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Diagnosis, Therapeutic Strategies, and Natural Course of Congenital Nasolacrimal Duct Obstruction ; A Clinical Cohort Study

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Abstract

Background: Congenital nasolacrimal duct obstruction (CNLDO) is a common pediatric condition. While most cases resolve spontaneously, the optimal timing and sequence of surgical escalation remain a point of clinical discussion. ***Objective***: To evaluate the efficacy of a staged management protocol—beginning with conservative Crigler massage and escalating to a stepped surgical approach—for the treatment of CNLDO. ***Methods***: A prospective interventional cohort study of 102 eyes was conducted. Patients initially underwent conservative management with standardized lacrimal sac massage. Persistent cases beyond 12 months progressed through a staged surgical protocol: (1) simple probing, (2) repeat probing with inferior turbinate fracture (ITF), and (3) dacryocystorhinostomy (DCR). Success was measured by clinical resolution of epiphora and a negative fluorescein dye disappearance test (FDDT). ***Results***: Conservative management achieved an 87.5% cumulative resolution rate by 12 months. Of the remaining 12 eyes requiring surgery, Stage 1 (simple probing) had a 75% success rate. Stage 2 (Probing + ITF) resolved 66.7% of subsequent failures, and Stage 3 (DCR) provided a 100% salvage rate. Intraoperative tactile "feel" was highly prognostic, with a 100% success rate for membranous obstructions versus 0% for firm/bony resistance ($p < 0.05$). Complication rates were low, with post-operative epistaxis (20% of surgical cases) being the most common minor adverse event. ***Conclusion***: A conservative-first approach is highly effective for the majority of infants. For persistent cases, a staged surgical protocol guided by intraoperative tactile feedback ensures high success rates (98.75% overall) while minimizing unnecessary invasive procedures.

Keywords: CNLDO (Congenital Nasolacrimal Duct Obstruction); Crigler Massage; Nasolacrimal Probing; Inferior Turbinate Fracture; Dacryocystorhinostomy (DCR).

INTRODUCTION

Congenital nasolacrimal duct obstruction (CNLDO) represents one of the most prevalent disorders in pediatric ophthalmology, characterized by impaired tear drainage due to blockage in the nasolacrimal system, leading to epiphora and discharge in newborns.[1] This condition arises from incomplete canalization of the nasolacrimal duct (NLD) during embryogenesis, typically at the valve of Hasner, with prevalence estimates ranging from 5-20% in infants under one year, affecting up to 95% symptomatically within the first month of life.[1,2]

Diagnosis primarily relies on clinical evaluation, including history of persistent tearing, mucopurulent discharge, and regurgitation upon lacrimal sac pressure, which indicates distal obstruction.[1] The fluorescein dye disappearance test (FDDT) confirms the obstruction with high sensitivity (90%) and specificity (100%), where dye persists in the tear meniscus after 5 minutes, distinguishing CNLDO from differentials like congenital glaucoma or infections.(1,2) Additional assessments, such as slit-lamp examination for eyelid margins and fundus reflex, rule out amblyopia risks, elevated in 10-12% of cases, while imaging like CT is reserved for complex bony variants or craniofacial anomalies.[1,3]

The natural course is largely benign and self-limiting, with spontaneous resolution in 90-96% by 12 months due to NLD maturation, tear flow, and blinking mechanics, dropping to 44-76% between 12-24 months.[1,2] Premature infants and those with syndromes (e.g., Down, 30% incidence) face higher risks, but bilateral cases often resolve concurrently.(2) Untreated persistence risks complications like recurrent dacryocystitis, cellulitis, or amblyopia from chronic epiphora disrupting emmetropization.[1]

Therapeutic strategies follow a graded, stepwise approach prioritizing conservative management. Initial observation with parental education on hygiene yields high success in early infancy.(1,2) Lacrimal sac massage (Crigler maneuver)—downward pressure 2-4 times daily—increases resolution to over 85-96% when combined, outperforming observation

alone without antibiotics unless infection evident. Topical antibiotics control superinfection but lack efficacy for obstruction resolution, risking resistance.[1]

For persistent symptoms beyond 6-12 months, invasive options escalate: office probing under topical anesthesia (75-95% success <16 months) ruptures membranous barriers, transitioning to general anesthesia probing/intubation for older children.[1,3] Repeat probing (56%), silicone intubation (85-96%, monocanalicular preferred), or balloon dilation (77-90%) address failures, with endoscopy aiding complex cases.[1,2] Dacryocystorhinostomy (82-96%), external or endoscopic, serves refractory bony obstructions as ultima ratio[2]

Optimal timing balances spontaneous resolution against symptom burden; early probing (<12 months) avoids fibrosis risks but conservative first-line prevails given 95% cure rates minimally invasively.[1,3] Long-term follow-up ensures visual development, as CNLDO links to refractive errors.

MATERIALS AND METHODS

Study Design and Patient Selection

A prospective, interventional cohort study was conducted at a tertiary referral center to evaluate a staged management protocol for congenital nasolacrimal duct obstruction (CNLDO). Consecutive pediatric patients presenting to the ophthalmology department with epiphora and mucopurulent discharge onset within the first month of life were enrolled.
Inclusion required symptom onset within the first few weeks of life and systematic follow-up through the stepped protocol. Patients were excluded for facial or orbital trauma, prior lacrimal surgery, punctal or canalicular agenesis, congenital glaucoma, active corneal pathology, or craniofacial syndromic anomalies (e.g., Down syndrome, Treacher Collins syndrome, cleft palate), ensuring a homogenous cohort of classic CNLDO.

Clinical Evaluation and Diagnostic Metrics

All patients underwent comprehensive ophthalmologic and adnexal examination at presentation. Epiphora severity, tear meniscus height (assessed by slit-lamp or handheld loupe), mucopurulent discharge, eyelash crusting, and medial canthal erythema or swelling were recorded.
Diagnosis was confirmed using two objective tests. The fluorescein dye disappearance test (FDDT) involved instilling one drop of 1% sodium fluorescein into the inferior conjunctival fornix bilaterally; dye clearance was graded after five minutes under cobalt blue light, with persistent pooling or asymmetric overflow indicating delayed lacrimal transit. The regurgitation on pressure over the lacrimal sac (ROPLAS) test applied gentle digital pressure over the lacrimal sac fossa in a superomedial direction; retrograde reflux of clear, mucoid, or purulent material through the puncta confirmed a distal anatomical block with a patent proximal canalicular system.

Conservative Management Protocol

All patients, regardless of age at presentation, were initially enrolled in conservative management. Caregivers were instructed in Crigler lacrimal sac massage: the index finger was placed over the common canaliculus to occlude proximal outflow, followed by a firm downward stroke along the lacrimal sac and nasolacrimal duct to generate hydrostatic pressure sufficient to rupture the membranous occlusion at Hasner's valve. Ten strokes were performed three to four times daily. Topical broad-spectrum antibiotics (tobramycin drops or erythromycin ointment) were prescribed adjunctively when significant discharge or conjunctival injection was present. Patients were reviewed at regular intervals throughout the first year. Resolution was defined as complete cessation of epiphora and discharge with a normal FDDT.

Stepped Surgical Intervention Protocol

Persistent symptoms beyond 12 months of age, or documented failure of conservative therapy despite caregiver compliance, prompted initiation of a stepped surgical protocol. All procedures were performed under general inhalation anesthesia.
Stage 1 — Primary Simple Probing: Following punctal dilation with a Nettleship dilator, a Bowman probe (size 00 or 0) was introduced vertically into the lower punctum, rotated 90° horizontally, and advanced through the canaliculus with lateral eyelid traction. A hard bony stop confirmed entry into the lacrimal sac; the probe was then redirected inferiorly, posteriorly, and laterally along the nasolacrimal duct axis. Intraoperative tactile resistance was categorized as:

- Membranous — smooth passage with a distal "pop," indicating a thin Hasner's valve membrane
- Complex/Stenotic — continuous gritty resistance without a pop, suggesting ductal narrowing or fibrosis
- Firm/Bony — unyielding stop, indicating osseous abnormality

Successful passage was confirmed by metal-to-metal contact with a secondary probe beneath the inferior turbinate and by free flow of fluorescein-tinted saline into the oropharynx via suction catheter.
Stage 2 — Repeat Probing with Inferior Turbinate Infracture: Patients with recurrence or persistence of symptoms 4–6 weeks post-Stage 1 underwent repeat probing combined with inferior turbinate infracture. A periosteal or Freer elevator

was used to medially displace the inferior turbinate, expanding the meatal space and relieving mechanical impingement on the nasolacrimal duct ostium.

Stage 3 — Dacryocystorhinostomy (DCR): Patients refractory to Stages 1 and 2 underwent DCR. A surgical osteotomy through the frontal process of the maxilla and lacrimal bone created a direct, permanent anastomosis between the lacrimal sac mucosa and the nasal mucosa of the middle meatus, bypassing the compromised duct entirely.

Safety and Complication Monitoring

All patients were monitored throughout the conservative and postoperative periods. Complications—including acute dacryocystitis, preseptal cellulitis, false passages or punctal/canalicular trauma, post-operative epistaxis requiring packing, and granuloma formation—were systematically documented and categorized by treatment stage.

RESULTS

At initial presentation, 102 eyes were evaluated. Epiphora remained the universal clinical sign, while diagnostic tests were used to confirm the site and nature of the obstruction.

Table 1. Clinical Presentation & Baseline Characteristics

Diagnostic Metric	Number of Eyes (n=102)	Percentage (%)
Epiphora (Primary Symptom)	102	100%
Increased Tear Lake Height	94	92.2%
Mucopurulent Discharge	78	76.5%
Positive FDDT	98	96.1%
Positive ROPLAS	62	60.8%
Bilateral Involvement	22 (patients)	27.5%

The cohort was initially managed with conservative therapy (Crigler lacrimal sac massage). The following table tracks the success of non-surgical resolution within the first year of life.

Table 2. Natural History & Conservative Management

Age Interval	Cumulative Resolution (n=80)	Success Rate (%)
0–6 Months	48	60.0%
6–9 Months	14	17.5%
9–12 Months	8	10.0%
Total Spontaneous Resolution	**70**	**87.5%**
Persistent Obstruction (>12m)	10	12.5%

For patients failing conservative management (n=10 patients; 12 eyes), a stepped surgical protocol was initiated. Per protocol adjustments, cases refractory to probing and turbinate fracture proceeded to DCR.

Table 3. Surgical Intervention Protocol

Intervention Stage	Success/Total (Eyes)	Percentage (%)	Primary Reason for Failure
Stage 1: Initial Simple Probing	9 / 12	75.0%	Buried inferior turbinate
Stage 2: Repeat Probing + ITF*	2 / 3	66.7%	Cicatricial changes / Bony block
Stage 3: DCR (External/Endo)	1 / 1	100%	N/A

*ITF: Inferior Turbinate Fracture

Standard protocol dictates documenting the tactile resistance encountered during the initial probe, as it correlates significantly with the success of simple irrigation and probing.

Table 4. Prognostic Value of Intraoperative "Feel"

Type of Obstruction	Number of Eyes	Probing Success (%)
Membranous (Hasner's Valve)	8	100%
Complex/Stenotic	2	50%
Firm/Bony Resistance	2	0%

Complications were monitored across both the conservative and surgical arms of the study.

Table 5. Safety Profile & Complications

Complication	Conservative (n=70)	Surgical (n=10)
Acute Dacryocystitis	2 (2.5%)	0 (0%)
Preseptal Cellulitis	1 (1.25%)	0 (0%)
Punctal Trauma	0 (0%)	1 (10%)
Post-operative Epistaxis	0 (0%)	2 (20%)
Granuloma Formation	0 (0%)	0 (0%)

DISCUSSION

The clinical presentation observed in this study, with universal epiphora (100% of 102 eyes), increased tear lake height (92.2%), mucopurulent discharge (76.5%), positive fluorescein dye disappearance test (FDDT; 96.1%), and regurgitation on pressure over lacrimal sac (ROPLAS; 60.8%), alongside 27.5% bilateral involvement, demonstrates strong concordance with established literature on congenital nasolacrimal duct obstruction (CNLDO). Vagge et al.[1] reported identical 100% epiphora prevalence, comparable tear lake elevation in 90-95% of cases, discharge rates of 70-80%, and FDDT sensitivity nearing 96%, underscoring these as hallmark diagnostic features in early infancy. Similarly, Saleem et al.[4] documented bilateral involvement in 14-33.8% of their cohort, often resolving synchronously, which aligns precisely with our 27.5% rate and supports the embryologic basis of symmetric duct maturation failures. These metrics affirm the reliability of non-invasive clinical tools like FDDT and ROPLAS, with positivity rates mirroring meta-analyses where FDDT exceeds 95% specificity for distal obstructions.

Regarding natural history and conservative management, the 87.5% spontaneous resolution rate (60% by 0-6 months, additional 17.5% by 6-9 months, 10% by 9-12 months; 12.5% persistence beyond 12 months among 80 eyes treated with Crigler massage) closely parallels reports emphasizing early intervention's role in augmentation. Lekskul et al.[5] observed 90-96% overall resolution with conservative approaches, peaking at 50-70% within 6 months (median onset 1.4-3.5 months), while Mohney et al.[6] noted 80-90% by one year, attributing delays to incomplete Hasner valve canalization.Our lower persistence (12.5% vs. typical 10-20%) likely stems from standardized massage protocols (10-15 repetitions, 4x daily), which Vagge et al. [1] showed boosts outcomes to 96% versus observation alone, reducing infection risks through mechanical duct patency. This reinforces guidelines prioritizing massage in infants under 12 months, where natural tear flow and blinking suffice for most membranous blocks.

Surgical outcomes further validate the stepped protocol: 75% success with initial simple probing (9/12 eyes, failures primarily from buried inferior turbinate), 66.7% with repeat probing plus inferior turbinate fracture (ITF; 2/3 eyes, limited by cicatricial or bony changes), and 100% with dacryocystorhinostomy (DCR) salvage.These rates align with Repka et al.'s [7] multicenter data (84-94% probing success under 24 months), where age-stratified efficacy declines post-infancy due to fibrosis. Shahgoli et al.'s[8] randomized trial reported 86-92% for probing with/without ITF (80-92% augmented), and >95% DCR benchmarks, highlighting ITF's utility in 20-40% of turbinate-related failures—mirroring our primary failure mode. Overall surgical success (91.7%) exceeds some intubation cohorts (85-90%), advocating non-hardware escalation to minimize complications.

The prognostic value of intraoperative "feel" proved highly discriminative: 100% success for membranous (Hasner valve; 8 eyes), 50% for complex/stenotic (2 eyes), and 0% for firm/bony resistance (2 eyes; $p<0.05$). This echoes Shrestha et al.'s [9] 90+% membranous success (predominant in 66% cases) versus 50-80% complex, and Kim et al.'s [10] 92% soft versus 33% firm resistances, where tactile cues predict simple versus atypical anatomy requiring adjuncts like endoscopy.(10,26) Han et al.[11] similarly stratified simple (90+%) from complex (62-85%) obstructions, validating "feel" as a low-cost, real-time guide over imaging.

Safety profiles were favorable: conservative arm showed 3.75% infections (2.5% acute dacryocystitis, 1.25% preseptal cellulitis in 70 eyes), akin to Ffooks' 1.6-1.8% and Eyewiki's <5% infection rates. Surgical complications (10% punctal trauma, 20% epistaxis in 10 patients) reflect ITF-specific epistaxis (10-20%) without vision loss, contrasting zero conservative epistaxis and aligning with general 1-10% procedural risks. Collectively, these results affirm a conservative-first, feel-guided paradigm, achieving 98.75% overall success with minimal morbidity, consistent with AAO guidelines and prior cohorts despite single-center constraints.

CONCLUSION

This study validates a conservative-first, staged intervention paradigm for managing CNLDO, achieving an overall success rate of 98.75%. Results confirm that standardized lacrimal sac massage is highly effective, resolving 87.5% of cases within the first year. For persistent obstructions, the stepped surgical protocol—escalating from simple probing to ITF and DCR—offers a safe and predictable pathway to resolution. Crucially, intraoperative tactile "feel" serves as a definitive prognostic

tool, where membranous resistance predicts high success for simple probing, while firm/bony resistance identifies cases requiring more invasive salvage procedures. This approach minimizes surgical morbidity while ensuring excellent functional outcomes.

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