International Journal of Integrated Health Sciences (IIJHS)
ISSN Print: 2302-1381; ISSN Online: 2338-4506

Original Article

Correlation between Nasal Septal Deviation and Paranasal Sinus Mucosal Thickening in Chronic Rhinosinusitis on CT-Scan

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Article History

Received: April 27, 2026
Accepted: May 29, 2026
Published: June 30, 2026

DOI: 10.15850/ijihs.v14n1.4932
IJIHS. 2026;14(1):44-50

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Abstract

Background: Nasal septal deviation is a common structural anomaly of the nasal cavity and a notable risk factor for ostiomeatal complex obstruction, which may compromise ventilation and drainage of the paranasal sinuses. Consequently, patients with septal deviation tend to have an elevated risk of developing chronic rhinosinusitis (CRS).

Objective: To examine the association between nasal septal deviation and paranasal sinus mucosal thickening in patients with CRS using CT imaging.

Methods: An analytic cross-sectional study was conducted at Dr. Zainoel Abidin Regional General Hospital (RSUDZA), Banda Aceh. Medical records and paranasal sinus CT scans of patients with CRS from January 2021 to December 2023 were retrospectively reviewed during a four-month study period (August–November 2024). A total of 46 eligible patients were included, and the association was analyzed using Fisher's exact test.

Results: Among 46 patients with CRS, nasal septal deviation was identified in 30 (65.2%): 17 (37.0%) had rightward deviation and 13 (28.3%) had leftward deviation, whereas 16 (34.8%) had no deviation. Mucosal thickening was detected in 32 patients (69.6%), most commonly in the maxillary sinus (36.95%), followed by the ethmoid sinus (19.56%). Nasal septal deviation was significantly associated with paranasal sinus mucosal thickening (p=0.002; odds ratio, 10.83; 95% CI, 2.60–45.16).

Conclusion: Nasal septal deviation was significantly associated with paranasal sinus mucosal thickening in patients with CRS undergoing paranasal sinus CT examination at RSUDZA, Banda Aceh. Given the cross-sectional design, this finding indicates an association rather than causation.

Keywords: Chronic rhinosinusitis, computed tomography, nasal septum, paranasal sinuses, sinus mucosa

Introduction

Nasal septal deviation is one of the most common anatomic variations of the nose and may cause nasal obstruction and discharge, thereby reducing patients' quality of life.[1] Anatomically, the nasal septum, which consists of cartilage and bone, divides the nasal cavity into right and left sides; septal deviation refers to displacement or curvature of the septum away from the midline.[2] The American Academy of Otolaryngology-Head and Neck Surgery reports that nearly 80% of the global population has some degree of septal deviation, and a recent comprehensive review confirmed its close association with chronic sinonasal conditions.[3] By altering airflow dynamics, impairing mucociliary clearance, and affecting the lateral nasal wall, septal deviation may contribute to various sinonasal

disorders, including chronic rhinosinusitis (CRS).[3,4]

CRS is a syndrome characterized by persistent inflammation of the mucosa of the nasal cavity and paranasal sinuses. According to the European Position Paper on Rhinosinusitis and Nasal Polyps (EPOS) 2020, CRS is defined by at least two symptoms, one of which must be nasal obstruction/congestion or nasal discharge; other symptoms include facial pain/pressure and a reduced or absent sense of smell. Symptoms must persist for at least 12 weeks and be accompanied by endoscopic or imaging evidence of mucosal inflammation.[5] The global prevalence of CRS ranges from 5% to 12%,[6] and a recent systematic review estimated a pooled prevalence of 8.71%, with higher rates among patients with nasal septal deviation.[7] At RSUDZA, Banda Aceh, 111 cases of CRS were recorded in 2019 and 97 in 2020,[8] whereas a study at Dr. Mohammad Hoesin Hospital, Palembang, reported CRS in 52% of rhinosinusitis cases.[9] Septal deviation is considered an important contributor to obstruction of the ostiomeatal complex, which impairs sinus ventilation and drainage and may increase the risk of sinus mucosal disease.[4,10]

CT of the paranasal sinuses is the reference standard for confirming CRS because it can demonstrate mucosal changes, ostiomeatal complex obstruction, and areas inaccessible to nasal endoscopy.[11] However, studies specifically examining the direction of septal deviation in relation to paranasal sinus mucosal thickening among patients with CRS in Aceh remain limited. Therefore, this study aimed to assess the association between nasal septal deviation and paranasal sinus mucosal thickening on paranasal sinus CT scans in patients with CRS at Dr. Zainoel Abidin Regional General Hospital Banda Aceh.

Methods

This analytic cross-sectional study was conducted at Dr. Zainoel Abidin Regional General Hospital (RSUDZA), Banda Aceh, Indonesia. The study population comprised patients with suspected CRS based on the EPOS 2020 criteria who underwent paranasal sinus CT imaging in the axial, coronal, and sagittal planes. Consecutive nonprobability sampling was used, and all patients with CRS who met the eligibility criteria during the study period were included.

The inclusion criteria were a diagnosis of CRS based on paranasal sinus CT findings, complete medical records containing the required data, and CT images of adequate quality. Patients with nasal polyps, suspected malignancy, or a history of nasal surgery were excluded. Data were collected retrospectively from medical records and paranasal sinus CT scans obtained between January 2021 and December 2023. Data collection was conducted over four months, from August to November 2024. A total of 46 patients met the eligibility criteria.

The study instruments included medical records, a 64-slice CT scanner (Siemens Somatom Perspective), a 128-slice CT scanner (Siemens Somatom Perspective), CT images acquired at a 1-mm slice thickness, the PACS Novarads 3D application, a dedicated radiology workstation, and a structured observation checklist. Nasal septal deviation, including its presence and direction, was the independent variable, whereas paranasal sinus mucosal thickening on CT was the dependent variable. Mucosal thickening was defined as soft-tissue density along the sinus wall measuring more than 2 mm at its maximum perpendicular thickness on bone-window CT images and was recorded as present or absent for each sinus. All CT images were independently assessed by two observers (an otorhinolaryngology resident and a radiologist) who were blinded to the patients' clinical data. Disagreements were resolved by consensus, and interobserver agreement was assessed using Cohen's kappa coefficient. Operational definitions are presented in Table 1.

Statistical analyses were performed using SPSS software. Categorical variables were summarized as frequencies and percentages. Because both the independent and dependent variables were categorical, normality testing was not required. Fisher's exact test was used to assess the association between nasal septal deviation and paranasal sinus mucosal thickening. The strength of the association was expressed as an odds ratio (OR) with a 95% confidence interval (CI). A p value <0.05 was considered statistically significant. Ethical approval was obtained from the Health Research Ethics Committee of Dr. Zainoel Abidin Regional General Hospital, Banda Aceh (approval No. 362/PPDS-ITHT-BKL/VII/2024; 1 August 2024).

Results

A total of 46 patients with CRS met the eligibility criteria. Their demographic and clinical characteristics are summarized in

Table 1 Operational Definitions of Variables

Variable	Operational Definition	Measurement Tool	Outcome	Scale
Chronic rhinosinusitis	Inflammation of the nasal and paranasal sinus mucosa lasting at least 12 weeks and accompanied by two or more symptoms, one of which is nasal obstruction/ congestion or nasal discharge, with confirmation on CT	Medical record	Present or absent	Nominal
Nasal septal deviation	Deviation of the cartilaginous and/or bony nasal septum to one side of the nasal cavity	Paranasal sinus CT scan (coronal plane)	Present (right/ left) or absent	Nominal
Paranasal sinus mucosal thickening	Soft-tissue density along the paranasal sinus wall measuring more than 2 mm at its maximum perpendicular thickness	Paranasal sinus CT scan	Present or absent	Nominal

Table 2. Women accounted for 52.2% of the sample, and most patients were adults aged 19–59 years (82.6%). Nasal septal deviation was detected in 30 patients (65.2%); rightward deviation (37.0%) was more common than leftward deviation (28.3%). Paranasal sinus mucosal thickening was observed in 32 patients (69.6%).

Table 3 shows the distribution of mucosal thickening across the paranasal sinuses. Multisinus involvement was the most common pattern, occurring in 12 patients (26.1%), with mucosal thickening involving all four paranasal sinuses: maxillary, ethmoid, frontal, and sphenoid. The second most common pattern was unilateral maxillary sinus involvement (15.2%). No patient had isolated frontal or sphenoid sinus involvement. Overall,

Table 2 Characteristics of the Study Sample

Characteristic	Frequency (n=46)	Percentage (%)
Sex		
Male	22	47.8
Female	24	52.2
Age		
Adolescent (10–18 years)	6	13.0
Adult (19–59 years)	38	82.6
Elderly (>60 years)	2	4.3
Nasal Septal Deviation		
Present	30	65.2
Absent	16	34.8
Direction of Septal Deviation		
None	16	34.8
Left	13	28.3
Right	17	37.0
Paranasal Sinus Mucosal Thickening		
Present	32	69.6
Absent	14	30.4

Table 3 Characteristics of Paranasal Sinuses Involved in Mucosal Thickening

Sinus Involved	Frequency (n=46)	Percentage (%)
No mucosal thickening	14	30.4
Unilateral maxillary	7	15.2
Unilateral ethmoid	1	2.2
Bilateral maxillary	2	4.3
Bilateral ethmoid	2	4.3
Multisinus (all sinuses)	12	26.1
Unilateral maxillary + unilateral ethmoid	2	4.3
Unilateral maxillary + bilateral ethmoid	1	2.2
Bilateral maxillary + bilateral ethmoid	3	6.5
Bilateral maxillary + bilateral sphenoid	2	4.3

the maxillary sinus was the most frequently affected (36.95%), followed by the ethmoid sinus (19.56%).

Table 4 shows the association between nasal septal deviation and paranasal sinus mucosal thickening. Among the 30 patients with septal deviation, 26 had mucosal thickening and 4 did not. Among the 16 patients without septal deviation, 6 had mucosal thickening and 10 did not. Fisher's exact test showed a statistically significant association between nasal septal deviation and paranasal sinus mucosal thickening in patients with CRS at RSUDZA, Banda Aceh (p=0.002). Patients with septal deviation had higher odds of mucosal thickening than those without septal deviation (OR, 10.83; 95% CI, 2.60–45.16).

Discussion

In this study, women comprised a slightly larger proportion of patients with CRS (52.2%). This finding is consistent with that of Putra *et al*., who reported that women accounted for 53.2% of CRS cases at RSUDZA, Banda Aceh.[8] Fouladvand *et al*. similarly reported that 55.4% of their participants with CRS were women.[12] The female predominance may reflect greater health-seeking behavior among women, resulting in more frequent use of health care services. In addition, the smaller sinus ostia generally observed in women may increase susceptibility to infection and obstruction.[13] Most patients in this study were adults aged 19–59 years (82.6%). This finding is consistent with those of Putra *et al*.,[8] Sogebi *et al*.,[14] and Fouladvand *et al*.,[12] who also reported that CRS was most prevalent among adults. Adults may spend more time outdoors and therefore be more frequently exposed to allergens and airborne pollutants that can trigger or exacerbate CRS.[15]

Septal deviation was present in 30 patients with CRS (65.2%); 17 (37.0%) had rightward deviation and 13 (28.3%) had leftward deviation. Romoozi *et al*. also reported a high prevalence of nasal septal deviation among patients evaluated using cone-beam CT.[16] Similarly, Alsaggaf *et al*. identified septal deviation in 51.3% of patients with CRS.[17] Malpani and Deshmukh identified septal deviation as an important risk factor for CRS.[18] Alghamdi *et al*. likewise described septal deviation as a common anatomic variation and a predisposing factor for CRS. It may increase airflow turbulence near the ostiomeatal

Table 4 Association Between Nasal Septal Deviation and Paranasal Sinus Mucosal Thickening

Nasal Septal Deviation	Paranasal Sinus Mucosal Thickening				Total		p value
	Present	%	Absent	%	n=46	%	
Present	26	56.5	4	8.7	30	65.2	0.002*
Absent	6	13.0	10	21.7	16	34.8	
Total	32	69.6	14	30.4	46	100	

*p value obtained using Fisher's exact test

complex, impair mucociliary clearance, and increase susceptibility to chronic sinonasal inflammation.[3]

In this study, most patients with CRS (69.6%) had paranasal sinus mucosal thickening. This finding is consistent with that of Putra *et al*., who reported that the maxillary sinus was the most frequently affected site (99.1%).[8] Overall, the maxillary sinus was the most commonly involved (36.95%), followed by the ethmoid sinus (19.56%). A similar pattern was reported by Poorey and Gupta, who found that mucosal abnormalities most commonly involved the maxillary sinus (73.13%), followed by the anterior ethmoid sinus (53.73%).[19] The frequent involvement of the maxillary sinus may be explained by its anatomy. Because its ostium is located above the sinus floor, effective drainage depends on ciliary activity. During infection, impaired ciliary function may hinder drainage and promote chronic sinusitis.[20] Furthermore, the close proximity of the inferior maxillary sinus wall to the roots of the first and second molars allows periapical or periodontal infections to spread into the sinus.[21]

Fisher's exact test showed a statistically significant association between nasal septal deviation and paranasal sinus mucosal thickening in patients with CRS (p=0.002). This finding is supported by previous studies. Husni *et al*. reported a significant association between septal deviation and the severity of maxillary sinusitis ($p<0.05$).[22] Using cone-beam CT, Temur *et al*. found that septal deviation was the most frequently observed anatomic variation associated with paranasal sinus mucosal thickening, particularly in the maxillary sinus.[23] Similarly, a systematic review by Malpani and Deshmukh concluded that marked septal deviation may play an important role in the development of CRS.[18]

The association between nasal septal deviation and paranasal sinus mucosal thickening may be explained by two main mechanisms. First, septal deviation may narrow the middle meatus and mechanically obstruct the ostiomeatal complex, compromising sinus ventilation and drainage. Second, it may alter intranasal airflow, creating turbulence around the ostiomeatal complex and disrupting mucociliary function.[18] Together with the epithelial barrier, mucociliary clearance (MCC) is a primary physical defense mechanism of the respiratory tract that removes pathogens and inhaled irritants. Reduced MCC has been associated with greater disease severity in CRS.[24] When ciliary function and the epithelial barrier are impaired, serous exudation and retained secretions accumulate within the sinuses, promoting bacterial overgrowth and chronic inflammation.[25] In CRS, mucosal inflammation, particularly at the ostiomeatal complex, may lead to mucosal edema, sinus ostium obstruction, secretion stasis, and eventually intrasinus hypoxia, creating conditions favorable for secondary bacterial overgrowth.[24]

This study has several limitations. First, it was a single-center retrospective study with a relatively small sample, which limits the generalizability of the findings. Second, the type and angle of septal deviation, which may influence the degree of mucosal thickening, were not evaluated. Third, potential confounders, including allergic rhinitis, smoking, and other anatomic variations such as concha bullosa, were not adjusted for and may have influenced the observed association. Finally, because of the cross-sectional design, the findings demonstrate an association rather than a causal relationship between septal deviation and mucosal thickening. Future prospective studies with larger samples should evaluate the type and angle of septal deviation and adjust for relevant confounders.

In conclusion, nasal septal deviation was common among patients with CRS, and rightward deviation was more common than leftward deviation. Paranasal sinus mucosal thickening was also common, with the maxillary sinus being the most frequently affected. Nasal septal deviation was significantly associated with paranasal sinus mucosal thickening (p=0.002; OR, 10.83; 95% CI, 2.60–45.16). However, because of the cross-sectional design, this association should not be interpreted as causal.

Acknowledgment

The authors sincerely thank the Department of Otorhinolaryngology-Head and Neck Surgery and the Department of Radiology at Dr. Zainoel Abidin Regional General Hospital, Banda Aceh, for providing access to the data and facilities used in this study.

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