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Original Article

Surgical Outcomes in Congenital Nasolacrimal Duct Obstruction After Probing Failure: A One-Stage Approach

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Abstract

Objectives: This study evaluates the outcomes of a one-stage obstruction-based strategy for congenital nasolacrimal duct obstruction (CNLDO) in children who have prior probing failure. The objective is to assess the success rates of probing, balloon dacrioplasty (BDP), monocanalicular intubation (MCI), and external dacryocystorhinostomy (external DCR) performed in the same anesthesia session.

Methods: A retrospective analysis included 55 eyes (45 patients, aged 12–120 months) with initial probing at another center. Procedures involved probing, probing plus BDP, MCI, and external DCR. For membranous obstruction (MO), the procedure concludes after probing; for incomplete complex obstruction (ICO) it includes BDP or MCI; and for complete complex obstruction (CCO), external DCR is performed. Success rates were assessed based on obstruction types and age groups, with improvement in symptoms and signs as the measure of success. Statistical analysis utilized Kruskal–Wallis, Fisher's exact test, and logistic regression.

Results: The overall success rate for all procedures was 72.7%. Success rates were 77.8% for MO, 66.7% for ICO, and 100% for CCO, introducing a promising perspective for the management of different CNLDO types. External DCR exhibited a 100% success rate, highlighting its effectiveness in cases of CCO. Success rates for interventions were 77.8% for probing, 61.5% for probing plus BDP, and 73.1% for MCI, emphasizing the feasibility and success of one-stage obstruction-based treatments. Age did not significantly correlate with success rates.

Conclusion: The one-stage obstruction-based approach, which demonstrated favorable success rates in treating CNLDO and introduced a paradigm shift in the treatment strategy after probing failure, underscores the importance of tailoring interventions to the specific obstruction type. The study also highlights the feasibility and cost-effectiveness of performing multiple BDP, MCI, or external DCR procedures concurrently during the same anesthesia session, further emphasizing the crucial role of customizing treatments based on the nature of the obstruction.

Keywords: Balloon dacrioplasty, congenital nasolacrimal duct obstruction, external dacryocystorhinostomy, monocanalicular intubation, obstruction type, probing

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Introduction

Congenital nasolacrimal duct obstruction (CNLDO) manifests with symptoms such as excessive tearing, lash crusting, and mucopurulent secretions. A significant cohort study revealed that CNLDO affects one in nine newborns, highlighting its public health significance (1). Controversies persist regarding the most appropriate time and type of intervention for managing CNLDO. During the 1st year of life, conservative management of lacrimal sac massage is the recommended course of action, except for complex situations like dacryocystocele and dacryocystitis, where surgical intervention becomes necessary if conservative therapy proves ineffective (2).

Limited studies exist on the impact of age on the success rate of repeat nasolacrimal probing (3,4), leaving clinicians with scant guidance for additional treatment options following initial probing failure. Two potential explanations for probing failure in children with CNLDO emerge from a literature review, primarily attributing the type of intervention to the patient's age and outcomes of prior treatment attempts (2,5,6). The age-based procedure typically involves successive probing, followed by balloon dilatation or silicone intubation, and ultimately, endonasal or external dacryocystorhinostomy (Ext DCR) (7). However, this strategy presents four main drawbacks: Recurring general anesthesia, repeated stress for parents and children, time and expense, and a potential impact on overall quality of life (8). It is widely acknowledged that as individuals age, the effectiveness of initial probing diminishes (9,10). While some previous studies suggested that the reduction could be due to fibrosis and chronic infection as individuals age (11,12), it is now clear that older children with unresolved epiphora are a specific group of patients who were born with a more complex type of CNLDO (13). Consequently, proponents of a single-stage obstruction-based approach, preferably endoscopic, advocate for a more personalized and problem-focused solution. Regardless of age and prior unsuccessful probing attempts, this approach specifically targets the main issue of obstruction type, demonstrating a high success rate post-surgery in CNLDO patients (14).

Insufficient research exists on the outcomes of surgical methods based on the obstruction type in cases of CNLDO with a history of previous unsuccessful probing. This study represents the second report of an approach involving one-stage obstruction-based intervention in cases of CNLDO with a history of probing failure. The aim is to provide a comprehensive report on the average 2-year outcomes of a one-stage obstruction-based approach in children with different CNLDO types who have experienced unsuccessful probing.

Methods

This study is a single-center retrospective analysis of treatments administered to children showing symptoms of CNLDO between January 2014 and January 2019. Initial probing was done at another center and subsequently referred to our department at Kartal Dr. Lütfi Kırdar City Hospital, Department of Ophthalmology, Oculoplasty Division, due to the persistence of symptoms. The study was conducted following the ethical principles outlined in the Declaration of Helsinki, and written informed consent was obtained from the parents of each participant.

CNLDO was diagnosed based on a history of tearing and/or discharges since or shortly after birth, as validated by the parents, and evidence on the dye disappearance test (9). The patients included in this study met specific criteria; a minimum of 6 months had passed since the initial probing, yet they continued to experience persistent symptoms despite the application of tear sac massage and/or intermittent use of topical antibiotic eye drops. Additionally, patients with a documented history of acute dacryocystitis following the initial probing were incorporated into the study. Patients exhibiting epiphora, a high tear meniscus, and mucopurulent discharge without conjunctivitis, trauma, or any other ocular disease and demonstrating the presence of mucopurulent discharge with lacrimal massage during clinical examination were evaluated for CNLDO. In cases where the results were inconclusive, a fluorescein dye disappearance test was employed to confirm the diagnosis. This involved placing one drop of 2% fluorescein solution into the lower conjunctival fornix and observing if the dye cleared from the lacrimal lake. An obstruction was identified when the fluorescein dye did not clear within 5 min. The study's exclusion criteria included puncto-canalicular complete obstruction, eyelid malposition, associated ocular disease, craniofacial anomaly, any genetic syndrome, and a follow-up period of <6 months. Informed consent was obtained after discussions with parents about various surgical options, potential complications, and the prognosis.

Surgical Technique

All procedures were performed by the senior author or conducted under their direct supervision (O.R.O.) under general anesthesia. The surgeon noted the presence of inferior concha and septal pathology during the probing procedure. To facilitate vasoconstriction of nasal mucosal vessels, a nasal sponge soaked in 0.001% adrenaline was placed between the inferior meatus and the septum for approximately 5 min. The probing procedure started with the dilation of the inferior punctum, followed by the insertion of Bowman's probe into the punctum. The probe was then rotated 90 degrees horizontally to enter the canaliculus. Advancing over

the lid while applying lateral tension, the probe touched the bony firmness, indicating contact with the nasal wall of the lacrimal sac. Subsequently, the probe was rotated up 90° and advanced down the nasolacrimal duct.

The nature of the obstruction was classified by the clinician as membranous obstruction (MO), defined as a single obstruction that was easily passed during the probing procedure, and incomplete complex obstruction (ICO), defined as a blockage or multiple blockages anywhere along the tear drainage pathway that causes more difficulty than usual with probe passage. Obstructions characterized by ease of opening and consisting of a single membrane were categorized as MO. The MO used in our study specifically refers to obstructions that are easy to open and are made up of a single membrane at the end of the nasolacrimal duct with a Hasner valve level. Conversely, obstructions involving bony stiffness and multiple resistances, posing a greater challenge to opening, were categorized as ICO. This includes problems with the Hasner valve, the inferior turbinate being too tight and blocking flow, the canalicular system, or the nasolacrimal duct being blocked more than once (8,15,16). The intraoperative success or patency of the lacrimal duct was confirmed by metal-to-metal contact between the probe and a second probe positioned under the inferior turbinate or by the passage of fluoresceinated normal saline into the nasal cavity. Cases where a firm bony resistance prevented the probe from reaching the nasal cavity and metal-to-metal contact could not be achieved were classified as complete complex obstructions (CCO) (15). Despite repeated probing, this resistance was observed to remain unchanged.

If the obstruction is classified as MO, the procedure concludes after probing. However, if it is classified as ICO, the treatment involves balloon catheter dilation – balloon dacryocystoplasty (BDP) or silicone tube intubation – monocanalicular intubation (MCI). While the BDP procedure is covered by our public health insurance system, the balloon catheter used in the procedure is not always available in our hospital. Therefore, depending on the current conditions, some patients with ICO underwent probing plus BDP, while others underwent probing plus MCI. During the balloon dilatation procedure, a balloon catheter (LacriCATH®, QUEST Medical, Allen, TX, USA) (2 or 3 mm, based on the patient's age) is inserted into the lacrimal duct in a deflated state after the probing procedure. The catheter is then advanced 15 mm proximally to the marked area and inflated twice: First at 8 bars for 90 s, and then again for 60 s, ensuring dilation of the distal end of the nasolacrimal duct. Subsequently, the catheter is retracted to the second 10 mm mark and inflated twice for 90 and 60 s, ensuring dilation of the proximal end of the nasolacrimal duct. Finally, the balloon catheter is deflated and removed.

For MCI, a Ritleng probe® (FCI; Paris, France) was inserted from the superior punctum and canaliculus to the nasolacrimal duct. The leading end of the stent was threaded into the probe's opening until it reached the inferior metal aperture. If the monofilament was visible, it was directly grasped with forceps; otherwise, a Ritleng hook® (FCI) was employed to reach and retrieve it when pulled out from the nose. The Self-Threading Monoka® (FCI) was then threaded through the lacrimal system until the punctal plug of the stent was securely positioned. Finally, any excess silastic stent extending beyond the nostril was trimmed. Usually, one tube was inserted through the superior punctum, and at times, a second tube was inserted through the inferior punctum. However, in the majority of cases, the inferior or superior punctum has just one tube.

In the event of a CCO obstruction, the surgery shifts to an external DCR. The utilized technique adhered to the established protocols for external DCR as previously published (17). A 6–7 mm paranasal incision was made, creating an appropriate osteotomy. The mucosal anastomosis was fashioned by suturing both the posterior and anterior mucosal flaps with 6/0 polyglactin (Vicryl; Ethicon Inc., Livingston, UK) sutures. All patients underwent bi-canalicular intubation (BCI), and skin closure was achieved with 7/0 polyglactin (Vicryl; Ethicon Inc.) interrupted sutures. Limited anterior nasal packing was implemented following surgery to absorb barely any post-operative ooze. Postoperatively, patients received a nasal decongestant spray (xylometazoline 0.05%) twice daily for 3 days, along with topical antibiotics (and twice a day systemic antibiotics for the external DCR subgroup) and steroids 4 times a day for 1 week. The tube remained in place for 3–6 months and was subsequently removed either under masked airway anesthesia or at the outpatient clinic. Success was characterized by the absence of symptoms or the occurrence of only a single episode of tearing triggered by noxious stimuli, such as pain, wind, or cold weather. The definition of success required a minimum follow-up period of 6 months.

Statistical Analysis

The statistical analyses were conducted using the SPSS version 24 program. To assess the normal distribution among the variables, the Shapiro–Wilk test was employed. Quantitative data, depending on the type and distribution, were presented as the mean±standard deviation (SD), median (interquartile range), and number (%). Age demonstrated a non-parametric distribution according to the Shapiro–Wilk test and non-parametric tests were utilized for its assessment. The Kruskal–Wallis test was applied to analyze the relationship among more than two independent variables that did not conform to a normal distribution. For investigating the relationship between categorical variables, the

Chi-square (or Fisher's exact test, where applicable) was employed. Logistic regression analysis was conducted to explore the impact of independent variables on binary categorical dependent variables. Sensitivity and specificity calculations were executed to evaluate the efficacy of the diagnostic tests applied. In addition, ROC analysis was performed to determine the cutoff point. The results were evaluated within a 95% confidence interval, and statistical significance was considered at a $p<0.05$.

Results

The study included 45 patients aged 12–120 months, all of whom had previously undergone a single probing surgery at another center due to CNLDO. Among them, 24 were female and 21 were male, distributed across three age groups: 12–24 months (11 patients), 25–36 months (10 patients), and 36 months and over (24 patients). The distribution of age groups based on the type of surgery revealed a statistically significant difference ($p<0.05$). Probing surgery was more prevalent in the 12–24 months age group whereas probing plus MCI surgery was more common in the 36-months and above age group ($p=0.012$). Out of the 55 eyes studied, 18 (32.7%) had MO, 33 (60.0%) had ICO, and 4 (7.3%) had CCO. Unilateral occlusion was present in 35 children (77.7%), with 20 (57.1%) on the right side and 15 (42.8%) on the left side. Ten patients (22.2%) had bilateral CNLDO. At the 6-month post-intervention assessment, the overall surgical success rate for all patients using a one-stage approach was 72.7% (40 out of 55 eyes). The observed incidence of the non-resolution of epiphora was in 15 patients, representing 27.3% of the total number of patients. The success rates for patients with MO, ICO, and CCO were 77.8% (14 out of 18 eyes), 66.7% (22 out of 33 eyes), and 100% (4 out of 4 eyes), respectively, with no significant difference observed in the type of CNLDO and surgical success rate ($p=0.477$) (Table 1).

The patients' median age was 35 months. Statistical analysis revealed a significant difference in surgeries conducted based on median age ($p=0.041$). Success rates among unilateral and bilateral cases showed no statistically significant difference ($p=0.465$). In addition, no significant differences were observed in surgery types based on gender ($p=0.966$), eye laterality ($p=0.286$), or between unilateral and bilateral cases ($p=0.628$). However, significant distinctions were found among obstruction types ($p<0.001$), particularly revealing a noteworthy association between MO and probing surgery. Details are presented in Table 2.

When examining patients who underwent a third operation, the success rate for the 36 months old and above age group is higher compared to other age groups, but there is no statistically significant difference ($p=0.354$). Success rates among gender groups are similar, and there is no statistically significant difference ($p=0.806$). There is no statistically significant difference in success rates between the right and left eye groups ($p=0.450$). Success rates are similar between unilateral and bilateral cases, and there is no statistically significant difference ($p=0.544$). While there are differences in success rates among surgery types, there is no statistically significant difference ($p=0.102$). For the ICO type, the success rate is higher compared to other obstruction types, but there is no statistically significant difference ($p=0.355$). No statistically significant differences were found among other variables, such as multiple-level nasolacrimal duct obstruction (NLDO), purulent drainage with dilate atonic sac, bone stiffness, metal–metal contact, and inferior turbinate impaction ($p>0.05$). Details are presented in Table 3.

Examining the intraoperative findings noted for the differentiation of obstruction, we observed that in 23.6% of cases (13 out of 55 eyes), there was bone stiffness, in 29.1% of cases (16 out of 55 eyes), there was purulent discharge with a dilated atonic sac and in 49.1% of cases (27 out of 55 eyes), and there were multiple-level NLDO. These findings were significantly more common in the ICO group ($p<0.001$, $p=0.006$, $p<0.001$, respectively). The median age of patients in the successful surgery group was 60 months, whereas in the failed surgery group, it was 25 months. There was no statistically significant correlation between age and success rate ($p=0.564$).

The MO of CNLDO was identified in 32.7% (18 out of 55) of cases. The median age of patients with MO was 27 months. Among the patients, 31 (60.0%) had ICO with a median age of 35 months, and 4 patients (7.3%) exhibited CCO with a median age of 66 months. A significant association

Table 1. 6-month follow-up outcomes for a one-stage obstruction-based approach in 55 eyes (45 patients) with various types of congenital nasolacrimal duct obstruction

	Membranous CNLDO (18 eyes)	Incomplete complex CNLDO (33 eyes)	Complete complex CNLDO (4 eyes)	p
Procedure	**Probing**	**BDP or MCI**	**External DCR**	
6-month success	77.8% (14 eyes)	66.7% (22 eyes)	100% (4 eyes)	0.477

BDP: Balloon dacrioplasty; CNLDO: Congenital nasolacrimal duct obstruction; External DCR: External dacryocystorhinostomy; MCI: Monocanalicular intubation.

Table 2. Outcomes at 6 months post-operative for congenital nasolacrimal duct obstruction: analysis by patient characteristics and surgical factors

	Post-operative 6th Month Results				
	Successful		Failure		
	n	%	n	%	P
Age groups					
12–24 months	11	27.50	2	13.30	0.378
25–36 months	8	20.00	5	33.30	
36 months and above	21	52.50	8	53.30	
Gender					
Male	15	44.10	6	54.50	0.73
Female	19	55.90	5	45.50	
Side					
Unilateral	27	77.10	8	22.90	0.465
Bilateral	7	70.00	3	30.00	
Obstruction type					
MO	14	35.00	4	26.70	0.408
ICO	22	55.00	11	73.30	
CCO	4	10.00	0	0.00	
Surgery type					
Probing	9	22.50	3	20.00	0.309
Probing plus BDP	8	20.00	5	33.30	
Probing plus MCI	19	47.50	7	46.70	
External DCR	4	10.00	0	0.00	
Other observations					
Multiple-level NLDO					
Detected	19	47.50	8	53.30	0.467
Not Detected	21	52.50	7	46.70	
Purulent discharge with atonic sac					
Detected	10	25.00	6	40.00	0.326
Not Detected	30	75.00	9	60.00	
Bone Stiffness					
Detected	8	20.00	5	33.30	0.31
Not Detected	32	80.00	10	66.70	
Metal-to-metal contact					
Detected	36	90.00	15	100.00	0.565
Not Detected	4	10.00	0	0.00	
Inferior turbinate					
Medialization done	14	35.00	9	60.00	0.128
Medialization not done	26	65.00	6	40.00	

BDP: Balloon dacrioplasty; CCO: Complete complex obstruction; External DCR: External dacryocystorhinostomy; ICO: Incomplete complex obstruction; MCI: Monocanalicular intubation; MO: Membranous obstruction; NLDO: Nasolacrimal duct obstruction.

was observed between the type of CNLDO and age; the median value is higher for the CCO type (p=0.048). However, there was no statistically significant relationship between the type of CNLDO and surgical success (p=0.477). Lateralization (unilateral–bilateral), type of obstruction, success rates based on the performed surgery, mean age, and success rates according to age groups did not exhibit statistically significant differences (respectively, p=0.652, p=0.408,

Table 3. Analysis of third operation outcomes in congenital nasolacrimal duct obstruction: Comparison of ınterventions and patient characteristics

	Third operation						p
	Absent		MCI		External DCR		
	n	%	n	%	n	%	
Age Group							
12–24 Months	10	25.0	3	30.0	0	0.0	0.354
25–36 Months	8	20.0	4	40.0	1	20.0	
36 Months and above	22	55.0	3	30.0	4	80.0	
Gender							
Male	14	43.8	4	50.0	3	60.0	0.806
Female	18	56.3	4	50.0	2	40.0	
Side							
Right	20	50.0	6	60.0	4	80.0	0.45
Left	20	50.0	4	40.0	1	20.0	
Laterality							
Unilateral	26	81.3	6	75.0	3	60.0	0.544
Bilateral	6	18.8	2	25.0	2	40.0	
Surgery Type							
Probing	9	22.5	3	30.0	0	0.0	0.102
Probing plus BDP	8	20.0	5	50.0	0	0.0	
Probing plus MCI	19	47.5	2	20.0	5	100.0	
External DCR	4	10.0	0	0.0	0	0.0	
Obstruction Type							
MO	15	37.5	3	30.0	0	0.0	0.355
ICO	21	52.5	7	70.0	5	100.0	
CCO	4	10.0	0	0.0	0	0.0	
Other Observations							
Multiple-level NLDO							
Detected	18	45.0	6	60.0	3	60.0	0.603
Not Detected	22	55.0	4	40.0	2	40.0	
Purulent discharge with atonic sac							
Detected	9	22.5	6	60.0	1	20.0	0.075
Not Detected	31	77.5	4	40.0	4	80.0	
Bone stiffness							
Detected	8	20.0	2	20.0	3	60.0	0.167
Not Detected	32	80.0	8	80.0	2	40.0	
Metal-to-metal contact							
Detected	36	90.0	10	100.0	5	100.0	0.71
Not Detected	4	10.0	0	0.0	0	0.0	
Inferior turbinate							
Medialization done	15	37.5	6	60.0	2	40.0	0.437
Medialization not done	25	62.5	4	40.0	3	60.0	

BDP: Balloon dacrioplasty, CCO: Complete complex obstruction, External DCR: External dacryocystorhinostomy, ICO: Incomplete complex obstruction, MCI: Monocanalicular intubation, MO: Membranous obstruction, NLDO: Nasolacrimal duct obstruction.

p=0.522, p=0.334, and p=0.432). The success rate of surgery was 77.1% (27 of 35) in unilaterally affected patients and 70% (7 of 10) in bilaterally affected cases (p=0.687).

The success rates for surgical interventions varied across age groups, with rates of 84.6% in the 12–24 month group, 61.5% in the 25–36 month group, and 72.4% in the 36-month and over group (p=0.378). Moreover, there was no statistically significant difference in success rates among subgroups, encompassing factors such as firm bone stiffness, impaction of the inferior turbinate, purulent secretion with atonic sac, tight and/or multiple-level NLDO, and/or canalicular stenosis (p>0.05).

Out of the 15 cases undergoing a third operation, three had MO, and 12 had ICO; 10 patients underwent MCI, and five patients underwent external DCR surgery. Following the third operation in total (our second operation), a 100% success rate was achieved in all cases, and no recurrence was observed during the 24-month follow-up. Among patients undergoing MCI, a slit punctum was encountered in one patient, and premature removal or loss of the tube was encountered in three patients. The average time for tube removal (MCI or BCI) was 15.21±3.24 weeks (range: 6–20 weeks), with three tubes lost between 6 and 8 weeks postoperation (three in the MCI group and none in the external DCR group).

Discussion

This study assesses the results of employing a one-stage obstruction-based strategy for CNLDO in children under the same anesthesia. The investigation centers on probing, BDP with probing, MCI, and external DCR procedures, specifically in cases preceding a history of prior probing failure. In this study, the overall success rate was 72.7%. Success rates for subsequent interventions were 77.8% for a second probing, 61.5% for BDP with probing, 73.1% for MCI, and 100% for external DCR. To the best of our knowledge, our study holds the distinction of being the first to focus on the feasibility of performing all procedures, including external DCR, in the same anesthesia session for individuals with a history of probing failure.

After the initial probing fails, the next traditional procedure is repeated probing, which has a less favorable outcome than the initial probing (18-20). In both cases of failed probing and primary BDP, inferior turbinate infracture is advised (21,22). Following one or more failed probings, the third conventional surgical step is silicon intubation, which has additionally been used as the main therapy for CNLDO in all age groups, particularly older individuals (23-25). Similarly, BDP with or without silicone intubation has been used to treat previously failed probings as well as the main therapy for CNLDO. BDP and silicone intubation are both equally efficient for formerly unsuccessful probing, according to the Pediatric Eye Disease Investigation Group (25). If prior approaches are ineffective, DCR may be a viable option for solving CNLDO. This procedure can be carried out through external, endocanalicular, or endonasal endoscopic approaches (26-28).

A thorough examination of existing literature reveals that the predominant approaches to CNLDO have historically revolved around age-based criteria, where a singular procedure is applied to diverse CNLDO types based on the patient's age or the outcomes of previous procedures (13,18,21,29). However, the literature suggests that an age-based approach may not be the most effective, as the type of CNLDO plays a crucial role in determining success (8). Kashouli et al. illustrated that the primary factor leading to probing failure at any age is the nature of CNLDO, not the age itself. Consequently, while straightforward probing yields notably high success rates in membranous CNLDO, more intrusive methods such as MCI and DCR become imperative for complex CNLDO cases, irrespective of age and prior unsuccessful procedures. Ali et al. similarly argued that probing is not a suitable initial treatment for complex CNLDO (30). This observation forms the basis for advocating a one-stage obstruction-based approach to CNLDO, designed to circumvent the necessity for repetitive procedures in cases of complex CNLDO among children (13). The demographic characteristics (excluding age) and clinical presentations showed no significant disparities among the three CNLDO types, underscoring their categorization under the same umbrella of CNLDO with varying degrees of severity (31-34).

Following an unsuccessful probing plus BDP, inferior turbinate infracture is recommended (21,22). A study has indicated a significantly higher incidence of inferior turbinate impaction in patients with a history of previous unsuccessful probing or intubation and unexpectedly membranous CNLDO (8). In our study, infracture of the inferior turbinate was observed in 41.8% of cases (23 out of 55 eyes). However, the incidence of inferior turbinate impaction was found to be equal between the MO and ICO groups (47.8% each). In addition, in their study on MO and complex CNLDO management, Ali et al. found bone obstruction to be the most common in cases with complex CNLDO (23%) (30). In contrast, in our cases, although the rate of bone obstruction was similar (23.6%), multiple-level NLDO (49.1%) ranked first. This difference might be attributed to the surgical history in our cases, suggesting that prior surgeries may trigger fibrosis.

BDP operates by expanding the nasolacrimal duct through the inflation of a balloon, and evidence indicates a decrease in complications associated with probing (25). In our study, the overall success rate for probing plus BDP was 61.5%

(eight out of 13 eyes). However, in recent studies, Dericioğlu et al. reported a higher overall success rate of 81.1% for BDP in their study. They maintained that primary BDP had a high rate of efficacy between 24 and 36 months, but that its success rate declined after 36 months (35). In our study, the lower success rate observed might be explained by the average age of patients undergoing BDP, which was 36±17 months with a median age of 31 months. This difference could be attributed to the fact that 10 out of the 13 patients receiving BDP had ICO and were not treatment-naïve.

MCI is preferred for treating CNLDO due to its ease of insertion and removal, minimizing manipulation of the lacrimal system. In our study, the success rate for MCI was 73.1%, and the average age of patients was 48±27 months, with a median age of 36 months. In a study by Arici and Oto which focused on patients aged four and above with CNLDO, approximately half of the patients had ICO, and they reported a success rate of 61.9% for BCI (36). Interestingly, in our study, even though 80% of the patients undergoing MCI had ICO, the success rate was higher at 73.1%. Similarly, Khatib et al. achieved a 71% success rate in the treatment of complex CNLDO using a specific type of MCI called a pushed monocanalicular stent (Masterka) (37). Furthermore, recent studies using tubes similar to those in our study for treating complex CNLDO reported success rates of 59.6% (38) and 73.5% (39) for pulled MCI tubes (Monoka Fayet). These success rates are consistent with our study's results.

External DCR serves as the final recourse for treating CNLDO in cases where all prior interventions prove unsuccessful. In pediatric patients, the outcomes and complication rates of external DCR exhibit negligible differences when compared to adult patients (40). Barnes et al. demonstrated a remarkable success rate in pediatric external DCR, achieving a complete cure of symptoms in 96% of cases (26). In our study, the success rate for external DCR, performed in cases with CCO and five cases with persistent symptoms despite MCI, was found to be consistent with the literature, reaching 100%. The efficacy of external DCR remains pertinent as a treatment method with very high cure and low complication rates, particularly in cases resistant to other therapeutic approaches for CNLDO.

It is noteworthy that our success rates remain lower than in some studies. In their study, Kashkouli et al. reported success rates of 96.5% for MO, 95.4% for ICO, and 100% for CCO (8). Although our success rates are the same for CCO, it is remarkable that our rates are lower for MO and ICO. In that study, 77 out of 226 eyes constituted a subgroup with prior failed probing or intubation. However, the success rates for this subgroup were not specified, and the success rates in our study precisely reflect this subgroup. In addition, Katowitz and Welsh found a secondary probing resolution rate of 52% in children aged 6–18 months and 18% in children aged 18–24 months, suggesting a significant reduction in success, likely due to complications from the primary procedure (12). This evidence shows that secondary probing is not working as well as it used to. This could be because of problems with the first procedure, like scarring, making the passage narrower (called cicatricial stenosis), or making the wrong passage (41,42). Moreover, the results we saw may have been caused by a number of things, such as the lack of endoscopy, hence the failure to look for buried cases and intranasal cysts, the fact that initial probings were done external center, the lack of perioperative examination findings, and the fact that obstruction types were not identified in the first probing. The lower success rate in our study may be attributed to these factors.

The endonasal endoscope has proven to be a priceless instrument in the treatment of CNLDO, with advantages such as redirecting the probe, medializing the impacted inferior turbinate, marsupializing the intranasal mucocele, retrieving the silicone tube without triggering nasal mucosal injury, and preventing untrue passage of the probe and nasal hemorrhaging (43,44). Li et al. used nasoendoscopy to perform a dacryoendoscopy-assisted incision of Hasner's valve to assess its effectiveness in treating membranous CNLDO in children over the age of one with a history of initially probing failure. They achieved surgical success in all cases, resulting in an impressive overall success rate of 100% (45). In a study by Gupta et al., dacryoendoscopy was utilized for refractory CNLDO, with dacryoendoscopic recanalization performed in seven cases. In addition, endoscopic DCR was carried out in six cases, resulting in a successful outcome in all instances (46).

The study is limited by its retrospective design and relatively small number of cases, and the involvement of various surgeons throughout the study period poses another potential limitation, as the procedures were either performed by the senior author (O.R.O.) or directly supervised by the author in a teaching hospital.

Conclusion

Our study has demonstrated high success rates for probing, BDP or MCI, and external DCR procedures in the treatment of CNLDO, even when a "blind" conventional technique is used in patients with a history of previous probing failure. In comparison to some studies in the literature, the lower success rates observed in our study may be attributed to factors such as the patients not being treatment-naive and the absence of endoscopic examination. It is crucial to acknowledge and accept this possibility in our interpretation of the results. Our findings also support the feasibility of performing balloon dilation and silicone intubation or DCR

procedures simultaneously during the same anesthesia session, irrespective of the child's age, providing an efficient and cost-effective management strategy. The stepwise method is a preferred and cost-effective approach for treating CNLDO, highlighting the importance of exploring and adopting it in clinical practice.

Disclosures

Ethics Committee Approval: This study is a single-center retrospective analysis of treatments administered to children showing symptoms of CNLDO between January 2014 and January 2019. Initial probing was done at another center and subsequently referred to our department at Kartal Dr. Lütfi Kırdar City Hospital, Department of Ophthalmology, Oculoplasty Division, due to the persistence of symptoms. The study was conducted following the ethical principles outlined in the Declaration of Helsinki, and written informed consent was obtained from the parents of each participant.

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