: 668–672.
14. Nouraei SA, Elisay AR, Dimarco A, et al. Variations in paranasal sinus anatomy: implications for the pathophysiology of chronic rhinosinusitis and safety of endoscopic sinus surgery. J Otolaryngol Head Neck Surg., 2009; 38: 32–37.
15. Alkire BC, Bhattacharyya N. An assessment of sinonasal anatomic variants potentially associated with recurrent acute rhinosinusitis. Laryngoscope, 2010; 120: 631–634.
16. Yassar Shiekh, Arshed Ali, et al. Concha bullosa and its association

with DNS and sinusitis. Int. J. of Adv. Res., 2017; 5(10): 362-367.
17. Hewaidi G, Omami G. Anatomic variation of sphenoid sinus and related structures in Libyan population: CT scan study. Libyan J Med., 2008; 3: 128–133
18. Mikami T, Minamida Y, Koyanagi I, et al. Anatomical variations in pneumatization of the anterior clinoid process. J Neurosurg., 2007; 106: 170–174.
19. Tomovic S, Esmaeili A, Chan NJ, et al. High-resolution computed tomography analysis of the prevalence of Onodi cells. Laryngoscope, 2012; 122: 1470–1473.
20. Kanowitz SJ, Nusbaum AO, Jacobs JB, et al. Superior turbinate pneumatization in patients with chronic rhinosinusitis: prevalence on paranasal sinus CT. Ear Nose Throat J, 2008; 87: 578–579.
21. Som PM, Park EE, Naidich TP, et al. Crista galli pneumatization is an extension of the adjacent frontal sinuses. AJNR, 2009; 30: 31–33.