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Original Research Article

CT evaluation of anatomical variations of paranasal sinus region and their clinical importance

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ABSTRACT

Background: Paranasal sinuses are air filled spaces present within the skull and facial bones. Paranasal sinuses region anatomy is highly variable. Knowledge of these variations is very important for radiologists as well as endoscopic surgeons for preoperative evaluation to avoid damage to adjacent vital structures. CT is the best modality to delineate the sinus anatomy as well as soft tissue structures. Thus, this study was undertaken to evaluate the anatomical variations of paranasal sinus region and ascertain their clinical importance.
Methods: A total of 142 patients, those referred from various outdoor/indoor departments with the symptoms related to nose and paranasal sinuses were included. Detailed history, appropriate clinical examinations, biochemical investigations and X-ray PNS were recorded. Unenhanced CT scan of the PNS was performed for these patients in the axial planes and reformatted coronal planes. Observation was made and analysed using descriptive tools and scientific methods.
Results: Deviated nasal septum was the most common variation followed by middle concha bullosa, Paradoxical middle turbinate, curved uncinate process, overpneumatized ethmoidal bulla, superior concha bullosa, prominent Agger Nasi cells, haller cells, onodi cells, maxillary sinus septae and pneumatization of uncinate process. Incidence of anatomical variation was 75% among the patients showing PNS mucosal changes while it was 94% among patients showing no mucosal changes. Chi square statics revealed that presence of anatomical variation does not mean a predisposition to mucosal changes.
Conclusions: The presence of anatomical variants does not indicate predisposition to sinus pathology but may predispose to increased risk of intraoperative complications. It is important to pay close attention to anatomical variations in the preoperative evaluation to avoid possible complications.

Keywords: Anatomical variations, Computed tomography, Sinusitis

INTRODUCTION

Paranasal sinuses are air filled spaces present within the skull and facial bones. This air filled strucures not only show complex design but also share significant relationship with the surrounding structures. As human anatomy is subjected to a large number of anatomical variations, the same rule applies to the paranasal sinuse region too. Paranasal sinus anatomy is highly variable as well as it has a complex structure in the lateral nasal wall known as Osteomeatal unit (OMU) that bears ostea of paranasal sinuses. Normal physiology of PNS and its mucous membrane is maintained by two factors, drainage and ventilation.[1]

Anatomical variations such as deviated nasal septum, choncha bullosa, curved uncinated process, paradoxical middle turbinate etc. can obstruct the narrow passage of osteomeatal channels, leads to impaired drainage and dysvetilation of the PNS and predispose to sinusitis.[2]

The nasal septum is of fundamental significance in the growth of the nose and development of paranasal sinuses. Septal deviation represents a divergence of septum from midline which could be C or S shape and associated with multiple deformities of lateral nasal wall. Incidence reported in general population is approx. 20%.[3] Pneumatisation of middle turbinate less commonly, of the inferior or superior turbinate is known as Choncha Bullosa. It may cause mucosal thickening, polyp formation, mucous retention cyst, empyema and pyocele formation. When middle turbinate shows concavity towards septum its known as paradoxical curvature of middle turbinate, it may lead to polyp formation and mucosal changes. Uncinated process shows various anatomical variations, most commonly encountered is marked medial curvature, which causes significantly narrowing of the hiatus semilunaris. Other variations includes secondary middle turbinate, turbinate to turbinate attachment, Haller's cell, agger nasi cells, Onodi cells, aerated crista galli, asymmetry of ethmoid roof and hypoplasia of frontal sinus.

Knowledge of these variations is important in each patient undergoing surgeries for radiologists as well as endoscopic surgeons to avoid damage to adjacent vital structures like orbit and brain.

Traditionally conventional radiography was used to examine the paranasal sinuses, using several projections. These projections have several limitations like superimpositions, absence of radiographic evidence of soft tissue involvement and unable to delineate all borders. Therefor a better modality id required which provides better information to the surgeon and help in preoperative evaluation more effectively and efficaciously.[4] Since CT scan was introduced in the mid 1970s, it has been evolved in term or quality and accuracy. CT is undoubtedly the modality of choice to evaluate inaccessible areas of nose and paranasal sinus region. It provides detailed information about soft tissue structures as well as variations if present.

Although, patient with sinonasal inflammatory disease are treated with medical treatment initially. Patients with persistent disease are often treated surgically and it has undergone tremendous changes since last 10-20 years because of better understanding of mucociliary clearance pathways, improved endoscopic techniques and preoperative evaluation of anatomical structures and its variations by high resolution CT scan of PNS.

METHODS

This is the descriptive cross sectional study. Various parameters and tables of the result are derived by using static analysis method (Chi-Square table).

A total of 142 patients were included in the study those, who referred to the department of Radiodiagnosis from various out or in patient departments with symptoms related to nose and paranasal sinus including congenital, inflammatory etiology and patients refractory to medical treatment from January 2018 to October 2018.

Patients with history of trauma, sinonasal malignancy, past history of sinus surgery and pediatric age group patients with ongoing development of sinuses were excluded from the study. Consent was taken from the subjects included in the study as well as ethical committee clearance was obtained from institution.

Every patient undergone a meticulous detailed history taking, routine general physical examination and appropriate X-ray examination. Details of the study protocol was explained to the subjects. CT was performed with a Philips Brilliance scanner. Direct axial sections were done in all patients in the supine position. Later scans were evaluated in axial as well as reconstructed sagittal and coronal sections using Philips software. Studied parameters were age, sex, anatomical variations and radiographic findings if any pathology was present. All data and detailed findings were collected and observation was made.

Data collected was analysed using descriptive tools and scientific methods adopted to conclude the study ad summerising key points of the study conducted.

Further the results were analysed and Association of incidence of anatomical variations and mucosal changes was calculated by using Chi-Square table.

RESULTS

CT findings of the 142 patients were evaluated who fulfilled the inclusion criteria and observation was made. Out of total patients included 69 were male and 73 were females. Slight female preponderance was noted with female to male ratio of 1.05:1. Maximum patients were of 2nd decade followed by 3rd decade.

Incidence of anatomical variation was 84.5% seen in 120 patients while incidence of mucosal changes was 65.5%.

Deviated nasal septum was the commonest anatomical variation in 54% patients followed by choncha bullosa (46.5%). other variations are listed below (Table 1).

Course of optic nerve was categorised depending on pneumatised sphenoid sinus, type I was noted in 117 patients on right side and 126 patients on the left side (most common). while type II was noted I 14 patients on right and 10 on left side. Type III was noted in 10 on the right side and 6 in the left side. Type IV was seen in any one case on right side.

Table 1: Distribution of the cases on the basis of anatomical variations observed.

Anatomical variations	Unilateral	Bilateral	Total
Concha Bullosa	41 (29%)	25 (17.5%)	66 (46.5%)
Superior Concha Bullosa	9 (6%)	11 (7.5%)	20 (13.5%)
Paradoxical middle	13 (9%)	6 (4%)	19 (13%)
Turbinate			
Curved uncinate process	10 (7%)	11 (7.7%)	21 (14.7%)
Up Neumatization	4 (3%)	1(0.7%)	5 (3.7%)
Overpeneumatized ethamoidal bulla	12 (8.5%)	10 (7%)	12 (15.5%)
Haller cells	8 (5.6%)	2 (1.4%)	10 (7%)
Onadi cells	3 (2%)	-	3 (2%)
Prominent agger nasi cells	15 (10.5%)	1 (0.7%)	16 (11.2%)
Maxillary sinus septae	7 (5%)	5 (3.5%)	12 (8.5%)
Hypoplastic frontal sinus	8 (5.6%)	15 (10.5%)	23 (16.1%)
Areated crista galli			12 (8.5%)

Similarly, asymmetry in ethmoidal roof was noted depending on height of the lateral lamella and classified according to Keros classification. Type II was noted in majority of the patients i.e. 78.9% followed by type I in 20.4% and 0.7% in type III.

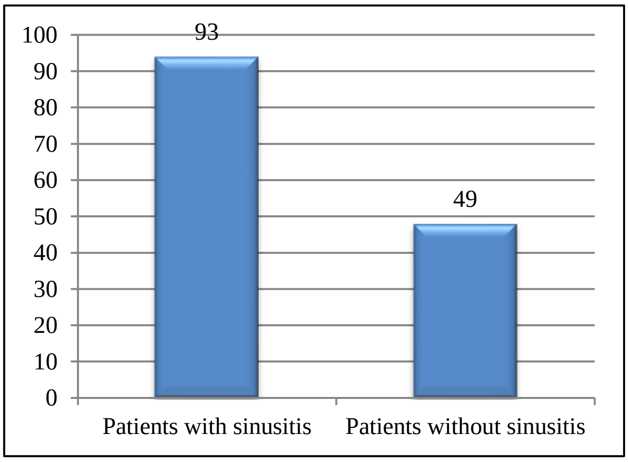

Figure 1: CT scan detection of mucosal abnormalities of sinuses.

Mucosal abnormalities were found in 94 patients out of 142 patients (Figure 1).

Maxillary sinus was most commonly involved in 70 patients (49%) followed by anterior ethmoids in 49 patients (34.4%), frontal in 29 patients (20.5%), posterior ethmoids in 19 patients (13.3%) and the sphenoid sinus in 5 patinets (3.5%). 78 patients had more than one sinus involvement. 13 patients (9%) revealed pansinusitis (Figure 2).

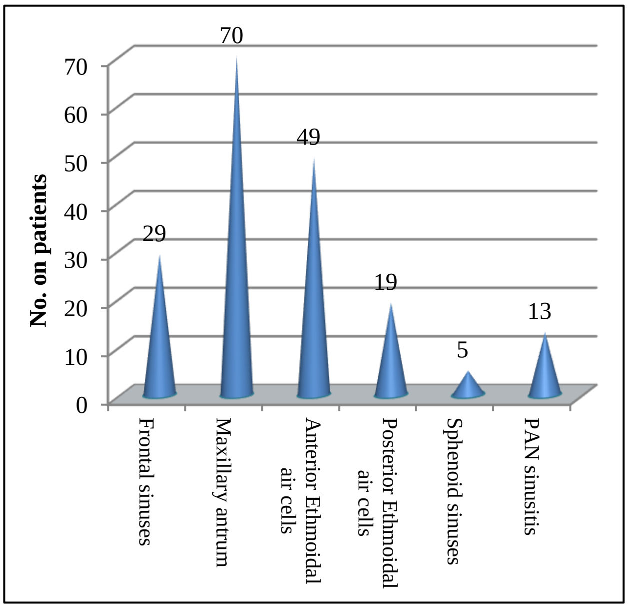

Figure 2: Distribution of the patients on the basis of sinus involvement.

In present study anatomical variations were seen in 73 (77%) out of 94 patients with PNS mucosal changes and 42 (85%) patients without PNS mucosal abnormality. Chi square table was made (Table 2) and chi square statics was calculated (5.0177).

Table 2: Chi- square statics.

Mucosal changes	Anatomical variations observed	No anatomical variants observed	Marginal row total
Mucosal changes present	74 (78.59) (0.27)	19 (14.41) (1.46)	93
No mucosal changes	46 (41.41) (0.51)	3 (7.59) (2.78)	49
Total	120	22	142

DISCUSSION

The PNS region is subjected to a large number of anatomical variation and lesions congenital anamolies as well as anatomical variations in this region is of particular interest as they leads to impairment in physiological maintenance of the sinuses and nose resulting in various pathologies such as sinusitis.[2]

In the present study slight female preponderance was noted, may be due to hormonal changes are more prominent in various stages like puberty, pregnancy, menstruation and sexual excitement due to vasomotor imbalance leading to frequent sinusitis.

Table 3: Comparison of CT scan detection of anatomical variants in various studies.

Anatomical variations	Present study	Peres-Pinas et al	Dua K et al	Zinreich S et al	Bolder et al
Year	2019	2005	2000	1993	1991
Number of patients	142	115	55	230	202
Concha bullosa	41%	24.50%	16%	36%	53.60%
Paradoxicalmiddle turbinate	13%	10%	10%	15%	27%
Dns	54%	58%	44%	21%	96%
Haller cells	8%	2.70%	16%	10%	45.90%
Onadi cells	3%	10.90%	6%	8%	11%
Prominent AGN cells	15%	98%	40%		98.50%
Pneumatization of uncinated rocess	3.70%	-	-	0.40%	2.50%

Table 4: comparison of sinuses involvements with various studies.

Study	Year	Maxillary sinus	Anterior ethmoid	Posterior ethmoid	Frontal sinus	Sphenoid sinus
Zinreich et al[9]	1987	65%	72%	40%	34%	29%
Bolger et al[5]	1991	77.7%	84.3%	38.6%	36.6%	25.4%
Maru et al[11]	2001	70.4%	73.7%	52.4%	48.3%	41.8%
Present study	2019	70%	49%	19%	5%	29%

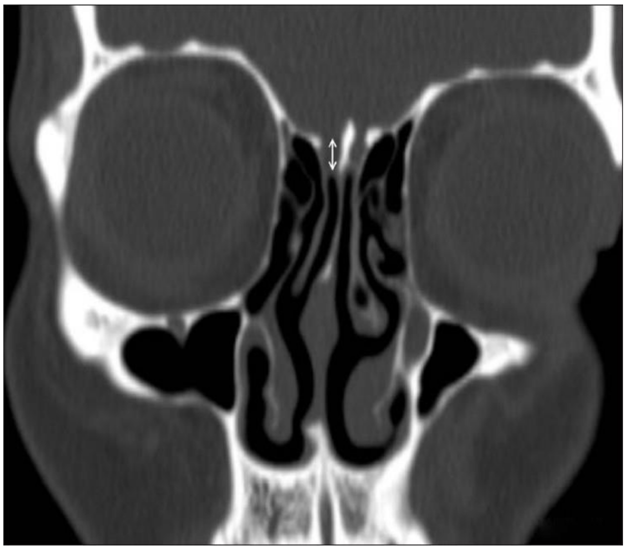

Figure 3: Coronal CT reveals that olfactory fossa are deeper and lateral lamellae are longer-keros type II.

Keros et al, in his anatomical study on 400 skulls found type I in 12%, of specimen, type II in 70% (most common) (Figure 3) of patients and type III in 18% of patients.[10] Present study, on comparison to study done by Kaplanoglu et al, in 2013 (type I 13.4%, type II 76.1% and type III 10.5%), found similar results.[12]

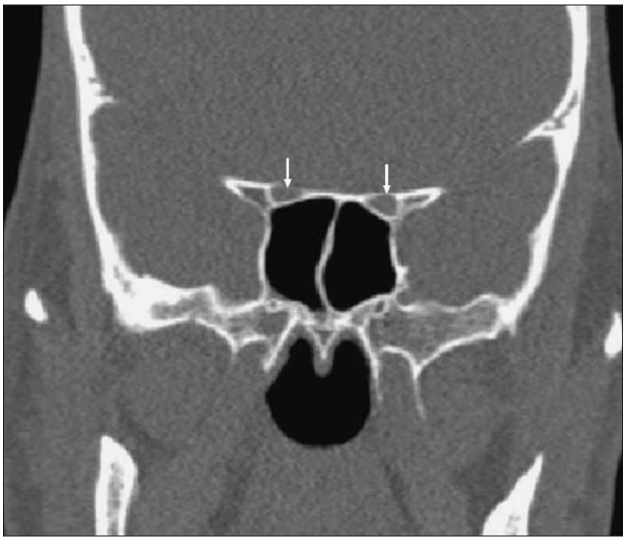

Figure 4: Coronal CT showing type I optic nerve (arrow) the nerve is seen to course immediately adjacent to sphenoid sinus, without contact with the posterior ethmoid air cells.

Depending on keros type variable segments of the lateral wall of olfactory fossa will be exposed during the FESS. Keros type III is most variable one considering the major risk for iatrogenic damage to cribriform plate.

Type I optic nerve (arrow) the nerve is seen to course immediately adjacent to sphenoid sinus, without contact with the posterior ethmoid air cells (Figure 4). Likewise, incidence of other type of optic nerves were calculated.

Involvement of various sinuses involvement were found comparable and satisfactory compared with various previous studies (Table 4).

Incidence of anatomical variation of PNS in patients with and without mucosal changes were studied using Chi-Square table where P(probability) attributed to <0.05 (95% confidence limit). According to the table X_c^2 (Chi-square calculation) 5.0177 is greater than X_E^2 (Chi-Square expected) (3.84) ($X_c^2 > X_E^2$).

This rejects the Null Hypothesis (H0 is not equal toH1) and accepts the alternate hypothesis. It suggests there is no association between mucosal changes and anatomical variations of sinuses for 1 degree of freedom at 95% confidence limit. This is statically significant ($p < 0.05$).

The clinical significance of anatomical variation of the nasal sinus region is controversial. Zinreich et al, found positive correlation between anatomical variation and appearance of inflammatory sinus pathology.[9] However, Bolger et al, and Stammberger et al, concluded that merely presence of variation does not mean a predisposition to sinus pathology.[2,5]

From our study we concluded that presence of anatomical variation does not mean a predisposition to sinus pathology but these variations may predispose patient to increased risk of intraoperative complications.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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