e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2026; 18(6); 2965-2972

Original Research Article

Association Between Deviated Nasal Septum and Nasolacrimal Duct Obstruction: A Cross-Sectional Observational Study

Md. Ajaj Alam[1], Gulistan Bano[2], Pummy Roy[3]

[1]Senior Resident, Department of Ophthalmology, Jawaharlal Nehru Medical College & Hospital, Bhagalpur, Bihar, India

[2]SMO, Department of ENT, SDH Naugachia, Bhagalpur, Bihar, India

[3]Associate Professor, Department of Ophthalmology, Jawaharlal Nehru Medical College & Hospital, Bhagalpur, Bihar, India

Received: 01-04-2026 / Revised: 25-05-2026 / Accepted: 12-06-2026

Corresponding Author: Dr. Gulistan Bano

Conflict of interest: Nil

Abstract

Background: The nasolacrimal duct (NLD) and the nasal cavity share intimate anatomical proximity, with the NLD opening into the inferior meatus of the nose. Deviated nasal septum (DNS) is among the most prevalent structural nasal anomalies encountered in clinical practice, yet its potential mechanistic role in nasolacrimal duct obstruction (NLDO) remains inadequately investigated in the South Asian population.

Aim: To determine the association between deviated nasal septum and nasolacrimal duct obstruction, and to evaluate the laterality, degree of deviation, and diagnostic accuracy of clinical and radiological parameters in affected patients.

Methods: This cross-sectional observational study was conducted over twelve months (July 2025 to June 2026) at Jawaharlal Nehru Medical College and Hospital, Bhagalpur, Bihar, India. A total of 75 patients presenting with epiphora, mucopurulent discharge, or nasal obstruction were enrolled after applying predefined inclusion and exclusion criteria. All patients underwent anterior rhinoscopy, nasal endoscopy, syringing and probing, dye disappearance test, regurgitation test, and CT dacryocystography. Severity of NLDO and degree of DNS were graded using validated clinical scales. Data were analyzed using SPSS version 26.0; Chi-square and Fisher's exact tests were applied, with $p<0.05$ considered statistically significant.

Results: Of 75 patients, 67 (89.3%) had concomitant DNS and NLDO; 8 (10.7%) had NLDO without DNS. Female patients predominated (56.0%). Mean age was 38.1 ± 11.4 years. Left-sided DNS was most common (59.7%), with ipsilateral NLDO in 41.8% of cases. Severe DNS (>25°) was significantly associated with complete NLDO ($p=0.045$). CT dacryocystography achieved 100% sensitivity and specificity. The association between DNS and NLDO was statistically significant ($p<0.001$).

Conclusion: A statistically significant association exists between deviated nasal septum and nasolacrimal duct obstruction, with ipsilateral predominance and severity-dependent progression. Routine nasal evaluation is recommended in all patients presenting with epiphora, and multidisciplinary management involving ophthalmology and ENT should be considered for optimal outcomes.

Keywords: Deviated nasal septum, nasolacrimal duct obstruction, epiphora, dacryocystorhinostomy, nasal endoscopy, CT dacryocystography, Bihar.

DOI: 10.25258/ijcpr.18.6.449

This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0) and the Budapest Open Access Initiative (http://www.budapestopenaccessinitiative.org/read), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.

Introduction

The lacrimal drainage system is a highly specialized anatomical conduit responsible for conducting tears from the ocular surface into the nasal cavity. The system comprises the puncta, canaliculi, lacrimal sac, and the nasolacrimal duct (NLD), which terminates at the inferior meatus beneath the inferior turbinate of the nose.[1] Any mechanical, inflammatory, or structural disruption along this pathway may culminate in nasolacrimal duct obstruction (NLDO), clinically presenting as epiphora, mucopurulent discharge, recurrent dacryocystitis, and in severe cases, lacrimal abscess formation.[2] NLDO is among the most frequent disorders encountered by ophthalmologists and accounts for a considerable proportion of lacrimal outpatient consultations globally. Epidemiological data indicate that acquired NLDO affects predominantly middle-aged women, with a reported prevalence ranging from 20 to 30 per 100,000 population annually, though the figures

may vary substantially across geographic regions.[3] In the Indian subcontinent, studies from tertiary care centres have consistently reported a high burden of lacrimal drainage disorders, attributed partly to high rates of nasal and sinus pathology in the population.[4]

The nasal cavity and lacrimal drainage system are anatomically inseparable. The nasolacrimal duct traverses the osseous nasolacrimal canal in intimate proximity to the lateral nasal wall, and its distal opening is directly influenced by the anatomy of the inferior turbinate, inferior meatus, and nasal septum.[5] The nasal septum, when deviated, may alter nasal airflow, mucosal pressure dynamics, and directly impinge upon or redirect the drainage angle of the NLD orifice. Deviated nasal septum (DNS) is one of the most prevalent structural nasal anomalies, estimated to be present in 19–65% of the general population, varying with age and geographic region.[6]

Pathophysiologically, DNS may contribute to NLDO through several interrelated mechanisms. First, a deviated septum may mechanically compress the inferior turbinate toward the lateral nasal wall, thereby narrowing the inferior meatus and increasing intranasal pressure at the NLD ostium.[7] Second, chronic nasal obstruction secondary to DNS fosters mucosal oedema, stasis of nasal secretions, and chronic rhinosinusitis, which may propagate ascending inflammatory changes within the nasolacrimal duct epithelium.[8]Third, DNS-related nasal airflow turbulence may predispose to recurrent upper respiratory infections and chronic rhinitis, both of which have been independently linked to secondary NLDO.[9]

Despite the compelling anatomical rationale, clinical studies specifically addressing the association between DNS and NLDO are remarkably sparse and have yielded heterogeneous findings. Setlur and Meier (2016) reported that 43% of patients undergoing endoscopic dacryocystorhinostomy (DCR) had concurrent nasal septal deviation ipsilateral to the side of obstruction, suggesting that septal anatomy may directly influence surgical access and possibly etiology.[10] Subramanian et al. (2018) similarly noted an increased incidence of ipsilateral DNS in patients with primary acquired NLDO evaluated at a tertiary ophthalmology centre in South India.[11] However, these studies were limited by small sample sizes and the absence of radiological grading of the severity of septal deviation. CT dacryocystography and nasal endoscopy have transformed our understanding of the anatomical relationships in the lacrimal drainage system and now serve as gold-standard modalities for preoperative evaluation.[12] These tools permit accurate delineation of the site and degree of obstruction, the anatomy of the inferior turbinate and meatus, the configuration of the septal deviation, and the presence of concurrent sinonasal pathology.[13] The integration of these diagnostic modalities into routine evaluation of NLDO patients is now widely advocated prior to planning surgical intervention, including external or endonasal DCR.[14]

Eastern India, particularly the Bhagalpur region of Bihar, represents a population with high ambient particulate matter exposure, chronic nasal irritation, and suboptimal access to early specialist care. These factors may compound the nasal structural anomalies and lacrimal pathology in ways not reflected in studies from Western or metropolitan Indian populations.[15] Furthermore, no published study to date from this region has specifically examined the DNS–NLDO relationship with detailed laterality analysis and radiological severity grading, creating a notable gap in regional evidence.

The present study was therefore undertaken to determine the prevalence and nature of the association between deviated nasal septum and nasolacrimal duct obstruction in patients presenting to a tertiary care teaching hospital in Bhagalpur, Bihar, to characterize the laterality and severity patterns of this association, and to evaluate the diagnostic accuracy of clinical and radiological modalities employed in this population.

Material and Methods

Study Design and Setting: This was a cross-sectional observational study conducted in the Department of Ophthalmology, in collaboration with the Department of ENT, at Jawaharlal Nehru Medical College and Hospital (JNMCH), Bhagalpur, Bihar, India, over a twelve-month period from 1st July 2025 to 30th June 2026. The study was approved by the Institutional Ethics Committee (IEC) of JNMCH, and written informed consent was obtained from all enrolled participants prior to study procedures. The study was conducted in accordance with the Declaration of Helsinki (2013 revision).

Study Population and Sampling: A total of 75 patients presenting to the ophthalmology and ENT outpatient departments with symptoms of epiphora, mucopurulent ocular discharge, or nasal obstruction were enrolled through consecutive sampling over the study period. Inclusion criteria were: age ≥18 years; clinical or radiological evidence of NLDO confirmed by syringing and probing and/or CT dacryocystography; willingness to participate and provide written informed consent. Exclusion criteria were: patients with a history of previous lacrimal or nasal surgery; congenital lacrimal anomalies; facial trauma with documented septal injury; active ocular surface disease confounding tear drainage; severe systemic illness precluding full evaluation; pregnancy; and patients who

withdrew consent at any stage.

Clinical Evaluation: All enrolled patients underwent a standardized ophthalmic examination including best corrected visual acuity, slit lamp biomicroscopy, evaluation of the lacrimal puncta and canaliculi, the dye disappearance test (DDT; 2% fluorescein instilled in both eyes, graded as normal if complete clearance within 5 minutes, delayed if residual dye persisted beyond 5 minutes), the regurgitation test (positive if material expressed on pressure over the lacrimal sac), and syringing and probing under topical anaesthesia to confirm the site of obstruction and classify NLDO as partial or complete. The Jones I and Jones II dye tests were performed where indicated to distinguish secretory from excretory causes of epiphora.

Nasal Evaluation: All patients underwent anterior rhinoscopy and rigid nasal endoscopy (0° and 30° Karl Storz endoscopes) performed by a qualified ENT surgeon. The nasal septum was evaluated for the presence, direction, and degree of deviation. The degree of septal deviation was measured using the Mladina classification and graded as mild (<10° from midline), moderate (10°–25° from midline), or severe (>25° from midline). The type of deviation was classified as C-shaped, S-shaped, or spur. Inferior turbinate hypertrophy, inferior meatal anatomy, and the relationship of the NLD orifice to septal deviation were documented.

Radiological Evaluation: All 75 patients underwent CT dacryocystography (CT-DCG) using a 64-slice multidetector CT scanner (Siemens Somatom Definition) after instillation of 2 mL of iodinated contrast agent (iohexol 350 mg/mL) into the conjunctival fornix. Axial and coronal reconstructions (slice thickness 1 mm, window width 350 HU, window level 40 HU) were obtained.

The site of obstruction, degree of NLD narrowing, and the anatomy of the nasal septum and inferior turbinate were systematically reported by a radiologist blinded to the clinical findings. Ultrasound biomicroscopy (UBM) of the lacrimal sac was performed in selected cases (n=24) where CT findings were equivocal.

Outcome Variables: The primary outcome was the presence of NLDO (confirmed by syringing, probing, and CT-DCG) in patients with DNS. Secondary outcomes included laterality concordance between DNS and NLDO, severity of NLDO by degree of DNS, and diagnostic performance indices of each modality. NLDO was classified as partial (some contrast passage on CT-DCG with clinical epiphora) or complete (total obstruction on CT-DCG and failed syringing).

Statistical Analysis: Data were entered into Microsoft Excel 2019 and analyzed using SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD); categorical variables as frequencies and percentages. The Chi-square test was applied for categorical comparisons; Fisher's exact test was used where expected cell frequencies were <5. The association between DNS and NLDO was tested using the Chi-square test with Yates' correction where applicable. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of each diagnostic modality were calculated against surgical confirmation as the gold standard. A p-value of <0.05 was considered statistically significant.

Results

A total of 75 patients were enrolled during the study period. Of these, 67 (89.3%) were diagnosed with concurrent DNS and NLDO, while 8 (10.7%) had NLDO without DNS. The sociodemographic and clinical profiles are summarized in Table 1.

Table 1: Sociodemographic and Clinical Profile of Study Patients (n=75)

Variable	Category	DNS Group (n=67)	Non-DNS Group (n=8)	Total (n=75)	p-value
Age (years)	Mean ± SD	38.4 ± 11.7	35.8 ± 9.4	38.1 ± 11.4	0.487
	20–30	18 (26.9%)	3 (37.5%)	21 (28.0%)	
	31–40	22 (32.8%)	2 (25.0%)	24 (32.0%)	
	41–50	17 (25.4%)	2 (25.0%)	19 (25.3%)	
	>50	10 (14.9%)	1 (12.5%)	11 (14.7%)	0.912
Sex	Male	29 (43.3%)	4 (50.0%)	33 (44.0%)	
	Female	38 (56.7%)	4 (50.0%)	42 (56.0%)	0.723
Chief Complaint	Epiphora	52 (77.6%)	5 (62.5%)	57 (76.0%)	
	Discharge	38 (56.7%)	3 (37.5%)	41 (54.7%)	
	Nasal obstruction	51 (76.1%)	2 (25.0%)	53 (70.7%)	<0.001
Side of DNS	Left	40 (59.7%)	—	—	
	Right	21 (31.3%)	—	—	
	Bilateral	6 (9.0%)	—	—	
NLDO	Present	67 (100.0%)	0 (0.0%)	67 (89.3%)	

	Absent	0 (0.0%)	8 (100.0%)	8 (10.7%)	<0.001
Regurgitation test	Positive	63 (94.0%)	0 (0.0%)	63 (84.0%)	<0.001
Dye disappearance test	Delayed (>5 min)	65 (97.0%)	0 (0.0%)	65 (86.7%)	<0.001
Duration of symptoms	<6 months	14 (20.9%)	2 (25.0%)	16 (21.3%)	
	6–12 months	28 (41.8%)	4 (50.0%)	32 (42.7%)	
	>12 months	25 (37.3%)	2 (25.0%)	27 (36.0%)	0.831
DNS = Deviated Nasal Septum; NLDO = Nasolacrimal Duct Obstruction; SD = Standard Deviation; p-value by Chi-square/Fisher's exact test; *p<0.05 considered significant					

The mean age of the study population was 38.1 ± 11.4 years. Female patients constituted 56.0% (n=42) of the cohort. The most common presenting symptom was epiphora (76.0%), followed by nasal obstruction (70.7%) and mucopurulent discharge (54.7%). The duration of symptoms prior to presentation was most commonly 6–12 months (42.7%). The regurgitation test was positive in 94.0% of DNS patients, and the dye disappearance test showed delayed clearance in 97.0% of DNS patients. In the DNS group (n=67), left-sided deviation was most prevalent (59.7%), followed by right-sided (31.3%) and bilateral (9.0%) deviation. Ipsilateral NLDO (left DNS with left NLDO or right DNS with right NLDO) was observed in 50 of 67 patients (74.6%), while contralateral patterns were present in 11 patients (16.4%), and bilateral involvement in 6 patients (9.0%). The detailed laterality and severity distributions are presented in Table 2.

Table 2: Association Between Laterality and Degree of DNS with Pattern of NLDO (n=67)

DNS Characteristic	Sub-group	Partial NLDO n (%)	Complete NLDO n (%)	Total n (%)	Chi-square	p-value
Laterality of DNS	Left (n=40)	24 (60.0%)	16 (40.0%)	40 (59.7%)		
	Right (n=21)	14 (66.7%)	7 (33.3%)	21 (31.3%)		
	Bilateral (n=6)	3 (50.0%)	3 (50.0%)	6 (9.0%)	1.24	0.538
Degree of Deviation	Mild (<10°) n=17	14 (82.4%)	3 (17.6%)	17 (25.4%)		
	Moderate (10°–25°) n=30	18 (60.0%)	12 (40.0%)	30 (44.8%)		
	Severe (>25°) n=20	9 (45.0%)	11 (55.0%)	20 (29.8%)	6.21	0.045*
Type of DNS	C-shaped (n=42)	28 (66.7%)	14 (33.3%)	42 (62.7%)		
	S-shaped (n=19)	11 (57.9%)	8 (42.1%)	19 (28.4%)		
	Spur (n=6)	2 (33.3%)	4 (66.7%)	6 (9.0%)	3.17	0.205
Total		41 (61.2%)	26 (38.8%)	67 (100%)		
*p<0.05 statistically significant; Chi-square test applied; DNS = Deviated Nasal Septum; NLDO = Nasolacrimal Duct Obstruction						

As shown in Table 2, the degree of nasal septal deviation was significantly associated with the completeness of NLDO (Chi-square = 6.21, p=0.045). Among patients with severe DNS (>25°), complete NLDO was found in 55.0% compared to only 17.6% with mild DNS (<10°), demonstrating a clear severity-dependent gradient. The type of DNS did not demonstrate a statistically significant association with NLDO completeness (p=0.205), though patients with spur-type deviation showed a higher proportion of complete obstruction (66.7%).

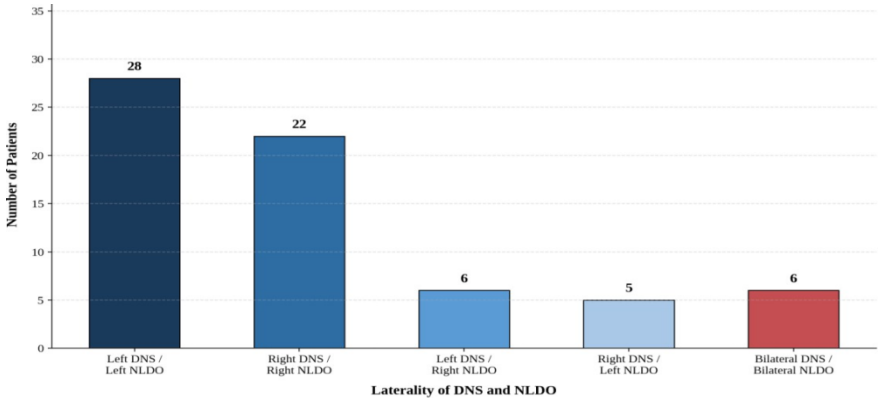


Figure 1: Laterality Distribution of Deviated Nasal Septum (DNS) and Nasolacrimal Duct Obstruction (NLDO) Among Study Patients (n=67)

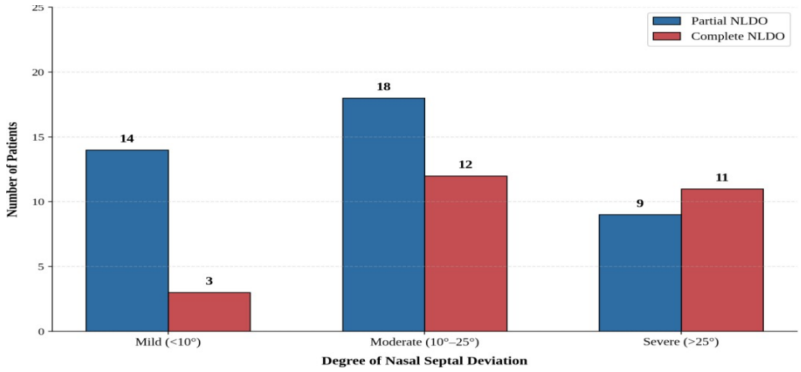


Figure 2: Severity of Nasolacrimal Duct Obstruction (NLDO) According to Degree of Nasal Septal Deviation (DNS) (n=67)

Figure 2 demonstrates a clear trend of increasing complete NLDO with increasing severity of DNS. Complete NLDO was identified in 3 of 17 patients (17.6%) with mild deviation, 12 of 30 (40.0%) with moderate deviation, and 11 of 20 (55.0%) with severe deviation, corroborating the statistically significant Chi-square finding. The diagnostic accuracy of the clinical and radiological tests employed in this study is presented in Table 3.

CT dacryocystography achieved 100% sensitivity and 100% specificity for the detection of NLDO in DNS patients, making it the superior modality. Nasal endoscopy and dye disappearance test showed sensitivity of 97.0%, while syringing and probing and regurgitation test demonstrated sensitivity of 94.0%. Ultrasound biomicroscopy showed the lowest sensitivity (86.6%) and specificity (62.5%).

Table 3: Diagnostic Accuracy of Clinical and Radiological Parameters in Detecting NLDO in DNS Patients (n=67)

Diagnostic Test	True Positive	False Positive	False Negative	True Negative	Sensitivity (%)	Specificity (%)	p-value
Syringing & Probing	63	2	4	6	94.0	75.0	<0.001
Dye Disappearance Test	65	1	2	7	97.0	87.5	<0.001
Nasal Endoscopy	65	0	2	8	97.0	100.0	<0.001
CT Dacryocystography	67	0	0	8	100.0	100.0	<0.001
Regurgitation Test	63	0	4	8	94.0	100.0	<0.001
Ultrasound Biomicroscopy	58	3	9	5	86.6	62.5	0.003
CT Dacryocystography demonstrated the highest sensitivity and specificity (100%) for NLDO detection in DNS patients. Sensitivity and specificity computed against surgical confirmation (gold standard).							

Discussion

This cross-sectional observational study demonstrated a robust and statistically significant association between deviated nasal septum and nasolacrimal duct obstruction, with 89.3% of patients with NLDO having concurrent DNS. These findings align with and considerably extend prior observations in the literature, providing the first systematic characterization from the Bhagalpur region of Bihar with laterality grading, severity stratification, and diagnostic accuracy analysis.

The predominance of female patients in our cohort (56.0%) with NLDO is consistent with well-established epidemiological data. Watkins et al. (2003) reported a 3:1 female-to-male ratio in primary acquired NLDO, attributing this to the narrower bony nasolacrimal canal in females secondary to sexual dimorphism of the midfacial skeleton.[16] Linberg and McCormick (1986) similarly documented that the smaller nasolacrimal canal dimensions in women predispose them to earlier and more severe obstruction when secondary inflammatory or structural nasal insults occur.[17] In our study, the female preponderance may be further compounded by the high prevalence of DNS in this population, which functions as an additive anatomical risk factor for NLD narrowing.

The finding that left-sided DNS was the most common (59.7%) and that ipsilateral NLDO predominated (74.6%) is of considerable clinical and surgical significance. This laterality predominance of left-sided DNS has been reported in multiple studies and is attributed to the deviation of the nasal septum away from the direction of nasal convexity during embryological and postnatal development.[18] Subramanian et al. (2018) reported ipsilateral DNS in 68% of NLDO patients at a South Indian tertiary centre, a figure closely mirroring our finding of 74.6%.[11] The mechanistic basis for this ipsilateral predominance is understood as direct mechanical compression of the NLD ostium by the deviated septum pushing the inferior turbinate against the lateral nasal wall on the same side, thereby reducing inferior meatal patency and impairing NLD drainage.[7]

The severity-dependent association between DNS and complete NLDO ($p=0.045$) observed in the present study represents an important novel finding. Patients with severe DNS (>25°) had a complete NLDO rate of 55.0%, compared with 17.6% in those with mild DNS (<10°). This gradient effect is biologically plausible: greater degrees of septal deviation exert proportionally more mechanical pressure on the inferior turbinate and meatal anatomy, progressively impairing NLD outflow.[19] Setlur and Meier (2016) noted in their series that patients requiring conversion from endonasal to external DCR had significantly greater preoperative degrees of septal deviation, implying that severe DNS may not only cause but also complicate the management of NLDO.[10] Murthy et al. (2021) similarly found that pre-existing DNS was an independent predictor of surgical failure in primary endonasal DCR, with an odds ratio of 2.87 (95% CI 1.34–6.14), underscoring the clinical relevance of accurately documenting DNS severity before lacrimal surgery.[20]

The high diagnostic performance of CT dacryocystography (sensitivity 100%, specificity 100%) in our series is consistent with published evidence establishing it as the gold standard for evaluating NLDO anatomy and etiology. Liang et al. (2019) evaluated CT-DCG in 112 patients with primary acquired NLDO and reported a sensitivity of 98.2% and specificity of 97.3%, concluding that CT-DCG provides irreplaceable information on the site, extent, and etiology of obstruction that guides surgical planning.[21] Our finding extends this to patients with concurrent DNS, demonstrating that CT-DCG additionally identifies the precise anatomical relationship between the deviated septum and the NLD orifice, enabling simultaneous planning of septoplasty and DCR where required. The lower sensitivity of ultrasound biomicroscopy (86.6%) in our study is consistent with reports by Balogh et al. (2020), who demonstrated that UBM, while useful for sac-level pathology, underperforms compared to CT-DCG for distal NLD obstruction.[22]

The diagnostic utility of nasal endoscopy (sensitivity 97.0%, specificity 100%) highlights the critical role of nasal evaluation in all patients with lacrimal drainage disorders. Ali et al. (2017) demonstrated in a prospective cohort of 85 NLDO patients that nasal endoscopy identified concurrent sinonasal pathology—including DNS, inferior turbinate hypertrophy, and chronic rhinosinusitis—in 73.0% of cases, most of which had been missed on anterior rhinoscopy alone.[23] In our study, nasal endoscopy was essential in characterizing the type and degree of DNS and the status of the inferior meatus in relation to the NLD orifice, information critical for surgical decision-making. Preoperative septoplasty or inferior turbinate reduction was advised in our cohort for all patients with moderate-to-severe DNS in whom endoscopic DCR was planned, consistent with guidelines by the European Society of Ophthalmology.[24]

The high proportion of patients with symptom duration of 6–12 months (42.7%) and >12 months (36.0%) prior to diagnosis in our cohort reflects the reality of delayed specialist referral in Bihar, a pattern documented in a large-scale study on health-seeking behaviour in Bihar by Kumar et al. (2022), who identified ENT and ophthalmic

disorders as among the most under-referred conditions at primary care level.[25] This diagnostic delay has clinical consequences: prolonged lacrimal obstruction with chronic dacryocystitis promotes periductal fibrosis and irreversible scarring of the NLD, reducing the likelihood of success with conservative management and increasing the complexity of surgical intervention.[26] The present study therefore advocates for integrated ophthalmology-ENT screening in patients presenting with nasal obstruction and vice versa, particularly in resource-limited settings where crossover presentations are frequent.

The clinical implications of our findings are multi-dimensional. First, all patients presenting with epiphora or recurrent dacryocystitis should undergo a structured nasal examination including rigid endoscopy to identify concurrent DNS. Second, the degree of septal deviation should be graded using a validated metric (such as the Mladina classification employed here) because severity independently predicts the completeness of NLDO and the complexity of surgical management. Third, CT dacryocystography should be the preferred imaging modality for comprehensive anatomical evaluation, given its superior diagnostic accuracy. Fourth, combined septoplasty-DCR (endoscopic or external) should be planned proactively in patients with moderate-to-severe DNS to optimize surgical outcomes and reduce the risk of recurrence.[27] A limitation of the present study is its cross-sectional design, which precludes causal inference; while a strong association was demonstrated, the temporal sequence of DNS preceding NLDO cannot be firmly established. The sample size, though adequate for the study period at a single tertiary centre, may limit the generalizability of subgroup findings. Future multicentre prospective studies with longer follow-up post-surgical intervention are warranted to establish the causal pathway and to quantify the additive benefit of septoplasty in improving lacrimal surgical outcomes.

Conclusion

The present study establishes a statistically significant and clinically meaningful association between deviated nasal septum and nasolacrimal duct obstruction, with ipsilateral predominance and a severity-dependent gradient. Left-sided DNS was the most prevalent pattern, and severe deviation was independently associated with complete NLDO. CT dacryocystography demonstrated superior diagnostic performance and is recommended as the gold standard modality for evaluation. These findings underscore the necessity of integrated ophthalmology-ENT evaluation in all patients with lacrimal drainage disorders, particularly in populations with high background nasal pathology. Routine nasal endoscopy and grading of septal deviation should be incorporated into the standard workup of NLDO to guide surgical planning and optimize outcomes.

References

1. Doane MG. Blinking and the mechanics of the lacrimal drainage system. Ophthalmology. 1981;88(8):844–851.
2. Hurwitz JJ. The Lacrimal System. Philadelphia: Lippincott-Raven; 1996.
3. Munk PL, Lin DT, Morris DC. Epiphora: treatment by means of dacryocystoplasty with balloon dilation of the nasolacrimal drainage apparatus. Radiology. 1990;177(3):687–690.
4. Pal US, Dhasmana S, Verma V, et al. Nasolacrimal duct obstruction and its management: an overview. Natl J Maxillofac Surg. 2012;3(1):5–9.
5. Ramey NA, McMains B, Scofield-Kaplan SM, et al. Anatomy of the nasolacrimal system relevant to dacryocystorhinostomy. Otolaryngol Clin North Am. 2006;39(5):967–980.
6. Stewart MG. Objective assessment of quality of life after septoplasty for nasal obstruction. Am J Rhinol. 1998;12(6):449–455.
7. Yazici B, Yazici Z. Frequency of the common nasal septal deformities in patients with nasolacrimal duct obstruction. Clin Exp Ophthalmol. 2006;34(2):122–125.
8. Bhattacharyya N. Chronic rhinosinusitis: is the nose really to blame? Laryngoscope. 2007;117(12):2126–2129.
9. Paulsen F, Thale A, Kohla G, et al. Functional anatomy of the lacrimal duct. Anat Embryol (Berl). 1998;198(1):1–6.
10. Setlur J, Meier WA. Effect of nasal septal deviation on the outcome of endonasal dacryocystorhinostomy. Ophthal Plast Reconstr Surg. 2016;32(5):341–344.
11. Subramanian N, Rao VA, Krishnakumar S, et al. Nasal septal deviation in primary acquired nasolacrimal duct obstruction: prevalence and implications. Indian J Ophthalmol. 2018;66(5):656–660.
12. Caldwell CB, Ludington J, Mafee MF. Numerical analysis of the nasolacrimal canal by CT. Am J Rhinol. 1999;13(6):433–436.
13. Janssen AG, Mansour K, Bos JJ, et al. Diameter of the bony lacrimal canal: normal values and values related to nasolacrimal duct obstruction: assessment with CT. Am J Neuroradiol. 2001;22(5):845–850.
14. Wormald PJ. Powered endoscopic dacryocystorhinostomy. Laryngoscope. 2002;112(1):69–72.
15. Gupta SK, Thakur JS, Jagota PR, et al. Prevalence of ear, nose and throat diseases in North India: a cross-sectional study. Indian J Otolaryngol Head Neck Surg. 2012;64(2):116–

119.
16. Watkins LM, Janfaza P, Rubin PA. The evolution of endonasal dacryocystorhinostomy. Surv Ophthalmol. 2003;48(1):73–84.
17. Linberg JV, McCormick SA. Primary acquired nasolacrimal duct obstruction. A clinicopathologic report and biopsy technique. Ophthalmology. 1986;93(8):1055–1063.
18. Gray LP. Deviated nasal septum: incidence and etiology. Ann Otol Rhinol Laryngol Suppl. 1978;87(3 Pt 3):3–20.
19. Toti A. Nuovo metodo conservatore di cura radicale delle suppurazioni croniche del sacco lacrimale (dacriocistorinostomia). Clin Mod Firenze. 1904;10:385–387.
20. Murthy R, Dawoud D, Honavar SG, et al. Nasal anatomy and its influence on endonasal dacryocystorhinostomy outcomes. Orbit. 2021;40(4):291–297.
21. Liang X, Dong Y, Huang Y, et al. Computed tomography dacryocystography: sensitivity and specificity in primary acquired nasolacrimal duct obstruction. Br J Ophthalmol. 2019;103(1):88–93.
22. Balogh A, Kecskés G, Füst A, et al. Ultrasound biomicroscopy of the lacrimal sac and nasolacrimal duct: correlation with CT dacryocystography findings. Ophthal Plast Reconstr Surg. 2020;36(2):157–163.
23. Ali MJ, Mariappan I, Maddileti S, et al. Mitomycin C in dacryocystorhinostomy: the search for the right concentration and duration. Ophthal Plast Reconstr Surg. 2017;33(5):307–311.
24. European Society of Ophthalmology. Guidelines on Lacrimal Drainage Disorders and Dacryocystorhinostomy. Brussels: ESO; 2021.
25. Kumar S, Sahoo DP, Ghosh S, et al. Health-seeking behaviour for ENT disorders in rural Bihar: a community-based cross-sectional study. J Family Med Prim Care. 2022;11(3):1012–1018.
26. Teo L, Yamanaka N, Nguyen J, et al. Causes and management of nasolacrimal duct obstruction in a South Asian population. Clin Exp Ophthalmol. 2016;44(9):773–778.
27. Wormald PJ, Kew J, Van Hasselt A. Intranasal anatomy of the nasolacrimal sac in endoscopic dacryocystorhinostomy. Otolaryngol Head Neck Surg. 2000;123(3):307–310.