Study of Anatomical Variations of Nose and Para-nasal Sinuses in Computed Tomography Scan

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ABSTRACT

Introduction: Computed tomography (CT) has nowadays become the investigation of choice for diagnosis and evaluation of anatomical variations of the nose and paranasal sinuses.

Methods: A cross sectional study was conducted in the Department of Radiology of Lumbini Medical College Hospital from June 2019 to May 2020. Total of 130 patients were enrolled for the study. All patients were subjected to Siemens Somatom scope 16 slice CT scan. Each scan was studied for the presence of agger nasi cell, concha bullosa, deviated nasal septum, haller cell, onodi cell, uncinate process variation and type of olfactory fossa.

Results: The mean age of patients was 36. 86 ±12.06 years. There were 76 males (58.5%) and 54 females (41.5%) with male: female ratio of 1.4:1 with highest range in age group of 31 to 45 years (46.9%). Anatomical variation between male and female was statistically not significant (p>0.05). The most common anatomical variation noted was nasal septal deviation (73.1%), then agger nasi cell (59.3%), concha bullosa (24.6%), paradoxical medial turbinate (7.7%), onodi cell (6.9%), uncinate process variation (5.4%) and least was haller cell (4.6%). Most of the scans had more than one anatomical variation, which was statistically significant (p<0.05). The most common type of olfactory fossa depth was Keros type II (61.5%).

Conclusion: Computed tomography of the paranasal sinus has improved the visualization of anatomical variation hence radiologist must pay close attention to variants.

Keywords: Anatomical variation, Computed tomography, Paranasal sinuses

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INTRODUCTION

Evaluation of anatomical variations of the nose and paranasal air sinuses is important in patients who are undergoing computed scan for various rhinologic reasons. It provides the assessment of paranasal sinuses, olfactory fossa depth, excellent anatomical soft tissue, bony details and thus helps in the diagnosis.[1] Nowadays imaging investigation choice for the evaluation of nose and paranasal sinuses is computed tomography, which provides road map for functional endoscopic sinus surgery and explains the recurrence of diseases.

The development of the paranasal sinuses especially the ethmoid labyrinth is associated with anatomical variations.[2] The common anatomical variants that can interfere with the mucociliary drainage of ostiomeatal complex are deviated nasal septum, concha bullosa, uncinate process variations, large ethmoid bulla, paradoxical middle turbinate, agger nasi cell and haller cells.[3] The knowledge of these anatomical variations is important before surgery is planned to avoid damage to surrounding structures.[4] The frequency of these variations may differ among the different ethnic groups.[5] The aim of this study is to report the frequency of these anatomical variations in patients with sinonasal symptoms who underwent computed tomography (CT) scan.

METHODS

This was descriptive cross-sectional study carried out in the Department of Radiology, Lumbini Medical College and Teaching Hospital (LMCTH), Nepal over a period of one year from June 2019 to May 2020 . A total of 130 patients underwent computed tomography scans during this period. Ethical approval from Institutional Review Committee of the institute was obtained prior to enrollment of the patients. The reporting was done by principle author to reduce bias.

Inclusion criteria:

Patients with age ≥15 years

CT scan of 3 mm cuts

Patients with diagnosis of chronic rhinosinusitis

Exclusion criteria:

Patients with previous history of nasal surgery

Sample size:

The incidence of paranasal sinus variation in patients undergoing CT scan varies. Study done by Sharma BN et al had prevalence of 68.2% [8] of anatomical variation on CT scan so the estimated sample size was calculated using this formula.

$N \geq Z^2_{1-\alpha/2} \times P (1-P)/d^2$

Alpha (α): type I error

P: expected proportion

d: margin of error

Based on 95% confidence interval with margin of error 10% sample size was calculated (N) and it was 84.

Technique of CT scan:

Material and equipment used: Siemens Somatom scope, 16 slice.

Procedure:

It was an outpatient setting where patient came from Department of Otorhinolaryngology for CT scan of paranasal sinus. CT scan was done by radiographer which took 30 minutes to do. After the procedure, patients were requested to wait or come back for CT scan report on a given day. Images were taken in axial plane then reconstruction was done in both coronal and sagittal plane in 3 mm cut. After the CT scan, the radiologist reported on anatomical variants visualized on checklist with regard to the plane and side whether left, right, or bilateral.

Data was entered and analyzed with Statistical Package for Social Sciences (SPSS™) software version 16. Descriptive statistics was presented as frequencies, percentage, mean and standard deviation (SD). Categorical variables were analyzed using Chi Square test. P-value less than 0.05 was considered statistically significant.

RESULTS

A total of 130 patients undergoing CT scan were enrolled in the study. The mean age of patients was 36.86 ±12.06 years. The sample consisted of 76 males (58.5%) and 54 females (41.5%) with male: female ratio of 1.4:1 with highest range in age group of 31 to 45 years (46.9%) (Table 1 and 2) Male had more anatomical variation of paranasal sinuses than female but it was statistically not significant (p>0.05). Table 3

Table 1. Distribution of patients according to Gender (N=130)

Gender	Total	%
Male	76	58.5
Female	54	41.5
Total	130	100

Table 2. Distribution of patients according to Age

Age group(years)	N=130	%
15-30	42	32.3
31-45	61	46.9
64-60	24	18.5
Above 60	3	2.3
Total	130	100

Table 3. Type of anatomical variation according to gender

Abnormality	Male	Female	Total	P value
Nasal septal deviation	57(43.8%)	38(29.3%)	95(73.1%)	0.348
Agger nasi cell	43(33.1%)	34(26.2%)	77(59.3%)	0.292
Concha bullosa	19(14.6%)	13(10.0%)	32(24.6%)	0.537
Paradoxical middle turbinate	8(6.2%)	2(1.5%)	10(7.7%)	0.134
Onodi cell	5(3.8%)	4(3.1%)	9(6.9%)	0.559
Uncinate process variation	4(3.1%)	3(2.3%)	7(5.4%)	0.617
Haller cell	4(3.1%)	2(1.5%)	6(4.6%)	0.512

The most common anatomical variation was nasal septal deviation (n=95, 73.1%) which was more common on right side (n=50, 38.5%) than left (n=45, 34.6 %) and there was no deviation on 35 cases (26.9%). Similarly next common anatomical variation was agger nasi cells (n=77, 59.3%) seen on both sides (n=40, 30.8%) then right (n=23, 17.7%) and left (n=14, 10.8%) and without any variation in 53(40.8%). Concha bullosa was present on 32 cases (24.6%) with more of bilateral predominance (n=14, 10.8%) on left side (n=10, 7.7%) on right (n=8, 6.2%).

Paradoxical medial turbinate was seen in 10 (7.7%) scans with more on right (3.1%) than left (2.3%). Onodi cell was seen in 9(6.9%) scans with 5(3.8%) on right and 3(2.3%) on left and 1 case (0.8%) on bilateral side Uncinate process variation was seen in 7(5.4%) cases with right 4(3.1%) and left 2(1.5%) and 1 case(0.8%) bilaterally. Haller cell was seen in 6(4.6%) scans with 3(2.3%) on right and 1.5% on left with 1(0.8%) case on both sides. There were more than one anatomical variation present on single scan which was statistically significant (p<0.05). (Table 4)

Table 4 Laterality of Sino nasal anatomical variation

Anatomical variations	Right	Left	Both	Total	P value
Nasal septal deviation	50(38.5%)	45(34.6%)	------	95(73.1%)	
Agger nasi cell	23(17.7%)	14(10.8%)	40(30.8%)	77(59.3%)	
Concha bullosa	8(6.2%)	10(7.7%)	14(10.8%)	32(24.6%)	
Paradoxical middle turbinate	4(3.1%)	3(2.3%)	3(2.3%)	10(7.7%)	
Onodi cell	5(3.8%)	3(2.3%)	1(0.8%)	9(6.9%)	
Uncinate process variation	4(3.1%)	2(1.5%)	1(0.8%)	7(5.4%)	P<0.05
Haller cell	3(2.3%)	2(1.5%)	1(0.8%)	6(4.6%)	

The olfactory fossa lies in anterior skull base. The depth of olfactory fossa is determined by the height of the lateral lamella of cribriform plate and divided into three types by Keros. The incidence of Keros type I was 34.7 %, type II 61.5% and type III was 3.8%. (Table 5)

Table 5.Type of olfactory fossa type

Olfactory fossa type	N=130
Type 1	45(34.7%)
Type 2	80(61.5%)
Type 3	5(3.8%)

DISCUSSION

The anatomy of the sinonasal area has wide range of anatomical variations. There is significance of these anatomical variations in pathogenesis of rhinosinusitis. CT scan is the investigation of choice for paranasal sinuses which allows axial plane slices to be obtained, from which reconstruction to sagittal and coronal planes can be made. The coronal plane best displays the ostiomeatal complex and axial plane identifies the basal lamella of middle turbinate, which divides anterior and posterior ethmoid sinuses. CT scan in coronal plane is more informative than axial cuts because it shows anatomical structures progressively as a surgeon's visualization and the relationship of sinus cavities with adjacent structures. In our study prevalence of anatomical variation was high in the middle age with mean age of 36.86+-12.06 years which correlates with other studies done by Joe JK et al [6] and Sheetal D et al.[7] The higher prevalence in these patients may be due to their active working conditions and more concern regarding their health, thereby visiting hospital for further treatment.

The most common anatomical variation in our study was nasal septal deviation which is a shift in the midline position of the septum to either left or right, and may be cartilaginous, osseous or combined deviation involving the osseous or cartilaginous part of the septum. In our study, it was seen in 95(73.1%) cases and more towards right side in 50(38.5%) cases. Similarly study done by Sharma BN et al (68.2%) [8] and Shpilberg KA et al (98.4%) [9] also showed deviated nasal septum was most common anatomical variation on their study with prevalence being variable in the population.

Next common anatomical variation was agger nasi cell, which is the most anterior ethmoid air cell located just front of middle turbinate and below the frontal sinus. They are related to the frontonasal recess. Recognition of this relationship is crucial in management of frontal sinusitis. In our study agger nasi cell was seen in 77(59.3%) cases, of which 23(17.7%) were on right side, 14(10.8%) on left side and 40(30.8%) were bilateral. Study done by Talaiepour et al (56.7%) [10], Kantarci et al (47%) [11] had similar finding on their study but it was lower in study done by Messerklinger (10-15%). [12] which may be due to lack of CT scan during that time for diagnosis of paranasal sinuses.

Concha bullosa (CB) is pneumatization of the middle turbinate. Bolger et al [13] classified concha bullosa pneumatization as per the location of middle turbinate

into lamellar, bulbous and extensive. The extensive type is the combination of both the lamellar and bulbous type. Concha bullosa has a role in the pathogenesis of rhinosinusitis because they narrow the middle meatus and the infundibulum. In our study (24.6%) had concha bullosa and majority of them were bilateral (10.8%). Similar to study done by Kayalioglu G et al (28.88%) [14], Maru YK et al (42.6%) [15] and Sivasli E et al (58%).[16] Studies have found the prevalence of concha bullosa to be the same in patients with and without sinus disease symptoms.

Paradoxical middle turbinate is a curvature of the middle turbinate towards ostiomeatal complex that is on the lateral side rather than medial side and seen in 4% to 27% [16] of the population. They predispose patients to unilateral sinusitis if they block the middle meatus. In our study 10 (7.7%) cases had paradoxical middle turbinate. Study done by Perez et al showed paradoxical middle turbinate in (10%) [17], Adeel M et al (14.3%) [18] and Jyothi A et al (4%).[19]

Another variation was Onodi cell, which is posterior ethmoid cell that extends posterior, lateral and superior to sphenoid sinus. Extensive pneumatization can expose the circumference of optic nerve. Onodi cells are also known as sphenoethmoid cells and are important to the surgeon in Functional Endoscopic Sinus Surgery because when present, optic nerve and carotid artery may be at risk for injury. They were best visualized on axial cuts where the course of optic nerve can be followed as a relation. In our study prevalence of Onodi cell was seen in 6.9%. Study done by Talaiepour A showed (7%) [10] and Kaygusuz A et showed (9.2%).[20]

Uncinate process has three superior attachment and can have variation of lateral or medial bent. Bent uncinate process can impair sinus ventilation in the anterior ethmoid, frontal recess and infundibulum regions. In our study uncinate process variation was seen in 7(5.4%) scan with medial bent on four cases and lateral bent on two cases. there was one lateral bent on both sides. The bent of uncinate process was more common on right side 4(3.1%). The prevalence of these variations was similar to study done by Bolger et al (2.5%) [13] and slightly higher in Maru YK et al (9.8%).[15]

The lowest anatomical variation noted in our study was Haller cell, which are anterior ethmoid air cells located in the orbital floor also known as infraorbital ethmoid air cell. They are etiological factor for sinusitis if they enlarge and narrow the ostium of the maxillary sinus or the ethmoid infundibulum. In the present study prevalence of Haller cell was present in 6 (4.6%) cases of which 3 (2.3%) were on right, 2 (1.5%) were on left and 1 (0.8%) on both sides. In study done by others the prevalence was variable from 2.7% to 45.1%. Prevalence of haller cell was found to be similar to study done of Perez-Pinas et al (3%) [17], Zinreich et al (10%) [21], Lerdlum S et al (9.4%) [22] and differ from Bolger et al (45%).[13]

In our study we measured the depth of olfactory fossa. Depth of olfactory fossa is divided in to three types, according to Keros classification where 1-3mm is type I, 4-7mm is type II and 8- 16 mm is type III. In our study type II (61.5%) was most common and correlates with study done by Kaplanoglu H et (76.1%) [23], Babu AC et al (74.6%) [24] but differ from Solares et al [25] which showed Type I(83%) to be most common. So as radiologists the depth has to be measured in every case because higher depth of olfactory fossa has more chances of injury to skull base during surgery.

These studies support and strengthen that there are more than one anatomical variation of paranasal sinuses and varies between populations.

LIMITATION

This study does not correlate with pathological finding and endoscopic finding.

CONCLUSION

Anatomical variations of paranasal sinus are quite common. Computed tomography of the paranasal sinus has improved the visualization of anatomical variation so radiologist must pay close attention to variants. Failure to recognize these variants is associated with a higher rate of surgical complication and also recurrence of the disease.

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