Original Article

Assessment of anatomical variations of nose and paranasal sinuses in multidetector computed tomography

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Abstract

Introduction: Paranasal sinuses are a group of air filled spaces developed as an expansion of the nasal cavities, eroding the adjacent bone structures. Conventional radiology does not permit a detailed study of anatomical variations of nose and paranasal sinuses. Currently, MDCT scanning is the standard imaging modality in the evaluation of the paranasal sinuses and anatomical variations.

Methodology: A cross-sectional hospital based study of 128 patients referred for CT scan of PNS was conducted from October 2015 to February 2016. CT scan was done in 128 slice Siemens Somatom Definition AS^{+} CT scanner machine applying standard protocol set by the department of radiology and imaging, Tribhuvan University Teaching Hospital, Maharajgunj. The images were evaluated for presence of any anatomical variants in paranasal sinuses.

Results: The absolute frequency of anatomical variations are Agger Nasi cell (75.8%) and DNS (68%) along with Concha Bullosa (35.9%), Paradoxical middle turbinate (26.6%), Haller's cell (15.7%) and Onodi cell (18.8%). In this study the most frequent type of olfactory fossa was Keros type 2 (63.3%). The typical orientation of uncinate process was found in both sides 199 (77.73%) whereas medial deviation in left side (20.3%) and right side was (18.8%) along with lateral deviation in left side was (3.9%) and right side was found in (1.6%) only.

Conclusion: Anatomical variations of nose and paranasal sinuses are best depicted on MDCT scan of PNS on coronal plane with thin slice (3.0 mm) section along with bone algorithm. Agger nasi cell is the commonest anatomical variation (75.8%) followed by DNS, Concha bullosa, Paradoxical middle turbinate, Onodi cells and Haller's cells.

Keywords: Concha bullosa, Multidetector CT, Osteomeatal complex, Paranasal Sinuses

Introduction

Paranasal sinuses communicate with the nasal cavities via small openings and narrow ducts that allow both aeration and sinus drainage.[1] Sinonasal inflammatory disease is a frequently encountered health problem in community. Traditionally, plain films were the modality of choice in evaluation of sinus pathology. Conventional radiography does not permit a detailed study of the nasal cavity and paranasal sinuses and has now largely been replaced by MDCT scan. Currently, CT scan is the standard imaging modality in the evaluation of the paranasal sinuses. This gives an applied anatomical view of the region and other anatomical variant that are often found in PNS. A precise knowledge of the normal anatomy of the paranasal sinuses is essential for the clinician to understand the variation which might be associated in the disease processes.[2]

Many studies on anatomical variations of nose and paranasal sinuses in MDCT scan found that these variations may cause blockage of OMC and lead to chronic sinusitis. The current endoscopic sinus surgery necessitates detecting these variants to prevent potential hazards.[3] The use of endoscopy for the evaluation and surgical treatment of paranasal sinus diseases are

increasing, hence attention is now being directed toward anatomy of latral nasal wall and paranasal sinuses.[4]

MDCT has replaced plain radiography especially prior to functional endoscopic sinus surgery (FESS) due to anatomical precision required by surgeons. MDCT has also been found to be superior to MR imaging in planning for FESS. Coronal CT has become the investigation of choice in evaluation of pathologies of nose and paranasal sinuses especially in planning FESS.[5,6,7]

Methods

A hospital based prospective observational study was conducted in the Department of Radiology and Imaging, Tribhuvan University Teaching Hospital, Maharajgunj, Kathmandu from October 2015 to February 2016. A total of 128 patients above 17 years of age referred by physician for MDCT scan examination of nose and paranasal sinuses were included in the study. All the patients with history of previous nasal surgery, severe bony erosive pathology were excluded. The study protocol was approved by the Institutional Review Board (IRB). The patients were explained about the MDCT scan examination and asked to remove any metallic object from the region of interest. A written consent was taken and MDCT scan of the patients were performed in 128 slice Siemens Somatom Definition AS^{+} CT scan (Model no. 08098027) according to the standard scan protocol with slice thickness of 3.0 x 3.0 mm set by the department. The axial sections were obtained in supine position with caudocranial direction from hard palate to superior margin of frontal sinus. Obtained image data were reconfigured into coronal, axial and sagittal planes using multiplanar reformation technique in Syngo via CT work station. Anatomical variants assessed were Agger nasi cells, Haller's cells, Onodi cells, Concha bullosa, DNS along with Uncinate process orientation, Keros type and other uncommon variations. DNS were observed by any deviation of nasal septum from straight line drawn from crista galli to maxillary crest. Uncinate process orientation was assessed by visual inspection. Data were analyzed using standard SPSS software Version 20.

Results

A total of 128 patients in which 57% male and 43% female patients were included in this study. The anatomical variations were found more in female patients than male and gender showed no significant correlation on any of the anatomical variants (P-values>0.05). (Table 1)

Table 1: Gender wise distribution of anatomical variants (n= 128)

Anatomical Variants	Categories	Gender		Total	P value
		Male	Female		
DNS	Right	18	28	46	0.639
	Left	20	21	41	
	Absent	18	23	41	
Concha Bullosa	Right	7	5	12	0.497
	Left	7	10	17	
	Bilateral	7	10	17	
	Absent	35	47	82	
Haller's cells	Right	0	2	2	0.427
	Left	5	8	13	
	Bilateral	3	2	5	
	Absent	48	60	108	
Agger nasi cells	Right	4	0	4	0.721
	Left	4	9	13	
	Bilateral	33	47	80	
	Absent	15	16	31	
Onodi cell	Present	12	12	24	0.395
	Absent	44	69	104	
Paradoxical middle turbinate	Present	17	17	34	
	Absent	39	55	94	

Age wise distribution of Anatomical variants

Most of the anatomical variants were found in age group of 27-36 followed by 17-26 and 37-56 respectively. The study showed significant correlation of age with Agger nasi cell (p = 0.021) and Haller's cells (p = 0.024) where as other variants had found no significant correlation. (Table 2)

Table 2: distribution of anatomical variation according to age (n= 128)

Anatomical Variants	Categories	Age						Total	P value
		17-26	27-36	37-46	47-56	57-66	67 -76		
DNS	Right	12	18	8	4	4	0	46	0.208
	Left	14	11	6	4	5	1	41	
	Absent	9	10	12	6	3	1	41	
Concha Bullosa	Right	4	2	4	1	1	0	12	0.763
	Left	2	9	3	2	1	0	17	
	Bilateral	3	7	3	4	0	0	17	
	Absent	26	21	16	7	10	2	82	
Haller's cells	Right	0	0	1	0	1	0	2	0.024*
	Left	2	5	2	1	2	1	13	
	Bilateral	2	0	1	1	1	0	5	
	Absent	31	34	22	12	8	1	108	
Agger nasi cells	Right	0	2	1	0	1	0	4	0.021*
	Left	2	2	4	2	3	0	13	
	Bilateral	22	25	15	10	7	1	80	
	Absent	11	10	6	2	1	1	31	
Onodi cell	Present	5	7	5	4	3	0	24	0.415
	Absent	30	32	21	10	9	2	104	
Paradoxical MT	Present	12	9	5	3	4	1	34	0.665
	Absent	23	30	21	11	8	1	94	

Note: * denote significant correlation at the 0.05 level, (2- tailed test)

Deviated nasal septum (DNS) Distribution

In this study DNS was found in 87 (68%) patients in which right side was in 46 (35.9%) and left side was in 41 (32%).

Paradoxical middle turbinate

In this study paradoxical middle turbinate was present in 34 (26.6%) patients whereas absent in 94 (73.4%) patients. (Fig. 1)

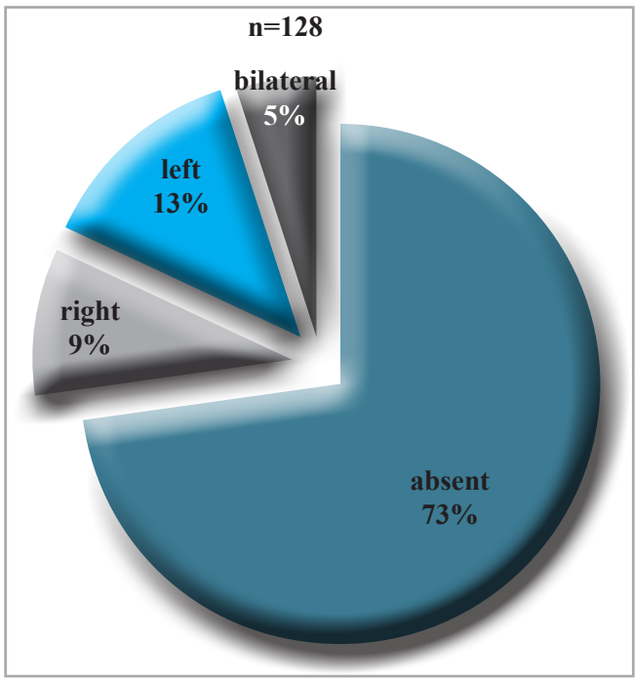

Figure: 1 Distribution of paradoxical middle turbinate (n=128)

Concha bullosa distribution

Out of 128 patients concha bullosa was found in 46 (35.9%) and absent in 82 (64.1%) patients and both sided concha bullosa was found in 17 (13.3%) in which left sided in 17(13.3%) and right sided found in 12(9.3%) patients. (Table 4)

Concha Bullosa	Frequency	Percent
Right	12	9.3
Left	17	13.3
Both side	17	13.3
Absent	82	64.1
Total	128	100

Haller cells distribution

Out of 128 patients Haller cells were found in 20 (15.7%) patients whereas absent in 108 (84.3%) patients. Both sided Haller cells were found in 5 (3.9) patients, left sided were in 13 (10.2%) and right sided were in 2 (1.6%) patients.

Agger nasi cells distribution

Out of 128 patients Agger nasi cells were found in 97 (75.8%) patients whereas absent in 31 (24.2%) patients. Both sided Agger nasi cells were found in 80 (62.5%) in which left sided were 13 (10.2%) and right sided were in 4 (3.1%) patients. (Fig. 2)

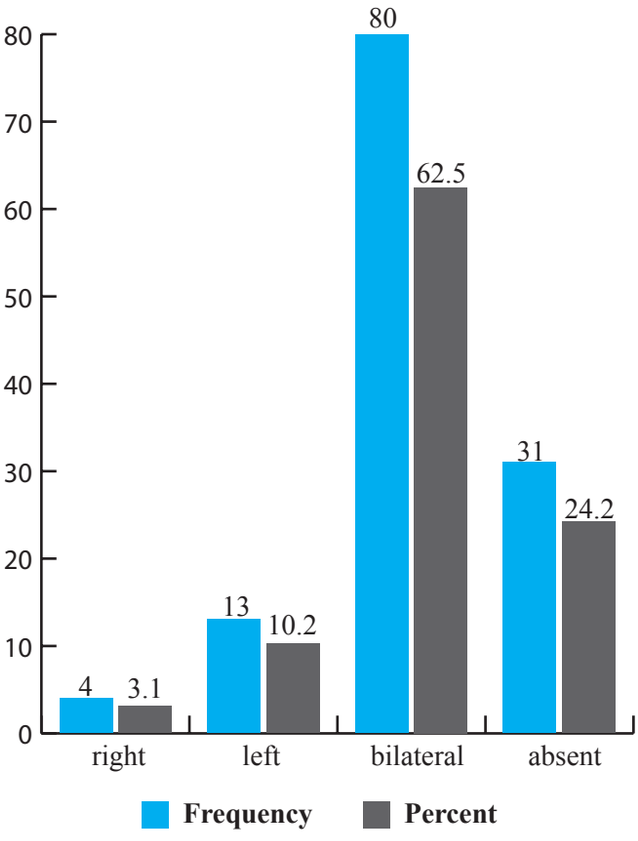

Figure. 2 Distribution of Agger nasi cells (n=128)

Onodi cells distribution

Out of 128 patients Onodi cells were present in 24 (18.8%) and absent in 104 (81.3%) patients.

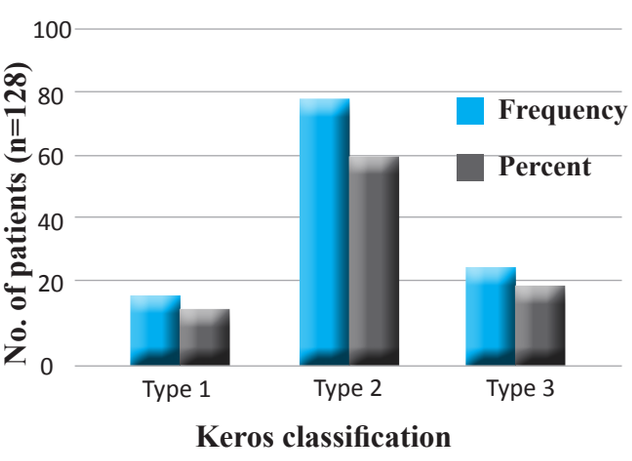

Figure 3 Distribution of Keros classification (n=128)

Discussion

Assessment of anatomical variations of nose and paranasal sinuses has been benefited from the introduction of MDCT. The standard study may be performed in the coronal plane or reconstructed in the coronal plane from multi detector axial data sets. Coronal and sagittal reformations from axial acquisitions may provide useful information to the radiologist or the referring clinicians. The capability of thin section acquisition improves visualization of small pathological detail and the isotropic nature of high spatial resolution data sets enables display in arbitrary planes.[8, 9] The prevalence of anatomical variations of nose and PNS were presented differently in various studies and it could be due to the result of discrepancies in analyzing and studying methods, definitions, racial varieties and the accuracy of study.[10, 11]Among anatomical variation of nose and PNS, deviated nasal septum was commonest in which the nasal septum is significantly off centre or crooked. According to the results obtained in the study conducted by Mohammed Hosein Daghighi et al, the septal deviation (39% in males, 35.29% in females) was the most common normal variation, in the present study deviated nasal septum was (29.68% in males, 38.28% in females) noted. [10, 12, 13]

A paradoxical middle turbinate (PMT) can lead to significant narrowing of the middle nasal meatus and impedes the normal drainage of paranasal sinuses due to ostiomeatal complex obstruction. In our study paradoxical middle turbinate was found in 34 (26.6%) patients while Tonai et al found 25% which was found to be close to the present study. In the other studies it was from 10 to 25%.[14] Haller's cells are an extension of ethmoid pneumatization along the roof of maxillary antrum, have also been suggested as a causative factor in sinusitis because of their ability to cause narrowing of the infundibulum. [15] In this study, Haller's cells were found in 15% of cases where as Kantarci and Sarna reported the frequency of Haller cell 18% and 10% respectively.

The reported prevalence of Agger nasi cell varies widely among investigator. [16] In the present study the incidence of Agger nasi cell was found in 75.8% of patients in which right sided in 3.1%, left sided in 10.2% and both sided in 65.2% of patient and Agger nasi cell was found statistically significant (p = 0.021) with age of the patient whereas A Azila et al found 83% in patient with CRS, 79% of incidence of Agger nasi cell in control group and found no statistical significant with age of the patient.

The Onodi cells are the posterior most ethmoid air cells that lie superior to the sphenoid sinus and are an important anatomical variant due to the intimate spatial relationship with the optic nerve and internal carotid artery. [17] In our study the frequency of Onodi cell was 18.8% with equal frequency in both male and female (9.4%). Fatmah Al Zahra Banaz et al reported the prevalence of Onodi cells among patients who underwent CT PNS was 14.4% and with no statistical significance with age and gender.

There were few uncommon anatomical variations in our study with crista galli penumatization in 3.1%, ethmoid bulla in 12.5%, maxillary sinus hypoplasia in 2.3%, nasal spur in 1.6%, septal pneumatization in 6%, superior turbinate pneumatization in 0.8% and uncinate process pneumatization in 3% of cases.

Conclusion

Agger nasi cell was the commonest anatomical variation of PNS followed by DNS, Concha bullosa, Paradoxical middle turbinate, Onodi cells and Haller's cells. Typical type orientation of uncinate process was the commonest orientation. Some uncommon varaiations like crista galli pneumatization, uncinate process pnumatization and maxillary sinus hypoplasia were also seen.

Conflict of interest: None declared.

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