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Original Article

Evaluation of the Types of Deviated Nasal Septum and Concha Bullosa and Their Association with Chronic Rhinosinusitis Severity Using the Lund–Mackay Score on Computed Tomography.

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ABSTRACT

Objective: To determine the association between the types of deviated nasal septum and concha bullosa and the radiological severity of chronic rhinosinusitis using the Lund–Mackay score on computed tomography.

Methods: A cross-sectional analytical study was conducted on 113 patients undergoing CT examination at the CT Scan Center, DHQ Hospital, Kasur. The type and laterality of deviated nasal septum and the morphology and laterality of concha bullosa were assessed on CT. Chronic rhinosinusitis severity was evaluated using the Lund–Mackay scoring system. Associations were assessed using the chi-square test, with $p < 0.05$ considered statistically significant.

Results: Deviated nasal septum was present in 84 patients (74.3%), with Mladina Types II and III being the most frequently observed types. Concha bullosa was identified in 23 patients (20.4%), with bulbous morphology being the most common type. A significant association was found between Mladina classification and CRS severity ($p = 0.036$), with severe CRS occurring particularly frequently in Types III and VII. The different types of concha bullosa were not significantly associated with CRS severity ($p = 0.579$). DNS laterality and concha bullosa laterality were also not significantly associated with disease severity.

Conclusion: Specific types of deviated nasal septum, particularly Mladina Types III and VII, showed a significant relationship with radiological severity of chronic rhinosinusitis, whereas the morphological types of concha bullosa did not. These findings support evaluation of specific anatomical patterns on CT when assessing patients with chronic rhinosinusitis.

INTRODUCTION

Chronic rhinosinusitis (CRS) is a common chronic inflammatory disorder involving the nose and paranasal sinuses. It is characterized by persistent sinonasal symptoms and may substantially affect daily functioning and quality of life. Several factors have been implicated in its development, including inflammatory processes, infection, allergy, mucociliary dysfunction, and anatomical abnormalities. Variations in sinonasal anatomy may alter airflow and mucociliary drainage, particularly around the osteomeatal complex, and may therefore influence the extent of sinonasal disease [1].Deviated nasal septum (DNS) is one of the most frequently encountered anatomical abnormalities of the nasal cavity. Because septal deviation can alter the dimensions of the nasal passages and the relationship of adjacent structures, its possible contribution to CRS has been investigated extensively. However, the relationship is not uniform across studies. The Mladina classification describes seven morphological types of septal deviation and provides a more detailed approach than simply recording the presence or absence of DNS. Previous studies have suggested that particular types, especially Type III and more complex deformities, may have greater clinical or sinonasal relevance [2-5].Concha bullosa (CB), defined as pneumatization of the middle turbinate, is another common anatomical finding on CT. It may be unilateral or bilateral and can be classified morphologically as lamellar, bulbous, or extensive. A large or strategically positioned concha bullosa may narrow the middle meatus or osteomeatal region, potentially affecting sinus ventilation and drainage. Nevertheless, previous research has produced inconsistent findings regarding whether CB, and particularly its morphological types, is associated with CRS or its severity [6-10].Medical research has increasingly benefited from the use of modern technologies and analytical methods for understanding and evaluating diseases. Genetic and molecular techniques have been used to investigate disease-causing mutations and to gain a better understanding of the underlying mechanisms of inherited disorders [11,12]. In addition, computational and artificial intelligence-based approaches are being explored for identifying and classifying diseases using clinical data [13]. Together, these developments show how technological advances are becoming an important part of contemporary medical research and diagnosis.In a similar way, imaging techniques can provide objective information about structural and pathological changes. Computed tomography is particularly useful in chronic rhinosinusitis as it provides detailed visualization of the sinonasal structures, mucosal changes, and anatomical variations, helping in the objective assessment of disease involvement. The Lund–Mackay (LM) scoring system provides a standardized CT-based method for grading the extent of sinus opacification and osteomeatal complex involvement. Although the association between DNS, CB, and CRS has been examined previously, evidence regarding the relationship of their specific types with radiological disease severity remains limited, particularly in the local population [14-17].Therefore, the present study was designed to evaluate the types of deviated nasal septum and concha bullosa and determine their association with the radiological severity of chronic rhinosinusitis using the Lund–Mackay score on computed tomography.

MATERIAL AND METHODS

Study Design and Setting

A cross-sectional analytical study was conducted at the CT Scan Center, District Headquarters (DHQ) Hospital, Kasur. The study was completed over a period of four months following approval of the study synopsis.

Sample Size and Sampling

The calculated sample size was 113 patients. Non-probability purposive sampling was used to select eligible patients undergoing non-contrast CT of the paranasal sinuses at the study institution.

Participants

Patients older than 17 years presenting with symptoms suggestive of CRS and undergoing non-contrast CT of the paranasal sinuses were included. Patients with previous sinonasal surgery, sinonasal tumors, facial trauma, or congenital craniofacial anomalies affecting the nasal septum or paranasal sinuses were excluded.

CT Assessment

High-resolution non-contrast CT examinations of the paranasal sinuses were assessed in axial and coronal planes using thin sections. Deviated nasal septum was classified according to the Mladina classification (Types I–VII), and concha bullosa was categorized as lamellar, bulbous, or extensive. Laterality of DNS and CB was also recorded.

Assessment of CRS Severity

The Lund–Mackay scoring system was used to assess radiological severity. Each sinus was graded as 0 for no opacification, 1 for partial opacification, and 2 for complete opacification; the osteomeatal complex was scored as 0 when patent and 2 when obstructed. CRS severity was categorized as no CRS (LM score 0–4), mild-to-moderate CRS (5–11), and severe CRS (12–24).

Statistical Analysis

Data were analyzed using SPSS version 27. Frequencies and percentages were calculated for demographic and radiological variables. Associations between DNS and CB variables and CRS severity were assessed using the chi-square test. A p-value < 0.05 was considered statistically significant.

RESULTS

Demographic Characteristics

A total of 113 patients were included in the study. Of these, 64 (56.6%) were males and 49 (43.4%) were females. The largest proportion of participants was in the 21–40-year age group (54, 47.8%), followed by 41–60 years (30, 26.5%), 1–20 years (15, 13.3%), 61–80 years (12, 10.6%), and 81–100 years (1, 0.9%). The demographic characteristics of the study population are summarized in Table 1.

Distribution and Types of Deviated Nasal Septum

Deviated nasal septum (DNS) was identified in 84 (74.3%) participants, whereas 29 (25.7%) had no DNS. Among the recorded laterality categories, left-sided deviation was observed in 47 (41.6%) participants and right-sided deviation in 39 (34.5%). According to the Mladina classification, Types II and III were the most frequently reported patterns, with 26 (23.0%) participants each. Types I and VII were each observed in 15 (13.3%) participants, while Type IV was observed in 4 (3.5%) and Types V and VI in 1 (0.9%) participant each (Table 1).

Distribution and Types of Concha Bullosa

Concha bullosa (CB) was identified in 23 (20.4%) participants. Bilateral involvement was the most frequently reported laterality (10, 43.5%), followed by right-sided (9, 39.1%) and left-sided involvement (4, 17.4%). Among the reported morphological types, bulbous CB was the most common (10, 43.5%), followed by lamellar (8, 34.8%) and extensive CB (4, 17.4%) (Table 2).

CRS Severity According to the Lund–Mackay Score

Based on the Lund–Mackay scoring system, participants were categorized into no CRS, mild-to-moderate CRS, and severe CRS. Severe CRS was reported as the most frequent category, followed by mild-to-moderate CRS and no CRS. The distribution of CRS severity should be reported using the final verified frequencies from the statistical dataset because the frequencies currently stated in the manuscript do not sum to the total sample of 113.

Association of Deviated Nasal Septum with CRS Severity

Among participants with DNS, 8 (9.5%) had no CRS, 20 (23.8%) had mild-to-moderate CRS, and 56 (66.7%) had severe CRS. Among participants without DNS,

14 (48.3%) had no CRS, 14 (48.3%) had mild-to-moderate CRS, and 1 (3.4%) had severe CRS. The presence of DNS was significantly associated with CRS severity ($p < 0.001$).

DNS laterality was not significantly associated with CRS severity ($p = 0.135$). Severe CRS was reported in 56.4% of participants with right-sided DNS and 72.3% of those with left-sided DNS.

Mladina classification was significantly associated with CRS severity ($p = 0.036$). Severe CRS was particularly frequent among participants with Type III (76.9%) and Type VII (80.0%) DNS. The distribution of CRS severity according to Mladina type is presented in Table 3.

Association of Concha Bullosa with CRS Severity

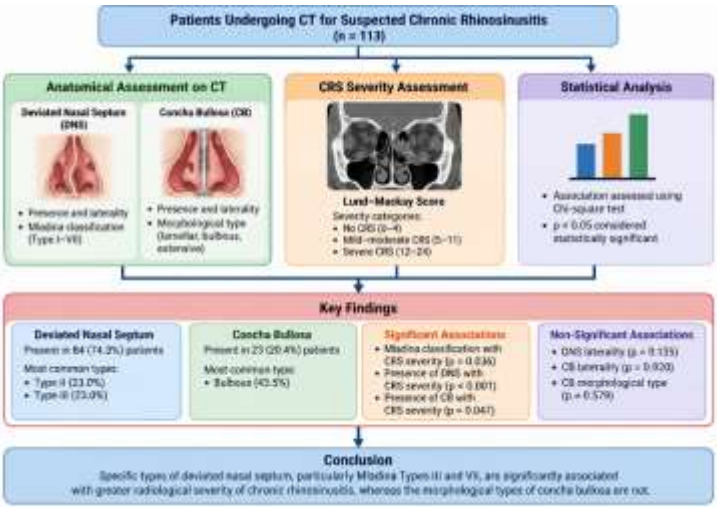
Among participants with CB, 7 (31.8%) had no CRS, 10 (40.9%) had mild-to-moderate CRS, and 6 (27.3%) had severe CRS. Among participants without CB, 15 (16.5%) had no CRS, 25 (27.5%) had mild-to-moderate CRS, and 51 (56.0%) had severe CRS.

The presence of CB was significantly associated with CRS severity ($p = 0.047$). However, CB laterality was not significantly associated with CRS severity ($p = 0.920$). Severe CRS was observed in 33.3% of lamellar, 20.0% of bulbous, and 25.0% of extensive CB cases, with no statistically significant association between CB morphological type and CRS severity ($p = 0.579$).

Sinus Involvement and CRS Severity

Radiological involvement of the maxillary, ethmoid, frontal, and sphenoid sinuses and the osteomeatal complex varied across the CRS severity categories. Severe CRS was the most frequently reported category across the assessed sinus regions. The manuscript reports a statistically significant overall association between sinus involvement and CRS severity ($p < 0.05$). The detailed distribution of sinus involvement according to CRS severity is presented in Table 3.

Figure 1. schematic illustrating the study design, CT-based anatomical assessment, Lund–Mackay scoring, statistical analysis, and key findings.



DNS = deviated nasal septum; **CB** = concha bullosa; **CRS** = chronic rhinosinusitis; **CT** = computed tomography; **LM** = Lund–Mackay. The figure summarizes the assessment of DNS and CB on CT, classification of CRS severity using the Lund–Mackay score, statistical analysis using the chi-square test, and the principal findings of the study. Mladina Types III and VII showed significant associations with greater radiological CRS severity, whereas CB morphological types did not show a statistically significant association.

Table 1. Demographic characteristics and distribution of deviated nasal septum among study participants

Variable	n (%)
Sex	
Male	64 (56.6)
Female	49 (43.4)
Age group (years)	
1–20	15 (13.3)
21–40	54 (47.8)
41–60	30 (26.5)
61–80	12 (10.6)
81–100	1 (0.9)
Deviated nasal septum	
Present	84 (74.3)
Absent	29 (25.7)
Mladina classification	
Type I	15 (13.3)
Type II	26 (23.0)
Type III	26 (23.0)
Type IV	4 (3.5)
Type V	1 (0.9)
Type VI	1 (0.9)
Type VII	15 (13.3)

Values are presented as frequency (percentage). DNS = deviated nasal septum. Mladina Types I–VII represent the morphological classification of septal deviation.

Table 2. Distribution and morphological types of concha bullosa

Variable	n (%)
Concha bullosa	
Present	23 (20.4)
Laterality of CB	
Right-sided	9 (39.1)
Left-sided	4 (17.4)
Bilateral	10 (43.5)
Morphological type	
Lamellar	8 (34.8)
Bulbous	10 (43.5)
Extensive	4 (17.4)

Values are presented as frequency (percentage) among participants with recorded CB findings. CB = concha bullosa. Morphological classification includes lamellar, bulbous, and extensive types.

Table 3. Association of anatomical findings with CRS severity

Anatomical variable	No CRS, n (%)	Mild–moderate CRS, n (%)	Severe CRS, n (%)	p-value
DNS				<0.001
Present	8 (9.5)	20 (23.8)	56 (66.7)	
Absent	14 (48.3)	14 (48.3)	1 (3.4)	
DNS laterality				0.135
Right	—	—	56.4% severe	
Left	—	—	72.3% severe	
Mladina classification				0.036
Type III	—	—	76.9% severe	
Type VII	—	—	80.0% severe	
Concha bullosa				0.047
Present	7 (31.8)	10 (40.9)	6 (27.3)	
Absent	15 (16.5)	25 (27.5)	51 (56.0)	
CB laterality				0.920
CB morphology				0.579
Lamellar	—	—	33.3% severe	
Bulbous	—	—	20.0% severe	
Extensive	—	—	25.0% severe	

CRS = chronic rhinosinusitis; DNS = deviated nasal septum; CB = concha bullosa. CRS severity was categorized according to the Lund–Mackay score as no CRS (0–4), mild–moderate CRS (5–11), and severe CRS (12–24). p-values were obtained using the chi-square test; $p < 0.05$ was considered statistically significant. Percentages for individual anatomical subgroups are reported as provided in the study dataset/manuscript.

DISCUSSION

The present study evaluated the association of deviated nasal septum (DNS) and concha bullosa (CB) with the radiological severity of chronic rhinosinusitis (CRS) using the Lund–Mackay score. DNS was present in 74.3% of the study population and showed a significant association with CRS severity ($p < 0.001$). Mladina classification was also significantly associated with CRS severity ($p = 0.036$), whereas DNS laterality was not ($p = 0.135$). CB was identified in 20.4% of patients and showed a significant association with CRS severity in the analyzed group ($p = 0.047$), while its laterality and morphological type were not significantly associated with severity.The significant association between DNS and CRS severity suggests that septal deviation may contribute to increased sinonasal disease through alteration of nasal airflow and drainage pathways. However, previous studies have reported inconsistent findings. Yasan et al. found no significant association between isolated DNS and chronic sinus disease, although they suggested that gross deviation may have greater clinical relevance than mild or moderate deviation [15]. Similarly, Janovic et al. reported that septal morphology and deviation angle were not significantly associated with nasal obstruction symptom severity [16], while Balikci et al. found no significant relationship between DNS and sinus disease [17]. In contrast, Tjahayadewi et al. identified Type III DNS as a significant risk factor for maxillary and ethmoid rhinosinusitis [18], and Mathias et al. reported that higher-grade Mladina Types V–VII were associated with greater nasal obstruction and reduced ipsilateral maxillary sinus volume [19]. These differences may reflect variations in patient selection, disease severity definitions, degree and type of septal deviation, and radiological assessment methods.

In the present study, Mladina DNS type was significantly associated with CRS severity ($p = 0.036$), with severe CRS particularly frequent in Types III, IV, V and VII. Type III and Type VII showed particularly high proportions of severe radiological disease. Mladina et al. reported Type III as the most common septal deformity, while Type VII represents a combination of deformities and is considered a more complex form of septal deviation [16]. Previous work has also reported frequent occurrence of Type III and Type VII deformities among patients with CRS [20]. These findings support the possibility that the pattern and configuration of septal deformity, rather than simply its presence, may be relevant to sinonasal disease.

CB showed a significant association with CRS severity in the analyzed group ($p = 0.047$), although CB laterality and type were not significantly associated with severity. This finding differs from Balikci et al., who found no significant relationship between CB and sinus disease [17], whereas Bhagat et al. reported a significant relationship between left-sided bulbous CB and the Lund–Mackay radiological score [21]. Regarding CB morphology, Aksakal et al. reported no significant relationship between CB types and maxillary sinusitis (35), while Bhagat et al. identified an association with left-sided bulbous CB [22]. These conflicting findings may be related to differences in CB prevalence, study populations, morphology, and criteria used to define CRS severity. Although a large CB may potentially narrow the osteomeatal region and affect sinus drainage, this should be considered a possible explanation rather than a direct causal conclusion.The maxillary and ethmoid sinuses showed substantial involvement across the CRS severity categories, with increasing radiological involvement as disease severity increased. The Lund–Mackay scoring system provided a standardized method for assessing sinus opacification and allowed anatomical variations to be compared with an objective measure of radiological disease severity. Previous studies have demonstrated its usefulness for staging CRS, although radiological severity does not always correspond directly with subjective symptoms [23,24].Overall, the findings indicate that the relationship between DNS, CB, and CRS is not the same for all anatomical patterns. The different types of DNS, particularly Mladina Types III and VII, showed a significant association with greater radiological severity of CRS, whereas the morphological types of CB did not show a significant association. These findings contribute local evidence to the inconsistent results reported in previous studies and support the importance of evaluating specific anatomical types rather than considering only the presence or absence of DNS or CB.

LIMITATIONS

The study was conducted at a single center, which may limit generalizability.The sample size was limited to 113 patients.The cross-sectional design does not allow assessment of temporal or causal relationships.Clinical symptoms and endoscopic findings were not used as parallel measures of disease severity.

CONCLUSION

The present study concludes that the types of deviated nasal septum and concha bullosa show a relationship with the radiological severity of chronic rhinosinusitis. Among the Mladina types of deviated nasal septum, certain types, particularly Types III and VII, were associated with greater CRS severity, whereas the morphological types of concha bullosa did not show a statistically significant association with severity. Overall, the findings emphasize the importance of evaluating the specific types of deviated nasal septum and concha bullosa in relation to CRS severity using computed tomography and the Lund–Mackay scoring system.

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Ethical Approval: The study was approved by the Ethical Review Committee of the Superior University, Lahore, and written informed consent was obtained from all participants prior to inclusion in the study.

Conflict of Interest: The authors declare no conflict of interest.

Data Availability: The datasets generated and/or analysed during the current study are available from the corresponding author on reasonable request.

Author Contributions: Wajeeha Tariq: study planning, data acquisition, statistical analysis, and preparation of the initial manuscript. **Tahira Batool**: academic supervision, development of the study concept, and manuscript editing. **Asma Irshad**: provided methodological guidance and contributed to the critical review of the manuscript.Shafaq Gulzar Shaukat: assisted with interpretation of the findings and reviewed the manuscript. All authors reviewed and approved the final version of the manuscript.

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