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ORIGINAL RESEARCH

Computed tomographical evaluation of anatomical variants of paranasal sinuses & related complications

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ABSTRACT

Background: Sinusitis is one of the leading health care problems nowadays, increasing in both incidence and prevalence. Present study was aimed to study computed tomographical evaluation of anatomical variants of paranasal sinuses & related complications, to evaluate the detailed anatomy (normal anatomy, anatomical variation and the extent of the disease process) that are commonly encountered in the osteomeatal complex and lateral nasal wall. **Material and Methods:** Present study was single-center, prospective, observational study, conducted in patients with symptoms suggestive of acute/ chronic sinusitis and Complications related to anatomical variants of para nasal sinuses, underwent endoscopic nasal evaluation. Followed by CT scan paranasal sinus.**Results:** The demographic profile shows the most common age group to be between 21-25yrs. Among the 100 cases studied 63% (63) of patients are male and 37%(37) of patients are female.In our study most of the patients had more than one anatomical variation. Out of 100 patients studied, 88% (88) of patients had more than one anatomical variation, of these 62.5% (55) were males and 37.5% (33) were females. Only minor group of patients presented with one anatomical variation 12% (12). In our study all the patients had at least one anatomical variation. Anatomical variations may present unilaterally or bilaterally. In our study, 82 (82%) patients out of 100 patients had bilateral anatomical variation. Only 18 (18%) patients had unilateral disease. **Conclusion:** Our present prospective study of anatomical variation of osteomeatal complex reveals that, among the anatomical variations of the osteomeatal complex in patients with chronic sinusitis not responding to medical therapy, a combination of anatomical variations is more commonly found.

Keywords: osteomeatal complex, chronic sinusitis, anatomical variations, computed tomography, endoscopic nasal evaluation

INTRODUCTION

Sinusitis is one of the leading health care problems nowadays, increasing in both incidence and prevalence.[1] At present diagnostic nasal endoscopic evaluation of nose and para nasal sinuses is a routine component for evaluating patients with evidence of suspected nose and paranasal sinus disease.[2] There are many anatomic variants in nasal region which are frequently observed on computed tomography (CT).

As a number of lateral nasal wall diseases cannot be recognized and identified by endoscope, we perform tomography even when the diagnostic nasal endoscopic finding is insignificant, provided that the history and clinical findings suggest the presence of some disease. The anatomical variations of lateral nasal wall and Para nasal sinuses are surgically and patho-physiologically important because they narrow the drainage pathway of the paranasal sinuses, which in turn lead onto stagnation of secretions, then infection and inflammation of the mucosa lining the sinuses.

Diseases in extensively pneumatised sinuses lead on to exposure of important structures like Optic nerve and Internal Carotid artery, to infection and inflammation, and also increases risk during surgical procedure.[3,4] Present study was aimed to study computed tomographical evaluation of anatomical variants of paranasal sinuses & related complications, to evaluate the detailed anatomy (normal anatomy, anatomical variation and the extent of the disease process) that are commonly encountered in the osteomeatal complex and lateral nasal wall.

MATERIAL AND METHODS

Present study was single-center, prospective, observational study, conducted in department of

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radiodiagnosis, at Dr. Vaishampayan Memorial government medical hospital, Solapur, India. Study duration (December 2022 to August 2024). Study was approved by institutional ethical committee.

Inclusion criteria

- Patients with symptoms suggestive of acute/ chronic sinusitis and Complications related to anatomical variants of para nasal sinuses, willing to participate in present study

Exclusion criteria

- Pregnant female
- Disoriented / uncooperative patients leading to motion artifacts
- Patients not willing for study

Study was explained to participants in local language & written informed consent was taken. After selecting the patients, they were subject to endoscopic nasal evaluation. The nasal endoscope used for diagnostic nasal endoscopicexamination was 4mm Hopkins rod endoscopes with 0º and 30º angulation. With these endoscopes, first, second, and third pass evaluation of nasal cavity and inturn about the paranasal sinuses by diagnostic nasal endoscopicevaluation done after proper decongestion of the nasal cavity of the patients. All these patients are then evaluated with CT scan paranasal sinus.

PATIENTS PREPARATION BEFORE CT SCAN

- A course of antibiotics, nasal decongestants and antihistaminic given for a period of 4 weeks
- Nasal decongestants (xylometazoline) – 15 minutes prior to CT scan.
- Patient asked to blow the nose forcefully just prior to CT scan.

CT scan was performed in a Philips MX 16 slice CT scanner, direct coronal sections were done in all patients. Limited axial scans parallel to the orbitomeatal line, with the patients in supine position, were also done whenever required. All films are taken without contrast. No intravenous contrast was used.

Parameters

- Patients position: prone with chin extended
- Gantry angulation: perpendicular to hard palate
- Section thickness:1 mm
- Scan limits: from glabella to the dorsum sella

Data was collected and compiled using Microsoft Excel, analysed using SPSS 23.0 version. Statistical analysis was done using descriptive statistics.

RESULTS

The demographic profile shows the most common age group to be between 21-25yrs. Among the 100 cases studied 63% (63) of patients are male and 37%(37) of patients are female.

Table 1: General characteristics

Characteristics	No. of subjects	Percentage
Age group (in years)		
15-20	21	21%
21-25	22	22%
26-30	15	15%
31-35	17	17%
36-40	8	8%
41-45	10	10%
46-50	5	5%
51-55	2	2%
Gender		
Male	63	63 %
Female	37	37 %

In our study most of the patients had more than one anatomical variation. Out of 100 patients studied, 88% (88) of patients had more than one anatomical variation, of these 62.5% (55) were males and 37.5% (33) were females. Only minor group of patients presented with one anatomical variation 12% (12). In our study all the patients had at least one anatomical variation.

Table 2: Anatomical variation

Anatomical variations	Male	Female
Single anatomical variation	8(66.7%)	4(33.3%)
Multiple anatomical variation	55(62.5%)	33(37.5%)

Anatomical variations may present unilaterally or bilaterally. In our study, 82 (82%) patients out of 100 patients had bilateral anatomical variation. Only 18 (18%) patients had unilateral disease. Nasal septal deviation is the most common anatomical variation noted in our study. Even though septal deviation is the commonest anatomical variation in our study, it is not a part of osteomeatal complex. Hence it is not taken into account directly. But these septal deviations indirectly contribute to the narrowing of the osteomeatal complex, by means of compressing the lateral wall of nose which in turn lead to anatomical narrowing of osteomeatal complex, by

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causing paradoxical middle turbinate, lateralized uncinate process etc.,

Table 3: Distribution of anatomical variation

Anatomical variation	Male	Female	Total
Deviated nasal septum	51	22	73
Aggernasaicell	48	21	69
Concha bullosa	40	20	60
Prominent bulla ethmoidalis	31	19	50
Paradoxical middle Turbinate	38	8	46
Intumescentia septi nasi anterior	25	9	34
Medialised uncinate process	14	7	21
Frontalcell	13	5	18
Onodicell	5	1	6
Haller cell	4	0	4
Pneumatisation of septum	3	1	4
Pneumatised uncinate process	2	0	2

Agger nasi is the most common anatomical variation of the osteomeatal complex per se, present in about 69 (69%) patients. Of which, unilateral presentation is 37 (53.6%) and bilateral presentation 32 (46.4%). Of the unilateral presentation right side is more common 23 patients and left side in 14 patients.

Table 4: Agger nasi cell

Agger nasi cell	Right	Left	Bilateral	Total
Male	15	11	22	48
Female	8	3	10	21

Our next common anatomical variation is Concha bullosa 60 % (60) that may present unilaterally or bilaterally .In our study most common is the unilateral presentation of concha bullosa 42 patients, which was also associated with other anatomical variations. Of this, unilateral presentation on right side is more common about 19 and left side is about 14 patients.

Table5: Concha bullosa

Concha bullosa	Right	Left	Bilateral	Total
Male	11	9	20	40
Female	7	5	8	20

Bulla ethmoidalis comes next, seen in about 50 patients (50%). Of which unilateral presentation is common about 37 patients(74%) and bilateral presentation is 13 (26%). Of the unilateral presentation left side in 19 patients and right side in 18 patients.

Table6: Prominentbullaethmoidalis

Prominent bulla ethmoidalis	Right	Left	Bilateral	total
Male	10	14	7	31
Female	8	5	6	19

Deviated nasal septum though it is not a part of osteomeatal complex , contributes to anatomical crowding of osteomeatal complex area. Deviated nasal septum was present in about 73(73%) patients. Of which right side deviation is common about 40 and left side 33 patients.

Table7: Deviated nasal septum

Deviated nasal septum	To right	To left	Total
Male	30(58.8%)	21(41.1%)	51
Female	10(45.5%)	12(54.5%)	22

Paradoxical middle turbinate present in 46 patients (46%) of which unilateral is 31 (67.4%) and bilateral presentation is 15(32.6%), right side being common 19 (41.3%) patients.

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Table8: Paradoxical middle turbinate

Paradoxical middle turbinate	Right	Left	Bilateral	Total
Male	16	10	12	38
Female	3	2	3	8

Medialiseduncinateprocesspresentedin21(21%)patients. Of which unilateral presentation is more common 14 (66.66%).

Table 9: Medialiseduncinate process

Medialiseduncinateprocess	Right	Left	Bilateral	Total
Male	6	4	4	14
Female	2	2	3	7

Frontalcellpresentedin18patients(18%),ofwhichunilateral presentation is common, about 10 (55.5%). Hallercellwasnotedin4patients(4%),ofwhichunilateral presentation is common about 3 (75%). Onodicellpresentedin6(6%)patientsofwhich2(33.3%) patients presented with bilateral presentation .

DISCUSSION

Computed Tomography of the para nasal sinuses has improved the visualization of para nasal sinus anatomy and has allowed greater accuracy in evaluating para nasal sinus disease. It evaluates the osteomeatal complex anatomy which is not possible to such an extent with plain radiographs. Anatomical variations studied on Computed Tomography Scan are found to block the osteomeatal complex, leading to impaired drainage of para nasal sinuses, thus causing chronic sinusitis.

Stammberger[5] proposed that stenosis of the osteomeatal complex, from either the anatomical configuration or hypertrophied mucosa, can cause obstruction and stagnation of secretions that may become infected or perpetuate infection.

According to Mackay and Lund[6] the osteomeatal complex acts a drainage pathway for maxillary, anterior ethmoids and frontal sinuses. Posterior osteomeatal unit was considered as part of the sphenoid sinus. In several areas of the osteomeatal complex overcrowding due to anatomical variation, two mucosal layers contact each other, thus increasing the likelihood of local impairment of mucociliary clearance. Secretions may then be retained at the site, creating the potential for infection even without ostial closure. Anatomically, the most likely areas of mucosal contact are in the narrow mucosa lined channels of the middle meatus and the ethmoidal infundibulum

Deviated nasal septum or bony spur causes a decrease in the critical area of the osteomeatal unit predisposing to obstruction and related complications. It was found in 73 of 100 patients, the maximum anatomical variation in our study about 73%.It was more tha n 55.7% in study by Maru *et al.*,[7]andmorethanthatof38 % reportedbyAsruddin *et al.*,[8]

Concha bullosa (pneumatized middle turbinate) has been implicated as a possible aetiological factor in the causation of recurrent chronic sinusitis. It is due to its negative influence on paranasal sinus ventilation and mucociliary clearance in the middle meatus region as quoted by Tonai *et al.*,[9] The incidence of concha bullosa was 60 % ,which is higher as compared to the reported incidence of 53.6% by Bolger*et al.*,[10] 42.6% by Maru *et al.*[64], 28% by Asruddin*et al.*,[8]and 24% by Llyod[11]

The middle turbinate may be paradoxically curved i.e. bent in the reverse direction. This may lead to impingement of the middle meatus and thus to sinusitis . It was found in 40 % in our study. The incidence is higher to that of 12 % by Asruddin*et al.*,[8] 15 % by Llyod[11] and Bolger *et al.*,[10] (27%)

Zinreich *et al.*,[12] first observed that the uncinate process may be curved or bent. It can impair sinus ventilation especially in the anterior ethmoid,frontalrecessandinfundibulum regions.The medialiseduncinatewas found in 21 % patients in our study. It is higher than that of 2.5% reported by Bolger *et al.*,[10] ,2% by Asruddin *et al.*,[8] and 9.8% by Maru *et al.*[7].

Onodi cells are posterior ethmoid cells that extend posteriorly, laterally and sometimes superior to sphenoid sinus, lying medial to the optic nerve. The chances of injury of optic nerve are increased when the bony canal of the nerve is lying dehiscent. It was found in 6 % patients in our study. A similar incidence was found by Arslan in 12/200 patients and higher than the study by Jones in 8/ 200 patients.[13]

Haller cells are ethmoid air cells that project beyond the limits of the ethmoid labyrinth into the maxillary sinus. They are considered as ethmoid cells that grow into the floor of orbit and may narrow the adjacent ostium of the maxillary sinus especially if they become infected [66]. The incidence of Haller cells in our study was 4 %. It was less than that reported by Bolger *et al.*,[10] (45.9 %), Llyod[11] (15 %), Maru *et al.*,[7] (36 %) and Asruddin *et al.*,[8] (28 %).

The osteomeatal unit was found to be involved in all the patients in our study. Maxillary sinus is the most common sinus involved in chronic sinusitis in our study. Zinreich *et al.*,[12] found middle meatus opacification in 72% of the patients with chronic sinusitis, and of these 65% had maxillary sinus mucoperiosteal sinus thickening.

Yousem *et al.*,[14] found that when the middlemeatuswasopacified,themaxillaryandethmoidsinusesshowed inflammatory changes in 84% and 82% respectively. Another study found frontal or maxillary

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sinus disease in 84% patients who had OMC opacification. Thus, these findings support the contention that the anatomical variation in osteomeatal complex will lead to obstruction of the narrow drainage pathways, which in turn lead to subsequent sinus inflammation.

CONCLUSION

Among the anatomical variations of the osteomeatal complex in patients with chronic sinusitis not responding to medical therapy, a combination of anatomical variations is more commonly found.

Of the anatomical variations in patients with chronic sinusitis, nasal septal deviation is the commonest abnormality noted. Moreover, 90% of anatomic variations are septal deviation, Agger nasi cell and Concha bullosa. Most of the anatomic variations originated from aerated cells of ethmoid sinus. With the proper pre-operative evaluation of anatomical variation, we can reduce inadvertent complications during surgery and also ensure the complete clearance of the disease.

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