Prevalence of Anatomical Variations of the Sinonasal Region and their Relationship with Chronic Rhinosinusitis

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ABSTRACT

Background

Precise knowledge of anatomic variations of nose and paranasal sinus complex is essential for achieving best surgical results during endoscopic sinus surgery. Computed tomography is the gold standard investigation for evaluation of paranasal sinuses and adjacent structures.

Objective

To study prevalence of anatomical variations of nose, paranasal sinuses and osteomeatal complex and to identify a probable association between anatomical variations and chronic rhinosinusitis.

Method

Prospective, analytical study conducted in 218 patients with Chronic rhinosinusitis in Department of Radiology, Dhulikhel Hospital, Kathmandu University Hospital between January 2015 to January 2016. Volumetric axial CT scan was done in 128 slice CT scanner in 3mm thickness from frontal sinus to floor of maxillary sinus with thin multiplanar reconstruction. Radiological findings were reviewed and obtained data analyzed with SPSS version 16. Pearson chi square test and Pearson correlation coefficient were used for statistical analysis.

Result

The most common anatomical variation was pneumatized agger nasi cells followed by concha bullosa and deviated nasal septum respectively. Statistical significance were seen between ipsilateral agger nasi cell and frontal sinusitis ($p< 0.001$), ipsilateral haller cell and concha bullosa with maxillary sinusitis ($p<0.001$) and onodi cell with sphenoid sinusitis ($p<0.001$), However, no obvious statistical correlation was noted between deviated nasal septum with ipsilateral maxillary sinusitis.

Conclusion

Precise knowledge of anatomic variations of the paranasal sinuses is important in chronic rhinosinusitis to prevent possible complications during surgery. Computed tomography is the modality of choice in evaluation of paranasal sinuses and adjacent structures.

KEY WORDS

Chronic rhinosinusitis, computed tomography, osteomeatal complex

INTRODUCTION

There may be variations in anatomy of the paranasal sinuses and osteomeatal unit which may have implications in the etiology of sinus infection, recurrence of rhinosinusitis and persistence of acute and chronic inflammation. The role of anatomical variations of sinonasal cavity in the pathogenesis of Chronic rhinosinusitis is debatable,[1-4] but it is important to note these variations on Computed Tomography (CT) because of their potential implications on surgical management. CT, due to its exquisite ability to display and differentiate hypertrophic mucosa, bone, and air, is the current imaging standard for the evaluation of rhinosinusitis. CT data also serve to guide surgical navigation and planning.[5]

Congenital anomalies and normal anatomical variations in the paranasal sinus region, though rare, are important as they may have pathological consequence or may be the source of difficulty during Functional endoscopic sinus surgery.[6] Therefore, precise knowledge of anatomy and anatomic variations of the nose and paranasal sinus complex is essential to help achieve best surgical results and avoid complications.

CT is currently the modality of choice in the evaluation of the paranasal sinuses and adjacent structures. Its ability to optimally display bone, soft tissue, and air facilitates accurate depiction of anatomy and extent of disease in and around the paranasal sinus region.[7]

This study aims to report the prevalence of congenital variations of paranasal sinus area and osteomeatal unit in Nepalese patients suffering from Chronic rhinosinusitis and to determine the relationship between these variations and extent of Chronic rhinosinusitis.

METHODS

This is the descriptive analytical study done in Department of Radiology Dhulikhel Hospital, Kathmandu University Hospital between January 2015 to January 2016. A total of 218 patients who were refractory to medical treatment and were diagnosed as Chronic rhinosinusitis by the widely accepted definition developed by the Rhinosinusitis Task Force of the American Academy of Otolaryngology, Head and Neck Surgery met the inclusion criteria.[8] Patients with malignancy of paranasal sinuses, acute rhinosinusitis, pregnancy, immunocompromised state, patients who had undergone endoscopic sinus surgery, fungal sinusitis, cystic fibrosis, facial trauma, craniofacial anomalies, nasal or facial neoplasms, allergic rhinitis and age less than 17 years were excluded from the study.

A detailed history was taken and proforma was filled up and written informed consent was taken. The study was approved by Kathmandu University School of Medical Sciences Institutional Review Committee. CT scan was performed in 128 slice Siemens somatom perspective machine. Patient was positioned in supine position and using the parameters-130 kV, 145 mAs, and scan time of 3.5 seconds, a volumetric axial CT scan was taken with 3 mm slices thickness from the frontal sinus to the floor of maxillary sinus. Multiplanar reconstruction was done using 1 mm thin slices with 0.5 mm interval and images were obtained in all planes. The scans were studied to identify the different types of anatomical variations separately on each side. Demographic data and radiological findings were reviewed and the obtained data analyzed with SPSS version 16. The Pearson chi square test and Pearson correlation coefficient were used for statistical analysis.

RESULTS

Out of 218 patients, 110 (50.5%) were males and 108 (49.5%) were females. The age of patients ranged from 18 to 60 years (mean age 35 years). The incidence of anatomical variations are listed in Table 1. In addition to these anatomical variations, we observed dehiscence of internal carotid artery in 23 (10.6%), pneumatization of uncinate process in 22 (10.1%), dehiscence of lamina papyracea in 20 (9.2%) cases and dehiscence of optic nerve in 15 (6.8%) patients. Statistical significance was seen between ipsilateral agger nasi cell and ipsilateral frontal sinusitis ($p< 0.001$). Statistical correlation was also seen for ipsilateral haller cell and concha bullosa with maxillary sinusitis ($p<0.001$). Similarly, causal relationship was also observed between onodi cell and sphenoid sinusitis. ($p<0.001$), However no obvious statistical correlation was noted between deviated nasal septum with ipsilateral maxillary sinusitis.

Table 1. Incidence of anatomical abnormalities in Nose and paranasal sinuses.

Abnormality	Right		Left		Bilateral	
	Fre-quency	%	Fre-quency	%	Fre-quency	%
Agger nasi	144	66.1	145	66.5	191	87.6
Septal deviation	92	42.2	32	14.7	124	56.8
Haller cell	16	7.3	24	11	40	18.3
Concha bullosa	52	23.9	33	15.1	33	81
Paradoxical middle turbinate	40	18.3	46	21.1	86	39.4
Onodi cell	25	11.5	27	12.4	52	23.8

Table 2. Incidence of rhinosinusitis according to location

Rhinosinusitis	Right		Left	
	Frequency	%	Frequency	%
Maxillary	88	40.4	87	39.9
Anterior ethmoid	101	46.3	44	20.2
Posterior ethmoid	99	45.4	112	51.4
Frontal	88	40.4	93	42.7
Sphenoid	33	15.1	32	14.7

Table 3. Relationship between agger nasi cell and ipsilateral Frontal sinusitis

Right agger nasi	Right Frontal sinusitis		
	Absent	Present	Total
Absent	72	2	74
Present	58	86	144
Total	130	88	218
Left agger nasi	**Left Frontal sinusitis**		
	Absent	Present	Total
Absent	66	7	73
Present	59	86	145
Total	125	93	218
χ^2 test, p<0.001			

Table 4. Relationship between onodi cell and ipsilateral Sphenoid sinusitis

Right onodi cell	Right Sphenoid sinusitis		
	Absent	Present	Total
Absent	178	15	193
Present	7	18	25
Total	185	33	218
Left onodi cell	**Left Sphenoid sinusitis**		
	Absent	Present	Total
Absent	181	10	191
Present	5	22	27
Total	186	32	218
χ^2 test, p<0.001			

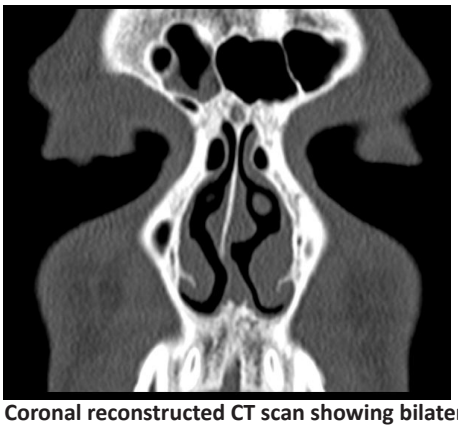

Figure 1. Coronal reconstructed CT scan showing bilateral agger nasi cells.

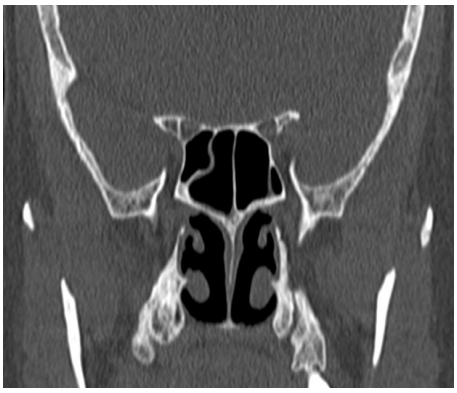

Figure 3. Coronal reconstructed CT scan showing onodi cells.

Table 5. Relationship between haller cell and ipsilateral Maxillary sinusitis

Right haller cell	Right Maxillary sinusitis		
	Absent	Present	Total
Absent	130	72	202
Present	0	16	16
Total	130	88	218
Left Haller cell	**Left Maxillary sinusitis**		
	Absent	Present	Total
Absent	131	63	194
Present	0	24	24
Total	131	87	218
χ^2 test, p<0.001			

Table 6. Relationship between ipsilateral concha bullosa and ipsilateral Maxillary sinusitis

Right concha bullosa	Right Maxillary sinusitis		
	Absent	Present	Total
Absent	112	54	166
Present	18	34	52
Total	130	88	218
Left Haller cell	**Left Maxillary sinusitis**		
	Absent	Present	Total
Absent	126	59	185
Present	5	28	33
Total	131	87	218
χ^2 test, p<0.001			

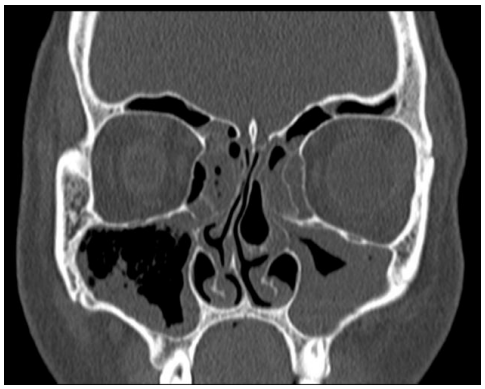

Figure 2. Coronal reconstructed CT scan showing left sided concha bullosa with nasal septal deviation to right and bilateral maxillary and ethmoid sinusitis.

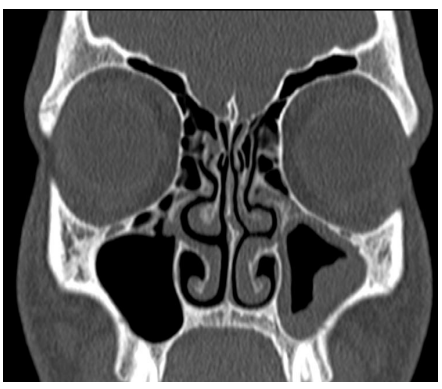

Figure 4. Coronal reconstructed CT scan showing right sided haller cells.

DISCUSSION

There is now worldwide interest among otolaryngologists in radiological definition of paranasal regional anatomy.[9] Whether the anatomical variations of paranasal sinus play a role in pathogenesis of chronic rhinosinusitis or not is still a matter of discussion and variable results have been reported.[10]

Previous studies showed no specific association of anatomic variations in rhinosinusitis and claimed that local, systemic, environmental factors and intrinsic mucosal disease were more significant in the pathogenesis of rhinosinusitis.[11-13]

In anatomical dissections, the agger nasi cell was encountered in 10-15% of specimens.[14] Recognition of this cell on Computed tomography and during surgery is essential for diagnosis and treatment of recurrent chronic frontal sinusitis. The unusual pneumatization of agger nasi causing narrowing of frontal recess can further obstruct mucociliary clearance from the frontal sinus.[15] In our study the incidence of agger nasi cells was 191 (87.6%). Our results are consistent with some other researchers who have reported frequency rates of agger nasi cell as high as 98.5% in adults.[16] In our study, statistical significance was seen between ipsilateral agger nasi cell and ipsilateral frontal sinusitis ($p< 0.001$) which is similar to that of some other researchers.[12]

Nasal septal deviation is present in 20-31% of the general population, and severe deviation has been noted as a contributing factor for sinusitis.[17] The prevalence of nasal septal deviation falls within the range of 19.4-79%.[3-5] In our study, nasal septal deviation was found in 124 (56.8%) patients. Our findings are similar to that of some other researchers.[11] We observed no significant association between ipsilateral nasal septal deviation and ipsilateral maxillary sinusitis .Similar finding was reported in an Italian study.[18] Our results are different from few of the other authors.[19,20] Perhaps, this was due to severity of deviation which was not prominent enough to cause obstruction.

Variable rates of incidence of Haller cells have been reported previously by different authors ranging from 10-45.1%.[16,21,22] In our study the incidence of Haller cell was found to be 18.3%. Haller cell is a clinically significant anatomical variation because it has been implicated as a possible etiologic factor in recurrent maxillary sinusitis due to its negative influence on maxillary sinus ventilation by narrowing the infundibulum and ostium.[23] In our study, we found a statistically significant relationship of ipsilateral haller cell with maxillary sinusitis ($p < 0.001$). Our results are similar to one of the German study.[24] However some of the other researchers found no significant association between the two.[11,15,25,26]

Onodi cells are cells that are located in the most posterior part among all posterior ethmoid cells crossing the anterior superior portion of the sphenoid sinus.[11] In a study performed among 278 computed tomographic scans from patients with rhinosinusitis , the incidence of onodi cell was reported to be 4.7%. Another study performed in New York, United States of America, reported its incidence to be from 3.4-51%.[12,27] However, in the current study, we found the Onodi cell prevalence to be 23.8%. The surgical significance of the presence of the Onodi cell makes its identification paramount. The presence of Onodi cell may possibly contribute to an increase in the risk of injury to optic nerve and to internal carotid artery, because an unsuspecting surgeon may not expect the optic nerve to be present in a posterior ethmoid cell rather than in the sphenoid sinus.[23] We found a statistically significant correlation between ipsilateral onodi cell and sphenoid sinusitis which was similar with the study performed in Brazilian population.[28]

Paradoxical curvature of the middle turbinate is described as a convexity pointing toward the middle meatus, and is reported as a possible cause for closed OMC and mucosal pathologies.[29] The incidence of paradoxical middle turbinate in our study is 39.4%. The rates of this variation in previous publications are highly variable, with incidences ranging from 3% to 40%.[16,30-32]

To the best of our knowledge, there has been no study in the past and our study is the first to report the prevalence of anatomical variations and its associations with the genesis of Chronic rhinosinusitis among Nepalese population.

CONCLUSION

Precise knowledge of anatomic variations of the paranasal sinuses is vital for carrying out good surgical therapy intra operatively and to prevent possible complications. Computed tomography is currently the modality of choice in evaluation of paranasal sinuses and adjacent structures due to its ability to optimally display bone, soft tissue, and air resulting in accurate depiction of anatomy and extent of disease in and around the paranasal sinus.

The most common anatomical variation in osteomeatal complex in chronic rhinosinusitis patients in our study were pneumatized agger nasi cells followed by concha bullosa, deviation of nasal septum, paradoxical middle turbinates, onodi cell, haller cell, dehiscence of internal carotid artery, pneumatization of uncinate process, dehiscence of lamina papyracea and dehiscence of optic nerve.

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