Anatomical Variations of Sinonasal Region, A Coronal CT Scan Study

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ABSTRACT

Introduction: The main aim of this study is to provide information regarding various anatomical variations of sinuses, their role in various sinonasal pathology and their importance before planning for endoscopic sinus surgery. With the advent of multidetector computed tomography (MDCT), imaging of paranasal sinuses prior to functional endoscopic sinus surgery (FESS) has become mandatory. Multiplanar imaging, particularly coronal reformations, offers precise information regarding the anatomy of the sinuses and its variations, which is an essential requisite before surgery.

Material and methods: The study was performed at JSS Medical College Hospital, Mysore in 100 consecutive patients from dec 2007- June 2009. All the 100 patients in the sample were referred from the ENT OPD and wards for CT PNS. Direct coronal scans of 3mm thickness were performed on TOSHIBA - ASTEION 4 slice spiral multi detector computed tomography. Scans were reviewed in both bone and soft tissue algorithm. All the scans were reviewed using Picture Archiving Communication System computer software. The scans were reviewed for the presence of deviated nasal septum, paradoxical middle turbinate, Haller cell, Onodi cell, and pneumatisation of the middle turbinate and uncinate process.

Results: The most common age group of the patients was between 20 – 30 years (36%) Further, the mean age of the total sample was 29.81±12.08 years and most of them were males the most frequent being the deviated nasal septum 62 (62%) also showed slight predominance to the left side(29%) and second common variation was Concha bullosa 43(18.2%). Occurrence of different types of special cells were studied which are better visualized on coronal CT scan images of which agger nasi is the most common variety(27%) and supra orbital cells is the least common of about(4%).

Conclusion: There is lot of variations in the anatomy of nose and paranasal sinuses especially lateral wall ofnose, all para-nasal sinus cases should be investigated individually and carefully to avoid complications and for patients' benefit. Coronal CT scan images can also be used for reconstruction in axial planes for additional information. It is fast and inexpensive compared to MRI which provides more soft tissue information than bone. Coronal CT provides more detailed information of posterior sinuses such as sphenoid and ethmoids.

Keywords: Anatomical Variations, FESS, paranasal sinuses

INTRODUCTION

Computed tomography (CT) of the para-nasal sinuses (PNS) has nowadays become the investigation of choice for the radiological diagnosis of nasal and sinus diseases.[1] Compare to plain radiography, sinus CT is best to know about anatomical soft tissue and bony details, which helps in the diagnosis, and provides detail of sinonasal anatomy and pathology for safe surgery.[2]

Endoscopic sinus surgery (ESS) is a common procedure which requires a meticulous assessment of patient and a detailed radiological description of the anatomy and its anatomical variations in nose and PNS.[3] Though the importance of anatomical variations of osteo meatal complex in the etiology of nose and para nasal disease is still in debate[4] but knowledge of these variations in each patient is important before planning for surgery to avoid injury to surrounding important structures like the orbit and the brain. The prevalence of these variations will vary ethnic groups.[5] In review of literature, there is no data on anatomical variations of nose and PNS in our population. The aim of this study was to report the frequency of these variations in patients with sinonasal symptoms who underwent CT scan in the hospital.

MATERIAL AND METHODS

The Hospital based study of CT scan PNS was done at the JSS Hospital, mysuru, and comprised data of 100 patients who visited the hospital from Dec 2007- June 2009. All patients had CT scan done for sinonasal symptoms.

Inclusion criteria

- Patients above fifteen years age. Paranasal sinuses are developed.
- Patients who consent to be included in the study.
- CT scans of three millimeter cuts.

Exclusion Criteria

- Patients with history of previous nasal surgery or trauma.
- Patients who do not consent to be included in the study.
- Patients below the age of fifteen years

All the 100 patients underwent CT scans using a Toshiba's Asteion 4-slice CT System. The study was reviewed in coronal section in bony window using Picture Archiving Communication System (PACS) software. Each scan was reviewed for the presence of haller cell, onodi cell, paradoxical middle turbinate, deviated nasal septum (DNS), pneumatisation in the nasal septum, superior and middle turbinate and uncinate process.

STATISTICAL ANALYSIS

The descriptive statistics was used to summarize the data by measuring mean, median, standard deviation and proportions. All the measurements were done using SPSS version 21.0. The

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How to cite this article: Pradeep Kumar, Rakesh BS, Rajendra Prasad. Anatomical variations of sinonasal region, a coronal ct scan study. International Journal of Contemporary Medical Research 2016;3(9):2601-2604.

graphs were made using Microsoft Excel

RESULT

The mean age of the patients was 29.81±12.08 years. Most of the patients in our study were in the age group of 20 to 30 years (32%). Male predominance was noted in the study (59%). We found most of the patients in the age groups of <20, 21-30, and 31-40 years and very few of them in higher age groups. In our study DNS was the most common variation (62%) and also showed slight predominance to the left side (29%) as compared to right side (23%). 43 patients showed concha bullosa out of which bilateral is the maximum of about 41.8% followed by right side of about 32.5% and least is on the left side of about 25.5%. In this study there were the occurrence of special cells like agger nasi cells 56 (56%) (Figure-1), Haller's cell 20.7% and Onodi cells 14.5%.

In our study frontal sinus showed septations in about 31.1%. Maxillary sinus showed septations in about 19.6%. Sphenoid sinus showed septations in about 49.1%. Frontal sinus hypoplasia was noted in 17% in which 3% were bilateral, a total of 3% of cases comprised to have hypoplastic sphenoid sinus, Maxillary sinus hypoplasia showed 2% bilaterally. In our study 43% of cases showed horizontal orientation of the uncinate process with 82% of the cases associated with enlarged ethmoidal bulla and 57% cases showed vertical orientation of the uncinate process with 8.7% of the cases associated with enlarged ethmoidal bulla. And the occurrence of different types of cribriform plates were as follows - Type 1 were 56%, Type 2 were 37% and Type 3 were 07%.

DISCUSSION

Sinonasal disease surgical management has evolved over the last few decades. External approaches and long hospital stays have been evolved to minimally invasive surgeries called endoscopic sinus surgery (ESS). Which is nothing but opening or widening of the obstructed sinus ostia to regain normal ventilation with preservation of adjacent normal mucosa and removal of disease. Literature has reported excellent results with ESS. But because of close proximity of nose and PNS to structures such as the orbit and the skull base, if any complications occur in surgery, they are dangerous and harmful usually many different anatomical variations are there in sinonasal region. though their role in the occurance of sinusitis remains unclear, but thorough knowledge of these variations is needed before the surgical procedure to avoid dreadful complications.

Compared to previous reports of Caucasian, Asian, Japanese and Indian races, in our study, we find different frequency of these variations. The best explanation for these variation is probably genetic and environmental factors.

A number of definitions are there for DNS. Any deviation that blocked at least half of the nasal cavity taken as DNS. It may be cartilaginous, osteocartilaginous or osseous. Gross DNS may result in compression of the inferior or middle turbinate, causing blockage of the normal mucous flow and, consequently, secondary inflammation and infection. DNS was found in 62 (62%) cases in our study. In other studies, this finding ranged from 14.1% to 80%.

Air cells in the nasal septum are commonly found within the posterior portion of the septum and communicate with the sphenoid sinus, allowing PNS infection to spread to these cells. And, if these cells are large, they may obstruct the drainage of the middle meatus but in our study no septal pneumatisation was seen.

CB is referred to as pneumatisation of the turbinate. The reported prevalence of CB varies widely from 14-80%, but few authors will only consider the pneumatisation of the vertical lamina and the inferior bulb of the middle turbinate as true concha bullosa. Presence of CB will limits the exposure of surgical field, and also block ostiomeatal complex (OMC) and, causes sinus disease.

The aeration of Middle turbinate was found in 43 (43%) of patients in the present study. Other studies have found prevalence ranging between 4% and 73%.

PMT is a laterally projected curvature of the middle turbinate, which may lead to the narrowing of the middle meatus. One study reported PMT as an etiologic factor for chronic rhinosinusitis because it may cause impaired ventilation of the OMC.

In our study PMT (Figure-2) was seen in 14 scans. Other studies found it from 11-25%.

In our study 43% of cases showed horizontal orientation of the uncinate process with 82% of the cases associated with enlarged ethmoidal bulla and 57% cases showed vertical orientation of the uncinate process (Figure-3) with 8.7% of the cases associated with enlarged ethmoidal bulla (Figure-4).

The frontal sinus drainage depends up on the attachement of upper end of uncinate process. If uncinate process is attached to the skull base or middle turbinate, the drainage of frontal

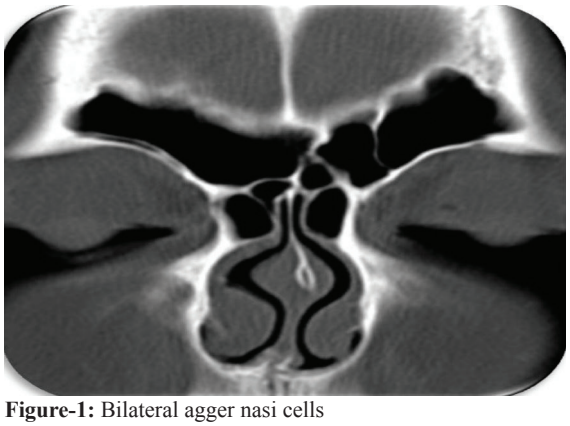

Figure-1: Bilateral agger nasi cells

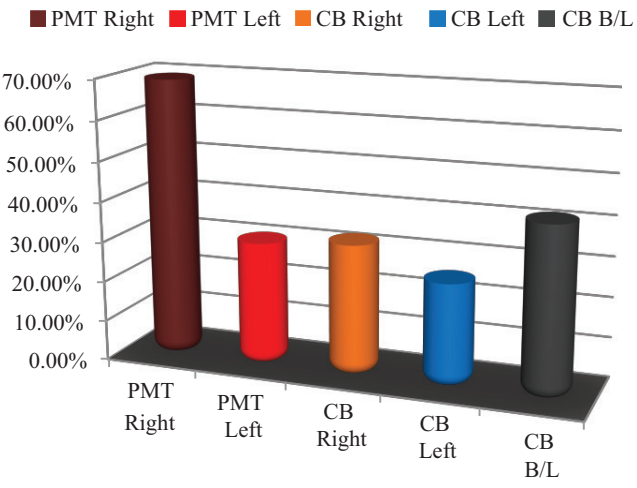

Figure-2: Frequency of variations of middle turbinate

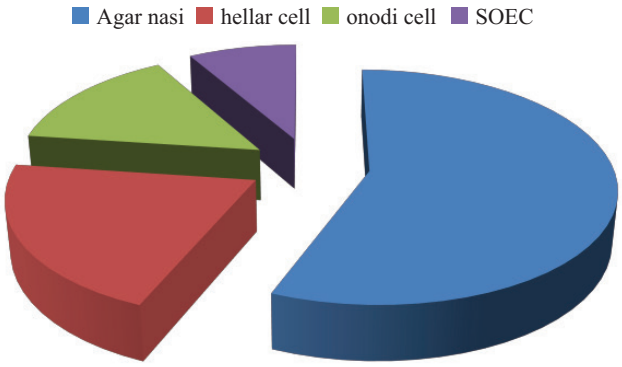

Figure-3: Frequency of occurence of special cells

Figure-4: Uncinate Process Vertical on Right and Horizontal on left side with Crista galli Pneumatisation

recess into the ethmoidal infundibulum and can be involved in infundibular disease. If attachment is to the lamina papyracea, the frontal sinus opens into the middle meatus directly and can be spared from infundibular disease. During surgery, this attachment needs to be cleared before reaching frontal recess. The medial deviation may contact the middle turbinate or can narrow the middle meatus. A lateral deviation of the uncinate process will causes the infundibulum narrow. when distance between the lateralized uncinate to be process and lamina papyracea is reduced, care needs to be taken while performing uncinectomy to prevent orbital injury.

The most posterior ethmoid air cell that extends laterally is called as Onodi cell. This is near the carotid canal and close to the optic nerve, which tells the clinical importance of considering this anatomic variation prior to any attempt for invasive intervention. Surgeon must put attention to the occasional Onodi cell in pre-operative evaluation to avoid potential complications of ESS.

Onodi cell was found in 14.5% patients in the current study. Other studies have reported Onodi cell presence from 0% to 9%.

The anterior ethmoid cells that project along the medial roof of the maxillary sinus and the most inferior portion of the lamina papyracea are called as Haller's cells (Infraorbital ethmoid cell). They present closely to the infundibulum. Because of their close proximity to the natural ostium of the maxillary sinus, there is a chance of maxillary sinus mucosal disease in patients with medium or large Haller's cells (45.8%) versus those with small cells (28.9%; $p < 0.05$) in one study. Few Other studies, didn't found any relation between Haller's cell and chronic sinus disease.

The prevalence of Haller's cell was 20.7% in this study. In few other studies, this ranged from 1% to 36%.[6]

A comparison of anatomic variants in patients with sinus disease and patients without was made by Kayalioglu. Clearly anatomical variants were common in patients with sinus disease.[7] His sample size was ninety sinus patients and eighty two non sinus patients. Concha bullosa which was close was seen 28.8% in sinus patients and 26.8% in non sinus patients. Basic n who did a CT scan study to determine frequency of anatomic variations in mainly ethmoid pneumatization and did indicate it is imperative to adopt standardized classification and definition of paranasal sinus variations. This would avoid discrepancies amongst various authors.[8] A study by Arslan H et al had a large sample size of two hundred patients and looked into anatomical variants of the paranasal sinus on two millimeter CT scan cuts where he found that 30% had concha bullosa while onodi cells at 12% and haller cells were 6%.[9]

In Malaysia, concha bullosa was statistically more common among females and the Indian and Chinese ethnic groups.[10] A study done by Baradaranfar et al looked into the frequency of anatomical variations in patients with chronic rhinosinusitis who underwent sinus surgery. A total of 120 patients and he found agger nasi in 36%, concha bullosa in 12.5%, septal deviation in 45% and haller cells in 4%.[11]

The underdevelopment or hypoplasia of the paranasal sinuses is a uncommon phenomenon that refers mainly to the frontal (12%), sphenoid sinus and secondarily to the maxillary sinuses (5–6%). This occurs more frequently in syndromes of craniosynostosis, osteodysplasia as well as in cases of Down's syndrome (hypoplasia of the frontal sinus).

Maxillary sinus hypoplasia has been reported as being very uncommon and mainly noticed on the coronal cuts of the CT scan. Bolger et al reported prevalence of unilateral hypoplastic maxillary sinus to be 10.4% while Kantarci et al reported 7% in a study of 512 patients.[12] It is imperative to look for other anomalies on the lateral nasal wall, especially the uncinate process which can impede mucociliary clearance of the sinuses. Secondary middle turbinate is rare anomaly characterized by a bony projection covered by soft tissue, arising from the lateral wall of the middle meatus, studies done by Khanobthamchai et al put the incidence at 1.5%[13], while Aykut et al found it to be 6.8%[14] and Aksungur et al at 0.8%.[15]

In our study Frontal sinus hypoplasia was noted in 17% in which 3% were bilateral. Most of the cases showed features of sinusitis. The diagnosis of sphenoid sinus hypoplasia is potentially important in patients in whom trans-sphenoidal hypophysectomy is contemplated. In our study a total of 3% of cases comprised to have hypoplastic sphenoid sinus.

Maxillary sinus hypoplasia is an uncommon condition that may be misdiagnosed as chronic sinusitis. Bolger et al found the prevalence of unilateral hypoplastic maxillary sinus to be 10.4% on coronal CT scans. In our study Maxillary sinus hypoplasia showed 2% bilaterally. Axillary sinus hypoplasia predisposes to orbital penetration during endoscopic sinus surgery; therefore this bony abnormality must be recognized as well as associated anatomic variations, especially prior to sinus surgery.

In our study the occurrence of different types of cribriform plates are as follows Type 1 is 56%, Type 2 is 37%, Type 3 is 07%. The type of Cribriform plate is important in predicting the

intra operative complications during FESS.

CONCLUSION

Considering the wide range of variations in the anatomy, each and every para-nasal sinus case should be planned individually and carefully to avoid dreadful complications and maximise patients' benefit.

Coronal CT scan images can also be used for reconstruction in axial planes for additional information.It is fast and inexpensive compared to MRI which provides more soft tissue information than bone. Coronal CT provides more detailed information of posterior sinuses such as sphenoid and ethmoids.

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Source of Support: Nil; **Conflict of Interest:** None

Submitted: 13-07-2016; **Published online**: 28-08-2016