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Original Article

Prevalence and relationship between concha bullosa and deviated nasal septum in patients referred to ENT clinic

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Abstract

Background: Concha bullosa and nasal septal deviation are common anatomical variants observed in paranasal sinus (PNS) CT scans. Previous studies suggest a significant association between these conditions. This study aimed to investigate their prevalence and relationship.

Methods: This cross-sectional study evaluated patients referred to the ENT clinic at Ayatollah Rouhani Hospital, Babol, Iran (July 1, 2018– October 20, 2019) using coronal CT scans. Concha bullosa was categorized by size (small, medium, large) and laterality (unilateral/bilateral). Rhinosinusitis was diagnosed based on CT findings, including mucosal thickening and sinus secretions. Data were analyzed using SPSS version 22.

Results: Among 399 patients (48% male, 52% female), concha bullosa was present in 199 patients (49.9%; 95% confidence interval [CI], 44.8–54.9%), with a significantly higher prevalence in females (60.8% vs. 39.2%, P=0.001). Rhinosinusitis was more frequent in patients with concha bullosa (37.7% vs. 27.5% without; P=0.03). Nasal septal deviation was observed in 265 patients (66.4%; 95% CI, 61.5%–71.0) and was significantly associated with concha bullosa (71.4% vs. 61.5%; P=0.037).

Conclusion: Our findings indicated that there is a significant relationship between concha bullosa, nasal septal deviation, and rhinosinusitis. Nasal septal deviation may exacerbate concha bullosa, leading to sinus inflammation and necessitating antibiotic treatment.

Keywords: Concha bullosa; Nasal septum; Sinusitis; Tomography, X-Ray Computed

Introduction

The nasal septum divides the nasal cavity into two separate chambers (right and left) and consists of both cartilaginous and bony components. Deviation occurs when uneven growth in these structures displaces the septum from the midline [1]. Beyond its structural role in partitioning the nasal passages, the septum helps maintain the shape of the nose, including the columella and nasal tip. Clinicians can diagnose septal deviation through physical examination or radiographic imaging [2]. Nasal deviation, characterized by displacement of the septal wall to one side, typically results in asymmetry of the nasal cavities. In severe cases, airway obstruction may occur, potentially causing breathing difficulties [3]. This anatomical variation can also alter nasal airflow patterns, leading to mucosal dryness, crusting, and epistaxis in some patients. Nasal obstruction may result from septal deviation, mucosal edema, or a combination of both [4]. Pharmacological management focuses on reducing inflammation and congestion to improve airway patency [5, 6].

Concha bullosa most commonly develops anterior to a deviated nasal septum, with studies demonstrating a direct correlation between the extent of septal deviation and the size/location of concha bullosa [7, 8]. The middle turbinate, a critical anatomical landmark in endoscopic sinus surgery, serves as both a lateral nasal wall structure and a guide to anterior sinus ostia [9]. Anatomically, the middle turbinate originates from the ethmoid bone and undergoes pneumatization through expansion of anterior ethmoid air cells [10]. This process of pneumatization, regardless of its extent or location, defines the formation of concha bullosa [11]. Importantly, middle turbinate pneumatization represents one of the most clinically significant anatomical variations in the sinonasal cavity [8].

The nasal turbinates consist of three distinct structures: the independent inferior turbinate bone, and the middle and superior turbinates which are ethmoidal extensions. These structures form the three nasal meatuses that regulate airflow [12]. Each meatus contains specific sinus drainage pathways: the inferior meatus houses the nasolacrimal duct, while the middle meatus drains the frontal, maxillary, and anterior ethmoid sinuses. The superior meatus provides drainage for the sphenoid and posterior ethmoid sinuses [12].

The relationship between concha bullosa and nasal septal deviation is a subject of ongoing investigation [13]. Some evidence suggest that a deviated nasal septum may alter intranasal airflow dynamics and pressure distribution, potentially influencing pneumatization patterns of the adjacent middle turbinate, thereby contributing to the development or configuration of concha bullosa [14, 15]. This structural interplay is clinically significant as it may collectively narrow the middle meatus, obstruct ostiomeatal complex drainage, and predispose individuals to recurrent or chronic sinusitis [16]. However, reported epidemiological associations vary considerably across studies and populations, highlighting a need for further investigation in diverse clinical settings.

While several studies in Iran have investigated concha bullosa and septal deviation [17-19], epidemiological data remain inconsistent, and population-specific estimates from northern Iran (Mazandaran province) are limited. Regional variations in genetics, environmental factors (e.g., climate, allergen exposure), and clinical referral patterns may influence the observed prevalence and relationships of these anatomical variants. Therefore, this study was designed to investigate the frequency and interrelationships of concha bullosa, nasal septal deviation, and rhinosinusitis in an ENT clinic population in Babol city, northern Iran, to provide region-specific data and contribute to a more nuanced understanding of these associations.

Methods

Ethical considerations

The study protocol adhered to the Declaration of Helsinki and was approved by the Ethics Committee of Babol University of Medical Sciences (Code: MUBABOL.HRI.REC.1399.110). All participants received written and verbal explanations of the study aims, and confidentiality was maintained through anonymized data collection.

Study Design and Population

This cross-sectional study was conducted at the ENT clinic of Ayatollah Rouhani Hospital, Babol, Iran, between July 1, 2018 and October 20, 2019. Participants were selected via convenience sampling from patients referred for paranasal sinus (PNS) CT scans. Inclusion criteria comprised: (1) adults (aged ≥14 years) scheduled for PNS CT imaging and (2) provision of written informed consent. Exclusion criteria included: (1) congenital nasal anatomical anomalies, (2) prior nasal surgery (e.g., septoplasty or turbinectomy), and (3) history of nasal trauma or fractures.

Sample size

A sample size of 399 was determined using the formula for cross-sectional studies, with a margin of error (*d*) of 0.05, a confidence level (A) of 95% (α =

0.05), and an estimated prevalence (P) of concha bullosa at 65%, based on prior regional studies.

Data Collection Tool and Variables

Data were collected using a structured form designed for this study. Demographic information (age, sex) was extracted from patients' electronic medical records. All clinical and anatomical data were obtained from the systematic evaluation of non-contrast paranasal sinus CT scans. The form captured the following variables: presence, laterality, and size of concha bullosa; presence, direction, and angular severity of nasal septal deviation; and radiological signs of chronic rhinosinusitis (mucosal thickening, sinus opacification/fluid).

Procedure and radiological evaluation

The study evaluated the prevalence of concha bullosa and its associations with nasal septal deviation and chronic rhinosinusitis through analysis of non-contrast coronal CT scans performed without nasal vasoconstriction. Concha bullosa was classified by size (small, medium, large; Figs. 1-3) and laterality (unilateral/bilateral), with size categories defined as follows: small indicated partial pneumatization occupying less than one-third of the middle meatus; medium represented pneumatization extending into one- to two-thirds of the meatus; and large denoted complete pneumatization obstructing over two-thirds of the meatal space. Nasal septal deviation was quantified by angular measurement from the midline, categorized as mild (<10°), moderate (10-30°), or severe (>30°). Chronic rhinosinusitis diagnosis relied on established radiological criteria, including mucosal thickening of 3 mm or greater and either sinus opacification or visible fluid accumulation within the sinus cavities [20, 21].

Data analysis

Data were analyzed using SPSS v.22 (IBM Corp.). Categorical variables (e.g., concha bullosa prevalence, septal deviation severity) were expressed as frequencies/percentages and compared using the Chi-square test. Continuous variables (e.g., age) were summarized as mean ± standard deviation. A *p*-value <0.05 was considered statistically significant.

Results

The study included 399 patients who underwent PNS CT scans, comprising 191 males (48%) and 208 females (52%). Age distribution revealed 101 patients (25.3%) were under 30 years, 232 (58.1%) were aged 30-60 years, and 66 (16.5%) were over 60 years, with an age range of 14 to 87 years.

Evaluation of concha bullosa prevalence showed distinct patterns of laterality and severity. Left-sided involvement was absent in 255 patients (63.9%), while 48 (12%; 95% CI, 9–15.6%) presented with small, 77 (19.3%; 95% CI, 15.5–23.5%) with moderate, and 19 (4.8%; 95% CI, 2.8-7.3%) with large concha bullosa. Right-sided findings demonstrated similar distribution: 277 patients (69.4%) had no concha bullosa, compared to 30 (7.5%; 95% CI, 5.1–10.5%) with small, 71 (17.8%; 95% CI, 14.1–21.9%) with moderate, and 18 (4.5%; 95% CI, 2.7–7.0%) with large presentations.

Gender-based analysis (Figure 1) revealed 200 patients (50.1%) without concha bullosa (87 females [43.5%] vs. 113 males [56.5%]), while 199 cases (49.9%) exhibited the condition, with a significant female predominance (121 females [60.8%; 95% CI, 53.6–67.6%] vs. 78 males [39.2%; 95% CI, 32.3–46.3%]; P = 0.001).

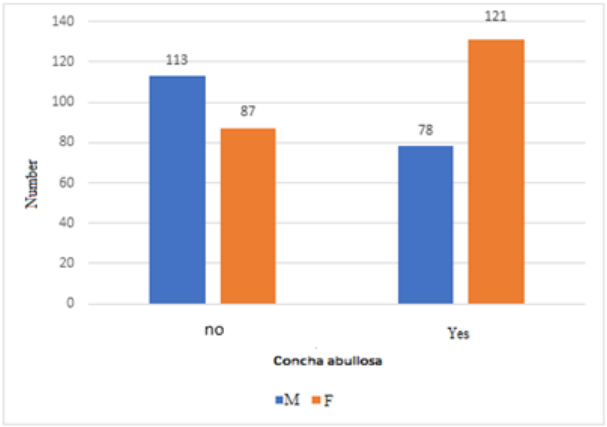

Figure 1: Frequency of people with and without concha bullosa by gender; M: Male; F: Female

Age and Concha Bullosa Prevalence

Analysis of concha bullosa by age revealed distinct patterns. Among 200 patients without concha bullosa, 39 (19.5%) were under 30 years, 125 (62.5%) were 30–60 years, and 36 (18%) were over 60 years. Conversely, of 199 patients with concha bullosa, 62 (31.2%; 95% CI, 24.7–38.1%) were under 30 years, 107 (53.8%; 95% CI, 46.5–60.8%) were 30–60 years, and 30 (15%; 95% CI, 10.4–20.8%) were over 60 years, with a significantly higher prevalence in the under-30 cohort (P = 0.028).

Rhinosinusitis Distribution

Rhinosinusitis was detected in 78 of 399 patients (19.6%; 95% CI, 15.7–23.8%) on the right side and in 82 patients (20.6%; 95% CI, 16.7–24.8%) on the left. Gender analysis (Figure 2) revealed no significant association, with rhinosinusitis present in 64 of 130 males (49.2%) and 66 of 130 females (50.8%) (P = 0.705). Notably, patients with concha bullosa had a significantly higher prevalence of rhinosinusitis (75/199, 37.7%; 95% CI, 30.9–44.8%) compared to those without (55/200, 27.5%; 95% CI, 21.4–34.2%; P = 0.03; Table 1).

Table 1: Association between concha bullosa and rhinosinusitis

Concha bullosa / Rhinosinusitis	Yes	No	P-value
No	124 (62.3%)	145 (72.5%)	P=0.03
Yes	75 (37.7%)	55 (27.5%)	

Retention Cysts and Nasal Deviation

Retention was detected in 63 of 399 patients (15.8%; 95% CI, 12.3–19.7%), with no gender disparity (52.4% female vs. 47.6% male; P = 0.96, Figure 3). Nasal septal deviation was present in 265 of 399 patients (66.4%; 95% CI, 61.5–71.0%), with no significant gender difference (52.8% females vs. 47.2% males; P > 0.05). Left- and right-sided deviations were detected in 158 (39.6%; 95% CI, 34.7–44.5%) and 131 (32.8%; 95% CI, 28.2–37.7%) of patients. Left-sided deviations were mild (12.5%; 50/399), moderate (21.1%; 84/399), or severe (6%; 24/399), while right-sided deviations were mild (9.8%; 39/399), moderate (18.5%; 74/399), or severe (4.5%; 18/399).

Age and Septal Deviation

Analysis of nasal septal deviation by age (Figure 4) revealed distinct patterns. Among 265 patients with deviation, the majority (157, 59.2%) were aged 30-60 years, while 76 (28.7%) were under 30 years and 32 (12.1%) were over 60 years. In contrast, the non-deviated group (n=134) showed different proportions: 25 (18.7%) under 30 years, 75 (56%) aged 30-60 years, and 34 (25.4%) over 60 years. Notably, septal deviation was significantly more prevalent in patients under 30 years (P=0.001). The statistical analysis revealed significant relationships between concha bullosa, nasal septal deviation, and rhinosinusitis. Analysis demonstrated that 71.4% of patients with concha bullosa exhibited concurrent nasal septal deviation, compared to 61.5% of those without concha bullosa (p = 0.037; Table 2). This association was particularly pronounced in the context of rhinosinusitis, where 83.1% of affected patients showed nasal septal deviation versus only 58.4% of patients without rhinosinusitis - a difference that was statistically significant (p < 0.001; Table 3).

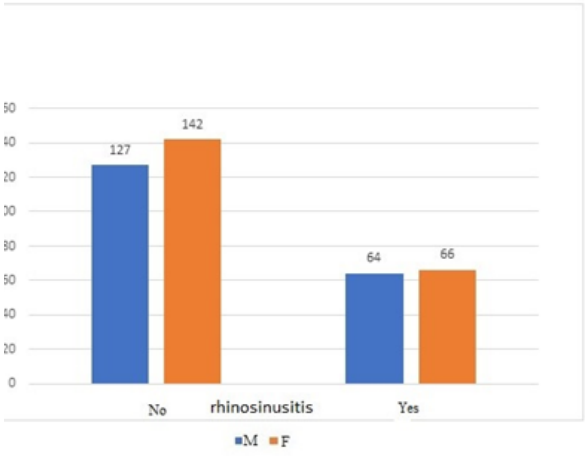

Figure 2: Prevalence of patients with rhinosinusitis and those without rhinosinusitis by gender; M: Male; F: Female

Table 2: Relationship between concha bullosa and nasal septal deviation

Rhinosinusitis / Nasal septal deviation	Yes	No	P value
No	22 (16.9%)	112 (41.6%)	P<0.001
Yes	108 (83.1%)	157 (58.4%)	

Table 3: Association between rhinosinusitis and nasal septal deviation

Concha bullos / Nasal septal deviation	Yes	No	P-value
No	57 (6.28%)	77 (38.5%)	P=0.037
Yes	142 (71.4%)	123 (61.5%)	

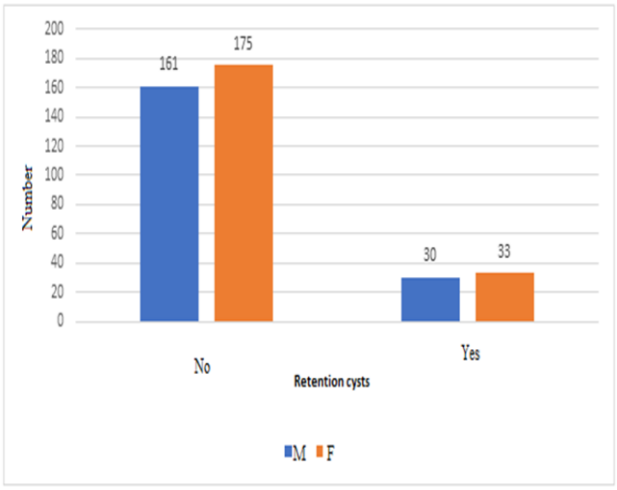

Figure 3: Prevalence of retention cysts by gender; M: Male; F: Female

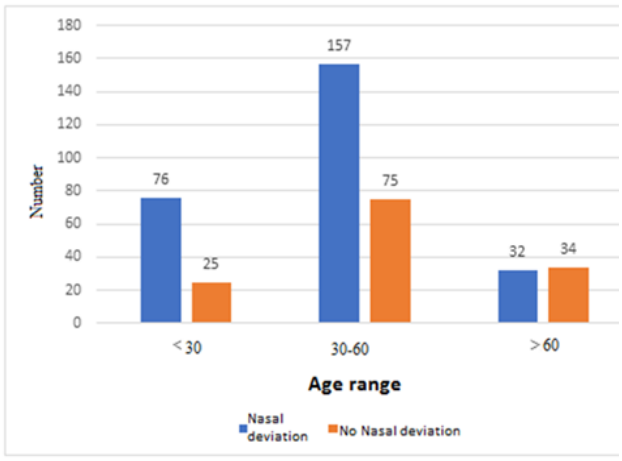

Figure 4: Frequency of nasal septal deviation based on age range

Discussion

Concha bullosa represents a common anatomical variant in ENT patients, with a well-documented association to rhinosinusitis and other rhinologic disorders. The reported prevalence of concha bullosa varies widely (4–80%) across different populations, with Iranian studies indicating a rate of 9.64% (14). Similarly, nasal septal deviation shows considerable epidemiological variation (34–90%), likely reflecting differences in diagnostic criteria and population characteristics [1]. The present study demonstrates significant associations between concha bullosa, nasal septal deviation, and chronic rhinosinusitis. Our findings align with previous reports indicating that concha bullosa occurs more frequently in females (60.8% vs 39.2%, P=0.001) and is strongly associated with septal deviation (71.4% vs 61.5%, P=0.037) [22, 23]. The higher prevalence of these anatomical variations in patients under 30 years (31.2% for concha bullosa, P=0.028; 28.7% for septal deviation, P=0.001) may reflect developmental factors in nasal cavity pneumatization. Our findings align with several key studies while revealing important discrepancies. The female predominance in concha bullosa prevalence (60.8% vs. 39.2%) corroborates Šubarić et al.'s report of prevalence in women [24]. However, our cohort demonstrated a younger mean age (30 years) compared to Subramanian et al.'s reported 45.6 years [25], potentially reflecting regional demographic differences or earlier symptomatic presentation in our population.

The significant association between concha bullosa and rhinosinusitis (P=0.03) supports Wardani et al.'s anatomical hypothesis [26], wherein pneumatized middle turbinates may compromise middle meatus drainage. Interestingly, while Rodrigues et al. reported male predominance in retention cysts [27], our study found no gender association (P=0.96), possibly due to healthcare-seeking behavior differences. The lower prevalence of septal deviation in younger patients (28.7% under 30 years) is accordance with Wojas et al.'s adult-predominant findings [28], potentially attributable to Iran's high rhinoplasty rates influencing detection in younger demographics. Notably, our results confirm Stallman et al.'s reported concha bullosa-septal deviation association [29] but contradict Kaya et al.'s null findings [30], possibly due to their smaller sample (n=100) or regional anatomical variations. The robust rhinosinusitis-septal deviation relationship (P<0.001) reinforces Ahn et al.'s mechanistic model [31], where structural obstruction impairs mucociliary clearance.

The clinical implications of these findings are significant, as nasal septal deviation remains a prevalent disorder with multisystem consequences. This anatomical variation can disrupt three critical physiological processes: (1) nasal airflow dynamics, potentially leading to obstructive symptoms and sleep disturbances; (2) middle ear ventilation, which may contribute to Eustachian tube dysfunction; and (3) sinus drainage pathways, predisposing to recurrent sinusitis. These wide-ranging effects underscore the importance of timely intervention, with treatment options ranging from medical management (e.g., topical corticosteroids) to surgical correction (e.g., septoplasty) when clinically indicated.

This study possesses several strengths. First, it provides specific epidemiological data on the relationship between concha bullosa and septal

deviation from a previously understudied region in northern Iran. Second, the use of CT imaging for diagnosis provided objective, high-resolution anatomical data, allowing for precise categorization of concha bullosa size and septal deviation angle. Third, the sample size (n=399) is relatively robust for a single-center radiological study, enhancing the statistical reliability of the observed associations. Several limitations must also be considered when interpreting our findings. First, the single-center design may limit generalizability to other populations with different demographic or environmental characteristics. Second, the use of convenience sampling from ENT clinic attendees introduces potential selection bias, as these patients may represent more symptomatic cases than the general population. Third, our retrospective CT analysis, while providing detailed anatomical information, lacks longitudinal follow-up data needed to establish causal inferences. Fourth, the subjective size classification of concha bullosa (small/medium/large) lacked volumetric quantification that might have provided more precise correlations. Finally, several unmeasured confounders - particularly allergy status and environmental factors like pollution exposure - were not assessed despite their potential influence on sinonasal pathology.

Conclusion

This study demonstrates significant interrelationships between concha bullosa, nasal septal deviation, and rhinosinusitis in our population. These findings highlight the importance of comprehensive anatomical evaluation via CT imaging in the management of chronic rhinosinusitis. While antibiotic therapy addresses acute inflammation, structural correction may be necessary for refractory cases associated with these anatomical variations. Future prospective studies should incorporate volumetric measurements and symptom correlation to strengthen these observations.

Acknowledgment

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Data availability

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Author's contribution

Conceptualization: A.T., H.SH.; Methodology: M.S., H.GH.; Sampling: M.S.; Statistical analysis and investigation: H.GH., M.S.; Writing – original draft preparation: M.S.; Writing - review and editing: A.T., M.S., H.GH, and H.SH.

Conflicts of interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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Ethical Statement

This study was approved by the Ethics Committee of Babol University of Medical Sciences (Ethical Code: MUBABOL.HRI.REC.1399.110). All procedures performed were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

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