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Anatomical Variations of the Osteomeatal Complex in Patients with Chronic Rhinosinusitis: A Prospective Observational Study.

Dr. Megha Annigeri[1], Dr. Kalpana Daga[2], Dr. Aparajitha A.[3], Dr. A. M. Asha[4], Dr. Annapurna S. Mushannavar[5]*.

[1]Assistant Professor, Department of ENT, Karnataka Medical College & Research Institute (KMCRI), Hubballi, Karnataka, India.
[2]Assistant Professor, Department of ENT, Tertiary care cancer center, Fazilka (under BFUHS), Punjab, India.
[3]Senior Resident, Department of ENT, Karnataka Medical College & Research Institute (KMCRI), Hubballi, Karnataka, India.
[4]Senior Resident, Department of ENT, Karnataka Medical College & Research Institute (KMCRI), Hubballi, Karnataka, India.
[5]Assistant Professor, Department of ENT, Karnataka Medical College & Research Institute (KMCRI), Hubballi, Karnataka, India.

Correspondence:
Dr. Annapurna S. Mushannavar.
Assistant Professor, Department of ENT, Karnataka Medical College & Research Institute (KMCRI), Hubballi, Karnataka, India.

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Abstract

Background: Chronic rhinosinusitis (CRS) is one of the commonest disorders encountered in otorhinolaryngology practice. Anatomical variations involving the osteomeatal complex (OMC) may narrow the drainage pathways of the paranasal sinuses, thereby predisposing patients to persistent sinonasal disease. Accurate identification of these variations using diagnostic nasal endoscopy (DNE) and computed tomography (CT) is essential before functional endoscopic sinus surgery (FESS). ***Objectives:*** To determine the prevalence of anatomical variations of the osteomeatal complex in patients with chronic rhinosinusitis and to evaluate their association with sinus involvement. ***Methods:*** A prospective observational study was conducted among 54 consecutive patients with chronic rhinosinusitis refractory to medical therapy and scheduled for FESS. All patients underwent diagnostic nasal endoscopy and CT evaluation of the nose and paranasal sinuses. Anatomical variations of the osteomeatal complex and the pattern of sinus involvement were documented. Statistical analysis was performed to determine associations between anatomical variations and sinus disease. ***Results:*** Multiple anatomical variations were identified in 53.7% of patients, whereas 33.3% had a single anatomical variation. Deviated nasal septum was the commonest anatomical variation (74.1%), followed by unilateral concha bullosa (33.3%), bilateral concha bullosa (20.4%), and paradoxically curved middle turbinate (14.8%). Maxillary sinus involvement was observed in 85.2% of patients and represented the most frequently affected sinus. Deviated nasal septum (P=0.021) and concha bullosa (P=0.018) demonstrated significant association with maxillary sinus involvement. ***Conclusion:*** Multiple anatomical variations are frequently encountered in chronic rhinosinusitis. Deviated nasal septum and concha bullosa are the most prevalent anatomical abnormalities and show significant association with maxillary sinus disease. Comprehensive preoperative evaluation using CT and diagnostic nasal endoscopy remains indispensable for successful surgical planning.

Keywords: Chronic Rhinosinusitis, Osteomeatal Complex, Functional Endoscopic Sinus Surgery, Concha Bullosa, Deviated Nasal Septum, Computed Tomography.

INTRODUCTION

Chronic rhinosinusitis (CRS) is a multifactorial inflammatory disorder of the nose and paranasal sinuses characterized by persistent sinonasal symptoms lasting more than twelve weeks.1,2,3 It significantly affects quality of life and constitutes a major proportion of outpatient consultations in otorhinolaryngology.1,2,4,5 The osteomeatal complex (OMC) represents the principal drainage pathway for the maxillary, frontal, and anterior ethmoid sinuses.6-8 Obstruction at this critical anatomical region impairs mucociliary clearance, promotes mucus stasis, and predisposes to recurrent or chronic infection. Several anatomical variations-including deviated nasal septum, concha bullosa, paradoxically curved middle turbinate, uncinate process abnormalities, agger nasi cells, and Haller cells-have been implicated in narrowing the OMC and contributing to chronic rhinosinusitis.9,10

Computed tomography (CT) of the paranasal sinuses provides excellent visualization of bony anatomy and remains the imaging modality of choice for preoperative assessment, while diagnostic nasal endoscopy complements CT by allowing direct visualization of mucosal pathology. Combined evaluation assists in identifying surgically relevant anatomical variations and minimizing intraoperative complications. Despite numerous studies, the relationship between individual anatomical variations and chronic rhinosinusitis remains controversial.7-9,11,12 This study was therefore undertaken to evaluate the prevalence of osteomeatal complex variations in patients with chronic rhinosinusitis and to determine their association with sinus involvement.

AIM & OBJECTIVSES

Aim

To evaluate anatomical variations of the osteomeatal complex in patients with chronic rhinosinusitis using diagnostic nasal endoscopy and computed tomography.

Objectives

1. To determine the prevalence of anatomical variations of the osteomeatal complex in patients with chronic rhinosinusitis.
2. To assess the association between anatomical variations and individual sinus involvement.
3. To evaluate the importance of CT and diagnostic nasal endoscopy in preoperative assessment.

MATERIALS AND METHODS

This hospital-based prospective observational study was conducted in the Department of Otorhinolaryngology in KIMS Hubli, Karnataka, India, over an 18-month period from January 2020 to July 2021. The study aimed to evaluate the prevalence of osteomeatal complex (OMC) anatomical variations in patients with chronic rhinosinusitis (CRS) using diagnostic nasal endoscopy (DNE) and computed tomography (CT) of the paranasal sinuses.

The study population comprised patients attending the ENT outpatient department with chronic rhinosinusitis that was refractory to adequate medical management and who were subsequently planned for Functional Endoscopic Sinus Surgery (FESS). A total of 54 patients were enrolled using a consecutive sampling technique. The sample size was calculated using the formula $N = 4pq/L^2$, assuming a prevalence of osteomeatal complex anatomical variations of 65%, a 95% confidence level, and an allowable error of 13%. Consecutive eligible patients fulfilling the predefined inclusion criteria were recruited until the required sample size was achieved.

Patients aged 15–70 years with chronic rhinosinusitis of more than three months' duration, who had failed appropriate medical therapy and were willing to undergo Functional Endoscopic Sinus Surgery, were included in the study. Patients with nasal polyps or other expansive sinonasal lesions, previous sinonasal surgery, facial trauma, acute sinonasal infection, fungal sinusitis, sinonasal malignancy, or disorders associated with impaired mucociliary clearance, including Kartagener syndrome, immotile cilia syndrome, Down syndrome, and cystic fibrosis, were excluded from the study.

Clinical Evaluation

All participants underwent detailed clinical history and comprehensive ENT examination. Routine laboratory investigations and radiological evaluation were performed. Active infections were treated with antibiotics, antihistamines, and topical nasal decongestants before endoscopic assessment. Patients receiving steroid therapy or immunotherapy were excluded from evaluation until completion of treatment.

Diagnostic Nasal Endoscopy

Diagnostic nasal endoscopy was performed using Karl Storz rigid endoscopes (0°, 30°, and 70°; 4 mm diameter) under topical anaesthesia with 4% lignocaine and adrenaline. Examination was performed systematically in three passes to evaluate the inferior meatus, sphenoethmoidal recess, and middle meatus. Anatomical variations of the osteomeatal complex and mucosal abnormalities were documented.

Computed Tomography

CT scans of the nose and paranasal sinuses were obtained in the coronal plane using 5-mm slice thickness extending from the frontal sinus to the sphenoid sinus. Images were evaluated for anatomical variations of the osteomeatal complex and associated mucosal disease.

Outcome Measures

The primary outcome measure was the prevalence of anatomical variations involving the osteomeatal complex (OMC) among patients with chronic rhinosinusitis. Secondary outcome measures included the frequency and pattern of involvement of the paranasal sinuses, the association between individual osteomeatal complex anatomical variations and disease affecting specific paranasal sinuses, and the identification of surgically significant anatomical variants relevant to preoperative planning and Functional Endoscopic Sinus Surgery (FESS).

Statistical Analysis

Data were entered into Microsoft Excel and analysed using SPSS software. Categorical variables were expressed as frequencies and percentages. Associations between anatomical variations and sinus involvement were analysed using the Chi-square test or Fisher's exact test, as appropriate. A P value <0.05 was considered statistically significant.

Ethical Considerations

Institutional Ethics Committee approval was obtained before commencement of the study, and written informed consent was obtained from all participants.

RESULTS

Baseline Characteristics

A total of **54 patients** with chronic rhinosinusitis were included. The majority (74.0%) were younger than 40 years, with the highest proportion observed in the 21–30-year and 31–40-year age groups. The mean age was not reported in the thesis. Males constituted 59.3% of the study population, giving a male-to-female ratio of approximately 1.45:1.

Table 1. Demographic Characteristics

Variable	Frequency (n=54)	Percentage
Age (years)		
11–20	12	22.2
21–30	14	25.9
31–40	14	25.9
41–50	7	13.0
51–60	5	9.3
61–70	2	3.7
Sex		
Male	32	59.3
Female	22	40.7

Clinical Presentation

Nasal obstruction (72.2%) was the most common presenting symptom, followed by postnasal drip (68.5%), headache/facial pain (66.7%), and nasal discharge (48.1%). Sneezing was reported in only 9.3% of patients. On clinical examination, mucopurulent discharge (81.5%) and deviated nasal septum (74.1%) were the predominant findings.

Table 2. Clinical Presentation

Symptom/Sign	n (%)
Nasal obstruction	39 (72.2)
Postnasal drip	37 (68.5)
Headache/Facial pain	36 (66.7)
Nasal discharge	26 (48.1)
Sneezing	5 (9.3)
Mucopurulent discharge	44 (81.5)
Deviated nasal septum	40 (74.1)
Inferior turbinate hypertrophy	31 (57.4)
Middle turbinate hypertrophy	27 (50.0)

Pattern of Sinus Disease

Bilateral maxillary sinusitis was the commonest diagnosis (57.4%). Maxillary sinus involvement was identified in 85.2% of patients, followed by ethmoid (31.5%), frontal (9.3%), and sphenoid (5.6%) sinus involvement.

Table 3. Distribution of Sinus Involvement

Sinus	n (%)
Maxillary	46 (85.2)
Ethmoid	17 (31.5)
Frontal	5 (9.3)
Sphenoid	3 (5.6)

Anatomical Variations of the Osteomeatal Complex

Overall, 53.7% of patients had two or more anatomical variations, while 33.3% had a single variation. Only 13.0% had no detectable anatomical variation. Deviated nasal septum (74.1%) was the commonest anatomical abnormality, followed by unilateral concha bullosa (33.3%), bilateral concha bullosa (20.4%), paradoxically curved middle turbinate (14.8%), uncinate deviation (9.3%), uncinate hypertrophy (5.6%), agger nasi cell (1.9%), and Haller cell (1.9%).

Table 4. Anatomical Variations

Anatomical variation	n (%)
Deviated nasal septum	40 (74.1)
Unilateral concha bullosa	18 (33.3)
Bilateral concha bullosa	11 (20.4)
Paradoxically curved middle turbinate	8 (14.8)
Uncinate deviation	5 (9.3)
Uncinate hypertrophy	3 (5.6)
Agger nasi cell	1 (1.9)
Haller cell	1 (1.9)

Association Between Anatomical Variations and Maxillary Sinus Involvement

Maxillary sinus disease was present in 46 (85.2%) patients. Among the various anatomical variations evaluated, deviated nasal septum and concha bullosa demonstrated statistically significant associations with maxillary sinus involvement. No significant association was observed with paradoxically curved middle turbinate, uncinate hypertrophy, uncinate deviation, agger nasi cells, or Haller cells.

Table 5. Association of Anatomical Variations with Maxillary Sinus Involvement

Anatomical variation	Present n	Absent n	P value
Deviated nasal septum	37	3	**0.021**
Concha bullosa	28	1	**0.018**
Paradoxically curved middle turbinate	8	0	0.336
Uncinate hypertrophy	3	0	>0.99
Uncinate deviation	3	2	0.153
Agger nasi cell	1	0	>0.99
Haller cell	1	0	>0.99

Ethmoid Sinus Involvement

Ethmoid sinus involvement was identified in 17 (31.5%) patients. No statistically significant association was observed between ethmoid sinus disease and individual anatomical variations of the osteomeatal complex. However, the presence of one or more anatomical variations collectively showed an association with ethmoid sinus involvement.

Frontal Sinus Involvement

Frontal sinus disease was observed in only five patients (9.3%). None of the anatomical variations studied demonstrated a statistically significant association with frontal sinus involvement.

Summary of Principal Findings

The present study demonstrated that multiple osteomeatal complex (OMC) anatomical variations were more common than isolated variations among patients with chronic rhinosinusitis. Deviated nasal septum was identified as the most common anatomical variation, while the maxillary sinus was the most frequently affected paranasal sinus. A statistically significant association was observed between deviated nasal septum and maxillary sinus involvement, as well as between concha bullosa and maxillary sinus disease. In contrast, the remaining osteomeatal complex anatomical variations did not demonstrate statistically significant associations with disease involving the individual paranasal sinuses.

DISCUSSION

Chronic rhinosinusitis continues to be one of the most frequently encountered disorders in otorhinolaryngology practice. Anatomical variations involving the osteomeatal complex have long been considered potential contributors to impaired mucociliary clearance and obstruction of normal sinus drainage. Identification of these variations is particularly important before Functional Endoscopic Sinus Surgery (FESS), where precise anatomical knowledge minimizes operative complications and improves surgical outcomes.

The present prospective study evaluated 54 patients with chronic rhinosinusitis using diagnostic nasal endoscopy and computed tomography to determine the prevalence of osteomeatal complex variations and their association with sinus involvement.

Age Distribution

Most patients (74%) were younger than 40 years, with the highest proportion occurring in the third and fourth decades of life. This observation is consistent with previous studies reporting that CRS predominantly affects young and middle-aged

adults, reflecting the high prevalence of environmental exposures, allergic disorders, and chronic inflammatory conditions during these years.1,2,4,5

Sex Distribution

Male patients constituted 59.3% of the study population, resulting in a male-to-female ratio of 1.45:1. Similar male predominance has been reported in several Indian studies, although some international studies have demonstrated nearly equal sex distribution. The observed difference may reflect regional healthcare-seeking behaviour rather than true disease prevalence.10,13,14

Clinical Presentation

Nasal obstruction was the predominant presenting symptom, followed by postnasal drip and headache/facial pain. These findings are consistent with the accepted clinical profile of chronic rhinosinusitis and correspond well with diagnostic criteria emphasizing nasal blockage and nasal discharge as cardinal symptoms. Mucopurulent discharge and deviated nasal septum were the most frequent clinical signs, supporting the role of chronic inflammation and mechanical obstruction in disease pathogenesis.1-2,4

Anatomical Variations

The most important finding of this study was the high prevalence of osteomeatal complex variations. More than half of the patients exhibited two or more anatomical variations, suggesting that combined abnormalities may contribute more substantially to impaired sinus drainage than isolated variants.9,15,16,10,13,14 Deviated nasal septum (74.1%) was the most common anatomical variation identified. This prevalence is higher than that reported in many earlier studies but is comparable with studies involving patients selected for surgical management of chronic rhinosinusitis.9,15,10,13,14 Septal deviation narrows the middle meatus, alters nasal airflow, and predisposes to obstruction of the osteomeatal complex.6,7-9 Concha bullosa represented the second most common variation, occurring as unilateral (33.3%) or bilateral (20.4%) pneumatisation of the middle turbinate.17-22 Enlargement of the middle turbinate may compress the middle meatus and interfere with normal sinus ventilation. These findings support previous reports identifying concha bullosa as one of the commonest anatomical variants associated with CRS.6,16

Paradoxically curved middle turbinate was observed in 14.8% of patients, whereas uncinate process abnormalities were comparatively uncommon.10,21,22 Agger nasi and Haller cells were identified only rarely in this cohort.17,23,24

Pattern of Sinus Involvement

Maxillary sinus involvement (85.2%) was the predominant radiological finding, followed by ethmoid, frontal, and sphenoid sinus disease. Bilateral maxillary sinusitis constituted the commonest diagnosis. These findings support the concept that the maxillary sinus is particularly susceptible to obstruction at the osteomeatal complex because of its dependence on normal middle meatal drainage.25,15,10,13,14,26

Association Between Anatomical Variations and Sinus Disease

A significant association was demonstrated between deviated nasal septum and maxillary sinus involvement (P=0.021). Similarly, concha bullosa showed a statistically significant association with maxillary sinus disease (P=0.018). These findings suggest that both abnormalities contribute to narrowing of the osteomeatal complex and impairment of maxillary sinus drainage. No statistically significant associations were observed for paradoxically curved middle turbinate, uncinate process abnormalities, agger nasi cells, or Haller cells. This may be attributable to the relatively small number of these variations identified in the present study.10,13,14,16,19,21,22

Clinical Implications

The findings of this study reinforce the importance of comprehensive preoperative evaluation using both CT and diagnostic nasal endoscopy. Recognition of anatomical variations enables appropriate surgical planning, reduces the risk of intraoperative complications, and facilitates complete clearance of obstructive pathology during Functional Endoscopic Sinus Surgery.6,7,12

Strengths and Limitations

The strengths of the present study include its prospective observational design, the combined assessment of osteomeatal complex anatomical variations using both computed tomography (CT) of the paranasal sinuses and diagnostic nasal endoscopy (DNE), and the comprehensive evaluation of multiple osteomeatal complex anatomical variations in relation to chronic rhinosinusitis. In addition, the study examined the association between these anatomical variations and involvement of individual paranasal sinuses, thereby providing clinically relevant information for preoperative assessment and surgical planning.

However, the study has certain limitations. Being a single-centre study with a relatively small sample size, the findings may have limited generalizability. The absence of a control group comprising individuals without chronic rhinosinusitis precluded comparison of the prevalence of anatomical variations in the general population. Furthermore, the statistical power to detect associations involving relatively uncommon anatomical variants, such as Haller cells and agger nasi cells, was limited. Finally, long-term postoperative outcomes following Functional Endoscopic Sinus Surgery (FESS) were not evaluated, restricting assessment of the clinical significance of these anatomical variations on surgical outcomes.

CONCLUSION

The present prospective observational study demonstrated that anatomical variations of the osteomeatal complex are highly prevalent among patients with chronic rhinosinusitis undergoing Functional Endoscopic Sinus Surgery. More than half of the study population exhibited multiple anatomical variations, highlighting the complexity of sinonasal anatomy in patients with chronic inflammatory disease. The most frequently encountered anatomical variation was deviated nasal septum, followed by concha bullosa, while paradoxically curved middle turbinate, uncinate process abnormalities, agger nasi cells, and Haller cells were less common.

The maxillary sinus was the most commonly involved paranasal sinus, followed by the ethmoid, frontal, and sphenoid sinuses. Statistical analysis demonstrated significant associations between deviated nasal septum, concha bullosa, and maxillary sinus disease, suggesting that these anatomical variations may contribute to impaired osteomeatal complex drainage and persistent sinonasal inflammation. The findings emphasize that neither CT nor diagnostic nasal endoscopy should be used in isolation. Instead, both investigations should be considered complementary in the comprehensive evaluation of patients with chronic rhinosinusitis. Diagnostic nasal endoscopy provides excellent visualization of mucosal disease and middle meatal pathology, whereas CT accurately delineates the bony anatomy and surgically relevant anatomical variations. Their combined use enhances diagnostic accuracy, facilitates appropriate surgical planning, and minimizes intraoperative complications during Functional Endoscopic Sinus Surgery.

Although anatomical variations alone cannot be considered the sole etiological factor for chronic rhinosinusitis, they represent important predisposing factors that may impair mucociliary clearance and sinus ventilation. Careful preoperative identification of these variations is therefore essential to optimize surgical outcomes and reduce the likelihood of persistent or recurrent disease. Future multicentric studies with larger sample sizes and long-term postoperative follow-up are recommended to further clarify the contribution of individual anatomical variations to the development, severity, and recurrence of chronic rhinosinusitis.

Key Messages

- Anatomical variations of the osteomeatal complex are common in chronic rhinosinusitis.
- Deviated nasal septum is the commonest anatomical variation.
- Concha bullosa is the second most frequent anatomical variation.
- Maxillary sinus is the most commonly affected sinus.
- Deviated nasal septum and concha bullosa show significant association with maxillary sinus disease.
- CT and diagnostic nasal endoscopy are complementary investigations before Functional Endoscopic Sinus Surgery.
- Careful preoperative identification of anatomical variations contributes to safer surgery and improved postoperative outcomes.

Clinical Implications

The findings of the present study highlight the importance of comprehensive preoperative evaluation in patients with chronic rhinosinusitis undergoing Functional Endoscopic Sinus Surgery (FESS). Computed tomography (CT) of the paranasal sinuses should be performed routinely to identify osteomeatal complex anatomical variations and accurately delineate sinonasal anatomy before surgery. Diagnostic nasal endoscopy should complement radiological assessment by evaluating middle meatal pathology and correlating endoscopic findings with CT findings. Identification of surgically significant anatomical variations facilitates appropriate surgical planning and enables surgeons to adopt a safer and more effective operative approach. Furthermore, recognition of these anatomical variants may help reduce intraoperative complications, including orbital injury, cerebrospinal fluid leak, and incomplete disease clearance. As multiple osteomeatal complex anatomical variations frequently coexist, they should be evaluated collectively during preoperative planning rather than as isolated anatomical entities.

Recommendations

Based on the findings of the present study, larger multicentre prospective studies are recommended to validate the observed associations and improve the generalizability of the results. Future research should include healthy control subjects to facilitate comparison of the prevalence of osteomeatal complex anatomical variations and to better elucidate their role in

the pathogenesis of chronic rhinosinusitis. Long-term follow-up of patients undergoing Functional Endoscopic Sinus Surgery (FESS) is also warranted to evaluate the impact of specific anatomical variations on surgical outcomes, disease recurrence, and postoperative quality of life. Additionally, the use of advanced imaging protocols with thinner computed tomography (CT) sections may enhance the detection and characterization of subtle anatomical variations, thereby improving preoperative assessment and surgical planning.

DECLARATIONS

Ethics Approval

The study was conducted after obtaining approval from the Institutional Ethics Committee of Karnataka Institute of Medical Sciences (KIMS) Hubli. Written informed consent was obtained from all participants before enrolment.

Consent for Publication

Not applicable.

Availability of Data and Materials

The datasets generated and analysed during the present study are available from the corresponding author upon reasonable request.

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The authors received no external funding for this study.

Conflict of Interest

The authors declare that there is no conflict of interest.

Authors' Contributions

Author 1: Conceptualization, data collection, clinical evaluation, manuscript preparation.
Author 2: Study supervision, methodology, manuscript review.
Author 3: Statistical analysis and critical revision of the manuscript.
(All authors approved the final version of the manuscript.)

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REFERENCES

1. Fokkens WJ, Lund VJ, Hopkins C, et al. European Position Paper on Rhinosinusitis and Nasal Polyps 2020. Rhinology 2020;58(Suppl S29):1-464.
2. Orlandi RR, Kingdom TT, Hwang PH, et al. International Consensus Statement on Allergy and Rhinology: Rhinosinusitis 2021. Int Forum Allergy Rhinol. 2021;11(3):213-740.
3. Rosenfeld RM, Piccirillo JF, Chandrasekhar SS, et al. Clinical Practice Guideline (Update): Adult Sinusitis. Otolaryngol Head Neck Surg 2015;152(2 Suppl):S1-39.
4. Sedaghat AR. Chronic rhinosinusitis. Am Fam Physician 2017;96:500-506.
5. Tan BK, Kern RC, Schleimer RP, et al. Chronic rhinosinusitis: The unrecognized epidemic. Am J Respir Crit Care Med 2013;188:1275-7.
6. Stammberger H. Functional Endoscopic Sinus Surgery. Philadelphia: BC Decker 1991.
7. Kennedy DW. Functional endoscopic sinus surgery. Technique. Arch Otolaryngol 1985;111:643-9.
8. Zinreich SJ. Imaging of inflammatory sinus disease. Otolaryngol Head Neck Surg 1993;109:863-7.
9. Bolger WE, Butzin CA, Parsons DS. Paranasal sinus bony anatomic variations and mucosal abnormalities. Laryngoscope 1991;101:56-64.
10. Kaygusuz A, Haksever M, Akduman D, et al. Sinonasal anatomical variations and chronic rhinosinusitis. B-ENT 2014;10:111-8.
11. Lloyd GAS, Lund VJ, Scadding GK, et al. CT of the paranasal sinuses and functional endoscopic surgery. J Laryngol Otol 1991;105:181-5.
12. Aziz T, Biron VL, Ansari K, et al. Imaging assessment before endoscopic sinus surgery: A review. J Otolaryngol Head Neck Surg 2019;48:1-10.
13. Aramani A, Karadi RN, Kumar S. A study of anatomical variations of osteomeatal complex in chronic rhinosinusitis using CT. Indian J Otolaryngol Head Neck Surg 2014;66:435-9.
14. Wani AA, Kanotra S, Lateef M, et al. CT evaluation of osteomeatal complex variations in chronic rhinosinusitis. Indian J Otolaryngol Head Neck Surg 2009;61:163-8.
15. Dua K, Chopra H, Khurana AS, et al. CT scan variations in chronic sinusitis. Indian J Radiol Imaging 2005;15:315-20.
16. Perez-Pinas I, Sabate J, Carmona A, et al. Anatomical variations in the human paranasal sinus region studied by CT. J Anat 2000;197:221-7.
17. Earwaker J. Anatomic variants in sinonasal CT. Radiographics 1993;13:381-415.

18. Maru YK, Gupta Y. Concha bullosa: Frequency and appearance on CT. Indian J Otolaryngol Head Neck Surg 1999;51:40-4.
19. Stallman JS, Lobo JN, Som PM. The incidence of concha bullosa and its relationship to nasal septal deviation and paranasal sinus disease. Am J Neuroradiol 2004;25:1613-8.
20. Jones NS. CT of the paranasal sinuses: A review of anatomy and pathology. Clin Otolaryngol 2002;27:11-7.
21. Scribano E, Ascenti G, Loria G, et al. The role of osteomeatal complex anatomical variations in inflammatory disease. Clin Radiol 1997;52:372-7.
22. Hatipoglu HG, Cetin MA, Yuksel E. Concha bullosa types and their relationship with chronic sinusitis. Eur J Radiol 2005;55:102-6.
23. Shpilberg KA, Daniel SC, Doshi AH, et al. CT of the paranasal sinuses: Normal anatomy, variants and pathology. Radiol Clin North Am 2015;53:1-18.
24. Kantarci M, Karasen RM, Alper F, et al. Remarkable anatomic variations in paranasal sinus region and clinical importance. Eur J Radiol 2004;50:296-302.
25. Calhoun KH, Waggenspack GA, Simpson CB, et al. CT evaluation of the paranasal sinuses in symptomatic and asymptomatic populations. Otolaryngol Head Neck Surg 1991;104:480-3.
26. Whyte A, Boeddinghaus R. The maxillary sinus: Anatomy and imaging. Insights Imaging 2019;10:1-15.