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Original Article

Anatomy Section

Computed Tomographic Evaluation of Nasal Septal Deviation According to Mladina Classification: A Cross-sectional Study

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ABSTRACT

Introduction: Nasal Septal Deviation (NSD) is one of the most common anatomical variations of the nasal cavity and may contribute to nasal obstruction, impaired airflow and sinonasal diseases. Computed Tomography (CT) provides accurate assessment of septal deformities and associated anatomical variations. The Mladina classification is a widely accepted system for categorising different types of NSD.

Aim: To evaluate the distribution of NSD according to the Mladina classification on CT scans and to assess its distribution with respect to age and gender.

Materials and Methods: A cross-sectional study was conducted at Kiran Multi Super Speciality Hospital, Surat, Gujarat, India. A total of 180 patients aged 10-80 years undergoing CT of the paranasal sinuses or CT brain were included. CT images were evaluated using Digital Imaging and Communications in Medicine (DICOM) software, and NSD was classified according to the Mladina classification. Data were analysed using Jamovi version 2.7.27.2. Categorical variables were presented as counts and percentages.

Results: Age-wise, the largest proportion of participants belonged to the 21-40-year group (38.6%), followed by the 41-60-year group (31.9%), with Types I-III predominating across these age groups. Of 180 participants, Type-I deviation was most frequent, occurring in 56 (31.1%), followed by Type-II in 49 (27.2%), Type-III in 44 (24.4%), Type-V in 15 (8.4%), and Type-IV in 6 (3.3%). No Type-VI or Type-VII deformities were identified, while 10 (5.6%) participants had no septal deviation. Type-I was the most common pattern in both males {28/90 (31.1%)} and females {28/90 (31.1%)}.

Conclusion: Type-I was the most frequently observed Mladina pattern in this CT-based study, followed by Type II and III. The findings describe the morphological distribution of NSD in the study population and demonstrate similar predominance of Type-I among males and females.

Keywords: Anatomic variation, Nasal cavity, Nasal obstruction, Sex distribution, Tomography

INTRODUCTION

The NSD is a common anatomical variation of the nasal cavity. Although minor deviations may be asymptomatic, clinically relevant deformities can alter nasal airflow and may be associated with nasal obstruction and other sinonasal complaints [1]. The nasal septum is an osteocartilaginous structure dividing the nasal cavity into two passages. Its morphology varies considerably among individuals, and several systems have been proposed to describe septal deformity. The Mladina classification is a commonly used morphology-based system for describing nasal septal deformities [2,3]. The Mladina system describes seven patterns of septal deformity. Types I-IV are predominantly vertical deformities, Types V and VI are horizontal deformities, and Type-VII represents a combination of the preceding patterns [3].

The CT provides multiplanar visualisation of the nasal septum, nasal cavity and paranasal sinus anatomy and permits detailed assessment of anatomical variations [4,5]. Recent CT-based evidence continues to demonstrate a high prevalence and considerable morphological diversity of NSD. Duzkalir HG et al., in a CT study of 200 patients, evaluated both the presence and Mladina types of NSD and reported NSD in more than 80% of the studied patients [6]. Similarly, recent Cone-Beam Computed Tomography (CBCT) studies have demonstrated the value of three-dimensional imaging in evaluating NSD together with associated sinonasal anatomical variations [7].

Previous studies using the Mladina classification have demonstrated substantial variation in the prevalence of individual septal types among different populations. Mladina R et al., found Type-III to be the most frequent deformity in a large international Ear, Nose, snd Throat (ENT) population, whereas Wee JH et al., reported Type-I as the most common Mladina pattern in a Korean population [8,9]. Moshfeghi M et al., also demonstrated marked variation in the distribution of Mladina types using cone-beam CT [5].

The clinical implications of NSD also remain an area of continuing investigation. A recent systematic review by Shulkin A et al., found that the relationship between NSD and rhinosinusitis remains inconclusive because of heterogeneity in definitions, diagnostic criteria, imaging measurements, and outcome reporting across published studies [10]. These findings further emphasise the importance of standardised morphological classification when reporting NSD.

The novelty of the present study lies in describing the CT-based morphological distribution of Mladina septal types in a contemporary Indian hospital population and examining their distribution by gender and age. Such local data may improve understanding of population-specific septal morphology and provide a standardised framework for radiological reporting. Therefore, this study aimed to evaluate NSD according to the Mladina classification on CT and assess its distribution by age and gender.

MATERIALS AND METHODS

This cross-sectional study was conducted at Kiran Multi Super Speciality Hospital, Surat, Gujarat, India from April 2025 to March 2026. The study was conducted after approval from the Institutional Ethics Committee (IEC No.: KMC_IEC_004_2025) in the meeting

held on 8 January 2025 and informed consent was taken from the participants.

Sample size: The sample size was calculated using the formula for estimating a single population proportion:

$$n = \frac{Z^2 \times p \times q}{d^2}$$

where:

- Z = 1.96 (95% confidence level)
- p = expected prevalence of NSD = 86.6% (0.866), based on the study by MoshfeghiM et al., [5]
- q = 1 - p = 0.134
- d = absolute precision = 5% (0.05)

$$n = \frac{(1.96)^2 \times 0.866 \times 0.134}{(0.05)^2} = 178.2$$

The minimum required sample size was 179. The study included a rounded sample size of 180 participants to improve the precision of the estimates.

Inclusion criteria: Patients aged 10-80 years undergoing CT of the paranasal sinuses or CT brain with images adequate for septal evaluation were included in the study.

Exclusion criteria: Patients with previous sinonasal surgery, severe facial trauma involving the paranasal sinuses, or congenital craniofacial anomalies were excluded from the study.

Study Procedure

A broad age range was selected to describe septal morphology across adolescent and adult age groups; age for age-stratified analysis was recorded. CT scans were reviewed using DICOM software. Axial and coronal CT images were evaluated for NSD. Deviation was classified as Mladina Types I-VII according to the original classification [3]. Demographic variables, including age and gender, were recorded, and the distribution of the different types of NSD was documented.

STATISTICAL ANALYSIS

Data were entered into Microsoft Excel and analysed using Jamovi version 2.7.27.2. Categorical variables were presented as counts and percentages.

RESULTS

[Table/Fig-1] shows that the majority of participants were aged 21-40 years (38.6%), followed by 41-60 years (31.9%). Type-I was the most common septal deviation, followed by Types II and III, with most cases occurring in the 21-60-year age groups. Types IV and V were less frequent, while Types VI and VII were not observed. Ten participants had no septal deviation.

Mladina classification	Age group (years)			
	10-20	21-40	41-60	61-80
Type-I	8 (4.5%)	18 (10.1%)	17 (9.5%)	13 (7.2%)
Type-II	5 (2.8%)	21 (11.7%)	19 (10.6%)	4 (2.2%)
Type-III	10 (5.6%)	20 (11.2%)	10 (5.6%)	4 (2.2%)
Type-IV	2 (1.1%)	3 (1.7%)	2 (1.1%)	0
Type-V	2 (1.1%)	5 (2.8%)	6 (3.4%)	1 (0.6%)
Type-VI	0	0	0	0
Type-VII	0	0	0	0
No septal deviation	3 (1.7%)	2 (1.1%)	3 (1.7%)	2 (1.1%)
Total (n=180)	30 (16.8%)	69 (38.6%)	57 (31.9%)	24 (13.3%)

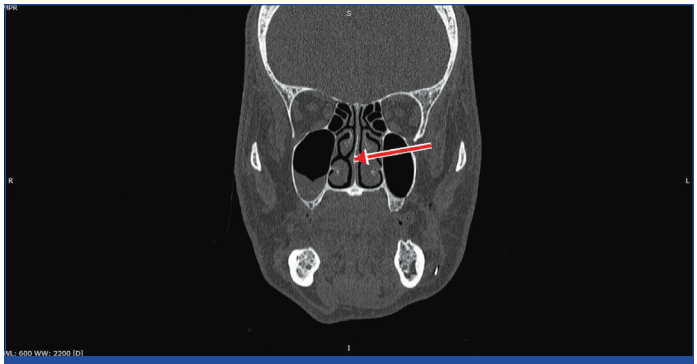
[Table/Fig-1]: Age-wise distribution of Nasal Septal Deviation (NSD) according to Mladina Classification.

[Table/Fig-2] shows the distribution of NSD according to the Mladina classification among 180 study participants. Type-I was the most common pattern, observed in 56 (31.1%) participants. Representative CT images of Mladina Types I-V are presented in [Table/Fig-3-7], with arrows identifying the septal deformity.

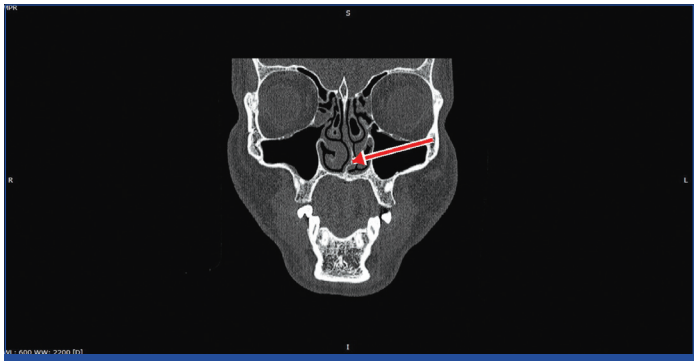
[Table/Fig-8] presents the gender-wise distribution of NSD according to the Mladina classification. About, 90 (50.0%) were males and 90 (50.0%) were females. Type-I was the most frequent pattern in both males {28 (31.1%)} and females {28 (31.1%)}.

Type of Nasal Septal Deviation (NSD)	n (%)
Type-I	56 (31.1)
Type-II	49 (27.2)
Type-III	44 (24.4)
Type-IV	6 (3.3)
Type-V	15 (8.4)
Type-VI	0
Type-VII	0
No septal deviation	10 (5.6)
Total	180 (100.0)

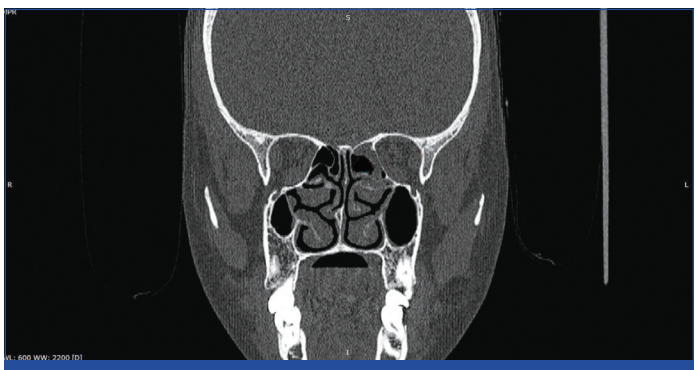
[Table/Fig-2]: Distribution of Nasal Septal Deviation (NSD) according to Mladina Classification (n=180).



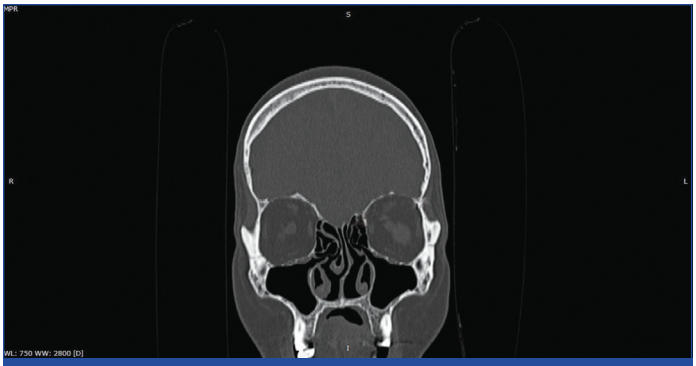
[Table/Fig-3]: Type-I (Mild deviation in vertical plane).



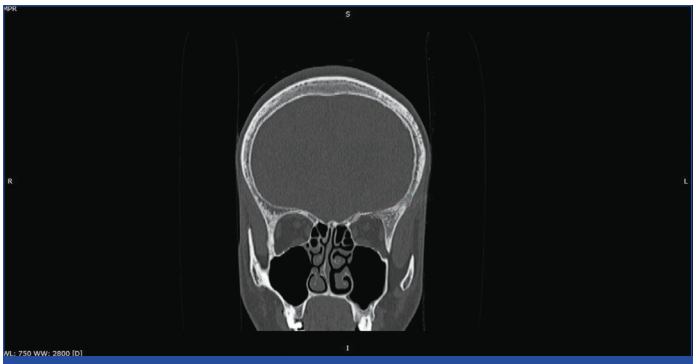
[Table/Fig-4]: Type-II (Moderate anterior vertical deviation of cartilaginous septum in full length).



[Table/Fig-5]: Type-III (Posterior vertical deviation at level of OM and middle turbinate).



[Table/Fig-6]: Type-IV ('S'-shaped, posterior to one side and anterior to other).



[Table/Fig-7]: Type-V (Horizontal septal crest touching or not touching the lateral nasal wall).

Mladina classification	Male (n=90)	Female (n=90)	Total (n=180)
Type-I	28 (31.1%)	28 (31.1%)	56 (31.1%)
Type-II	25 (27.8%)	24 (26.7%)	49 (27.2%)
Type-III	23 (25.6%)	21 (23.3%)	44 (24.4%)
Type-IV	3 (3.3%)	3 (3.3%)	6 (3.3%)
Type-V	6 (6.7%)	9 (10.0%)	15 (8.4%)
Type-VI	0	0	0
Type-VII	0	0	0
No septal deviation	5 (5.6%)	5 (5.6%)	10 (5.6%)
Total	90 (100%)	90 (100%)	180 (100%)

[Table/Fig-8]: Gender-wise Distribution of Nasal Septal Deviation (NSD) according to Mladina Classification.

DISCUSSION

The present study evaluated the distribution of NSD according to the Mladina classification using CT in 180 patients. CT provides detailed visualisation of the nasal septum and adjacent sinonasal anatomy and is useful for assessment of anatomical variations relevant to radiological evaluation and surgical planning [8,11]. More recent literature has continued to employ CT and CBCT for characterisation of septal morphology and its relationship with surrounding sinonasal structures [6,11-14].

In the present study, Type-I NSD was the most frequently observed deformity, followed by Types II and III. Types IV and V were less common, while Types VI and VII were not identified. This distribution differs from several published populations, supporting geographic and sample-related variation in septal morphology.

Mladina R et al., in an international study of 2,589 adult ENT patients from 17 centres in 14 countries, reported septal deformity in 89.2% and identified Type-III as the most frequent pattern (20.4%) [8]. In contrast, Wee JH et al., evaluated 970 Korean participants and reported Mladina Type-I as the most common pattern (35.4%) [9]. The predominance of Type-I in the present study was therefore more consistent with the Korean study than with the international ENT cohort. Moshfeghi M et al., evaluated 386 patients using CBCT and found NSD in 86.6%; Type-VII was the most frequent pattern (30.3%), followed by Type-III (20.7%) and Type-I (19.4%) [5]. These findings differ substantially from the present study, in which Types VI and VII were absent. More recently, Duzkalir HG et al., retrospectively evaluated CT examinations of 200 patients according to the Mladina classification and reported NSD in 89.4% of patients with an accessory maxillary ostium and 81.3% of those without an accessory ostium [6]. They found no significant difference in the distribution of NSD types according to the presence or localisation of the accessory maxillary ostium. Collectively, these studies show that NSD is common on cross-sectional imaging, although the distribution of individual Mladina types varies among study populations.

Recent imaging studies have expanded assessment beyond the septum itself. In a CBCT study of 30 participants with NSD and 30 without NSD, Patil K et al., found significantly greater pneumatisation of the maxillary sinus floor, middle turbinate concha bullosa, and superior frontal sinus wall among participants with NSD. Seven of nine assessed parameters differed significantly, and the total assessment of pneumatisation of the paranasal sinuses score was higher in the NSD group (p-value <0.001) [7]. These findings suggest that septal morphology should be considered within the broader anatomical configuration of the sinonasal complex, although the observed associations do not establish causality.

In the present study, the largest proportion of participants belonged to the 21-40-year age group (38.6%), followed by the 41-60-year group (31.9%). Types I, II, and III were the predominant patterns across age groups, with most cases occurring between 21 and 60 years. Type-I remained relatively frequent in the 61-80-year group, whereas Types IV and V were uncommon and Types VI and VII were not observed in any age group. Age may influence the distribution of septal morphology. Subaric M and Mladina R studied 1,797 participants aged 2-22 years and reported NSD prevalences of 28.0%, 21.1%, 40.6%, and 41.8% in the 2-6, 7-14, 15-18, and 19-22 year groups, respectively. Types I and II occurred in the youngest children, whereas Types V and VI appeared in older groups [12]. Teul I et al., studied 235 participants aged 5-60 years and found NSD in 43.0%. Deformities were most frequent in the 15-22-year group; Type-III was most common overall (12.4%), and Type-I decreased with age while Types III and V increased [13]. These observations support age-stratified assessment in studies spanning a wide age range.

Gender-wise, Type-I was equally frequent among males and females in the present study {28 (31.1%) in each group}. Moshfeghi M et al., found no statistically significant association between gender and the presence of NSD [5]. In contrast, Teul I et al., reported that a straight septum was more frequent among females and that NSD overall was more frequent among males [13]. Thus, published findings do not establish a consistent sex-specific pattern of septal morphology; differences may reflect population characteristics, age distribution, referral patterns, sample selection, developmental factors, and assessment methods [Table/Fig-9] [5,12,13].

An important consideration was that morphological NSD identified on CT should not automatically be considered synonymous with clinically significant nasal obstruction or sinonasal disease. Janovic N et al., demonstrated that detailed CT morphology may contribute to the assessment of nasal obstruction but that anatomical characteristics alone do not completely explain subjective symptom severity [15]. Rehman A et al., in a study of 200 symptomatic patients, found CT useful for demonstrating anatomical variations such as septal deviation, inferior turbinate hypertrophy, and concha bullosa, although CT findings of incidental sinus disease correlated less well with intraoperative findings [4]. Furthermore, a 2025 systematic review by Shulkin A et al., which included 34 studies, concluded that the relationship between NSD and rhinosinusitis remains inconclusive because of substantial heterogeneity in definitions, diagnostic criteria, and outcome measures [10]. Thus,

Study	Population/year	n	I %	II %	III %	IV %	V %	VI %	VII %	Most common
Present study	India, 2026	180	31.1	27.2	24.4	3.3	8.4	0	0	I
Moshfeghi M et al., [5]	Tehran, Iran, 2020	386	19.4	6.2	20.7	5.4	4.4	0.3	30.3	VII
Mladina R et al., [8]	International ENT cohort, 2008	2589	16.2	16.4	20.4	8.7	14.0	9.4	4.1	III
Subaric M and MladinaR [12]	Zagreb, Croatia, 2002	1797	14.7	6.8	1.4	0.2	2.9	2.6	0.2	I
Teul I et al., [13]	Szczecin, Poland, 2009	235	4.2	10.3	12.4	3.2	9.2	1.3	2.7	III

[Table/Fig-9]: Comparison of Mladina-type distributions with selected published studies.

CT-defined septal morphology should be interpreted together with clinical symptoms and endoscopic findings when determining its clinical relevance.

Limitation(s)

This study was conducted at a single hospital and therefore may not represent the distribution of nasal septal morphology in the wider population. Participants were selected from patients undergoing CT rather than from a population-based sample, introducing the possibility of referral or selection bias. The study primarily describes morphological distribution and does not establish associations with symptoms or clinical outcomes. Larger multicentric studies with standardised age-stratified analysis are recommended.

CONCLUSION(S)

The present CT-based study demonstrated that Type-I nasal septal deviation was the most common Mladina pattern (31.1%), followed by Type-II (27.2%) and Type-III (24.4%). Most participants belonged to young and middle age groups, with Types I–III predominating. Type-I deviation was equally frequent among males and females. CT-based Mladina classification provides a systematic approach to assessing nasal septal deformities, although findings should be correlated with clinical symptoms and endoscopic examination.

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