



## Analysis of Nasal Septal Deviation Types on Sinusitis Incidence: Literature Review

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### Article Info

#### Article history:

Received 5 May 2025

Received in revised form 19 June 2025

Accepted 7 July 2025

#### Keywords:

Type

Nasal Septal Deviation

Sinusitis

### Abstract

Nasal septal deviation is a common anatomical abnormality found in the general population and is thought to play a role in the pathogenesis of sinusitis. Some types of nasal septal deviation can impair sinus drainage and airflow, leading to inflammation and infection. However, there is no consensus on which type of septal deviation contributes most to sinusitis. Objective: This literature review aims to analyze and identify the types of nasal septal deviation that are most frequently associated with sinusitis. Methods: The data review was conducted using the PRISMA method, with data searches from PubMed, Google Scholar, ScienceDirect and Wiley with research data criteria between 2020-2024. The keywords used to search for data were "Type", "Nasal Septal Deviation", and "Sinusitis". A total of 23,943 articles were screened, with the final result being 20 articles that met the criteria for review. Results: Based on the review of the review in this study, nasal septal deviation (SND), especially types 3 and 5 according to the Mladina classification, contributes to chronic sinusitis through impaired ventilation and sinus drainage. Discussion : Nasal septal deviation (SND) is an anatomical abnormality that can interfere with airflow and sinus drainage, thus playing a role in the pathogenesis of sinusitis, especially types 3 and 5 according to the Mladina classification. These two types are often associated with osteomeatal complex obstruction and chronic mucosal irritation. The mechanisms involved include local hypoxia, mucociliary disorders, chronic inflammation, and changes in the microbiome.

## Introduction

Nasal septal deviation (SNDS) is an anatomical abnormality in the nasal cavity characterized by a shift in the nasal septum from the midline, either anteriorly or posteriorly, and can occur due to congenital factors or trauma with a prevalence reaching 80% in the general population. (Alghamdi et al., 2022). A deviated nasal septum can cause airflow obstruction, osteomeatal canal obstruction, and pressure changes within the sinus cavity, all of which play a role in the pathogenesis of sinusitis (Patel et al., 2020).

Sinusitis is an inflammatory condition of the paranasal sinus mucosa and nasal cavity that can last less or more than 12 weeks. (2) This disease has a high prevalence globally and has a significant impact on patients' quality of life. According to data from the European Position

Paper on Rhinosinusitis and Nasal Polyps (EPOS 2020), chronic sinusitis affects approximately 11% of the European population, and this figure is estimated to be higher in developing countries due to limited early diagnosis and treatment (Fokkens et al., 2020).

Nasal septal deviation has long been considered an important anatomical factor in the pathogenesis of sinusitis, particularly chronic sinusitis. A midline nasal septum can cause unilateral or bilateral narrowing of the nasal cavity, resulting in altered nasal airflow and impaired ventilation of the paranasal sinuses. One of the primary mechanisms linking septal deviation to sinusitis is obstruction of the osteomeatal complex. The osteomeatal complex is a crucial area in the lateral region of the nasal wall where the primary drainage of the maxillary, frontal, and anterior ethmoid sinuses occurs (Khana et al., 2019). Significant septal deviation can cause pressure or impaction on the inferior or middle turbinates, narrowing or occlusion of the osteomeatal complex. This results in impaired ventilation and accumulation of secretions in the sinuses, which can trigger mucosal inflammation and support the growth of pathogenic microorganisms. Furthermore, nasal septal deviation can cause airflow turbulence, resulting in mucosal drying, chronic irritation, and decreased efficiency of the mucociliary system in clearing particles and pathogens from the nasal cavity. This mucociliary disorder prolongs the contact time between the mucosa and infectious agents, which ultimately increases the risk of infection and chronic inflammation in the sinuses (Malpani & Deshmukh, 2022).

Several radiological studies using computed tomography (CT) have shown that nasal septal deviation, particularly those classified as specific types (e.g., type IV or type V deviation according to the Mladina classification), is associated with an increased incidence of unilateral sinusitis, particularly on the contralateral side of the deviation due to compensatory changes in other nasal structures, such as enlargement of the inferior turbinate (Mladina et al., 2015). However, this association is not absolute. Not all individuals with a deviated septum will develop sinusitis, and conversely, not all cases of sinusitis are caused by a deviated septum. Therefore, septal deviation is considered a predisposing factor that works synergistically with other factors, such as upper respiratory tract infections, allergies, nasal polyps, or environmental exposures (Ashwinirani et al., 2023).

The relationship between nasal septal deviation and sinusitis has been a topic of much research in the otolaryngology literature. A significant septal deviation can cause narrowing or obstruction of the middle meatus, the primary drainage channel for the maxillary, frontal, and anterior ethmoid sinuses. This obstruction can potentially lead to secretion buildup, poor sinus ventilation, and secondary infections that can lead to sinusitis.

However, research on the correlation between types of nasal septal deviation and the incidence of sinusitis still shows variability. Some studies have found a significant association between certain types of deviation and the incidence of unilateral or bilateral sinusitis, while others have shown no consistent correlation (Khana et al., 2019). Therefore, this literature review aims to further analyze the relationship between types of nasal septal deviation and the incidence of sinusitis based on the latest scientific findings, with the hope of contributing to a better understanding of the pathophysiology of sinusitis and a more accurate diagnostic approach.

## Methods

The method for writing the results of this *literature review* begins with the PRISMA method ( *Preferred Reporting Item Systematic Review and Meta-Analyses* ). The PRISMA method consists of 5 stages: 1) Determining eligibility criteria, 2) Determining information sources, 3) Data selection, 4) Data collection, 5) Data retrieval. We searched various studies published between 2010 and 2025 from PubMed, Google Scholar, Science direct, and Wiley using search terms or keywords such as " *type* ," " *nasal septal deviation* ," and " *sinusitis* ." Researchers used Boolean Operators in literature searches from internet search engines using these keywords.

Table 1. Boolean for each database

Database	Boolean Operator
Pubmed	"Type AND nasal septal deviation AND sinusitis"
Google scholar	"Type" AND "nasal septal deviation" AND "sinusitis"
Science direct	Type AND nasal septal deviation AND sinusitis
Wiley	Type AND nasal septal deviation AND sinusitis

Several similar studies were identified, and then selected based on the suitability and relevance of our literature review objectives and the source of the articles, the year of publication, and the source of the articles used as literature references. All journals in the four databases were stored in the *Zotero application*, then analyzed by the authors and data filtered to select relevant studies. This literature review was analyzed descriptively and described narratively. Data were taken from an assessment based on study inclusion. Researchers analyzed data from journals, including article title, author, year, country, research design and methods, research results, and conclusions and implications contained in an article. Selected articles were reviewed in their entirety, and key points from the review were noted and presented in descriptive narrative form. Data were presented in tabular form to facilitate the review process.

## Result and Discussion

The results of the data search were in the form of articles regarding the type of Nasal Septal Deviation in relation to the incidence of Sinusitis from various databases, including 13 articles from *Pubmed*, 22,900 articles from *Google Scholar*, 990 articles from *ScienceDirect*, and 40 articles from *Wiley*. The final screening results were as follows: The number of full-text articles is 20. After careful evaluation, the 20 articles were deemed suitable for use in the review. The PRISMA diagram can be seen in Figure 1.

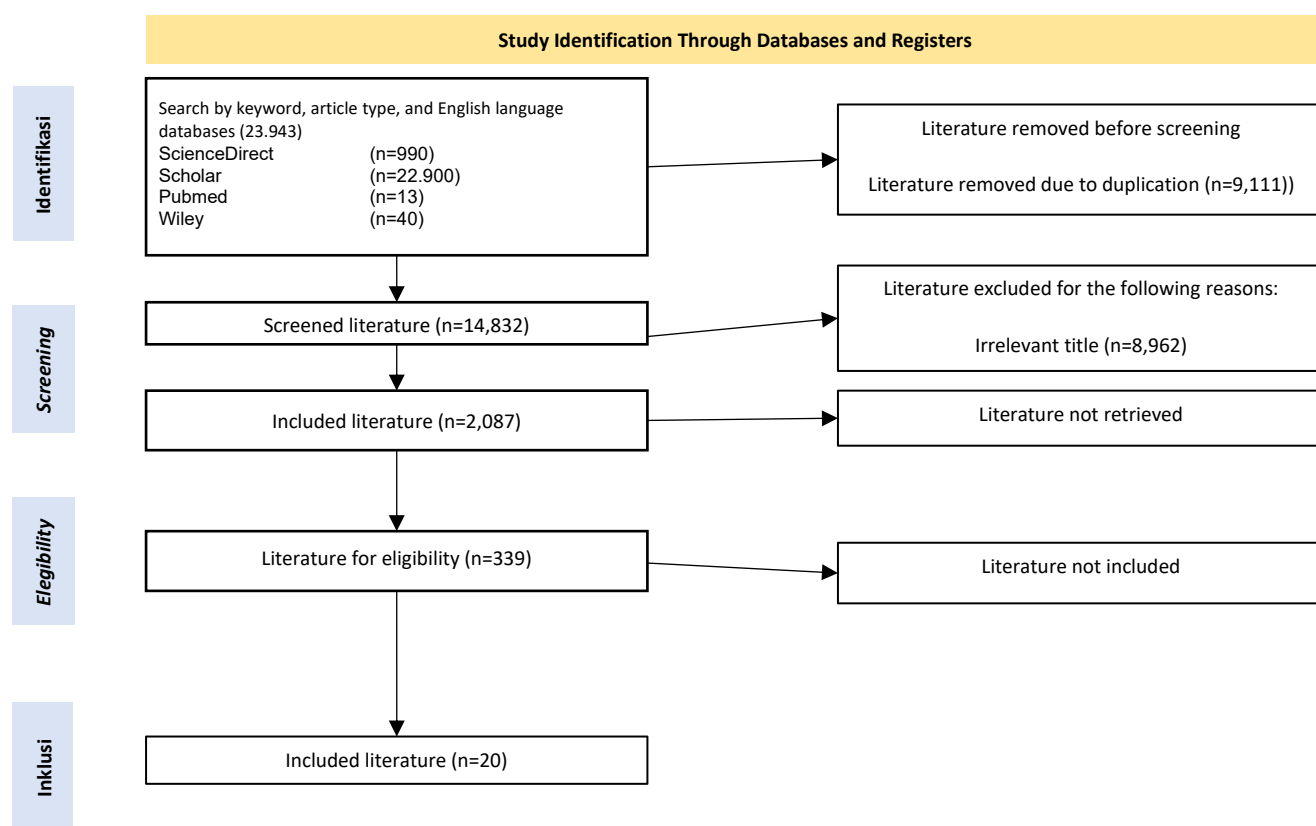


Figure 1. Prism

There are 20 research articles that we have *reviewed* , namely as follows:

Table 2. Review article

No	Title	Author/ Year/ Country	Research purposes	Method	Results
1	<i>To Study the Role of Nasal Septal Deviation and Its Relation to Synonasal Pathology</i>	Naiya R, Ginni D, Gurchand S / 2020 / India	To find the incidence of nasal septal deviation types and the relationship between NSD and sinus pathology.	This study involved a study of 100 subjects attending the ENT department, with a history and clinical examination, including nasal endoscopy and classification of septal deviation using the Mladina system. This examination was performed after decongestion and local anesthesia, and sinus pathology was assessed using the Lund-Mackay scoring system.	The results showed that type II nasal septal deviation was the most common and had a significant association with sinus pathology, especially rhinosinusitis. Approximately 84% of patients with septal deviation experienced sinusitis, and there was a statistically significant correlation between the two ( $p < 0.05$ ) (N. Rao <i>et al.</i> , 2022).
2.	<i>Correlation Study Between Nasal Septal Deviation and Rhinosinusitis</i>	Sumit P, Saurabh V, SS Bist, Sarita M, Namita K / 2013 / India	The aim of this study was to observe the correlation between nasal septal deviation (NSD) and sinusitis, and to study the relationship between various levels of NSD severity based on Mladina's classification with sinusitis.	This study involved CT scans of adult patients with nasal obstruction, discharge, and headaches to assess for NSD and sinusitis. The sample consisted of 120 cases, predominantly male, and NSD was found in 114 cases (95%).	The results show that the type of nasal septal deviation that most often causes sinusitis is type V with a percentage of 90.9% (Prasad <i>et al.</i> , 2013).
3.	<i>The Variations in Deviation of Nasal Septum and their Impact on Maxillary Sinus Volume and Occurrence of Sinusitis</i>	Gopika K, Pallavi S, Anchal G, Parmod K, Aditya S / 2023 / India	To study the effect of variations in nasal septal deviation on maxillary sinus volume and the incidence of sinusitis.	This research method is a prospective observational study involving 130 patients with deviated nasal septum (DNS), using 256 slice CT scan to measure sinus volume and assess the degree of deviation based on the Mladina classification.	The study results showed that the higher the DNS grade, the smaller the sinus volume and the greater the likelihood of osteomeatal complex (OMC) obstruction, which is associated with sinusitis. The type of DNS that most often causes sinus pathology is a high grade (such as

					grade 7), as it causes sinus narrowing and increases the risk of sinusitis. (Kalsotra <i>et al.</i> , 2023).
4.	<i>The frequencies of different types of nasal septum deviation and their effect on increasing the thickness of maxillary sinus mucosa</i>	Hamid T, Zohreh H / 2019 / Iran	To investigate the prevalence of anatomical variations of nasal septal deviation and evaluate the effect of these factors on increased sinus mucosal thickness.	This study used CBCT to evaluate nasal septal deviation and its relationship to increased maxillary sinus mucosal thickness. The sample consisted of patients referred to the Tabriz Faculty of Dentistry, with sinusitis classified based on mucosal thickness.	The results of the study showed that the most common type of Mladina and associated with sinusitis was type V, which was the most common type found in the study sample. (Taghiloo & Halimi, 2019).
5.	<i>Prevalence of nasal septum deviation and its association with chronic maxillary sinusitis</i>	Shruti K, SR Ashwinirani, Girish S, Abhijeet S / 2022 / India	This study aims to investigate the prevalence of nasal septal deviation in the Western population of Maharashtra, compare the degree of deviation between genders and investigate its association with chronic sinusitis.	This research method is a retrospective study conducted by analyzing radiographs from 80 patients to assess the prevalence of nasal septal deviation (DNS) and its relationship with chronic maxillary sinusitis.	The results showed that the prevalence of DNS was 62.5%, and approximately 88% of patients with DNS also had sinusitis. The most common type of deviation causing sinus pathology was type III, a deviation to one side that causes ostiomeatal narrowing, supporting the mechanism and pressure theory in the pathogenesis of sinusitis (S. R. Ashwinirani <i>et al.</i> , 2022).
6	<i>The relationship between the type of nasal septal deviation according to the Mladina classification and the incidence of rhinosinusitis and Eustachian tube function</i>	Tanty TT, Abdul Qadar P, Muhammad FP / 2013 / Indonesia	To determine whether there is a relationship between the type of nasal septal deviation according to the Mladina classification with the incidence of rhinosinusitis and Eustachian tube function.	This cross-sectional study involved 70 patients with nasal septal deviation. A nasoendoscopic examination was performed to determine the type of septal deviation based on the Mladina classification, a coronal CT scan of the paranasal sinuses to determine	The results of the study showed that the most common type of nasal septal deviation was type 5, namely with a horizontal orientation (38.6%) (Toluhula, 2013).

				the presence of rhinosinusitis, and tympanometry to determine Eustachian tube function. Data were analyzed using the chi-square likelihood ratio test.	
7.	<i>Risk factor differences of Nasal Septum Mladina Type III Classification with Maxillary Rhinosinusitis and Ethmoidal Rhinosinusitis occurrences</i>	Shelly T, Muhammad Sukron, Siti Thomas Zulaikhah / 2020 / Indonesia	The aim of this study was to determine the differences in risk factors from the Mladina Type III Nasal Septum Classification on the incidence of Maxillary Rhinosinusitis and Ethmoidal Rhinosinusitis.	This study was an observational case-control study, using data from medical records and CT scans of the paranasal sinuses to compare the risk factors for Mladina III type septal deviation and the incidence of maxillary and ethmoidal rhinosinusitis. The sample consisted of 44 patients who met the inclusion and exclusion criteria.	The results of this study indicate that Mladina III type nasal septal deviation is a significant risk factor for the occurrence of Maxillary and Ethmoidal Rhinosinusitis, with a 7.5 times and 6.3 times greater likelihood of experiencing these pathologies compared to those without septal deviation. Based on these results, Mladina III type is the type that plays the most role in causing sinus pathology (Tjahayadewi <i>et al.</i> , 2020).
8.	<i>Clinical Implications of Nasal Septal Deformities</i>	Ranko Mladina, Neven Skitarelic, Gorazd Poje, Marin subaric / 2015 / Croatia	To determine the type of nasal septal deviation according to Mladina's classification which has an impact on sinusitis.	This research method is a descriptive study that aims to determine the incidence of nasal septal deviation and rhinosinusitis.	The results of this study indicate that from a clinical perspective, type III is the most common septal defect in the general population and is very frequently found in all cases of chronic sinusitis. The incidence of type 3 is 21.63% (41). It occurs in CRS patients (Mladina <i>et al.</i> , 2015).
9.	<i>Clinical Presentations Of Deviated Nasal Septum and Mladina's Classification</i>	Sanjeev Kumar Thakur, Baleshwar Yadav, Raj Kumar Bedajit, Afaque Anwar / 2019/ India	The aim of this study was to describe the clinical presentation of nasal septal deviation which is classified based on the Mladina	This research method involved classifying 150 cases of nasal septal deviation based on the Mladina system through interviews, nasal examinations, and nasal	The results of the study showed that types II and V were the most common. However, the type that most often causes sinus pathology is type

			system, and to determine the relationship between the type of nasal septal deviation and the incidence of sinusitis.	endoscopy. Data were analyzed using the Chi-square test to determine the relationship between trauma and deviation type.	V, which is the most common and contributes to sinus pathology. (Thakur <i>et al.</i> , 2019).
10.	<i>Association between Symptomatic Deviated Nasal Septum and Sinusitis: A Prospective Study</i>	Syed Mohammed Shoib, B. Viswanatha / 2016 / India	This study was conducted to determine the relationship between symptomatic septal deviation and rhinosinusitis.	This research method used descriptive and inferential statistical analysis. A total of 200 patients with chronic rhinosinusitis with persistent symptoms for more than 12 weeks who were unresponsive to medical therapy were analyzed for 18 months (October 2013–May 2015) to analyze the relationship between septal deviation and sinusitis severity.	The results showed that 112 patients were male and 88 were female. Type 4 deviated nasal septum, or type S, is known to be the most common cause of sinusitis, occurring in 50% of patients. (Shoib & Viswanatha, 2016)
11.	<i>A Review on Deviated Nasal Septum: Classification, Clinical Features and Management</i>	Suhani Jain & PT Deshmukh / 2021 / India	To determine the type of nasal septal deviation according to Mladina's classification which has an impact on sinusitis.	This study method is a cross-sectional study. Data from the following review articles were collected during the period July 25–August 17, 2021. The most relevant published articles with current developments regarding clinical features and histopathological changes were used.	The results of this study indicate that horizontal deviation type V is more susceptible to sinusitis, and is more likely to cause sinusitis because it involves the nasal valve area. DNS type V is more likely to cause sinusitis because of decreased airflow circulation (Jain & Deshmukh, 2021).
12.	<i>Clinical Study of Septal Deviation and Its Association with Sinusitis</i>	Mahesh Mishra, Sumit Sharma / 2022 / India	To determine the relationship between nasal septal deviation and sinusitis and the clinical profile of Chronic Rhinosinusitis in nasal septal deviation.	This research method is a cross-sectional study of 50 patients who came to the ENT department at VIMS, Bellary with symptoms of chronic rhinosinusitis, reviewed and analyzed regarding the relationship between their nasal septal deviation and the occurrence of	The results of the study showed that deviated nasal septum (septum deviation) is a common factor and plays a role in the pathogenesis of sinusitis, although its exact role is still not completely certain, but it is known that type V mladina is the most likely cause of sinus pathology in

				sinusitis that followed.	this study (Mishra & Sharma, 2022).
13.	<i>Computed Tomography Analysis of the Nasal Septal Deviation and Related Paranasal Sinus Pathologies</i>	Dayan A, Shekoofeh Y, Mansoureh J, Mohammad Hossein T, Amir S / 2024 / Iran	The aim of this study was to understand the prevalence of various types of nasal septal deviation (NSD) and associated paranasal sinus (PNS) conditions, and to assess the association between these abnormalities and NSD using CT analysis. This study aims to aid in the diagnosis and treatment of these conditions, improve patient outcomes, and avoid unnecessary surgeries such as rhinoplasty.	This study was a prospective cross-sectional study using paranasal CT to assess the prevalence of nasal septal deviation (NSD) and paranasal sinus (PNS) conditions in a selected population. Data were obtained from non-contrast CT scans, with analysis of NSD type based on the Mladina classification, as well as other conditions such as pansinusitis and mucocoele.	Research suggests that certain types of NSD are more likely to be associated with sinus pathology, although the most common type causing sinus pathology is not specifically mentioned in this summary. However, in general, type III NSD, which causes narrowing of the ostiomeatal complex (OMC) and interferes with sinus drainage, usually contributes to sinus pathology. (Amanian <i>et al.</i> , 2024).
14.	<i>Evaluation of the relationship between the presence of an accessory maxillary ostium and the presence and type of nasal septum deviation: A computed tomography study</i>	Hanife GD, Ozge AI, Gunay R / 2024 / Türkiye	The aim of this study was to evaluate the relationship between the presence of an accessory maxillary ostium and the presence and type of nasal septal deviation using computed tomography (CT) studies.	This research method uses computed tomography (CT) image studies to evaluate the relationship between the presence of an accessory maxillary ostium and nasal septal deviation and the type of deviation.	The results of this study indicate that the type of septal deviation most frequently associated with sinus pathology is type III because it can interfere with sinus ventilation and increase the risk of sinus disease (Duzkalir, 2024).
15.	<i>International study of the incidence of particular types of septal deformities in chronic rhinosinusitis patients: The outcomes from five countries</i>	Cemal C, Nuray BM, Mustafa A, Neven S, Josip M, <i>et al</i> / 2016 / America	The aim of this study was to study the incidence and certain characteristics of medical conditions, such as chronic sinusitis and related factors in different countries, and to compare data between countries and different subject groups.	This study involved direct examination of the nasal septum using three techniques: anterior rhinoscopy before and after decongestion, and endoscopy under topical anesthesia. This international study included 505 subjects from five countries, including CRS patients and healthy volunteers, to identify the type of septal deformity based on the	The results showed that vertical deformities (types 2, 3, and 4) were more frequently found in CRS patients, with type 3 being the most common in some countries. Type 3 deformity is considered to contribute most to sinus pathology due to its high prevalence in the CRS group and its association with sinus disorders.

				Mladina classification.	(Cingi <i>et al.</i> , 2014).
16.	<i>Is there any relationship between septal deformities and chronic rhinosinusitis?</i>	Codrut Sarafoleanu, Andreea Negrila Mezei / 2014 / Romania	The aim of this study was to determine the role of septal deviation in the pathogenesis of chronic rhinosinusitis (CRS).	This research method used a retrospective clinical study on 262 patients. Patients with septal deformity were assessed by native anterior rhinoscopy, anterior rhinoscopy after decongestion, fiberoptic endoscopy, and CT scan in axial and coronal projections. The Mladina septal deformity classification was used to record septal findings.	The results of this study indicate that type 3 is at higher risk for developing CRS than other types. Further studies are needed to determine the role of bone in the pathogenesis of chronic rhinosinusitis, allowing for better surgical and medical approaches (Sarafoleanu & Negrila-Mezei, 2014).
17.	<i>Prevalence of septal deformities in patients with chronic rhinosinusitis</i>	Petar Males /	The aim of this study was to assess the prevalence of septal deviation in CRS patients undergoing ESS treatment for sinonasal diseases at the Department of ORL and HNS, University Hospital of the Sisters of Charity in Zagreb and to compare the results with other studies.	This study used a retrospective observational method. A total of 108 CRS patients who underwent endoscopic sinus surgery in 2018 were retrospectively reviewed. Demographics, CRS phenotype, septal deviation, and surgical procedure type were then analyzed.	The results of this study indicate that from a clinical perspective, it is known that type 3 is the most common septal deformity in the general population and is very frequently found in all cases of chronic rhinosinusitis (CRS) (Maleš, 2020).
18.	<i>Nasal septal deformities in chronic rhinosinusitis patients: clinical and radiological aspects</i>	G. Poje, Zinreich, N. Skitarelic, K. Duric Vukovic, G. C. Passali, Mladina.	The aim of this study was to determine the incidence of nasal septal deformity in patients with chronic rhinosinusitis (CRS) using the Mladina classification, and to assess the relationship between septal deformity and CRS.	This study used the Mladina classification to assess the incidence of nasal septal deformity in patients with chronic rhinosinusitis (CRS) through MSCT radiological examination and endoscopic examination. This study compared the results in CRS patients and a healthy control group to determine the relationship between deformity type and sinus pathology.	The results of this study showed that type 7 was the most frequently found in CRS patients, especially consisting of a combination of types 3 and 5, and this type was more common in the CRS group than in controls (approximately 30% vs. 6.25%) (Poje <i>et al.</i> , 2014).

19	<i>A Systematic Analysis of Septal Deviation Associated With Rhinosinusitis</i>	Richard R, Orlandi / 2010 / USA	The aim of this study was to conduct a systematic analysis of the relationship between septal deviation and sinusitis, and to identify whether there is a significant association between the two based on data from various available studies.	This research method is a systematic analysis of previous studies using a structured literature search and quantitative and qualitative analysis to evaluate the relationship between septal deviation and sinusitis.	The results showed that septal deviation with an angle of more than 20° such as type V Mladina had a more significant relationship with the occurrence of sinusitis. (Orlandi, 2010).
20	<i>Relation Between Chronic Sinusitis And Deviated Nasal Septum</i>	Ajmal M, Usman N / 2017 / India	This study aims to determine whether there is a relationship between chronic sinusitis and nasal septal deviation.	This study was cross-sectional in design, involving 150 patients with nasal septal deviation. A nasoendoscopic examination was performed to determine the type of septal deviation based on the Mladina classification, and a coronal CT scan of the paranasal sinuses to determine the presence of chronic sinusitis.	The most common type of nasal septal deviation according to the Mladina classification is type III, namely the C-shaped DNS form. (Ajmal & Usman, 2017)

Nasal septal deviation is an anatomical abnormality in which the nasal septum, the structure that separates the right and left nasal cavities, is not in the midline position, but instead deviates to one side (Mustain et al., 2022). The septum is composed of a combination of bone and cartilage: the vomer, the perpendicular lamina of the ethmoid bone, and the septal cartilage. Normally, the septum maintains balanced airflow and supports the mucociliary barrier function of the upper airway. However, when deviation occurs, this balance is disrupted, which can affect airflow and sinus ventilation, leading to various clinical disorders, including chronic sinusitis (Rao et al., 2005).

A deviated septum can be congenital or acquired, for example, due to blunt facial trauma, sports injuries, or childbirth. While not all deviated septums are symptomatic, in many cases, significant deviations can cause symptoms such as unilateral nasal obstruction, facial pain, recurrent nosebleeds, impaired sense of smell, and even exacerbate conditions such as chronic rhinosinusitis (Sriprakash, 2017).

To simplify the classification and management of this deviation, Croatian expert Dr. Mirko Mladina developed a classification system based on the anatomical shape and location of the deviated septum. This classification consists of seven types, each with its own unique characteristics and potential impact on nasal function and the risk of sinusitis (Alghamdi et al., 2022).

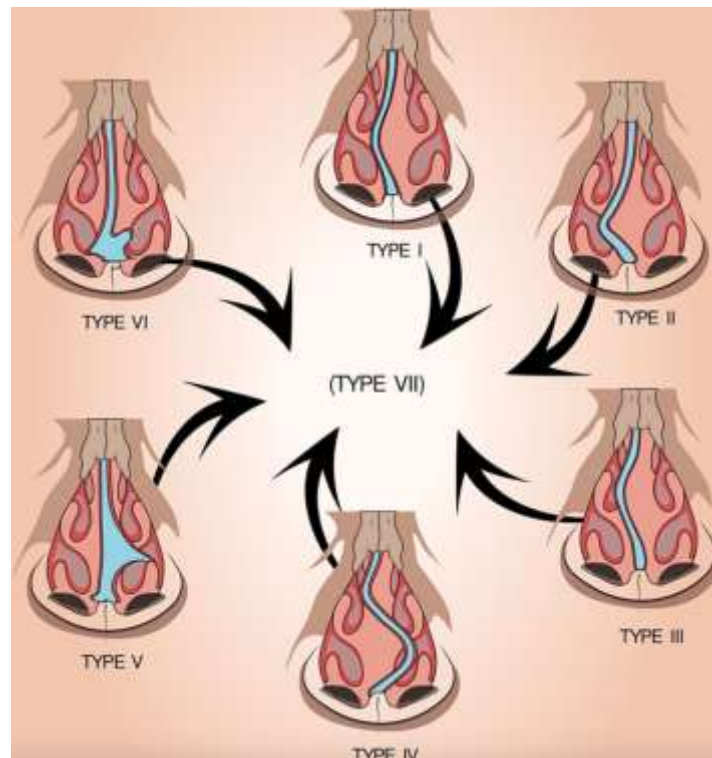


Figure 2. Mladina Classification of Nasal Septal Deviation

The first type is a mild anterior septal deviation that generally does not touch the lateral wall of the nasal cavity and often causes no symptoms. In contrast, the second type is also anterior but touches the inferior conchae, thus disrupting airflow and predisposing to sinusitis. The third type describes a posterior deviation, meaning the septal deviation occurs in the back of the nose, near the choanae. This deviation can impede the drainage of posterior sinuses such as the ethmoid and sphenoid sinuses, thus contributing to chronic sinusitis, especially in the posterior area of the nasal cavity. It can also be described as C-shaped. The fourth type is characterized by a double deviation resembling the letter "S," where the deviation occurs in two different locations, anterior and posterior, causing bilateral obstruction and often causing more complex symptoms.

The fifth type, which is one of the most frequently encountered in the literature, is a deviation that forms a sharp, thorn-like protrusion (spur) laterally, which can compress structures such as the conchae and cause mucosal contact. This contact can cause chronic irritation and local inflammation, leading to mucociliary dysfunction and mechanical obstruction of the sinus drainage pathway. Then, the sixth type is a combination of spur and deviation, causing multiple disturbances in both the shape and anatomical relationships between nasal structures. Finally, the seventh type reflects a complex form of deviation, combining two or more characteristics of the previous types. This type is generally found in cases with a history of trauma or extensive facial malformation (Mladina et al., 2015).

A deviated nasal septum is a common nasal anatomical abnormality encountered in clinical practice. Although not always symptomatic, a deviated nasal septum has important implications for nasal physiology, particularly in relation to paranasal sinus ventilation and the risk of sinusitis. Several pathophysiological mechanisms have been identified as pathways explaining how this abnormality may contribute to the development of sinus inflammation. One key mechanism is disruption of airflow within the nasal cavity. A deviated septum causes uneven airflow between the two sides of the nasal cavity. The narrower side tends to experience decreased ventilation, while the wider side experiences turbulence. This imbalance directly impacts the function of the mucosal epithelium, particularly the ciliated cells responsible for

transporting mucus to the nasopharynx. Decreased airflow causes local hypoxia in the mucosa, which in turn inhibits ciliary function. As a result, mucus is not eliminated properly and begins to accumulate in the sinus cavity, creating conditions that favor microbial colonization and trigger inflammation (Ajmal & Usman, 2017).

Furthermore, a deviated septum can cause mechanical obstruction of the ostiomeatal complex (OMC), the crucial area where the maxillary, anterior ethmoid, and frontal sinuses drain into the nasal cavity. When the OMC is narrowed or closed due to a deviated septum, the flow and drainage of mucus from the sinuses are impaired. This trapped mucus becomes a fertile medium for the growth of bacteria, viruses, or fungi, increasing the risk of sinus infection and inflammation, leading to acute or chronic sinusitis. In certain types of deviation, such as type 5 in the Mladina classification, a bony prominence or spur forms that protrudes laterally and can touch structures such as the middle or inferior conchae. Continuous contact between the septal mucosa and the conchae can lead to chronic irritation, local inflammation, and even changes in mucosal morphology. This chronic inflammation exacerbates the narrowing of the sinus ostia and interferes with normal drainage, thus reinforcing the inflammatory cycle and predisposing to chronic sinusitis (Malpani & Deshmukh, 2022).

The mucosa, irritated and hypoxic due to a deviated septum, also responds immunologically. Inflammatory mediators such as interleukins and tumor necrosis factor- $\alpha$  (TNF-  $\alpha$  ) are released, attracting immune cells such as neutrophils and eosinophils to the area. This immune system activation exacerbates epithelial damage and impairs local defenses against microorganisms. Over time, changes in the mucosal environment can disrupt the normal microbiome balance in the nasal cavity and sinuses, facilitating the colonization of pathogenic microorganisms. Over the long term, chronic inflammation and repeated obstruction lead to structural changes in the sinus mucosa. The mucosa becomes thickened, hyperplastic, and loses its ciliary function. This condition marks the transition from acute sinusitis to chronic sinusitis, which is more difficult to treat and often requires surgical intervention such as septoplasty or endoscopic sinus surgery to restore the anatomical and physiological function of the sinuses (Malpani & Deshmukh, 2022).

Thus, it can be concluded that nasal septal deviation can cause sinusitis through a combination of airflow obstruction, sinus drainage obstruction, mucosal irritation and inflammation, and local immune system disorders. However, it is important to note that not all types of deviation have the same clinical impact. Some types, particularly types 3 and 5, have been significantly associated with an increased incidence of sinusitis because their location and shape can obstruct airflow and narrow the ostiomeatal complex, a crucial area for ventilation and drainage of the paranasal sinuses. Therefore, Mladina's classification is not only useful academically but also very helpful in clinical practice, particularly in determining indications for corrective procedures such as septoplasty or sinus endoscopy (Ajmal & Usman, 2017; Sumaily et al., 2017).

The results of this literature review indicate that types 3 and 5 nasal septal deviations, according to the Mladina classification, are the types most frequently associated with sinusitis. This finding aligns with several previous studies highlighting the influence of septal deviation on airflow disturbances, as well as ventilation and drainage of the paranasal sinuses. Type 3 septal deviation, characterized by posterior deviation of the nasal septum in the choanae, potentially obstructs airflow to the nasopharynx and ostiomeatal complex, thereby impairing ventilation of the maxillary and ethmoid sinuses. This obstruction creates an ideal environment for mucus stasis and microbial growth, thus triggering sinus inflammation or sinusitis. Meanwhile, type 5, characterized by the presence of a laterally protruding spine or spur, can lead to constant mucosal contact between the septum and conchae. This contact not only causes mechanical obstruction but can also trigger local inflammation due to chronic irritation, which contributes to the pathogenesis of chronic sinusitis (Bayer et al., 2024).

The role of septal deviation in sinusitis is not merely a structural abnormality, but also closely related to impaired nasal airflow dynamics and sinus ventilation. Studies have shown that the more complex or prominent the septal deviation, particularly in types 3 and 5, the greater the likelihood of sinus drainage impairment.

However, it is important to remember that not all cases of septal deviation lead to sinusitis. Other factors such as turbinate hypertrophy, nasal polyps, allergies, and infections also contribute to sinusitis symptoms. Therefore, a comprehensive clinical evaluation remains essential to establish a diagnosis and determine appropriate intervention. Limitations in some of the literature, such as varying methods of classifying deviations and the lack of quantitative assessment of deviation severity, should also be considered when interpreting these results. Furthermore, some of the reviewed studies did not explicitly differentiate between acute and chronic sinusitis, which may affect the validity of the association between deviation type and sinusitis incidence.

## Conclusion

Nasal septal deviation (SND) is an anatomical abnormality that can disrupt airflow and sinus drainage, thus playing a role in the pathogenesis of sinusitis, particularly chronic sinusitis. This literature review found that types 3 and 5 of the Mladina classification are the deviations most frequently associated with sinusitis. Type 3, which is a posterior deviation, can impede sinus ventilation and drainage, while type 5, which is a sharp protrusion or spur, can cause chronic irritation due to mucosal contact and mechanical obstruction of the osteomeatal complex. However, not all cases of SND lead to sinusitis, as other factors such as infection, allergies, and additional anatomical conditions also play a role. Therefore, identifying the type of SND through the Mladina classification is crucial in clinical practice to support diagnosis, determine treatment, and plan interventions such as septoplasty or sinus surgery when necessary.

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