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Original research article

CT scan study of anatomical variations of paranasal sinuses in patients with sinus disease

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Abstract

A precise knowledge of the anatomy of the paranasal sinuses is essential for the clinician. Conventional radiology does not permit a detailed study of the nasal cavity and paranasal sinuses, and has now largely been replaced by computerized tomographic (CT) imaging. This gives an applied anatomical view of the region and the anatomical variants that are very often found. All the patients who satisfied the inclusion criteria of the study were subjected to history taking and physical examination to identify clinical signs at presentation. Then the patients were subjected to CT scan of nose and paranasal sinus region and the anatomy of the sinonasal region was thoroughly assessed after a probable diagnosis was made. The most common anatomical variation was Deviated nasal septum which was seen in 60% of the patients. The next most common anatomical variation was concha bullosa which was seen in 54% of patients. In optic nerve variations Type I was the most common type (84%). In ethmoid roof variations Kero's Type II was the most common type (80%).

Keywords: Anatomical variations, paranasal sinuses, CT scan

Introduction

The understanding of the pathophysiology of the mucociliary activity of paranasal sinuses has revolutionized the surgical management in recent times. The endoscopic surgical procedures have reduced patient morbidity dramatically. Detailed anatomic knowledge of the microanatomic areas and their variants is required to effectively implement the surgical procedures and produce good results.

Variations in paranasal sinus are of potential significance because they may pose risks during surgery or predispose to certain pathologic conditions.

Certain anatomic variations are thought to be predisposing factors for the development of sinus diseases and thus it becomes necessary for the radiologist to be aware of these variations, especially if the patient is a candidate for functional endoscopic sinus surgery (FESS) [1].

For Endoscopic sinus Surgery, precise knowledge of the anatomy and variations of paranasal sinus is essential for surgeon. Computed tomography provides accurate evictions of the anatomy, the anatomical variants and the extent of the disease in and around the paranasal sinuses [2].

A precise knowledge of the anatomy of the paranasal sinuses is essential for the clinician. Conventional radiology does not permit a detailed study of the nasal cavity and paranasal sinuses, and has now largely been replaced by computerized tomographic (CT) imaging. This gives an applied anatomical view of the region and the anatomical variants that are very often found. The detection of these variants is essential for the use of current endoscopic surgery on the sinuses to prevent potential hazards.

Computerized tomographic imaging (CT) of the paranasal sinuses (PNS) has become a widely accepted tool for assessing the Paranasal sinuses and providing a detailed anatomy of the lateral nasal wall. Computed Tomography (CT) is considered a prerequisite for endoscopic sinus surgery (ESS).

Nose and paranasal sinuses have wide structural variations with unique anatomical complexity resulting in functional impairment. A large number of important structures are housed in this relatively small region.

Adequate knowledge of these anatomical variations not only aids in doing a successful surgery but to helps in avoiding surgical complications.

Studying the relative frequency and concurrence of these variations in a given populations and comparing the results with that of other races may yield hints in medical decisions making and surgical planning for all patients [3].

Paranasal sinuses are air filled cavities lined by evagination of mucous membrane of the nasal cavity into the substance of adjacent skull bones. The functions attributed to nose and para nasal sinuses are humidification, air conditioning, lightening of skull bones, vocal resonance, dampening of the pressure,

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heat insulation and increasing the olfactory area [4].
Offlate the surgeons are more and more accustomed with functional endoscopic sinus surgery (FESS) for the management of chronic inflammatory nose and para nasal sinus diseases in comparison with the conventional non-endoscopic surgeries.
Before functional endoscopic sinus surgery, CT scan has a vital role for safe and effective surgery, as it provides information about the disease as well as the sino-nasal structural integrity and the variations associated with it.
Computed tomography is the imaging modality of choice and Gold standard in the study of detail anatomical structure of PNS, anatomical variations & the extent of disease in & around the PNS [5].
Disruption of the mucocilliary clearance due to an anatomical variations and mucosal disease of the osteomeatal complex is considered to be the prime factor for the persistence of rhinosinusitis. With the help of FESS, we maintain the normal physiology of paranasal sinuses along with removal of diseases.
The importance of anatomic variations as a predisposing cause for sinus disease, particularly in relation to the osteomeatal complex, has been stressed by several authors [6].
In this study detailed anatomical study of the variations of paranasal sinuses and their bearing on the sinus infection is evaluated.

Methodology
Source of study: Patients referred by the out-patient department of ENT to the department of Radiology Medical College and Hospital.

Study design: Prospective study.

Sample size: 50.

Sample design: A prospective study on correlation of anatomical variations of Paranasal Sinus region with chronic rhinosinusitis.

Method of collection of data
- All the patients who satisfied the inclusion criteria of the study were subjected to history taking and physical examination to identify clinical signs at presentation.
- Then the patients were subjected to CT scan of nose and paranasal sinus region and the anatomy of the sinonasal region was thoroughly assessed after a probable diagnosis was made.
- After completing all investigations, definitive management was done and the radiological features were correlated with the clinical and endoscopic diagnosis.

Inclusion criteria: All patients with clinical diagnosis of sinus disease between 18 to 65 years presenting to the OPD of department of Radiology.

Exclusion criteria
- Paranasal sinus neoplasms.
- Previous sinonasal surgery.
- Facial trauma.
- Sinonasal anatomy alteration or obscuration due to inflammatory diseases.
- Younger age of the patients (<18 years).

Results

Table 1: Anatomical Variations of Paranasal Sinuses

			Present		Absent	
			Count	%	Count	%
Agger Nasi Cells		Right	4	8.00	46	92.00
		Left	4	8.00	46	92.00
Nasal Septal Deviation (Towards Right)		With Spur	5	10.00	45	90.00
		Without Spur	10	20.00	40	80.00
Nasal Septal Deviation (Towards Left)		With Spur	4	8.00	46	92.00
		Without Spur	9	18.00	41	82.00
S Shaped		S Shaped	2	4.00	48	96.00
Uncinate Process Variations		Lateralised	4	8.00	46	92.00
		Medialized	3	6.00	47	94.00
		Pneumatised	2	4.00	48	96.00
		Bent	1	2.00	49	98.00
Middle	Concha	Right	15	30.00	35	70.00

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Turbinate Variations	Bullosa	Left	12	24.00	38	76.00
	Lamellar Concha	Right	9	18.00	41	82.00
		Left	11	22.00	39	78.00
	Paradoxical Curvature	Right	5	10.00	45	90.00
		Left	4	8.00	46	92.00
	Haller Cells	Right	4	8.00	46	92.00
		Left	6	12.00	44	88.00
Supraorbital ethmoidal cells Ethmoid Cell		Right	7	14.00	43	86.00
		Left	8	16.00	42	84.00
Frontoethmoidal Cell Variations		Type 1	10	20.00	40	80.00
		Type 2	13	26.00	37	74.00
		Type 3	12	24.00	38	76.00
		Type 4	2	4.00	48	96.00
Sphenoid Sinus Variations	Onodi Cell	Right	6	12.00	44	88.00
		Left	4	8.00	46	92.00
	Pneumatised ACP	Right	4	8.00	46	92.00
		Left	3	6.00	47	94.00
	Pneumatised Pterygoid Process	Right	11	22.00	39	78.00
		Left	10	20.00	40	80.00
	Optic Nerve Variations	Type 1	42	84.00	8	16.00
		Type 2	4	8.00	46	92.00
		Type 3	3	6.00	47	94.00
		Type 4	1	2.00	49	98.00
Ethmoid Roof Variations	Kero's Type	Type 1	10	20.00	40	80.00
		Type 2	40	80.00	10	20.00
		Type 3	0	0.00	50	100.00
Aerated Crista Galli			3	6.00	47	94.00
Variations of Maxillary Sinuses		Hypoplastic	0	0.00	50	100.00
Septations		Right	7	14.00	43	86.00
		Left	9	18.00	41	82.00
Other Incidental Findings		Mastoid Sclerosis	3	6.00	47	94.00

As even minor variations were considered in the study all the patients had one or the other anatomical variation. Some patients had a single variation and in some a combination of various anatomical variations were seen.

The most common anatomical variation was Deviated nasal septum which was seen in 60% of the patients. The next most common anatomical variation was concha bullosa which was seen in 54% of patients.

In optic nerve variations Type I was the most common type (84%).

In ethmoid roof variations Kero's Type II was the most common type (80%).

Table 2: Association between Anatomical Variations of Sinus and Sinus Pathology distribution

		Sinus Pathology						P value
		Present		Absent		Total		
		Count	%	Count	%	Count	%	
Agger Nasi Cells	Right	3	8.82	1	6.25	4	8.00	0.754
	Left	3	8.82	1	6.25	4	8.00	0.754
Nasal Septal Deviation (Towards Right)	With Spur	4	11.76	1	6.25	5	10.00	0.544
	Without Spur	7	20.59	3	18.75	10	20.00	0.88
Nasal Septal Deviation (Towards Left)	With Spur	3	8.82	1	6.25	4	8.00	0.754
	Without Spur	4	11.76	5	31.25	9	18.00	0.094
S Shaped	S Shaped	1	2.94	1	6.25	2	4.00	0.578
Uncinate Process Variations	Lateralised	3	8.82	1	6.25	4	8.00	0.754
	Medialized	3	8.82	0	0.00	3	6.00	0.22
	Pneumatised	1	2.94	1	6.25	2	4.00	0.578
	Bent	1	2.94	0	0.00	1	2.00	0.488
Concha Bullosa	Right	11	32.35	4	25.00	15	30.00	0.597
	Left	11	32.35	1	6.25	12	24.00	0.044*
Lamellar Concha	Right	6	17.65	3	18.75	9	18.00	0.925
	Left	8	23.53	3	18.75	11	22.00	0.704
Paradoxical Curvature	Right	4	11.76	1	6.25	5	10.00	0.544
	Left	2	5.88	2	12.50	4	8.00	0.421
Haller Cells	Right	2	5.88	2	12.50	4	8.00	0.421
	Left	4	11.76	2	12.50	6	12.00	0.941

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Supraorbital Ethmoid Cell	Right	5	14.71	2	12.50	7	14.00	0.834
	Left	7	20.59	1	6.25	8	16.00	0.197
Frontoethmoidal Cell Variations	Type 1	7	20.59	3	18.75	10	20.00	0.88
	Type 2	11	32.35	2	12.50	13	26.00	0.135
	Type 3	10	29.41	2	12.50	12	24.00	0.192
	Type 4	0	0.00	2	12.50	2	4.00	0.035*
Onodi Cell	Right	5	14.71	1	6.25	6	12.00	0.391
	Left	4	11.76	0	0.00	4	8.00	0.153
Pneumatised ACP	Right	3	8.82	1	6.25	4	8.00	0.754
	Left	3	8.82	0	0.00	3	6.00	0.22
Pneumatised Pterygoid process	Right	8	23.53	3	18.75	11	22.00	0.704
	Left	7	20.59	3	18.75	10	20.00	0.88
Optic Nerve Variations	Type 1	30	88.24	12	75.00	42	84.00	0.234
	Type 2	2	5.88	2	12.50	4	8.00	0.421
	Type3	1	2.94	2	12.50	3	6.00	0.184
	Type 4	1	2.94	0	0.00	1	2.00	0.488
Kero's	Type 1	7	20.59	3	18.75	10	20.00	0.88
	Type 2	27	79.41	13	81.25	40	80.00	0.88
	Type 3	0	0.00	0	0.00	0	0.00	
Aerated Crista Galli		1	2.94	2	12.50	3	6.00	0.184
Variations of Maxillary Sinuses	Hypoplastic	0	0.00	0	0.00	0	0.00	
Septations	Right	4	11.76	3	18.75	7	14.00	0.507
	Left	6	17.65	3	18.75	9	18.00	0.925
Other Incidental Findings	Mastoid Sclerosis	1	2.94	2	12.50	3	6.00	0.184

In the present study there was positive association between Concha bullosa and sinus disease (p value-0.044).
There was no positive association with the sinus disease in other variations.

Discussion

In this study the most common anatomical variation was Deviated nasal septum which was seen in 60% of the patients. The next most common anatomical variation was concha bullosa which was seen in 54% of patients.
Comparison of incidence of various anatomical variations in studies conducted by various authors is shown in the table given below.

Table 3: Comparison of Anatomical Variations in Percentage in Various Studies

Anatomical variation	Present study	Katya A. Shpilberg [7]	Saraswathi Gopal [8]	Shephali S Pawar [9]	Devimeenal Jagannathan [10]	Bhatia JSS [11]	Neeraj Suri [12]
DNS	60	61.4	67	77	56.5	86.25	75
Agger Nasi cell	16	83.3	79	42	37	15	6.6
Concha Bullosa	54	26	39	34	20.5	28.75	41.6
Lamellar Concha	40	-	-	-	39	17.5	-
Paradoxical Middle Turbinate	18	15.6	-	11.3	16	13.75	8.3
Haller Cell	20	39.1	12	10	18.5	8.75	1.6
Supra orbital Ethmoidal cell	30	28.1	-	-		-	-
Frontal cells	74	-	45	-		-	-
Onodi Cell	20	12	23	06	10	20	4.1
Pneumatized anterior clinoid process	42	16.7	-	-	19	17.5	-
Aerated Crista Galli	06	9.9	-	-	22	8.75	-
Septations of maxillary sinus	32	-	21	-	4	-	-

In the present study the incidence of uncinate process variations was 20% which includes lateralized (8%) and medialized uncinate (6%) process, pneumatized uncinate process (4%) and bent uncinate process (2%).
Study conducted by Neeraj Suri *et al*. showed that the incidence of uncinate process deviation/hypertrophy was 12.5%, whereas the incidence of pneumatized uncinate process was not reported.
Study conducted by Katya A. Shpilberg *et al*. showed the incidence of pneumatized uncinate process was 13.5% whereas the incidence of lateralized/medialized/bent uncinate process was not calculated.
Study conducted by Devimeenal Jagannathan *et al*. showed the incidence of uncinate process variants such as horizontal uncinate, hypertrophied uncinate, pneumatization of uncinated process was 9%.
Study conducted by Demet Yazici *et al*. reported the incidence of uncinate process pneumatization to be 5.3% in 225 patients.
Study conducted by Shephali S Pawar *et al*. showed that pneumatization of uncinated process is a rare

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anatomical variant was found in 2% patients and was unilateral in all cases [14].

Table 4: Comparison of Optic Nerve Variations

Optic Nerve Variations	Present Study (%)	Devimeenal Jagannathan [10]	Demet Yazici [13]
Type 1	84	81	54.2
Type 2	8	9	12.9
Type 3	6	8	16
Type 4	2	2	16.9

Table 5: Comparison of Ethmoidal Roof Variations

Kero's Types	Present Study	Devimeenal Jagannathan [10]
Type 1	20	26.3
Type 2	80	73.3
Type 3	0	0.5

Conclusion

The most common anatomical variation in this study was Deviated nasal septum and the next most common was concha bullosa. In optic nerve variations Type I was the most common type. In ethmoid roof variations Kero's Type II was the most common type.

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