



Original Article:

Anatomical Variations of the Nose and Paranasal Sinuses in Palakkad Population Using CT Scan - A Case Control Study.

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Abstract: Background and Objectives: Chronic sinusitis is repeated spells of acute infection or persistent inflammation of the sinuses. Computerized tomographic imaging provides a complete anatomical examination of the paranasal region. Methods: A case-control pilot study was carried out on 60 patients with a clinical diagnosis of chronic rhinosinusitis. The control group comprising of 60 are from ENT clinic patients with diagnoses other than sinusitis. Results: 73.3% of the males in the cases group had mucosal thickening of maxillary sinus. 60% of the females in the posterior ethmoidal complex. The most commonly encountered anatomical variations was deviated nasal septum being 70.0% of the left side for males in the cases group and 56.7% of the right side in the females cases group. Then, 53.3% in the right side for males and 53.3% for left side for females in the control group. Conclusion: Precise knowledge of the anatomy of the paranasal sinuses is essential for the clinician to plan the outcome of any treatment procedures. The underlying anatomical variations could possibly be the causative factor for persistent sinusitis.

Key Words: Computerised tomography scan, chronic rhino sinusitis, paranasal sinuses, anatomical variations

Introduction:

Chronic sinusitis is repeated spells of acute infection or persistent inflammation of the sinuses. Sinusitis is a very widespread disease and factors which cause immune suppression or blockage of normal sinus drainage are revealed by radiological interpretation.(1)

Computerised tomography (CT) scan is the imaging modality of choice in paranasal sinusitis, illuminating anatomic details of the sinuses and the adjacent neurovascular structures. The nasal cavity and paranasal air sinuses comprises an anatomical and functional unit. Covered by the similar respiratory mucosa, the paranasal sinuses communicate with the nasal cavities via small openings and narrow ducts. They favour aeration and mucosal drainage of the sinuses.(2)

This CT study aimed to determine the prevalence and clinical significance of the important anatomical variations of the

lateral nasal wall and paranasal sinuses in chronic sinusitis patients and the normal Palakkad population.

Materials and Methods

Design

A descriptive, case-control pilot study was carried out on 60 patients with a clinical diagnosis of chronic rhino sinusitis who was referred for a sinus CT scan by ENT specialists. The control group comprising of 60 were chosen from the non ENT and neurology clinic patients with diagnosis other than sinusitis. The patients age group ranged from 18 to 65 years.

Method

For the tomographic study, Siemens AG, Somatom Spirit spiral scanner, was used. It provides precise high-resolution reconstruction of the anatomical structures. In all cases, systematic studies of the nasal sinus region were performed in coronal and axial slices using bone algorithm with 3-mm inter scan interval.

The study parameters were age, sex, clinical diagnosis and radiographic findings, which comprised the site of sinus infection, the presence of septal deviation, concha bullosa, osteo meatal complex (OMC), haller cells, agger nasi cells, onodi cells, dehiscence of anterior ethmoidal artery and infra orbital nerve. Each CT scan was analysed separately in half-heads. Anatomical findings of each patient was carefully scrutinized and recorded on the patient's data sheet.

Statistical analysis

Analysis is performed using SPSS version 16. Data will be analysed in terms of the number, and percentage of the variations of the osteomeatal complex. Cross tabulations done for variations and sex. Chi-square test will be applied to assess the significance of association between the sex and variations.

Ethical approval

This study is approved by institutional review board. (Ethical Approval No: kmc/cert./10-2015/36). Written informed consent was obtained from the patients for participation and publication of this research.

Results

Table 1 shows the demographic profile of the cases and control group and further sub grouped into males and females.

Table 2 shows the incidence of chronic rhino sinusitis in all the paranasal sinuses for the cases group. The selection criteria was made by radiological appearance of the mucosal thickening. At the end of the study, out of 60 patients, 73.3% of the males in the cases group had mucosal thickening of maxillary sinus. Of the females, 60% had mucosal thickening in the posterior ethmoidal complex. Cross tabulation had been done between the sinuses and the sex in the cases group.

Table 3, 4 depict the anatomical variations of nasal cavity and para nasal sinuses for both cases and control groups. Data is shown in terms of number and percentage of anatomical variations. Cross tabulation has been done between the anatomical variations and the sex in the cases group. The results of chi square tests are shown.

In this study, the most commonly encountered anatomical variation was deviated nasal septum, being present on left side in 70.0% of the males in the cases group and on the right side in 56.7% of the female cases group. Among the control group, 53.3% of males had it on the right side and 53.3% of females had it on the left side.

Other unlisted and unexpected incidental anatomical variations incorporated are dehiscence of infra orbital nerve 60% of occurrence in males and anterior ethmoidal artery 20% bilaterally occurring in females of the cases group.

Table 1: Demographic profile of the cases group and control group.

Age	Cases			Controls		
	Male	Female	Total	Male	Female	Total
Up to 25	1	4	5	6	5	11
26 to 35	6	5	11	5	5	10
36 to 45	12	9	21	6	6	12
46 to 55	4	5	9	6	6	12
Above 56	7	7	14	7	8	15
Total	30	30	60	30	30	60

Table 2: Prevalence of chronic rhino sinusitis from the Palakkad population

Particulars	Male					Female					P Value	χ ²
	Absent	Right	Left	Bilateral	Total	Absent	Right	Left	Bilateral	Total		
MAXILLARY SINUS												
Mucosal thickening	2	5	1	22	30	5	3	5	17	30	0.165	5.093
	6.7%	16.7%	3.3%	73.3%	100.0%	16.7%	10.0%	16.7%	56.7%	100.0%		
ANTERIOR ETHMOIDAL SINUS												
Mucosal thickening	20	1	0	9	30	13	2	1	14	30	0.272	3.905
	66.7%	3.3%	0.0%	30.0%	100.0%	43.3%	6.7%	3.3%	46.7%	100.0%		
FRONTAL SINUS												
Mucosal thickening	20	1	0	9	30	15	2	3	10	30	0.251	4.100
	66.7%	3.3%	0.0%	30.0%	100.0%	50.0%	6.7%	10.0%	33.3%	100.0%		
POSTERIOR ETHMOID SINUS GROUP												
Mucosal thickening	12	0	5	13	30	9	2	1	18	30	0.116	5.902
	40.0%	0.0%	16.7%	43.3%	100.0%	30.0%	6.7%	3.3%	60.0%	100.0%		
SPHENOID SINUS												
Mucosal thickening	11	2	4	13	30	13	3	1	13	30	0.539	2.167
	36.7%	6.7%	13.3%	43.3%	100.0%	43.3%	10.0%	3.3%	43.3%	100.0%		

Table 3: Anatomic variations of paranasal sinuses using CT Scans for 60 chronic rhino sinusitis patients (30 males & 30 females)

Particulars	Male				Female				P Value	χ ²
	Absent	Right	Left	Bilateral	Absent	Right	Left	Bilateral		
Deviated nasal septum	2	7	21	-	1	17	12	-	0.031	6.955*
	6.7%	23.3%	70.0%	-	3.3%	56.7%	40.0%	-		
Concha Bullosa	18	3	0	9	14	1	2	13	0.238	4.227
	60.0%	10.0%	0.0%	30.0%	46.7%	3.3%	6.7%	43.3%		
Osteo Meatal Complex pa	6	1	6	17	11	2	2	15	0.269	3.929
ncy	20.0%	3.3%	20.0%	56.7%	36.7%	6.7%	6.7%	50.0%		
Haller cell	25	1	3	1	29	1	0	0	0.231	4.296
	83.3%	3.3%	10.0%	3.3%	96.7%	3.3%	0.0%	0.0%		
Dehiscence of infraorbital nerve	10	1	1	18	12	0	1	17	0.751	1.210
	33.3%	3.3%	3.3%	60.0%	40.0%	0.0%	3.3%	56.7%		
Agger nasi cell	18	0	1	11	12	2	1	15	0.282	3.815
	60.0%	0.0%	3.3%	36.7%	40.0%	6.7%	3.3%	50.0%		
Onodi cell	14	2	4	10	12	5	1	12	0.331	3.421
	46.7%	6.7%	13.3%	33.3%	40.0%	16.7%	3.3%	40.0%		
Dehiscence of Anterior Ethmoid Artery	23	1	2	4	20	0	4	6	0.517	2.276
	76.7%	3.3%	6.7%	13.3%	66.7%	0.0%	13.3%	20.0%		

* p value <0.05 is statistically significant.

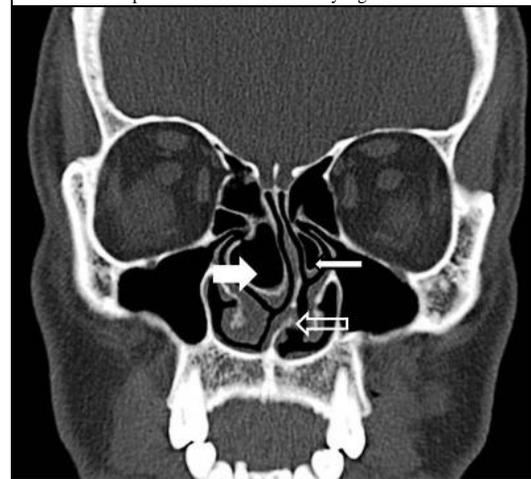


Figure 1: Coronal CT of paranasal sinuses shows the deviated nasal septum (White outlined arrow) and bilateral concha bullosa (white arrows).

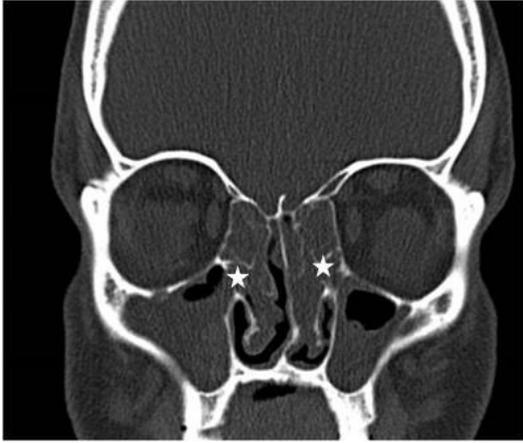


Figure 2: Coronal CT scan shows osteomeatal complex blockage (white stars) with bilateral chronic maxillary sinusitis and ethmoidal complex sinusitis.



Figure3: Axial CT scan shows bilateral dehiscence of the infra orbital nerve (white arrows).

Table 4: Anatomic variations of paranasal sinuses using CT Scans for 60 non sinus patients –control group(30 males & 30 females).

Particula rs	Male				Female				P Value	X ²
	Abse nt	Righ t	Left	Bilate ral	Abse nt	Righ t	Left	Bilate ral		
Deviat ed nasal septum	3	11	16	-	7	16	7	-	0.049	6.048*
	10.0 %	36.7 %	53.3 %	-	23.3 %	53.3 %	23.3 %	-		
Concha Bullosa	16	0	1	13	18	1	5	6	0.095	6.363
	53.3 %	.0%	3.3 %	43.3%	60.0 %	3.3 %	16.7 %	20.0%		
Osteo Meatal Comple x Patency	0	0	0	30	2	0	0	28	0.150	2.069
	.0%	.0%	.0%	100.0 %	6.7%	.0%	.0%	93.3%		
Haller cell	27	1	1	1	30	0	0	0	0.368	3.158
	90.0 %	3.3 %	3.3 %	3.3%	100.0 %	.0%	.0%	.0%		
Dehisce nce of Infra orbital nerve	15	0	0	15	13	2	0	15	0.343	2.143
	50.0 %	.0%	.0%	50.0%	43.3 %	6.7 %	.0%	50.0%		
Agger nasi cell	30	0	0	0	30	0	0	0	-	-
	100.0 %	.0%	.0%	.0%	100.0 %	.0%	.0%	.0%		
Onodi cell	16	0	4	10	13	1	1	15	0.250	4.110
	53.3 %	.0%	13.3 %	33.3%	43.3 %	3.3 %	3.3 %	50.0%		
Dehisce nce of anterior ethmoid artery	27	1	0	2	26	0	2	2	0.389	3.019
	90.0 %	3.3 %	.0%	6.7%	86.7 %	.0%	6.7 %	6.7%		

* p value <0.05 is statistically significant.

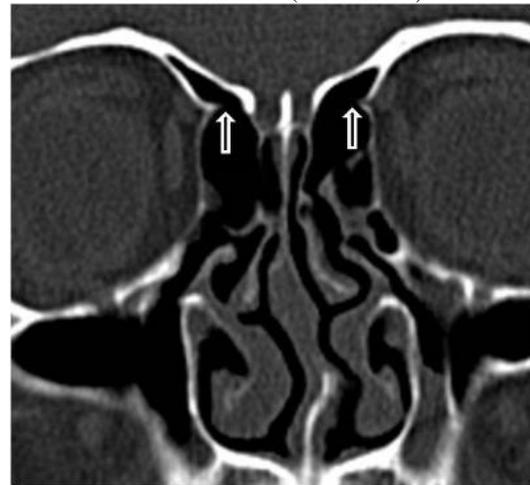


Figure 4: Coronal CT scan shows bilateral dehiscence of anterior ethmoidal artery (White outlined arrows).

Discussion

Paranasal sinus CT scan is the chief method used to demonstrate the stages of benign inflammatory diseases preoperatively and also nearby vital structures. The CT scan provides anatomical and pathological images for the surgeons to navigate during endoscopic sinus surgery. Anatomical variations in the sinonasal region play a significant role in the pathogenesis of paranasal sinus diseases.(3,4)

Nasal Septum

The term septal deviation represents a divergence of the septum from the midline which ultimately pushes the turbinates laterally. The direction of the deviation was defined by the side of the convexity of the curvature. It leads to obstruction in the drainage of ipsilateral maxillary, anterior ethmoid and frontal sinuses. We found a statistically significant difference between the sex with regard to the deviated nasal septum (p value <0.05) in both the groups, as also found by Deosthale et al.(5-9)

Middle Turbinate

Concha bullosa (CB), is an anatomic variation manifesting as aeration of the middle turbinate. CB is best diagnosed radiographically as they are easily identified on CT scan. It appears as an air space of the middle turbinate surrounded by an oval bony rim. CB reflects its embryological origin from the ethmoidal air cell development.(10) Concha bullosa is of concern as a potential etiologic factor in recurrent sinusitis, due to postulated negative influence on paranasal sinus

ventilation and mucociliary clearance in the middle meatus region.(11-13) In our study, for cases group, 30% males and 43.3% females had bilateral CB and under control group, 43.3% males had CB bilaterally.

Osteo Meatal Complex (OMC) patency

The osteomeatal complex is a complex including the maxillary sinus ostium, ethmoid infundibulum and middle meatus. It acts as a drainage pathway for maxillary, anterior ethmoid sinus and frontal sinuses. In several areas of the osteomeatal complex, two mucosal layers contact each other, thus increasing the likelihood of local impairment of mucociliary clearance.(14) Secretions may then be retained at the site, creating the potential for infection even without closure of ostium. Anatomical variations studied on CT scan are found to block the OMC and cause chronic sinusitis. In our present study, 20% of males and 36.7% of females had blocked OMC in the cases group. The blockade in the OMC leads to impaired drainage of maxillary, frontal and anterior ethmoid thus causing chronic sinusitis.(7)

Haller Cell

Haller cells are ethmoidal air cells extending along the medial roof of the maxillary sinus.(15,16) They are located below the ethmoid bulla and lateral to the uncinate process and closely related to the ethmoid infundibulum. The haller cell is thought to cause chronic sinusitis cases by impinging on the ostium of the maxillary sinus and infundibulum by inhibiting the ciliary function, leading to obstruction of the ostium.(15,17,18) In this study, 10.0% and 3.3% of males belonging to cases and control group respectively, but none of the females, had Haller cells.

Agger Nasi Cell

It is the most anterior ethmoid air cell located on the lateral nasal wall and anterosuperior to the hiatus semilunaris. It is located anterior to the vertical attachment of the middle turbinate to the skull base. As it forms the anterior and inferior wall of the frontal recess, the surgical access to recess is by passing through these agger nasi cells.(5,15,19) In this study, 36.7% of males and 50% of females of the cases group had Agger Nasi cells.

Onodi cell

Onodi cells are migrated ethmoid cells in the anterior region of the sphenoid sinus. The presence of onodi cells during surgery may lead to increased risk of injury to the optic nerve and internal carotid artery. The onodi cell may be poorly aerated and drained, leading to stasis of secretions and chronic infections.(3,4,20,21) In this study, 33.3% of males and 40% of females of the cases group and 50% in females belonging to control group had bilateral Onodi cells.

Anterior Ethmoidal Artery Dehiscence

Topographic relationships of the anterior ethmoidal artery are of precise significance in its course from the orbit to the olfactory fossa as it passes three cavities: orbit, ethmoidal labyrinth and the anterior cranial fossa. The course through the lateral lamella of the lamina cribrosa is the peak critical site, as it is the area of least resistance. In the study we conducted, 13.3% of males for the cases group and 6.7% in both the gender of the control group had the dehiscence.(4,22)

Stenosis of the osteomeatal complex, from the anatomical configuration or hypertrophied mucosa can cause obstruction and stagnation of secretions leading to infection. Untreated chronic sinusitis can result in severe complications such as orbital cellulitis, osteomyelitis, subdural empyema, frontal lobe abscess, cavernous sinus thrombosis, and death. The surgical interventions of the functional endoscopic sinus surgery are designed to remove the osteomeatal blockage and aids in restoring the normal sinus ventilation and mucociliary function. Understanding the complex anatomy of the skull base is crucial for the safe endoscopic sinus surgery. There are many racial and genetic factors responsible for these anatomical variations.(23) Precise knowledge of the anatomy

of the paranasal sinuses is essential for the clinician to plan the outcome of any treatment procedures.

Conclusion

Computerised tomography of the paranasal sinuses is required for the diagnosis and consequent treatment of sinusitis. The underlying anatomical variations could possibly be the causative factor for persistent sinusitis. CT evaluates the osteomeatal complex anatomy which is not possible with plain radiographs. Therefore, endoscopic surgeons must be completely aware of these anatomical variations during functional sinus surgeries to avoid iatrogenic lethal consequences.

References

1. Badia L, Lund VJ, Wei W, Ho WK. Ethnic variation in sinonasal anatomy on CT-scanning. *Rhinology*. 2005;43:210-4.
2. Duarte AF, Soler RdC, Zavarezzi F. Nasal endoscopy associated with paranasal sinus computerized tomography scan in the diagnosis of chronic nasal obstruction. *Rev Bras Otorrinolaringol*. 2005;71(3):361-3.
3. 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 July–Sept;66(3):260–6.
4. Al-Abri R, Bhargava D, Al-Bassam W, Al-Badaai Y, Sawhney S. Clinically significant anatomical variants of the paranasal sinuses. *Oman Medical Journal*. 2014;29(2):110-3.
5. Riello APdFL, Boasquevisque EM. Anatomical variants of the ostiomeatal complex: tomographic findings in 200 patients. *Radiol Bras*. 2008 May/Jun;41(3):149–54.
6. Stallman JS, Lobo JN, Som PM. The incidence of concha bullosa and its relationship to nasal septal deviation and paranasal sinus disease. *AJNR Am J Neuroradiol* 2004 October;25:1613–8.
7. Tsai T-L, Lan M-Y, Ho C-Y. There is no structural relationship between nasal septal deviation, concha bullosa, and paranasal sinus fungus balls. *The Scientific World Journal*. 2012;1:1-4.
8. Prasad S, Varshney S, Bist SS, Mishra S, Kabdwal N. Correlation study between nasal septal deviation and rhinosinusitis. *Indian J Otolaryngol Head Neck Surg*. Oct–Dec 2013;65(4):363–6.
9. Deosthale NV, Khadakkar SP, Singh B, Harkare VV, R P, Dhoke, et al. Anatomical variations of nose and paranasal sinuses in chronic rhinosinusitis. *People's Journal of Scientific Research*. 2014 July;7(2):1-7.
10. 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. *International Journal of Dentistry*. 2010;1:1-5.
11. Adeel M, Rajput MSA, Akhter S, Ikram M, Arain A. Anatomical variations of nose and para-nasal sinuses; CT scan review. *Journal of the Pakistan Medical Association*. 2013;63(3):317-9.
12. Asruddin, Yadav SPS, Yadav RK, Singh J. Low dose CT in chronic sinusitis. *Indian Journal of Otolaryngology and Head and Neck Surgery*. 2008;52(17-22).
13. Biswas J, Patil CY, Deshmukh PT, Kharat R, Nahata V. Tomographic evaluation of structural variations of nasal cavity in various nasal pathologies. *International Journal of Otolaryngology and Head & Neck Surgery*. 2013;2:129-34.

14. Dua K, Chopra H, Khurana AS, Munjal M. CT scan variations in chronic sinusitis. *Ind J Radiol Imag.* 2005;15(3):315-20.
15. Wani AA, Kanotra S, Lateef M, Ahmad Rq, Qazi SM, Ahmad S. CT scan evaluation of the anatomical variations of the ostiomeatal complex. *Indian J Otolaryngol Head Neck Surg.* 2009 July–September;61:163–8.
16. Ameri AA, Eslambolchi A, Bakhshandeh H. Anatomic Variants of Paranasal Sinuses and Chronic Sinusitis. *Iran J Radiol.* 2005 June 2005; 2(3,4):121-4.
17. Daghighi M, Daryani A, Nejad KC. Evaluation of anatomic variations of paranasal sinuses. *The Internet Journal of Otorhinolaryngology.* 2007;7(1):1-4.
18. Mamatha H, Shamasundar NM, Bharathi MB, Prasanna LC. Variations of ostiomeatal complex and its applied anatomy: a CT scan study. *Indian Journal of Science and Technology.* 2010 Aug;3(8):904-7.
19. Mazza D, Bontempi E, Guerzezi A, Monte D, Cipolla G, Perrone A, et al. Paranasal sinuses anatomic variants: 64-slice CT evaluation. *Minerva Stomatologica.* July 2007.
20. Cherla DV, Tomovic S, Liu JK, Eloy JA. The central onodi cell: A previously unreported anatomic variation. *Allergy & Rhinology.* 2013;4:e49 –e51.
21. Miranda CMNRd, Maranhão CPdM, Arraes FMNR, Padilha IG, Farias LdPGd, Jatobá MSdA, et al. Anatomical variations of paranasal sinuses at multislice computed tomography: what to look for. *Radiol Bras.* 2011 Jul/Aug;44(4):256–62.
22. Beale TJ, Madani G, Morley SJ. Imaging of the paranasal sinuses and nasal cavity: normal anatomy and clinically relevant anatomical variants. *Semin Ultrasound CT MRI.* 2009;30:2-16.
23. Nitinavakarn B, Thanaviratananich S, Sangsilp N. Anatomical variations of the lateral nasal wall and paranasal sinuses: A CT study for endoscopic sinus surgery (ESS) in thai patients. *J Med Assoc Thai.* 2005;88(6):763-8.