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PREVALENCE OF RADIOLOGICAL INFERIOR TURBINATE ANOMALIES AND THEIR CLINICAL IMPLICATIONS

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Abstract

Background: *Inferior turbinate anomalies are often underrecognized contributors to chronic nasal obstruction and other sinonasal symptoms.*

Objective: *To determine the prevalence of inferior turbinate anomalies on CT imaging and to evaluate their clinical implications in patients with sinonasal symptoms.*

Methods: *This prospective, observational study was conducted at CMH, Lahore from 10 January 2023 to 20 December 2023. A total of 110 patients who presented with symptoms of nasal obstruction, chronic rhinosinusitis, allergic rhinitis, or related sinonasal complaints were enrolled in the study. All enrolled patients underwent non-contrast high-resolution computed tomography (HRCT) scans of the paranasal sinuses using a 64-slice multidetector CT scanner. Axial images were acquired with a slice thickness of ≤1 mm and multiplanar reformations were performed to obtain coronal and sagittal views.*

Results: *Out of 110 patients, 78 (70.9%) had at least one inferior turbinate anomaly. The most common was hypertrophy (56.4%), followed by paradoxical curvature (16.4%), pneumatization (8.2%), medial/lateral deviation (10.9%), and bony outgrowth (5.5%). A statistically significant association was found between inferior turbinate hypertrophy and higher NOSE scores ($p < 0.01$). Coexisting nasal anomalies such as deviated nasal septum (65.5%) and middle turbinate concha bullosa (25.5%) were common.* ***Conclusion:*** *It is concluded that inferior turbinate anomalies are prevalent and clinically significant in patients with sinonasal symptoms. Routine CT evaluation of the inferior turbinates is crucial for comprehensive diagnosis and optimal treatment planning. The correlation between radiological anomalies and symptom severity highlights the need for structured radiological reporting and individualized clinical management.*

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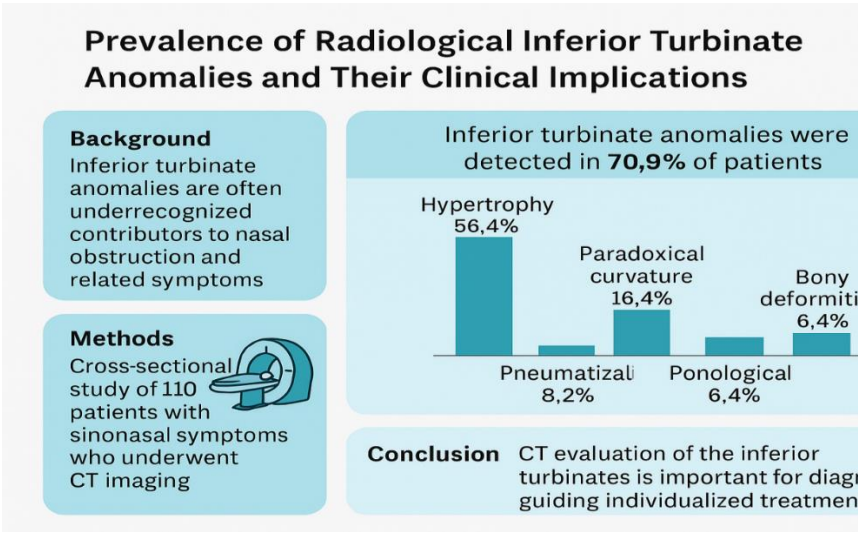

Figure 1: Graphical Abstract

INTRODUCTION

The inferior nasal turbinates are critical anatomical structures within the lateral walls of the nasal cavity, contributing significantly to the conditioning of inspired air by ensuring effective filtration, humidification, and temperature regulation. Structurally, they are formed by a bony core surrounded by vascular mucosa, which makes possible the dynamic increase or decrease on physiological requirements [1]. With these anatomical positioning and physiological functions any anatomical difference whether present at birth or acquired can have profound impact on nasal airflow and respiratory function. Inferior turbinates range from hypertrophy to paradoxical curvature, pneumatization (concha bullosa) of the inferior turbinates, medial or lateral deviation, and abnormal bony attachments at all corners [2]. These anomalies can be unilateral or bilateral and can co-exist with other nasal abnormalities such as septal deviations or concha bullosa of the middle turbinate thus complicating nasal obstruction symptoms [3]. Inferior turbinate hypertrophy is most relevant in considering chronic therapeutic conditions like allergic (anat. or hist.) rhinitis and non-allergic rhinitis, frequently associated with nasal congestion unaffected by medical therapy. Although hypertrophy is a frequent clinical problem dealt with, other structural anomalies might not be detected unless a radiological assessment is performed [4].

The growing use of diagnostic imaging and especially high-resolution computed tomography (HRCT) has enabled us to determine such minor anatomical differences more accurately. CT imaging provides precise coronal, axial, and sagittal views of the sinonasal anatomical area, which enables evaluation of the turbinate structure, the level of the mucous membrane, and its relationships with neighboring bodies [5]. Despite the availability of such advanced imaging modalities, inferior turbinate anomalies are less studied in comparison to more widely studied anatomical anomalies such as nasal septal deviation and middle turbinate concha bullosa [6]. The clinical implications of these anomalies have wide ranging consequences. For example, paradoxical inferior turbinate curvature will interfere even with nasal gas passage in the case of no mucosal edema thus a pneumatization of inferior turbinate may be interpreted as sinonasal polyps or tumors [7].

In patients undergoing functional endoscopic sinus surgery (FESS), unrecognized anomalies may increase the risk of intraoperative complications or suboptimal surgical outcomes. Thus, accurate preoperative identification of turbinate anomalies is essential for both planning and surgical navigation [8]. From a clinical management perspective, distinguishing

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between functional hypertrophy and anatomical anomalies can help tailor therapeutic strategies. Although intranasal corticosteroids and decongestants can help alleviate mucosal inflammation-related symptoms, they are rarely effective against structural deviations [9]. In such cases, surgical correction ranging from turbinate reduction to rhinoplasty or outfracture is considered. The presence of anatomical anomalies also influences surgical approach; for example, submucosal resection might be required instead of traditional reduction methods if bony hypertrophy is present [10].

Objective

To determine the prevalence of inferior turbinate anomalies on CT imaging and to evaluate their clinical implications in patients with sinonasal symptoms.

Methodology

This prospective, observational study was conducted at CMH, Lahore from 10 January 2023 to 20 December 2023. A total of 110 patients who presented with symptoms of nasal obstruction, chronic rhinosinusitis, allergic rhinitis, or related sinonasal complaints were enrolled in the study.

Inclusion Criteria

Patients aged >18 years

Patients presenting with symptoms such as nasal obstruction, nasal discharge, postnasal drip, facial pressure, or headache.

Patients undergoing non-contrast CT scan of the paranasal sinuses.

Patients who provided informed consent to participate in the study.

Exclusion Criteria

Patients with a history of nasal trauma or prior nasal or sinus surgery.

Presence of sinonasal tumors or malignancy.

Acute infectious sinusitis at the time of scanning.

Patients with craniofacial anomalies or congenital syndromes affecting sinonasal structures.

Data collection

All enrolled patients underwent non-contrast high-resolution computed tomography (HRCT) scans of the paranasal sinuses using a 64-slice multidetector CT scanner. Axial images were acquired with a slice thickness of ≤1 mm and multiplanar reformations were performed to obtain coronal and sagittal views. Images were assessed under both bone and soft tissue window settings to ensure optimal visualization of the inferior turbinate structure. Two experienced radiologists independently reviewed the CT scans, with any discrepancies resolved by mutual consensus. Variations in the inferior turbinate were specifically identified and categorized. Bony spur formation, paradoxical curvature (medial convexity), medial or lateral deviation, mucosal or bony hypertrophy, pneumatization (inferior turbinate concha bullosa), and accessory or bifid turbinates were among the anomalies examined. Each anomaly was documented for its laterality and frequency. Associated anatomical variations such as septal deviation, middle turbinate abnormalities, and obstruction of the ostiomeatal complex were also noted to evaluate co-existing sinonasal variations. A detailed clinical examination was performed for all patients by ENT specialists, and symptom severity was assessed using standardized scoring systems, including the Visual Analog Scale (VAS) and the Nasal Obstruction Symptom Evaluation (NOSE) score. Patient-reported symptoms were matched with the radiological findings to determine the clinical relevance of each turbinate anomaly.

Statistical Analysis

Data were analyzed using SPSS v26. Descriptive statistics were used to summarize the prevalence of different anatomical variations. The Chi-square test was applied to assess the significance of associations between turbinate anomalies and patient symptoms. A p-value of less than 0.05 was considered statistically significant.

Results

A total of 110 patients were included in the study, with a mean age of 35.6 ± 11.4 years and an age range of 18 to 62 years. There were 64 male patients, comprising 58.2% of the population, and 46 femalepatients, making up 41.8%. The most common age group was 31 to 40 years, accounting for 42.7% of the total participants.

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Table 1: Demographic and Baseline Characteristics of Patients

Parameter	Value
Total Number of Patients	110
Mean Age (years)	35.6 ± 11.4
Age Range (years)	18–62
Male Patients	64 (58.2%)
Female Patients	46 (41.8%)
Most Common Age Group	31–40 years (42.7%)

Inferior turbinate anomalies were observed in the majority of patients, with inferior turbinate hypertrophy being the most common, seen in 62 patients (56.4%). Paradoxical curvature was identified in 18 cases (16.4%), followed by medial or lateral deviation in 12 patients (10.9%) and pneumatization (concha bullosa) in 9 patients (8.2%). Less frequently observed were bony spur or outgrowth (5.5%) and accessory or bifid turbinates (1.8%). In terms of laterality, bilateral anomalies were more common, present in 47 patients (60.2%), while 31 patients (39.8%) had unilateral involvement.

Table 2: Prevalence of Inferior Turbinate Anomalies

Anomaly Type	Frequency (n = 110)	Percentage (%)
Inferior turbinate hypertrophy	62	56.4
Paradoxical curvature	18	16.4
Pneumatization (concha bullosa)	9	8.2
Medial/lateral deviation	12	10.9
Bony spur/outgrowth	6	5.5
Accessory/bifid turbinate	2	1.8
Laterality		
Bilateral	47	60.2
Unilateral	31	39.8

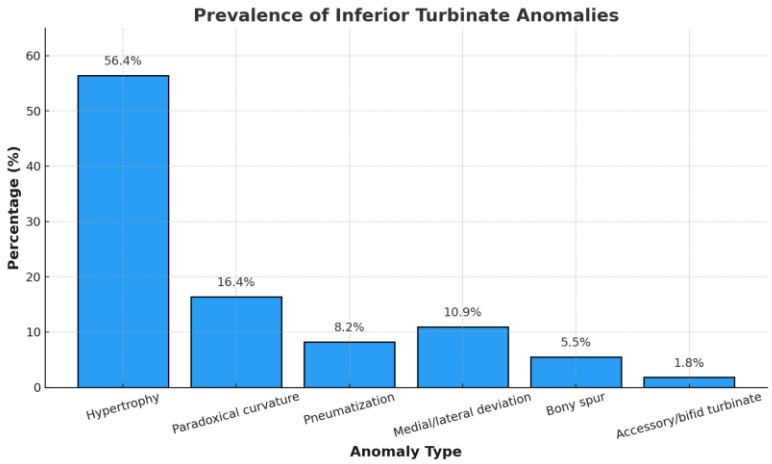

Figure 2: Prevalence of Inferior Turbinate Anomalies

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Among the associated anatomical variations, deviated nasal septum was the most frequently observed, present in 72 patients (65.5%). Middle turbinate concha bullosa was seen in 28 patients (25.5%), while ostiomeatal complex obstruction was noted in 35 cases (31.8%). Regarding the type of inferior turbinate hypertrophy, bilateral hypertrophy was more common, found in 41 patients (37.3%), compared to unilateral hypertrophy in 21 patients (19.1%)

Table 3: Coexisting Anatomical Variations

Anatomical Variation	Frequency	Percentage (%)
Deviated Nasal Septum (DNS)	72	65.5
Middle Turbinate Concha Bullosa	28	25.5
Ostiomeatal Complex Obstruction	35	31.8
Hypertrophy Type		
Bilateral	41	37.3
Unilateral	21	19.1

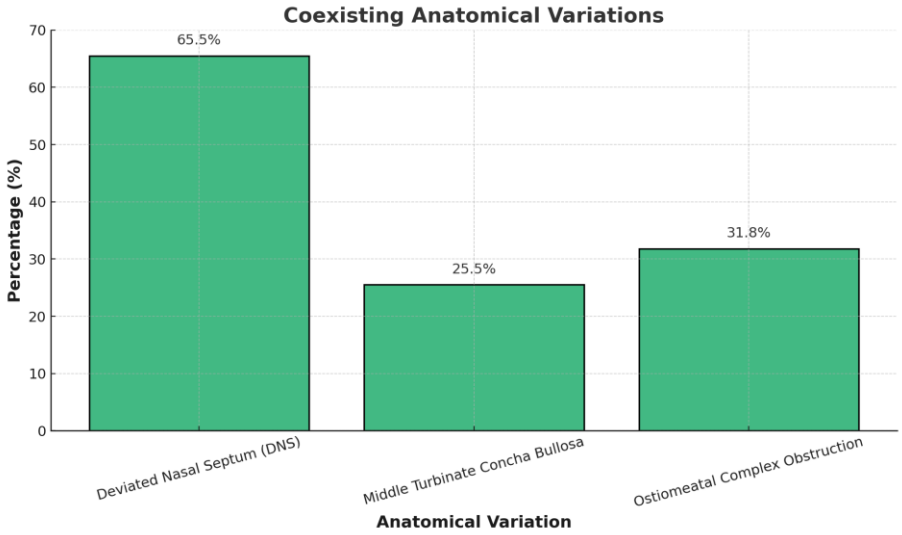

Figure 3: Coexisting Anatomical Variations

Severe pain (score 41–60) was reported by 28 patients (45.2%), while very severe pain (score 61–100) was observed in 26 patients (41.9%). Moderate symptoms were noted in 5 patients (8.1%), and only 3 patients (4.8%) reported mild discomfort. This distribution indicates a high burden of nasal obstruction symptoms among patients with turbinate hypertrophy.

Table 4: Correlation Between Hypertrophy and NOSE Scores

NOSE Score Range	Number of Patients with Hypertrophy	Percentage (%)
0–20 (Mild)	3	4.8
21–40 (Moderate)	5	8.1
41–60 (Severe)	28	45.2
61–100 (Very Severe)	26	41.9

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Figure 4: This coronal CT scan of the paranasal sinuses in a 29-year-old male shows partially opacified maxillary and ethmoid sinuses with mucosal thickening, more pronounced on the left side, consistent with chronic rhinosinusitis. The nasal septum appears midline, the orbits are symmetric, and the bony walls are intact with no evidence of erosion or aggressive pathology.

Discussion

The present study offers valuable insights into the anatomical variability of the inferior turbinate as observed on radiological imaging, with a particular focus on prevalence and clinical implications. Of the 110 patients examined, a sizeable 70.9% were diagnosed with some identifiable lesion of the inferior turbinate. This finding demonstrates the relative prevalence and clinical significance of these often incompletely appreciated variants in patients who present with nasal obstruction or sinus-related symptoms. The most frequent observed anomaly was inferior turbinate hypertrophy (56.4%). This is in line with prior studies which have demonstrated that turbinate hypertrophy is a primary structural aeroconstriction mechanism contributing to nasal airway obstruction – especially within the context of allergic/chronic rhinitis [11]. The hypertrophy was mostly bilateral which signifies diffuse response and not focal swellings that were seen in chronic mucosal

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inflammatory diseases. The statistically significant relationship between hypertrophy and higher NOSE scores in our study bolsters the clinical relevance of achieving this [finding], since it directly translates into symptom burden [12].

The second most common abnormality was paradoxical curvature, which was found in 16.4% of patients. Traditionally more emphasized in the middle turbinate, paradoxical curvature of the inferior turbinate remains less frequently reported. However, its presence can significantly alter the dynamics of nasal airflow and result in unilateral obstruction of the nose. The slight right-side predominance that was observed could be a result of developmental asymmetries or septal deviations that occurred simultaneously [13]. Pneumatization of the inferior turbinate, or concha bullosa inferior, though relatively rare (8.2%), is an important anatomical variant. While it is less frequently encountered than middle turbinate pneumatization, its misinterpretation as soft-tissue pathology such as a polyp or mass on imaging is a known diagnostic pitfall [14]. Awareness and identification of this entity on CT are critical, particularly in pre-surgical planning for endoscopic sinus surgery. Medial or lateral deviations and bony spurs or outgrowths, though less prevalent, can contribute to functional obstruction and also complicate surgical interventions [15]. The presence of accessory or bifid turbinates, though rare (1.8%), points to the need for meticulous imaging review, as such anomalies can be mistaken for pathological masses or polyps if not correctly identified. Importantly, a significant proportion of patients exhibited coexisting anatomical variations, such as septal deviation (65.5%) and middle turbinate concha bullosa (25.5%) [16]. This demonstrates the need for a comprehensive analysis of sinonasal anatomy and the multifactorial nature of nasal obstruction. It also highlights the potential for compounded airflow resistance when multiple variations coexist, thereby increasing the severity of patient symptoms [17]. The correlation between radiological findings and clinical symptoms in this study strengthens the argument for routine inclusion of inferior turbinate assessment in CT reporting protocols. In many cases, patients with functional complaints undergo imaging for diagnosis or surgical planning, yet inferior turbinate anomalies may go unmentioned, which could result in incomplete treatment planning.

The study's limitations include the absence of follow-up data to assess symptom resolution post-intervention, and the potential for observer variability in interpreting subtle anatomical changes, despite dual-radiologist review. Additionally, the results were not stratified according to the etiology of nasal symptoms (such as allergic vs. non-allergic rhinitis), which may have provided additional insights.

Conclusion

It is concluded that radiological anomalies of the inferior turbinate are highly prevalent among patients presenting with sinonasal complaints, particularly nasal obstruction. Inferior turbinate hypertrophy emerged as the most common anomaly, followed by paradoxical curvature, pneumatization, and bony outgrowths, each contributing variably to the severity and nature of symptoms. The significant correlation between hypertrophic changes and high NOSE scores underscores the functional impact of these anatomical variants. The study also highlights the importance of identifying coexisting anatomical variations, such as deviated nasal septum and middle turbinate concha bullosa, which often occur alongside inferior turbinate anomalies and collectively worsen nasal airflow resistance.

References

Subbiah N, Bakshi S S, Arumugam S, et al. (April 18, 2025) Clinical and Radiological Significance of Anatomical Variations in Paranasal Sinuses: A Retrospective CT-Based Study. Cureus 17(4): e82506. doi:10.7759/cureus.82506

Karki S, Pokharel M, Suwal S, Poudel R: Prevalence of anatomical variations of the sinonasal region and their relationship with chronic rhinosinusitis. Kathmandu Univ Med J. 2016, 14:342-6.

Kapusuz Gencer Z, Ozkırış M, Okur A, Karaçavuş S, Saydam L: The effect of nasal septal deviation on maxillary sinus volumes and development of maxillary sinusitis. Eur Arch Otorhinolaryngol. 2013, 270:3069-73. 10.1007/s00405-013-2435-y

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

Al-Rawi NH, Uthman AT, Abdulhameed E, Al Nuaimi AS, Seraj Z: Concha bullosa, nasal septal deviation, and their impacts on maxillary sinus volume among Emirati people: a cone-beam computed tomography study. Imaging Sci Dent. 2019, 49:45-51. 10.5624/isd.2019.49.1.45

Ali IK, Sansare K, Karjodkar F, Saalim M: Imaging analysis of Onodi cells on cone-beam computed tomography. Int Arch Otorhinolaryngol. 2020, 24:e319-22. 10.1055/s-0039-1698779

Kaya M, Çankal F, Gumusok M, Apaydin N, Tekdemir I: Role of anatomic variations of paranasal sinuses on the prevalence of sinusitis: computed tomography findings of 350 patients. Niger J Clin Pract. 2017, 20:1481-8. 10.4103/njcp.njcp_199_16

Balikci HH, Gurdal MM, Celebi S, Ozbay I, Karakas M: Relationships among concha bullosa, nasal septal deviation, and sinusitis: Retrospective analysis of 296 cases. Ear Nose Throat J. 2016, 95:487-91. 10.1177/0145561316095012

Ozcan KM, Selcuk A, Ozcan I, Akdogan O, Dere H: Anatomical variations of nasal turbinates. J Craniofac Surg. 2008, 19:1678-82. 10.1097/SCS.0b013e318188a29d

Gupta S, Gurjar N, Mishra HK: Computed tomographic evaluation of anatomical variations of paranasal sinus region. Int J Res Med Sci. 2017, 4:2909-13. 10.18203/2320-6012.ijrms20161975

Cellina M, Gibelli D, Cappella A, Martinenghi C, Belloni E, Oliva G: Nasal cavities and the nasal septum: anatomical variants and assessment of features with computed tomography. Neuroradiol J. 2020, 33:340-7. 10.1177/1971400920913763

Tuğtağ Demir B, Sarı N, Çankal F. Inferior turbinate variations: A radioanatomic study. Eur J Rhinol Allergy 2022;5(3):84-88.

Kalaiarasi R, Ramakrishnan V, Poyyamoli S. Anatomical Variations of the Middle Turbinate Concha Bullosa and its Relationship with Chronic Sinusitis: A Prospective Radiologic Study. Int Arch Otorhinolaryngol. 2018 Jul;22(3):297-302. doi: 10.1055/s-0038-1625978. Epub 2018 Mar 13. PMID: 29983772; PMCID: PMC6033609.

Aktas D, Kalcioglu M T, Kutlu R, Ozturan O, Oncel S. The relationship between the concha bullosa, nasal septal deviation and sinusitis. Rhinology. 2003;41(02):103–106

Papadopoulou AM, Bakogiannis N, Skrapari I, Bakoyiannis C. Anatomical Variations of the Sinonasal Area and Their Clinical Impact on Sinus Pathology: A Systematic Review. Int Arch Otorhinolaryngol. 2022 Jan 28;26(3):e491-e498. doi: 10.1055/s-0042-1742327. PMID: 35846811; PMCID: PMC9282972.

Kaya M, Çankal F, Gumusok M, Apaydin N, Tekdemir I. Role of anatomic variations of paranasal sinuses on the prevalence of sinusitis: Computed tomography findings of 350 patients. Niger J Clin Pract. 2017;20(11):1481–1488

Roman R A, Hedeşiu M, Gersak M, Fidan F, Băciuţ G, Băciuţ M. Assessing the prevalence of paranasal sinuses anatomical variants in patients with sinusitis using Cone Beam Computer Tomography. Clujul Med. 2016;89(03):419–421

Balikci H H, Gurdal M M, Celebi S, Ozbay I, Karakas M. Relationships among concha bullosa, nasal septal deviation, and sinusitis: Retrospective analysis of 296 cases. Ear Nose Throat J. 2016;95(12):487–491