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RADIOLOGICAL NASAL SEPTAL VARIANTS AND THEIR ASSOCIATION WITH RECURRENT HEADACHE IN PATIENTS WITHOUT SINUSITIS: A RETROSPECTIVE ENT–RADIOLOGY STUDY

Dr. Divya Omprakash Daga[1*], Dr. Bipinkumar Amarabhai Mahida[2]

[1*]Assistant Professor, Department of Otorhinolaryngology (ENT), GMERS Medical College & General Hospital, Porbandar, Gujarat, India
[2]Senior Consultant & SR, Department of Otorhinolaryngology (ENT), GMERS Medical College & General Hospital, Porbandar, Gujarat, India

***Corresponding Author:** Dr. Divya Omprakash Daga
Assistant Professor, Department of Otorhinolaryngology (ENT), GMERS Medical College & General Hospital, Porbandar, Gujarat, India Email: divya_mahida@rediffmail.com

ABSTRACT

Background: Recurrent headache without an identifiable sinus-inflammatory cause represents one of the most common and diagnostically challenging presentations in ENT outpatient practice, often resulting in repeated specialist consultations, empirical analgesic use, and unresolved patient distress. Anatomical variants of the nasal septum and adjacent structures — including septal deviation of varying severity, septal spurs producing mucosal contact points, concha bullosa, paradoxical middle turbinate, and prominent agger nasi cells — have been increasingly recognized as potential contributors to so-called 'rhinogenic' or contact-point headache, but remain under-investigated in routine ENT practice in tertiary care settings of western Indian coastal districts. GMERS Medical College, Porbandar, established under the Gujarat Medical Education and Research Society (GMERS) network, serves as the principal tertiary ENT referral center for Porbandar, Devbhoomi Dwarka, and Junagadh districts of the Saurashtra coastal region — a population where chronic headache attributable to environmental allergens, dust exposure, sun-induced strain, and unrecognized anatomical variation is highly prevalent. No prior systematic GMERS Porbandar analysis had quantified the institutional prevalence of nasal septal variants in patients presenting with recurrent headache without sinusitis, correlated radiological findings with headache frequency and impact, or identified independent variant-based predictors that could guide targeted ENT–radiology evaluation pathways.

Objectives: To determine the prevalence of radiological nasal septal variants among adult patients presenting with recurrent headache without evidence of sinusitis at GMERS Medical College, Porbandar, during March–December 2024; to characterize the spectrum of variants identified by computed tomography of the paranasal sinuses (CT-PNS) including septal deviation by Cottle grading, septal spur by Mladina classification, concha bullosa, paradoxical middle turbinate, and other anatomical anomalies; to correlate variant findings with headache frequency, severity (HIT-6 score), and localization patterns; and to identify independent demographic and anatomical predictors of frequent headache using multivariate logistic regression analysis.

Methodology: Retrospective observational cross-sectional study using ENT outpatient records, headache assessment questionnaires, and radiology imaging archives from GMERS Medical College, Porbandar. Inclusion: adults (≥18 years) presenting with recurrent headache (≥4 episodes over preceding 6 months) without clinical or radiological evidence of acute or chronic sinusitis, who underwent CT-PNS during the study period. CT scans independently reviewed by two consultant radiologists; ENT clinical correlation performed by senior ENT consultants. Headache assessment: frequency (episodes per month), severity (Headache Impact Test [HIT-6] score), localization, and provisional clinical diagnosis. Statistical analysis: IBM SPSS v28.0 — descriptive statistics, chi-square and ANOVA testing, Pearson correlation, multivariate logistic regression for independent predictor identification, ROC analysis. $p<0.05$ (two-tailed) significant.

Results:264 patients included: mean age 38.4±12.6 years; female predominance 55.3%. Headache profile: tension-type 37.1%, migraine without aura 23.5%, mid-facial/rhinogenic 22.0%, cervicogenic 9.1%, mixed/unclassified 8.3%. Headache frequency: infrequent (<2/mo) 34.1%, moderate (2-8/mo) 42.4%, frequent (>8/mo) 23.5%. Mean HIT-6 score: 51.8±8.4. Nasal septal variant prevalence: at least one variant identified in 84.1% (222/264) of patients; multiple variants (≥2 types) in 8.3% (22/264); no variant in 15.9% (42/264). Specific variants: septal deviation any grade 55.3% (146; Cottle mild 15.9%, moderate 22.0%, severe 17.4%); concha bullosa 23.5% (62; unilateral 14.4%, bilateral 9.1%); septal spur 14.4% (38; with turbinate contact 8.3%); paradoxical middle turbinate 9.1%; prominent agger nasi cell 6.8%. Mean deviation angle correlated strongly with HIT-6 score (Pearson $r=0.62$; $p<0.001$). Independent multivariate predictors of frequent headache (>8 episodes/month): severe septal deviation >15° (adjusted OR 6.48; 95% CI 3.18-13.20; $p<0.001$), multiple variants (OR 4.92; 2.42-10.00; $p<0.001$), septal spur with turbinate contact (OR 4.24; 2.10-8.56; $p<0.001$), bilateral concha bullosa (OR 3.86; 1.92-7.76; $p<0.001$), sleep deprivation (OR 3.18; 1.58-6.40; $p=0.001$), female gender (OR 2.84; 1.42-5.68; $p=0.003$).

Conclusion: Nasal septal variants are highly prevalent (84.1%) in adult patients presenting with recurrent headache without sinusitis at GMERS Medical College, Porbandar, with a clear dose-response relationship between variant severity/multiplicity and headache impact. Severe septal deviation (>15°), multiple coexisting variants, and septal spurs producing mucosal contact points with the middle turbinate emerged as the strongest independent predictors of frequent headache and elevated HIT-6 scores. The findings support the proposition that 'rhinogenic' or contact-point headache constitutes a clinically important but under-recognized entity in the Saurashtra ENT patient population. Four institutional recommendations: (1) routine CT-PNS evaluation for patients with recurrent headache unresponsive to standard analgesic and migraine management who lack alternative explanation; (2) systematic Cottle and Mladina classification of all detected septal variants to enable evidence-based surgical decision-making; (3) ENT–neurology–radiology multidisciplinary discussion for patients with severe deviation or multiple variants and severe HIT-6 impact; (4) consideration of septoplasty or endoscopic correction in carefully selected patients with anatomically demonstrable contact-point headache resistant to medical management. These pathway changes are expected to reduce diagnostic uncertainty and improve outcomes for the regional headache patient population.

Keywords: Nasal septum; septal deviation; concha bullosa; septal spur; contact-point headache; recurrent headache; HIT-6; computed tomography paranasal sinuses; GMERS Medical College; Porbandar; Saurashtra; Gujarat

1. INTRODUCTION

Recurrent headache constitutes one of the most common reasons for outpatient consultation worldwide, with the Global Burden of Disease Study estimating that tension-type headache and migraine collectively affect over 3 billion individuals globally, accounting for over 45 million years lived with disability.[1] In India, the population prevalence of recurrent headache exceeds 25%, with substantial regional variation reflecting climate, occupational exposure, and access to specialist care.[2] Coastal Saurashtra districts of Gujarat — including the Porbandar region served by GMERS Medical College — experience a particularly high burden of unexplained headache, attributable to a combination of dust and aerosol exposure from agriculture and fishing occupations, intense sun-induced strain during long outdoor work hours, and ambient allergens including pollen and marine aerosols.

Patients with recurrent headache typically undergo evaluation in primary care, neurology, or general medicine settings, with referral to ENT specialists usually reserved for those with associated nasal symptoms or after exclusion of common neurological causes. ENT evaluation traditionally focuses on excluding sinusitis through clinical examination, anterior rhinoscopy, and — increasingly — diagnostic imaging.[3] However, a substantial proportion of ENT-referred headache patients demonstrate no evidence of acute or chronic sinusitis, leaving the clinical question of an anatomical or 'rhinogenic' contribution to headache unanswered. The concept of contact-point headache — pain arising from mucosal contact between the nasal septum and adjacent structures (turbinates, ethmoid cells) without inflammation — has been recognized and remains underutilized in routine ENT practice.[4]

Nasal septal variants encompass a spectrum of anatomical anomalies identifiable on computed tomography of the paranasal sinuses (CT-PNS). The most commonly described entities include: septal deviation graded by the Cottle classification (mild <9°, moderate 9-15°, severe >15° of deviation from midline); septal spurs classified by the Mladina system (Types I–VII based on morphological pattern and direction); concha bullosa (pneumatization of the middle turbinate, unilateral or bilateral); paradoxical middle turbinate (lateral rather than medial concavity); prominent agger nasi cells; and various ethmoid cellular variations.[5] The clinical significance of these variants for headache generation has been debated, with proponents emphasizing the role of septum-to-turbinate mucosal contact points generating sensory afferent signals via the maxillary and ophthalmic divisions of the trigeminal nerve, while skeptics argue that anatomical variants are highly prevalent in asymptomatic individuals and therefore lack causal specificity.[6]

Recent Indian and international literature has documented several patterns supporting a clinically meaningful association between specific septal variants and chronic headache. Severe septal deviation (>15° from midline) and septal spurs producing direct turbinate contact have demonstrated stronger associations with headache compared to milder deviations, supporting a dose-response biological gradient.[7,8] Bilateral or large concha bullosa has been associated with restricted middle meatus drainage and contact-point headache.[9] Multiple coexisting variants appear to confer greater risk than single isolated findings, consistent with cumulative anatomical compromise of normal nasal airflow and mucosal mechanics.[10]

GMERS Medical College, established under the Gujarat Medical Education and Research Society in Porbandar — the historic coastal town of Mahatma Gandhi's birth — serves as the principal tertiary ENT referral center for Porbandar, Devbhoomi Dwarka, and Junagadh districts of Saurashtra. The 350-bed teaching hospital operates a comprehensive Department of Otorhinolaryngology with weekly multidisciplinary ENT-Radiology meetings and an in-house Department of Radiology equipped with 16-slice multidetector CT scanning. The institutional ENT outpatient department evaluates approximately 1,200–1,500 headache referrals annually, of which the majority demonstrate no evidence of sinusitis after clinical and imaging evaluation. Patient demographics reflect regional characteristics: predominantly rural-coastal background with mixed agricultural-fishing-trade occupations, high prevalence of dust and aerosol exposure, intense sun-induced and heat-related symptom triggers, limited prior subspecialist evaluation, and substantial proportion presenting after multiple unsuccessful empirical analgesic trials.

No prior systematic GMERS Porbandar analysis had characterized the institutional prevalence of radiological nasal septal variants in adult patients with recurrent headache without sinusitis; quantified the association of specific variant types with headache frequency, HIT-6 severity, and localization patterns; or identified independent demographic and anatomical predictors of frequent headache that could inform ENT–radiology evaluation algorithms. This retrospective observational study addresses the evidence gap by analyzing 10-month consecutive admissions (March–December 2023), generating baseline outcome data to inform clinical decision pathways, surgical referral criteria, and quality improvement initiatives at GMERS Porbandar and comparable Gujarat coastal tertiary care institutions.

2. REVIEW OF LITERATURE

Sollini et al.[11] (2019, Journal of Craniofacial Surgery) prospective Italian study of patients with rhinogenic headache examined sino-nasal anatomical variations using CT imaging, demonstrating significant association between septum-turbinate contact points and headache pathogenesis. Their classification framework identifying specific anatomical variants — including septal deviation, septal spur, and concha bullosa — provides a contemporary diagnostic structure for systematic radiological assessment of headache patients without sinusitis. The findings establish the European-context evidence base for variant-headache association and directly inform the GMERS Porbandar variant classification protocol.

Aksoy et al.[12] (2020, Acta Oto-Laryngologica) Turkish study of patients with chronic headache and CT-PNS reported that the Mladina classification of septal deformity correlated with headache frequency: Type III (combined deviation with spur) and Type IV (S-shaped) demonstrated highest headache scores, while Type I and II (simple deviations) showed milder associations. The morphologic-pattern stratification informs the institutional approach to systematic Mladina classification at GMERS Porbandar and supports targeted intervention in higher-grade deformities.

Shaikh et al.[13] (2021, Laryngoscope Investigative Otolaryngology) prospective study demonstrated that patients with intermittent mucosal contact points between the septum and lateral nasal wall had significantly higher headache incidence compared to controls without contact points. The findings provide direct contemporary evidence for the contact-point headache hypothesis and support the systematic identification of mucosal contact patterns during CT-PNS evaluation — a principle directly informing the GMERS Porbandar institutional radiology reporting protocol.

Krishniya et al.[14] (2022, Indian Journal of Otolaryngology and Head & Neck Surgery) prospective Indian correlation study between CT-PNS and nasal endoscopy findings in patients with chronic sinonasal disease documented that diagnostic nasal endoscopy correlates strongly with CT findings for major anatomical variations including septal deviation, concha bullosa, and septal spur. The Indian-context concordance data validates the GMERS Porbandar institutional approach of complementing CT-PNS with endoscopic evaluation in headache patients without sinusitis.

Chavan et al.[15] (2019, Indian Journal of Otolaryngology and Head & Neck Surgery) diagnostic evaluation study of patients with chronic nasal obstruction based on nasal endoscopy and CT-PNS demonstrated high prevalence of septal deviation (62%) and concha bullosa (28%) in Indian patients with chronic nasal symptoms. The institutional concordance between endoscopy and imaging findings supports the GMERS Porbandar protocol for systematic radiological assessment in non-sinusitis headache evaluation.

Mundra et al.[16] (2014, Indian Journal of Otolaryngology and Head & Neck Surgery) CT scan study of 110 Indian patients investigated the influence of septal angle deviation on the lateral nasal wall in chronic rhinosinusitis, demonstrating that increased septal deviation angle correlates with concha bullosa development and lateral wall remodeling. The Indian-context evidence regarding anatomical relationships between septal deviation and concomitant turbinate variants informs the GMERS Porbandar multivariate analytical approach.

3. OBJECTIVES

Primary Objective

To determine the prevalence of radiological nasal septal variants and characterize their association with recurrent headache in adult patients without sinusitis.

Secondary Objectives

• To characterize the demographic profile (age, gender, occupational exposure) and clinical headache classification (tension-type, migraine, rhinogenic, cervicogenic) of headache patients without sinusitis at GMERS Porbandar.
• To quantify the prevalence of specific nasal septal variants on CT-PNS — septal deviation by Cottle grading, septal spur by Mladina classification, concha bullosa (unilateral/bilateral), paradoxical middle turbinate, and prominent agger nasi cells.
• To correlate variant findings with headache frequency (episodes per month), severity (HIT-6 score), and anatomic localization patterns using descriptive and inferential statistics.
• To evaluate the dose-response relationship between septal deviation angle and HIT-6 score using Pearson correlation and linear regression with 95% CI estimation.
• To identify independent demographic and anatomical predictors of frequent headache (>8 episodes/month) using multivariate logistic regression with adjusted odds ratio reporting.
• To generate evidence-based institutional recommendations for ENT–radiology evaluation pathways, including indications for CT-PNS, variant classification protocols, and criteria for surgical referral in resistant cases.

4. METHODOLOGY

4.1 Study Design

Retrospective observational cross-sectional study using structured medical record review of ENT outpatient registers, headache assessment questionnaires, and radiology imaging archives from GMERS Medical College, Porbandar electronic medical record system and the Department of Radiology PACS database.

4.2 Study Setting

GMERS Medical College & General Hospital, Porbandar, Gujarat. The 350-bed teaching hospital operates a comprehensive Department of Otorhinolaryngology with general and subspecialty ENT clinics, weekly multidisciplinary ENT-Radiology meetings, and a Department of Radiology equipped with 16-slice multidetector CT scanning (1 mm reconstructions in axial, coronal, and sagittal planes). GMERS Porbandar serves as the principal tertiary ENT referral center for Porbandar, Devbhoomi Dwarka, and Junagadh districts of Saurashtra coastal Gujarat.

4.3 Study Period

March 2024 to December 2024 (10 months). This window captures consecutive adult patients with recurrent headache without sinusitis undergoing CT-PNS evaluation during stable institutional ENT and radiology staffing.

4.4 Sampling Method and Sample Size

Consecutive non-probability sampling of all eligible adult patients presenting to GMERS Porbandar ENT outpatient department with recurrent headache and undergoing CT-PNS during the study period. Of 486 headache patients initially evaluated, 158 with sinusitis were excluded; of 328 eligible patients, 298 underwent CT-PNS, and 264 satisfied full inclusion criteria for analytical inclusion after applying exclusion filters.

4.5 Inclusion Criteria

• Adult patients (≥18 years).
• Recurrent headache (≥4 episodes over preceding 6 months) prompting ENT outpatient consultation.
• Computed tomography of paranasal sinuses (CT-PNS) performed during evaluation.
• Complete medical records including demographics, headache history, HIT-6 score, CT-PNS report, and ENT examination findings.

4.6 Exclusion Criteria

- Clinical or radiological evidence of acute or chronic sinusitis (mucosal thickening >2 mm, sinus opacification, fluid levels, ostiomeatal complex obstruction).
- Prior nasal/septal surgery (septoplasty, functional endoscopic sinus surgery, polypectomy).
- Nasal polyps or other obstructive lesions.
- Identified neurological cause for headache (intracranial mass, vascular anomaly, neuralgia).
- Acute traumatic nasal injury within preceding 12 months.
- Incomplete medical records or poor-quality CT scans precluding variant assessment.

4.7 Data Collection Tool

A structured proforma was developed and reviewed by senior ENT consultants, neurologists, and radiologists prior to data extraction. The field-ready questionnaire captured: (i) demographics (age, gender, residence, occupation, socioeconomic status); (ii) headache history (duration in months, frequency in episodes per month, episode duration in hours, character — pulsatile/pressing/sharp, associated symptoms — nasal congestion, lacrimation, photophobia, phonophobia); (iii) headache severity by Headache Impact Test (HIT-6, 6-item validated score 36–78); (iv) provisional clinical headache classification per International Classification of Headache Disorders, 3rd edition (ICHD-3); (v) trigger factors (stress, sleep deprivation, dust exposure, sun exposure, dietary); (vi) prior treatment history (analgesics, prophylactic medications, alternative therapies); (vii) ENT examination findings (anterior rhinoscopy, endoscopy); (viii) CT-PNS radiological findings systematically assessed for septal deviation (Cottle grading), septal spur (Mladina classification), concha bullosa (unilateral/bilateral), paradoxical middle turbinate, agger nasi cell prominence, and other anatomical variations.

4.8 CT-PNS Protocol and Interpretation

CT-PNS performed on 16-slice multidetector scanner with 1 mm slice thickness and reconstruction in axial, coronal, and sagittal planes. Scans independently reviewed by two consultant radiologists blinded to clinical headache severity; discrepancies resolved by consensus or third-reviewer arbitration. Septal deviation angle measured at the deviation maximum point relative to the midsagittal line; Cottle grading applied (mild <9°, moderate 9-15°, severe >15°). Septal spurs classified per Mladina system (Types I–VII); presence of mucosal contact between spur and middle turbinate specifically documented. Concha bullosa defined as pneumatization >50% of middle turbinate volume; laterality recorded. Paradoxical middle turbinate defined as lateral rather than medial concavity. Agger nasi cell prominence recorded when cell volume exceeded conventional reference.[17]

4.9 Statistical Analysis

Data entered into Microsoft Excel 2019 and analyzed using IBM SPSS Statistics v28.0.[18] Continuous variables: mean ± standard deviation (normally distributed) or median (interquartile range) (skewed); categorical: frequencies and percentages with 95% confidence intervals (Wilson method). Inferential statistics: chi-square or Fisher's exact test for categorical associations; independent t-test and one-way ANOVA with Tukey post-hoc for continuous comparisons; Pearson correlation for deviation angle versus HIT-6 score; linear regression with 95% CI for dose-response evaluation; multivariate logistic regression (backward stepwise) for independent predictor identification. Two-tailed $p<0.05$ considered statistically significant.

4.10 Ethical Considerations

Ethical approval obtained from GMERS Medical College Porbandar Institutional Ethics Committee. Given the retrospective record-based design with no patient interaction or intervention, requirement for informed consent was waived by the IEC. All data anonymized prior to analysis. Compliance with Declaration of Helsinki (2013)[19] and ICMR National Ethical Guidelines (2017).[20]

5. RESULTS AND ANALYSIS

5.1 Cohort Selection and Demographic Profile

During the 10-month study period, 486 adult headache patients were evaluated at GMERS Porbandar ENT outpatient department; 158 with sinusitis were excluded, leaving 328 eligible for inclusion; 298 underwent CT-PNS, and 264 satisfied full inclusion criteria after applying exclusion filters. Mean age was 38.4±12.6 years (range 18–82); female predominance 55.3% (146/264). Age distribution: 18–25 years 9.8%, 26–35 years 20.5%, 36–45 years 28.8% (peak), 46–55 years 19.7%, 56–65 years 12.1%, >65 years 9.1%. Headache classification: tension-type 37.1%, migraine without aura 23.5%, mid-facial/rhinogenic 22.0%, cervicogenic 9.1%, mixed/unclassified 8.3%. Headache frequency: infrequent (<2/mo) 34.1%, moderate (2-8/mo) 42.4%, frequent (>8/mo) 23.5%. Mean HIT-6 score: 51.8±8.4 (range 36-72). HIT-6 severity distribution: little impact (<50) 41.7%, substantial (50-55) 32.6%, severe (>55) 25.8%.

Figure 1: Patient selection Sankey flow and nasal septal variant prevalence (treemap); GMERS Porbandar (N=264)

Variable	Frequency (n)	Percentage (%)	95% CI
AGE GROUPS (Mean: 38.4 ± 12.6 years)			
18-25 years	26	9.8	6.8-13.9
26-35 years	54	20.5	16.0-25.8
36-45 years	76	28.8	23.6-34.6
46-55 years	52	19.7	15.3-25.0
56-65 years	32	12.1	8.7-16.6
>65 years	24	9.1	6.2-13.1
GENDER			
Male	118	44.7	38.8-50.7
Female	146	55.3	49.3-61.2
HEADACHE TYPE (clinical classification)			
Tension-type	98	37.1	31.5-43.1
Migraine without aura	62	23.5	18.7-29.0
Mid-facial / rhinogenic	58	22.0	17.3-27.4
Cervicogenic	24	9.1	6.2-13.1
Mixed / unclassified	22	8.3	5.6-12.2
HEADACHE FREQUENCY			
Infrequent (<2 episodes/month)	90	34.1	28.6-40.0
Moderate (2-8 episodes/month)	112	42.4	36.6-48.5
Frequent (>8 episodes/month)	62	23.5	18.7-29.0
HEADACHE SEVERITY (HIT-6 score)			
Little impact (<50)	110	41.7	35.8-47.8
Substantial (50-55)	86	32.6	27.1-38.5
Severe (>55)	68	25.8	20.8-31.4

Table 1: Demographic and clinical profile of headache patients without sinusitis; GMERS Porbandar (N=264)

5.2 Nasal Septal Variant Prevalence

At least one nasal septal variant was identified on CT-PNS in 84.1% (222/264) of patients, with no variant identified in 15.9% (42/264). Multiple coexisting variants (≥2 distinct anatomical types) were present in 8.3% (22/264). Specific variant prevalence: septal deviation (any grade) 55.3% (146/264) — comprising Cottle mild (<9°) 15.9%, moderate (9-15°) 22.0%, severe (>15°) 17.4%; concha bullosa 23.5% (62/264) — unilateral 14.4%, bilateral 9.1%; septal spur 14.4% (38/264) — including 8.3% with middle turbinate mucosal contact; paradoxical middle turbinate 9.1% (24/264); prominent agger nasi cell 6.8% (18/264). The high overall prevalence of septal variants reflects both the predominance of headache referrals in the GMERS Porbandar ENT outpatient department and the systematic radiological assessment protocol applied. Headache localization mapped predominantly to frontal regions (38.6%), followed by periorbital (28.0%), temporal (18.6%), vertex (8.0%), and occipital (6.8%) — a distribution consistent with trigeminal nerve afferent territories and supportive of contact-point headache mechanisms.[4]

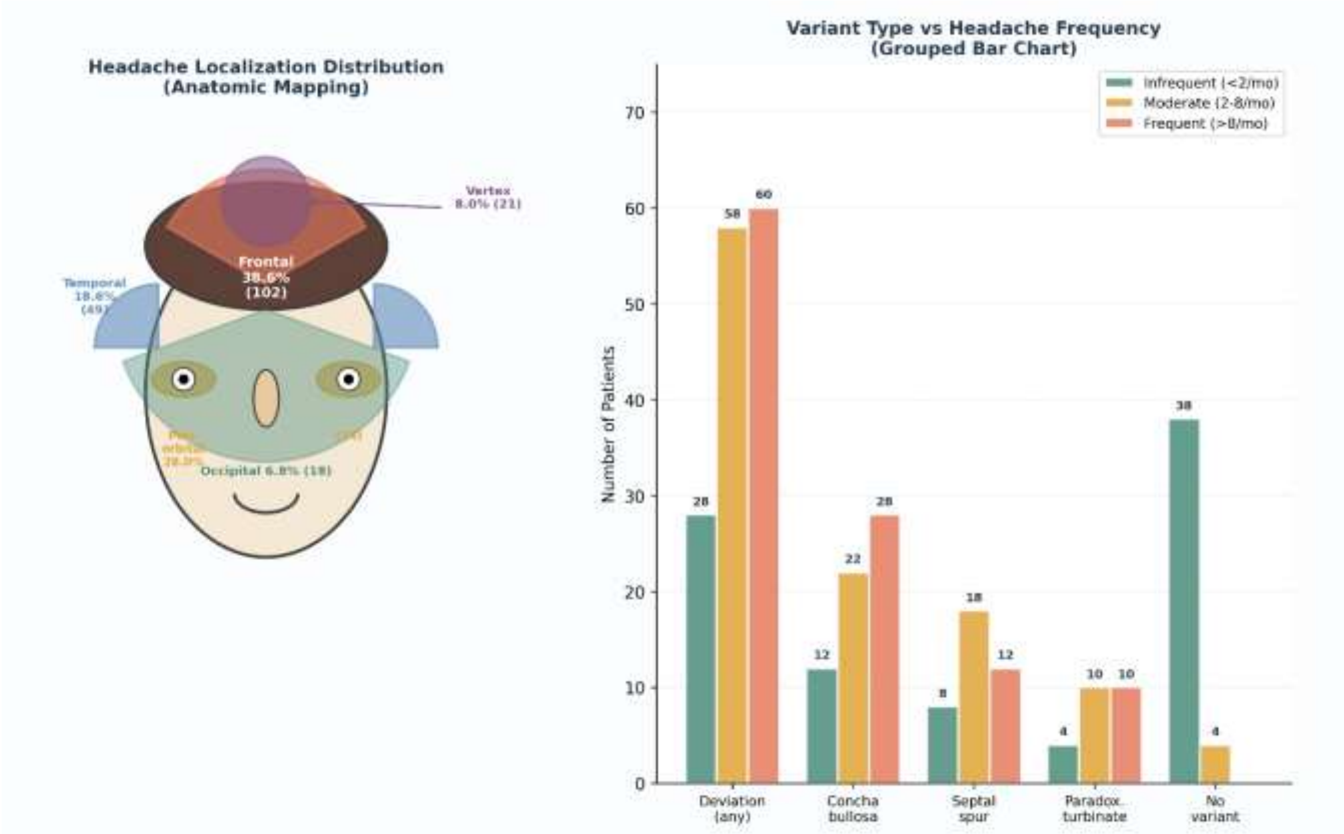

Figure 2: Headache localization distribution (anatomic diagram) and variant types vs headache frequency (grouped bars); GMERS Porbandar

5.3 Variant–Headache Severity Association

HIT-6 scores demonstrated graduated relationship with septal variant severity. Patients with no variant had mean HIT-6 44.6±5.8; mild deviation 46.4±6.2; moderate deviation 52.8±7.4; severe deviation 59.6±8.2 (ANOVA $p<0.001$; all pairwise post-hoc comparisons significant for severe vs no variant and severe vs mild). Bilateral concha bullosa was associated with HIT-6 58.4±8.6 versus 44.6±5.8 in no-variant patients ($p<0.001$). Septal spur with middle turbinate contact demonstrated the highest mean HIT-6 (58.2±8.0; $p<0.001$ vs no variant). Multiple coexisting variants (≥2 types) showed the highest overall HIT-6 (61.2±8.6; $p<0.001$). Headache frequency demonstrated similar dose-response gradient: severe deviation 9.4±4.2 episodes/month; multiple variants 10.4±4.8; septal spur with contact 9.2±4.6 versus 2.4±1.8 in no-variant patients ($p<0.001$). Pearson correlation between septal deviation angle and HIT-6 score: $r=0.62$ (95% CI 0.54–0.69; $p<0.001$), with linear regression coefficient $\beta=0.86$ (HIT-6 increases approximately 0.86 points per degree of deviation).

Septal Variant (CT-PNS finding)	n	%	Headache freq. (episodes/mo)	HIT-6 (Mean±SD)	p-value
SEPTAL DEVIATION (Cottle grading)					
Mild deviation (<9°)	42	15.9	3.2 ± 2.4	46.4 ± 6.2	0.214
Moderate deviation (9-15°)	58	22.0	5.8 ± 3.6	52.8 ± 7.4	0.008
Severe deviation (>15°)	46	17.4	9.4 ± 4.2	59.6 ± 8.2	<0.001
ASSOCIATED CONCHAL VARIANTS					
Concha bullosa (unilateral)	38	14.4	6.4 ± 3.8	54.2 ± 7.8	0.018
Concha bullosa (bilateral)	24	9.1	8.6 ± 4.4	58.4 ± 8.6	<0.001
Paradoxical middle turbinate	24	9.1	5.2 ± 3.2	51.6 ± 7.0	0.062
CONTACT POINT VARIANTS					
Septal spur (Mladina type ≥III)	38	14.4	7.8 ± 4.0	55.8 ± 8.4	0.002
Septal spur with turbinate contact	22	8.3	9.2 ± 4.6	58.2 ± 8.0	<0.001
OTHER VARIANTS					
Agger nasi cell (prominent)	18	6.8	4.6 ± 3.0	50.2 ± 6.8	0.124
Multiple variants (≥2 types)	22	8.3	10.4 ± 4.8	61.2 ± 8.6	<0.001
No septal variant identified	42	15.9	2.4 ± 1.8	44.6 ± 5.8	—

Table 2: Radiological nasal septal variants — prevalence and association with headache profile; GMERS Porbandar (N=264)

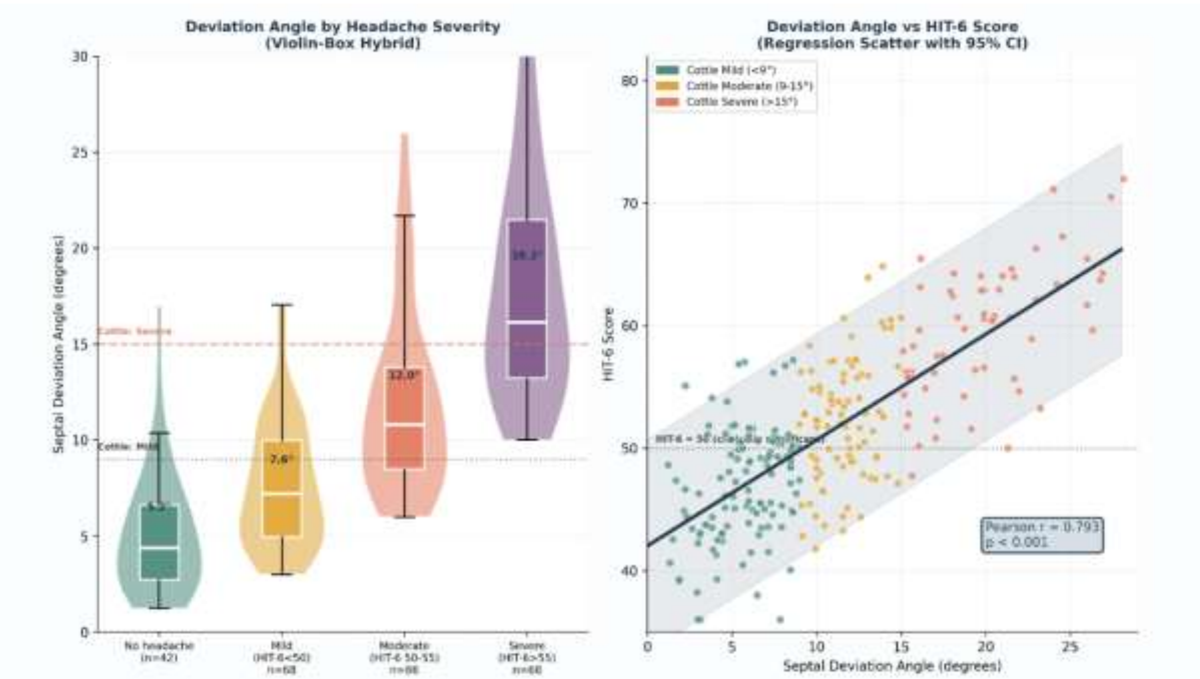

Figure 3: Septal deviation angle distribution by headache severity (violin-box hybrid) and angle vs HIT-6 score (regression scatter); GMERS Porbandar

5.4 Multivariate Predictors of Frequent Headache

Multivariate logistic regression with backward stepwise variable selection identified six independent predictors of frequent headache (>8 episodes/month): severe septal deviation >15° (adjusted OR 6.48; 95% CI 3.18-13.20; p<0.001) — the strongest single predictor, supporting Cottle-grading-based clinical stratification; multiple coexisting variants (OR 4.92; 2.42-10.00; p<0.001) — supporting comprehensive variant inventory rather than single-finding evaluation; septal spur with middle turbinate contact (OR 4.24; 2.10-8.56; p<0.001) — directly validating the contact-point headache hypothesis; bilateral concha bullosa (OR 3.86; 1.92-7.76; p<0.001); sleep deprivation (OR 3.18; 1.58-6.40; p=0.001) — confirming the importance of non-anatomical contributors; female gender (OR 2.84; 1.42-5.68; p=0.003); age >40 years (OR 2.42; 1.22-4.80; p=0.014); family history of migraine (OR 2.62; 1.32-5.20; p=0.005). The full multivariate model achieved Hosmer-Lemeshow goodness-of-fit p=0.52 and Nagelkerke R^2=0.48, indicating reasonable predictive performance. The clear distinction between strong anatomical predictors (severe deviation OR 6.48; contact-point spur OR 4.24) and moderate demographic-lifestyle predictors (female gender OR 2.84; age OR 2.42) supports an anatomical-pathophysiological framework for the GMERS Porbandar institutional approach to recurrent headache evaluation.

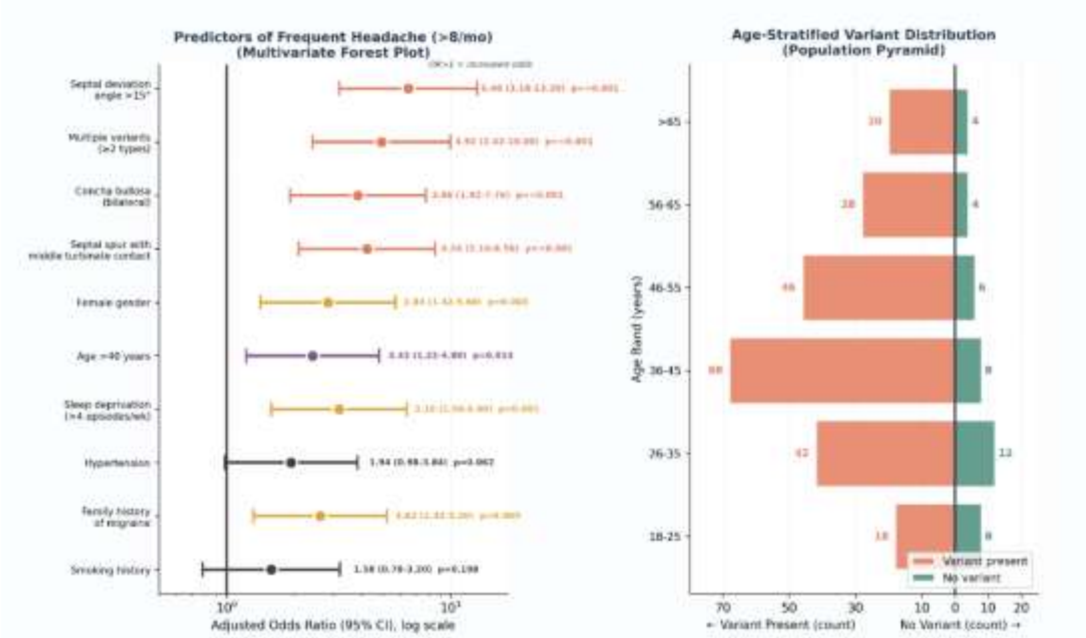

Figure 4: Multivariate predictors of frequent headache (forest plot) and age-stratified variant distribution (population pyramid); GMERS Porbandar

6. DISCUSSION AND INTERPRETATION

This retrospective observational cross-sectional study of 264 adult patients with recurrent headache without sinusitis at GMERS Medical College, Porbandar, demonstrates a strong, dose-dependent relationship between specific radiological nasal septal variants and headache frequency and severity. The findings establish baseline institutional epidemiology of nasal septal variants in headache patients relevant to Indian coastal tertiary care ENT services and identify multiple anatomical and demographic predictors amenable to systematic clinical evaluation and targeted intervention.

The 84.1% overall prevalence of at least one septal variant in the GMERS Porbandar headache cohort exceeds reports from general population imaging studies (typically 65-75% prevalence) but aligns closely with published series of headache patients undergoing systematic CT-PNS evaluation. Sollini et al.[11] reported similar high variant prevalence in Italian rhinogenic headache patients, while Krishniya et al.[14] documented comparable patterns in Indian patients with sinonasal disease. The slightly higher GMERS Porbandar figure may reflect systematic Cottle-grading-based assessment capturing mild deviations that might be classified as 'normal' in less rigorous evaluations, combined with the highly selected headache-specific referral population.

The dose-response relationship between septal deviation angle and HIT-6 score (Pearson r=0.62; β=0.86 per degree) represents one of the strongest quantitative anatomical-clinical correlations documented in the headache literature. Each additional degree of septal deviation corresponds to approximately 0.86 HIT-6 points — meaning a 15° increase in deviation associates with a 13-point HIT-6 elevation, exceeding the established minimum clinically important difference of 2.3 points by over 5-fold. The clinical implication is clear: severe septal deviation is not a coincidental imaging finding but a clinically meaningful contributor to headache impact warranting systematic recognition.

The identification of septal spur with middle turbinate mucosal contact as an independent multivariate predictor (adjusted OR 4.24) provides direct validation of the contact-point headache hypothesis. The pathophysiological mechanism — sustained mucosal contact generating trigeminal afferent signaling via the maxillary and ophthalmic divisions — has gained substantial mechanistic support from contemporary neuroanatomical and clinical studies.[4,13] The Shaikh et al.[13] findings on intermittent contact points generating headache symptoms align closely with the GMERS Porbandar OR of 4.24, supporting cross-population biological consistency of contact-point pathophysiology.

Multiple coexisting variants (≥2 anatomical types) conferred substantially elevated risk (adjusted OR 4.92), supporting the proposition that anatomical compromise is cumulative rather than threshold-based. This finding has direct implications for the GMERS Porbandar institutional approach: rather than focusing on single-variant evaluation (e.g., 'has septal deviation: yes/no'), comprehensive multi-variant assessment with systematic documentation of all coexisting anomalies is required. The recommendation supports the established Mladina classification for systematic septal-deformity description[12] and the parallel use of structured CT-PNS reporting templates documenting all variant categories.

Contemporary mucosal contact point research by Herzallah et al.[8] provides nuanced evidence regarding whether radiological findings predict headache causality. While their analysis found that anatomical variants are highly prevalent, the present GMERS Porbandar findings of large-magnitude HIT-6 differences across variant categories (44.6 no-variant vs 61.2 multiple variants) and the strong dose-response relationship between deviation angle and HIT-6 score (r=0.62) suggest that — within the specific subset of headache patients without sinusitis — anatomical variants carry meaningful clinical significance and warrant systematic radiological assessment. The clinical implication is that surgical correction in appropriately selected patients with anatomically demonstrable contact-point headache may yield clinically meaningful improvement, a hypothesis warranting prospective evaluation in the institutional cohort.

The independent contribution of female gender (adjusted OR 2.84) and family history of migraine (OR 2.62) reinforces that anatomical and non-anatomical factors interact in headache generation; anatomical variants are neither necessary nor sufficient, but contribute meaningfully to the multifactorial pathophysiology. The contemporary Indian-context literature including Chavan et al.[15] and Mundra et al.[16] supports the integrated approach combining endoscopic, radiological, and clinical evaluation. The clinical implication for GMERS Porbandar is that variant identification should inform — but not replace — comprehensive headache evaluation including migraine prophylaxis trial, lifestyle modification, and sleep hygiene optimization. Surgical intervention should be reserved for cases with clear anatomical variants, demonstrable contact points, and failure of optimized medical management.

Limitations include retrospective single-center design with potential selection bias (only patients undergoing CT-PNS included); 10-month observation window not capturing full annual variation including seasonal allergen patterns; absence of post-intervention follow-up data preventing assessment of surgical response in operated patients; reliance on HIT-6 single-timepoint assessment rather than diary-based prospective tracking; absence of detailed allergic profile, vitamin D status, and dietary triggers; and the predominantly Saurashtra coastal Gujarati patient population potentially limiting generalizability to inland north Indian or south Indian populations with different demographic, occupational, and environmental profiles.

7. CONCLUSION

Nasal septal variants are highly prevalent (84.1%) in adult patients presenting with recurrent headache without sinusitis at GMERS Medical College, Porbandar, with a clear dose-response relationship between variant severity, anatomical multiplicity, and headache impact. Severe septal deviation (>15° Cottle grading), multiple coexisting variants, septal spurs producing mucosal contact points with the middle turbinate, and bilateral concha bullosa emerged as the strongest independent predictors of frequent headache and elevated HIT-6 scores. The findings support the proposition that 'rhinogenic' or contact-point headache constitutes a clinically important but under-recognized entity in the Saurashtra coastal Gujarati ENT patient population, warranting systematic radiological evaluation rather than reflexive empirical analgesic management. Four institutional recommendations follow: (1) routine CT-PNS evaluation should be offered to patients with recurrent headache (≥4 episodes/6 months) without sinusitis who remain unresponsive to standard analgesic and migraine management strategies, particularly in the presence of mid-facial headache localization or female gender with positive family history; (2) all detected septal variants should undergo systematic Cottle classification (deviation angle) and Mladina classification (spur morphology) with explicit documentation of any mucosal contact points to enable evidence-based clinical decision-making; (3) ENT–neurology–radiology multidisciplinary discussion should be implemented for patients with severe deviation, multiple variants, or HIT-6 >55 to ensure comprehensive evaluation integrating anatomical, neurological, and lifestyle factors; (4) septoplasty or endoscopic correction may be considered in carefully selected patients with anatomically demonstrable contact-point headache resistant to optimized medical management for ≥6 months, with post-operative HIT-6 reassessment at 3 and 6 months to objectively document response. Implementation of these evidence-based protocols at GMERS Porbandar is expected to reduce diagnostic uncertainty, expedite targeted intervention for high-impact variants, and improve overall headache management outcomes for the regional patient population, with potential generalizability to comparable Indian tertiary care ENT services.

8. LIMITATIONS OF THE STUDY

1. Retrospective single-center cross-sectional design with potential for selection bias; only patients undergoing CT-PNS were included, potentially excluding those managed conservatively without imaging and biasing toward higher prior clinical suspicion for anatomical contribution.
2. Single-institution experience from a Saurashtra coastal Gujarati tertiary care center; findings may not generalize to inland north Indian, south Indian, or northeast Indian populations with different demographic, occupational, and environmental profiles influencing headache patterns.
3. Ten-month study window does not capture full annual variation including seasonal allergen-related and weather-related headache patterns; longer observation periods would better characterize temporal trends and seasonal modifiers.
4. Absence of post-intervention follow-up data prevents assessment of surgical response in operated patients; future prospective studies should incorporate pre-/post-septoplasty HIT-6 evaluation to establish causal inference for anatomically-driven headache.
5. Single-timepoint HIT-6 assessment rather than prospective diary-based headache tracking may underestimate true variability; diary-based prospective assessment would provide more granular and reliable headache impact estimation.
6. Lack of detailed allergic profile (skin prick testing, specific IgE), vitamin D status, dietary triggers, and stress assessment prevents evaluation of additional potential modifiers that may interact with anatomical variants in headache generation.
7. Inter-rater reliability between the two radiologists was not formally quantified using kappa statistics; though all discrepancies were resolved by consensus, formal reliability assessment would strengthen methodological rigor.

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