

# Dacryocystoscopy for Lacrimal Duct Obstruction Manifesting In Childhood

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## Abstract

**Purpose:** To evaluate the results of dacryocystoscopy as a diagnostic and therapeutic option for lacrimal duct obstruction manifesting in childhood.

**Methods:** Retrospective, non-comparative analysis of 50 dacryocystoscopies performed on 43 eyes of 35 children. All children have had lacrimal surgery (probing and/or intubation) at least twice before. Mean age was 34.1 months (range, 1-104). Thirty-five eyes could be included for follow-up which ranged from 3 to 61 months (mean, 25.8).

**Results:** Indications for treatment were: chronic dacryocystitis because of congenital nasolacrimal duct obstruction (CNLDO) (n=40) under which three eyes showed iatrogenic foreign bodies, presaccal stenosis (n=5), amniotocele (n=3), and lacrimal fistula (n=2). Dacryocystoscopy was performed as therapeutic (n=38) or diagnostic (n=12) intervention. Surgery was performed as primary (n=43) or secondary (n=7) endoscopy.

Complication rate was 2% (n=1). Seven eyes (16.3%) required dacryocystorhinostomy (DCR). Three of these showed recurrence of symptoms, two had bony stenosis, and two eyes were treated twice by transcanalicular endoscopic intervention showing persisting chronic dacryocystitis.

Thirty-five of 43 primary endoscopies were performed as a therapeutic intervention. Thirty-two of these eyes (91.4%) were treated successfully by dacryocystoscopy.

**Conclusions:** Dacryocystoscopy performed in children offers additive diagnostic and therapeutic options. Advantages are visual control with preservation of topographic anatomy due to its minimally-invasive character. Our analysis gives evidence that after an initial failure, a second endoscopic intervention has a reduced likelihood for cure. Proving this further data is needed. Performed by experienced surgeons it is a safe technique.

## Introduction

Led by the desire to develop a minimally-invasive diagnostic and operative procedure for lacrimal duct obstructions, dacryocystoscopy was developed over 20 years ago. Today, lacrimal stenosis can be eliminated by transcanalicular surgery very often and there is a clear trend towards the usage of this minimally-invasive technique. Even if a therapeutic application is not possible, imaging of the localization and shape of stenosis offers better predictive information for prognosis and choice of a suitable surgery [1-4].

Congenital nasolacrimal duct obstruction (CNLDO) is a common problem in pediatric ophthalmology. About 6-20% of the children present clinical symptoms [5,6]. Chronic purulent dacryocystitis may develop due to a persistence of the Hasner's Membrane. Very often symptoms are limited to infectious conjunctivitis. But epiphora due to lacrimal duct obstruction manifesting in childhood is not the symptom of a homogenous pathology. Other anomalies such as atresia or aplasia as well as complex pathologies in syndromes might exist [7]. Also different diseases have to be ruled out such as inflammation of the ocular surface, lid anomalies or even glaucoma [7,8]. Fortunately, many of the children with CNLDO show a spontaneous improvement, mostly within the first 4 weeks of life. If not, therapy should be done because refractive errors can develop and recurrent infections of the ocular surface may occur [9]. Because of the young age most of the diagnostic opportunities for adults cannot be used. Furthermore, a long persistent inflammation in the lacrimal drainage system lowers the chance for cure whereas the risk for acute complications (e.g., orbital cellulitis, acute dacryocystitis) increases [10,11].

If therapy is needed, probing can be regarded as the first-line therapy when conservative treatment failed. Although several therapeutic interventions were performed in some children symptoms

of lacrimal duct obstruction persist and further surgery such as dacryocystorhinostomy (DCR) has to be considered. Surgery should not be done prior to the first year of age and should be regarded as a last line treatment after probing and intubation did not cure [12]. Here, dacryocystoscopy might be a helpful therapeutic tool, even in very young children.

## Patients and Methods

Dacryocystoscopies of 50 eyes were studied retrospectively. Surgeries were done between September of 2009 and September of 2014 in the Department of Ophthalmology, University Hospital Halle of Martin-Luther-University Halle/Wittenberg. To evaluate indications and results of dacryocystoscopic interventions in children this retrospective, non-comparative study was conducted.

## Patients

Forty-three eyes of 35 patients, 17 female and 18 male, were

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	N°	Mean age in months (range)	Sex		Eye		
			female	male	OD	OS	OU
Patients	35	34.11 (1-104)	17	18	12	15	8
Endoscopies	50	41.02 (1-119)	28	22	16	16	9

OD: right eye; OS: left eye; OU: both eyes

Table 1: Demographic data.

included in the study. Mean age was 37.6 months (range, 1-104). Cut-off age for the first endoscopy was 8 years. As treatment was done twice in seven eyes, 50 endoscopies were performed (mean age, 41.0 months; range, 1-119). Children were followed up for at least 3 months (mean, 25.8 months; range, 3-61). Demographic data are summarized in Table 1.

In case of classic congenital manifestation (congenital nasolacrimal duct obstruction, CNLDO), all children had previous conservative treatments and at least twice blind probing therapies. Three patients only suffered epiphora without purulent secretion. This was due to canalicular stenosis of the upper and lower canaliculus after Herpes-infection, canalicular stenosis after trauma and a congenital presacral stenosis. Amniotocoeles were treated in three cases. Two patients with congenital lacrimal fistula also underwent dacryocystoscopy.

For the evaluation of each postoperative outcome, a telephone interview was conducted. Only the primary performed endoscopies were included. We recorded symptoms such as epiphora, pus and pain. In addition parent's feedback regarding other complaints was collected. We categorized these symptoms into four groups (excellent, good, fair, poor). Thirty-five eyes of thirty patients could be included. Excellent result meant a complete absence of complaints. A good result existed if there was a difference between both eyes concerning epiphora which did not require any further therapy (mucosal discharge or pain were absent). A fair result implicated symptoms (epiphora or mucosal discharge) only appearing in case of a cold or infection of the nose and upper airways. If a dacryocystorhinostomy had to be done or a second endoscopic intervention followed we grouped it as a poor result. Overall, 35 eyes of 30 children could be included for follow-up. Only primary endoscopies were followed-up.

### Surgical technique

Dacryocystoscopy was always done under general anesthesia. Because of the narrow anatomy we only used a diagnostic endoscope (EndoGnost<sup>®</sup>, Schwind eye-tech-solutions, Kleinostheim, Germany) with a probe diameter of 0.9 mm (Figure 1). This rigid fiber endoscope has integrated image and illumination fibres as well as a drainage duct for irrigation. The optic provides a resolution of 6.000 pixels. It offers a 70° angle view with a 0° direction view. Light is generated by a 100 W xenon cold light source. The dynamic procedure is controlled visually over a TV screen to which the camera is adapted. Video documentation was done in every surgery. In one case we used the therapeutic endoscope (probe diameter of 1.1 mm) for laser dacryoplasty to remove intracanalicular granulomatous tissue after trauma.

Prior to surgery, epinephrine hydrochloride 1% eye drops were applied. This was followed by a xylometazoline hydrochloride (1 mg/ml) tamponade of the middle and inferior nasal meatus for subsiding. Later a clinical examination of the lacrimal system was done. After inspection of the lids, presence of discharge was done by massaging the lacrimal sac. Then the upper and lower punctum were dilated and a blunt cannula by Bangerter was placed in the canaliculus. First the tip of the cannula was advanced only about 4 mm. Irrigation showed whether a presacral stenosis existed by reflux over the same or the opposite

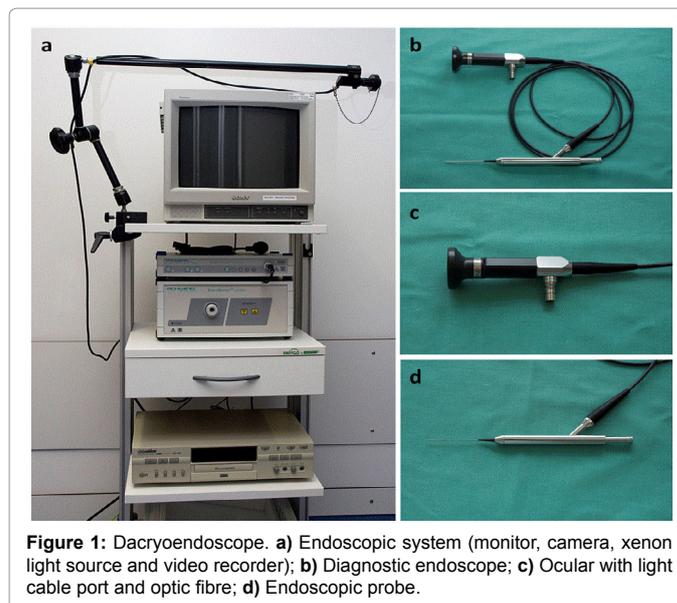


Figure 1: Dacryocystoscopy. a) Endoscopic system (monitor, camera, xenon light source and video recorder); b) Diagnostic endoscope; c) Ocular with light cable port and optic fibre; d) Endoscopic probe.

canaliculus. The existence of a hard stop was checked by further advancing of the cannula. This was done in both canaliculi. If syringing showed discharge, stenosis could be localized intra- or postsacral.

Next dacryocystoscopy was performed. After further dilatation, the endoscope was placed into the upper canaliculus. This changed if the upper punctum was too tight or the superior canaliculus showed a relevant stenosis. After the lacrimal sac was reached (hard stop), the endoscope was turned about 90° to enable a further advance into the lacrimal sac and nasolacrimal duct. The whole endoscopy was done under constant irrigation with physiological saline. The condition of the mucosa was observed and evaluated with care. Therefore we looked for scars, foreign bodies or dacryoliths and we examined the mucosal tissue by inspection. If possible, the whole lacrimal drainage system was examined. Stenosis tissue could be opened and enlarged under visualization or dacryoliths could be fragmented. So even if a diagnostic endoscope was used, we could utilize it as a therapeutic tool. Visually controlled the lacrimal pathway was probed (in case of stenosis). Because of the anatomical conditions in children we preferred to use only the diagnostic endoscope with 0.9 mm probe diameter.

After finishing the dacryocystoscopy silicone tubing was performed. This was done in every eye, except for one. For monocanalicular intubation, self-threading Monoka<sup>®</sup> (FCI, Paris, France) using the technique of Ritleng was applied. Therefore we favoured the upper punctum. Nevertheless, standard protocol had to be abandoned if necessary. In two eyes a bicanalicular intubation was performed using the technique of Jünemann (U-Intubation).

Postoperatively, topical combined antibiotic and steroid eye drops were prescribed five times daily for one week, then three times daily for another week. Three months postoperatively in-office removals of the silicone tubes were performed.

The use of endoscope was differentiated. If stenosis could be opened endoscopically the endoscopic procedure was therapeutic. Sometimes this was not feasible. Then the endoscopic intervention was defined as a solely diagnostic procedure. If possible, stenosis could be rechanneled with a Bangerter probe and intubation followed. The first endoscopic intervention is defined as the primary, the second one as the secondary procedure.

## Results

In general we performed 43 primary and 7 secondary endoscopic interventions (n=50). Of these, 12 (24%) were diagnostic and 38 were therapeutic (76%). Thirty-five of 43 (81.4%) primary endoscopies were done as a therapeutic intervention. Thirty-two of 38 eyes (91.4%) were treated successfully by therapeutic dacryocystitis. Eight of these 43 (18.6%) primary endoscopies were solely diagnostic. This was because the presaccal anatomy was too tight (n=2), localized a lacrimal fistula (n=1) or presence of a presaccal foreign body (n=1). Two eyes showed a postsaccal stenosis. These were simply reopened with a Bangerter probe. In two other eyes bony stenosis were detected requiring a DCR. One of these 2 patients could not be operated with DCR directly because parents withheld approval. Twenty months later when DCR was approved we performed endoscopy to confirm the indication. The second case revealed persisting epiphora after successful DCR with intubation. Therefore a second diagnostic endoscopy was done to exclude foreign body (silicone tube). Regarding all 43 primary endoscopies (therapeutic n=35; diagnostic n=8), cure rate was 83.7% (36/43).

### Endoscopic findings

In one of the patients clinical signs of lacrimal stenosis developed after lacrimal surgery was done due to trauma (laceration of the inferior canaliculus). A bulky formation occluded the entrance to the lacrimal sac (Figure 2a). Using endoscopy granulomatous tissue could be coagulated and removed by Erbium:YAG-Laser. To prevent cicatricial strictures an intubation was performed, too.

All children with CNLDO presented more or less mucosal discharge during surgery. This can be regarded as a clinical sign for chronic inflammation. Thirty-three eyes of 26 patients were treated by primary

dacryocystitis. Three eyes had bony stenosis. Two of them required DCR. Here, endoscopy could only be used as a diagnostic tool. In one case stenosis could be opened with a Bangerter probe. Later restenosis developed requiring DCR.

In another three eyes endoscopy was performed as a diagnostic approach as surgery was limited by anatomical conditions. Here opening of stenosis was reached by using a Bangerter probe, too. All endoscopies showed cicatricial tissue sometimes combined with strictures leading to a complete stenosis. Sometimes mucous restricted the endoscopic view. Hyperemia of the mucosa was a frequent condition. Furthermore, fibrinous membranes could be found very often.

The two children with lacrimal fistulas showed a connection between the skin (inferonasal to medial canthus) and common canaliculus. These were congenital fistulas. Both children suffered purulent secretion out of the fistula. After localizing the connections to the lacrimal pathway the fistulas were extirpated. Afterwards an intubation was inserted. One of them had a combined presaccal stenosis (Figure 2b) and signs of chronic dacryocystitis. The stenosis could be opened mechanically by endoscopic manipulation.

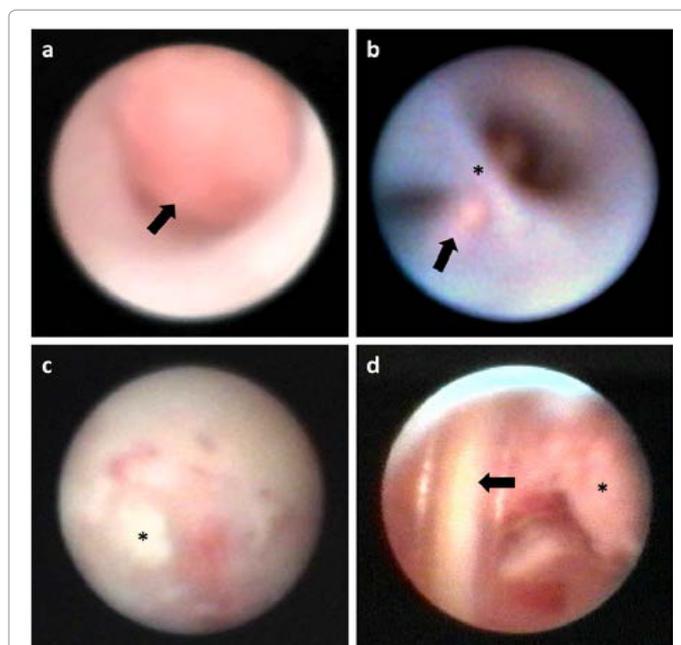
Amniotocoeles (mucocele of the lacrimal sac) were treated in three cases. Initially, children showed amniotic fluid discharging after tear sacs were compressed. After prior treatment (massage of the lacrimal sac and probing) was not successful they developed severe infection with purulent discharge. The ages of the children were 1, 2 and 3 months. Two were treated by dacryocystitis with intubation of a monocular silicone tube. In one case (1 month of age) surgery was planned to be performed by an ophthalmologist together with a physician for ENT. After probing under general anesthesia was not successful we decided to perform dacryocystitis to localize stenosis and to be able to remove mucous clots. A diaphanoscopy localization of the tear duct was scheduled. After endoscope was placed inside the lacrimal duct the region of Hasner's valve could be passed and the lacrimal duct could be irrigated. The endoscopy showed a partly scarred lacrimal duct. Nevertheless, this stenosis was incomplete and could be passed. The mucosa showed fibrinous plaques and hyperemia of the mucosal tissue (Figure 2c).

One child suffered severe chronic dacryocystitis of both eyes. Several interventions for lacrimal duct surgery with silicone intubation had been carried out. Using endoscopy the fragments of intrasaccal silicone tubes could be localized. The mucosa of the lacrimal sac was very vulnerable and distinct scarring existed (Figure 2d). As the tubes were knotted and scarred they had to be mobilized very carefully. The foreign bodies could be removed using a 20 Gauge vitrectomy forceps while they were visualized by endoscope. Both lacrimal ducts were intubated and the silicone tubes were removed after three months. No injuries of the canaliculi or recurrence of stenosis appeared so far (follow-up 36 months; Figure 3).

### Complications and recurrence

Two therapeutic endoscopies showed recurrences of symptoms. In three different eyes a repeated endoscopic surgery also failed. Therefore DCR had to be performed later. Another two eyes had a bony postsaccal stop. DCR was performed subsequently in the same surgery in one eye. The other child was treated at a later time by DCR as parents did not initially agree to DCR. Overall seven eyes (7/50; 14%) had to be treated by DCR.

Complications occurred in one case which means a complication rate of 2%. This was a rupture of the canaliculus while passing the valve



**Figure 2:** Endoscopic findings. **a)** Granulomatous tissue (arrow) of the inferior canaliculus after lacrimal surgery because of trauma, **b)** View of entrance of the saccus; lacrimal fistula localized by dacryocystitis and Bowman probe (arrow) and presaccal stenosis (star), **c)** Chronic dacryocystitis with fibrinous plaques (star) due to postsaccal re-stenosis after probing and syringing, **d)** Intrasaccal silicone tube (arrow) causing chronic dacryocystitis with granulomatous tissue (star).

of Rosenmüller. Even in this case surgery was finished uncomplicated with silicone tubing. No clinical symptoms persisted and the outcome was evaluated as excellent (follow-up 49 months).

The follow-up results showed 62.9% (n=22) with excellent, 11.4% (n=4) with a good result, in 11.4% (n=4) outcome was fair and 14.3% (n=5) had a poor outcome. The two eyes with bony stenosis were not included for follow-up because DCR was primarily required. Three-fourths of the children had an excellent or good outcome (Figure 4). Mean follow-up was 24.5 months (range, 3-61). Mean age was 38.8 months (range, 1-104). The main clinical characteristics of the 50 treatments and the follow-up results are shown in Table 2. Table 3 gives

a complete overview of indications, anamnesis and therapy as well as outcome for each patient.

### Discussion

Lacrimal duct obstruction (e.g., CNLDO) is the most frequent cause for epiphora in children. Commonest stenosis is caused by persistence of the Hasner's membrane. However, other pathologies of the lacrimal pathway such as combined pre- and postsaccal occlusions or atresia have to be considered. In 95% the children with CNLDO develop clinical signs during their first month of life [5-7]. Besides the disturbance caused by tearing and mucosal discharge severe complications such as acute dacryocystitis, preseptal or orbital cellulitis and respiratory tract infection may occur [13,14]. Untreated lacrimal duct obstruction in children affects the development of vision and refraction. A higher prevalence of anisometropia and amblyopia is described [9]. Since the last decades new therapeutic strategies were developed and the range of surgical options has increased. Nevertheless, standard procedure to treat CNLDO remains syringing and probing [15].

With the development of dacryocystitis as a therapeutic option for transcanalicular surgery a paradigm shift in therapy of lacrimal stenosis in adults occurred. Experimental investigation showed that dacryocystitis is a suitable technique for the evaluation and examination as well as treatment of the lacrimal duct system [16]. The improvement of stenting materials, endoscopic devices and a further spectrum of therapeutic options such as laser-technique, microdrill or balloon-dilators brought an enormous advancement [3,4]. Some authors report successful use of dacryocystitis in children [17-19]. But patient numbers have been rather small and doubts as well as controversies still exist. Besides that, the wide range of indications for dacryocystitis in children was not revealed yet.

The aim of our study was to present the opportunities and the wide range of indications for dacryocystitis in childhood. Thus, our cohort is inhomogeneous. As only a few children had to be treated by this method, our study is limited. The study was retrospective and a control-group would have been desirable. The follow-up varies and only 35 cases could be included. However, we report 50 endoscopies. Regarding the whole cohort, 12 of these interventions were diagnostic and 38 were therapeutic. In case of therapeutic application the occluded lacrimal duct system was rechanneled under visual control by mechanical manipulation with the endoscope. Diagnostic means that stenosis could not be opened with the endoscope. So we only had a diagnostic benefit in those cases. But this gave us important information for further treatment. Seven eyes were treated a second time so that overall 43 interventions were done primary. Thirty-five of these primary endoscopies were performed as therapeutic application. Here, cure rate was 91.4% (32/35). The other 8 interventions were diagnostic. The secondary endoscopies (n=7) were separated into 3

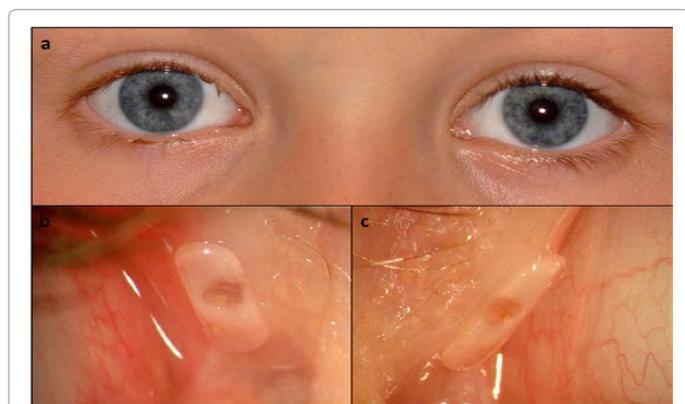


Figure 3: Postoperative findings after removal of foreign bodies. a) Overview of both eyes. b) Right eye: Plug of the Monoka in the upper punctum, c) Left eye: Plug of the Monoka in the upper punctum.

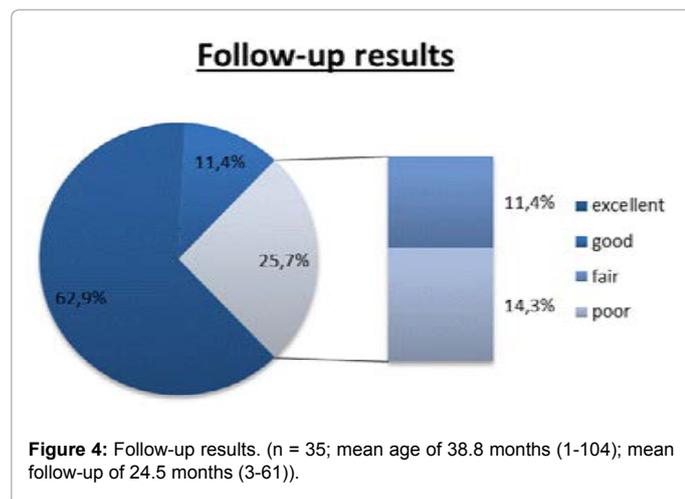


Figure 4: Follow-up results. (n = 35; mean age of 38.8 months (1-104); mean follow-up of 24.5 months (3-61)).

	Use of endoscopy			Complications				Outcome				
	N°	T	D	N°	abort	DCR*	DCR**	N°	excellent T/D	good T/D	fair T/D	poor T/D
DC	39	31	8	0	3	2	5	25	14/0	3/0	2/1	5/0
PrS	6	3	3	1	2	0	0	5	2/1	1/0	0/1	0
AC	3	3	0	0	0	0	0	3	3/0	0	0	0
LF	2	1	1	0	0	0	0	2	1/1	0	0	0
<b>Total</b>	<b>50</b>	<b>38</b>	<b>12</b>	<b>1</b>	<b>5</b>	<b>2</b>	<b>5</b>	<b>35</b>	<b>22 (20/2)</b>	<b>4 (4/0)</b>	<b>4 (2/2)</b>	<b>5 (5/0)</b>

\* DCR because of bony stenosis, \*\* DCR because of recurrence DC: Chronic Dacryocystitis; PrS: Presaccal Stenosis; AC : Amniotocoele; LF: Lacrimal Fistula; T: Therapeutic endoscopy; D: Diagnostic endoscopy

Table 2: Indication/Anamnesis/Intraoperative findings/Therapy/Outcome.

Pat. no.	Case no.	Sex	Age (month)	Eye	Indication	Anamnesis	Intraoperative findings	Therapy	Use	Follow-up	Outcome	DCR
1	1	M	54	OD	EP	Ringintubation after trauma	PrS, IC with granulomatous tumor	transcanalicular Laser, Monoka IP	T	61	excellent	no
2	2	M	93	OS	EP	Herpes-infection	PrS of both canaliculi after 5 mm	diagnostic endoscopy, opening with Bangerter probe; U-Intubation	D	53	excellent	no
3	3	W	14	OS	EP	EP	PrS	endoscopic opening; Monoka SP	T	3	excellent	no
4	4	M	11	OD	EP	status post lacrimal surgery	PrS, foreign body, canaliculitis	diagnostic endoscopy, foreign body extracted surgically, Monoka SP	D	17	fair	no
	5	M	11	OS	EP	status post lacrimal surgery	PrS, mild DC, no foreign body	endoscopic widening, Monoka SP	T	17	good	no
5	6	W	1	OD	AC	bacterial superinfection	PoS, membranous	endoscopic opening	T	42	excellent	no
6	7	M	2	OS	AC	bacterial superinfection	PoS, membranous	endoscopic opening; Monoka SP	T	39	excellent	no
7	8	W	3	OS	AC	bacterial superinfection	PoS, membranous	endoscopic opening; Monoka SP	T	4	excellent	no
8	9	M	69	OD	LF	EP, MD	PrS and PoS, DC	endoscopic opening; Monoka SP	T	14	excellent	no
9	10	M	23	OS	LF	MD	PrS, DC	endoscopic localization, Monoka SP excision of fistula	D	3	excellent	no
10	11	W	36	OS	DC	CNLDO	PrS, membranous, long	endoscopic opening; Monoka SP	T	41	excellent	no
11	12	W	24	OS	DC, MD	CNLDO	PrS and PoS, short bony	diagnostic endoscopy, opening with Bangerter probe; Monoka SP	D	49	fair	no
12	13	W	15	OS	DC, MD	CNLDO	PoS, membranous	endoscopic opening; Monoka SP	T	47	fair	no
13	14	M	103	OS	DC	CNLDO	PoS, intrasaccal cyst	endoscopic opening; Monoka SP	T	30	excellent	no
14	15	W	5	OD	DC, MD	CNLDO	PoS, membranous	endoscopic opening; Monoka SP	T	5	excellent	no
15	16	W	23	OS	DC, MD	CNLDO	PoS, membranous	endoscopic opening; Monoka SP	T	33	fair	no
16	17	M	24	OD	DC, MD	CNLDO	PoS, membranous	endoscopic opening; Monoka SP	T	33	excellent	no
17	18	W	12	OS	DC, MD	CNLDO	PoS, membranous	endoscopic opening; Monoka SP	T	3	excellent	no
18	19	M	27	OS	DC	CNLDO	PoS, membranous	endoscopic opening; Monoka SP	T	33	excellent	no
19	20	M	55	OD	DC	CNLDO	PoS, membranous	endoscopic opening; Monoka SP	T	23	excellent	no
20	21	W	3	OD	DC	CNLDO	PoS, membranous	endoscopic opening; Monoka SP	T	23	excellent	no
21	22	M	9	OD	DC, MD	CNLDO	PrS and PoS	endoscopic opening; Monoka SP	T	17	excellent	no
22	23	W	6	OD	DC, MD	CNLDO	PoS, membranous	endoscopic opening; Monoka SP	T	31	excellent	no
23	24	W	4	OS	DC	CNLDO	PrS of IC, PoS, DL	endoscopic opening, DF, Monoka IP	T	n.i.		no
24	25	M	52	OS	DC	CNLDO	PoS, membranous	endoscopic opening; Monoka SP	T	n.i.		no
25	26	M	13	OD	DC	CNLDO	PoS	endoscopic opening; Monoka SP	T	n.i.		no
	27	M	13	OS	DC	CNLDO	PoS	endoscopic opening; Monoka SP	T	n.i.		no
26	28	M	54	OD	DC	CNLDO	PrS, PoS	endoscopic opening; Monoka SP	T	n.i.		no
	29	M	54	OS	DC	CNLDO	PrS, PoS	endoscopic opening; Monoka SP	T	n.i.		no
27	30	M	63	OD	DC, MD	CNLDO, multiple probing	intrasaccal foreign body	transcanalicular extraction, Monoka SP	T	28	excellent	no
	31	M	63	OS	DC, MD	CNLDO, multiple probing	intrasaccal foreign body	transcanalicular extraction, Monoka SP	T	28	excellent	no
28	32	W	71	OD	DC, MD	CNLDO	PoS	endoscopic opening; Monoka SP	T	39	good	no
	33	W	71	OS	DC, MD	CNLDO	PoS	endoscopic opening; Monoka SP	T	39	good	no
29	34	W	27	OD	DC, MD	CNLDO	PoS, membranous	endoscopic opening; Monoka SP	T	22	excellent	no
	35	W	27	OS	DC, MD	CNLDO	PoS, membranous	endoscopic opening; Monoka SP	T	22	excellent	no
30	36	W	51	OS	DC, MD	CNLDO	PoS	endoscopic opening, Monoka SP	T	43	poor	
	37	W	61	OS	DC, MD	CNLDO	PoS	diagnostic endoscopy; DCR	D	43		yes
31	38	M	78	OD	DC, MD	CNLDO	PrS, PoS	diagnostic endoscopy, opening with Bangerter probe, Monoka SP	D	3	poor	
	39	M	78	OS	DC, MD	CNLDO	PrS, PoS	diagnostic endoscopy, opening with Bangerter probe, Monoka SP	D	3	poor	
	40	M	81	OD	DC, MD	CNLDO	PoS	endoscopic opening, Monoka SP	T	6	poor	yes
	41	M	81	OS	DC, MD	CNLDO	PoS	endoscopic opening, U-Intubation	T	6	poor	yes
32	42	W	21	OD	DC, MD	CNLDO	PoS	endoscopic opening, Monoka SP	T	4	poor	
	43	W	27	OD	DC, MD	CNLDO	PoS	endoscopic opening, U-Intubation	T	17	poor	yes
33	44	M	104	OD	DC, MD	CNLDO	PoS, bony, atresia IP	diagnostic endoscopy, DCR	D	5		yes
	45	M	104	OS	DC, MD	CNLDO	PoS, atresia SP	endoscopic opening, Monoka SP	T	5	good	no
	46	M	119	OD	EP after DCR	exclusion foreign body	no foreign body, PrS	diagnostic endoscopy	D	12	good	
34	47	M	10	OD	DC, MD	CNLDO	PoS; bony stenosis	endoscopic opening, Monoka SP and IP	T	10	poor	
	48	M	16	OD	DC, MD	CNLDO	PoS, broad	diagnostic endoscopy, DCR	D	4		yes
35	49	W	34	OD	DC, MD	CNLDO	PoS, bony, atresia SP	diagnostic endoscopy	D	20		
	50	W	64	OD	DC, MD	CNLDO	PoS, bony, atresia SP	diagnostic endoscopy, DCR	D	3		yes

OD: right eye; OS: left eye; M: masculine; F: feminine; D: diagnostic; T: therapeutic; AC: amniotocele; DC: dacryocystitis; DL: dacryolith; DF: dacryolith-fragmentation; EP: Epiphora; MD: mucous discharge; IC: inferior canaliculus; PoS: postsaccal stenosis; IP: inferior punctum; PrS: presaccal stenosis; SP: superior punctum; LF: lacrimal fistula; n.i.: not included

Table 3: Dacryocystitis for lacrimal duct obstruction manifesting in childhood.

therapeutic and 4 diagnostic procedures.

There seems to be evidence that success rates fluctuate in dependence on several factors. Honavar reports a success rate of 73% after the first probing, which increased to 80% after a second treatment was performed. All of the children included in that study have had one unsuccessful treatment before. Besides that the study gives evidence that the kind of stenosis (e.g., rigid resistance, length of occlusion) is meaningful [20]. Furthermore, results seem to be influenced by the kind of surgery. Success rates of balloon dilation and intubation were compared. Results differed slightly (79% in the balloon dilation group vs. 84% in the intubation group) [21]. Another study reports a success rate of even 97% after probing although children were treated twice before and no additional intubation techniques were used [22]. In comparison to these studies we report a cure rate of 83.7%. A main risk factor for unsuccessful probing might be complex stenosis. Many children with CNLDO but so far uneventful lacrimal duct findings are treated successfully in young ages, so that complex cases accumulate with increasing age. Classical membranous stenosis had a cure rate of over 90%, but complex situations were treated successfully in only about 33%. According to that a significant age correlation was seen, too. The children with complex stenosis were older [23]. Our results seem to be related to that. The mean age of our cohort was about 34 months. So the subjects were rather selected and predisposed to complex stenosis of the lacrimal duct.

It has been proven that therapeutic probing in older children is not that effective. This might be due to scarring in the lacrimal duct because of long lasting inflammation. The response to a second or third probing is rather low if the first probing was unsuccessful [10,11,24]. Sasaki et al. advise primary endoscopic probing as an alternative to standard probing. In this study authors present thirteen eyes of ten children who underwent an endoscopic intervention as a first therapeutic approach for CNLDO. Surgery was effective and safe. The benefits of saving the mucosa of the lacrimal duct by visualization of each surgical step were pointed out [18].

Children not responding to repeated probing and syringing are often indicated for DCR [12]. Here, transcanalicular endoscopic surgery might be added as a therapeutic approach. As we only included children having had standard therapy before endoscopic surgery, we conclude that dacryocystitis offers a valuable addition. Some years ago, this minimally-invasive technique was reserved for adults as the narrow anatomy was thought to be a contraindication in juvenile patients [25]. In 2% of adults having transcanalicular endoscopic surgery complications occurred. These were bleeding or edema of the lid because of *via falsa*, and nose bleedings or injuries like slitting of the lacrimal punctum [25]. In our study only diagnostic endoscopes (probe diameter of 0.9 mm) were used. In this consideration the complication rate in children was not higher than in adults. We did not observe severe complications in any of our cases. Out of all 50 endoscopies there was one with a rupture of the canaliculus. Surgery was not affected and could be finished successfully. After removing intubation no complaints persisted. Our findings ultimately confirmed that dacryocystitis is a safe and suitable intervention in childhood. It has to be considered that the anatomy of the lacrimal duct system in children is very narrow. Nevertheless, tissue is very elastic. The canaliculus used for dacryocystitis has to be dilated very carefully. The ring-muscle should not be damaged. Dilation has to be repeated very often until endoscope can pass without force. If this is kept in mind, even large foreign bodies can be removed through the canaliculus. One child had bilateral silicone tubes inside the lacrimal sacs which caused chronic

dacryocystitis. The foreign bodies could be removed by transcanalicular surgery although they had diameters of approximately 1.5 mm [26].

In seven eyes of our cohort the first treatment using dacryocystitis was not successful. Surgery was uneventful and seemed to be curative as long as there were silicone tubes inside the lacrimal pathways. After removing intubations symptoms recurred. As there were no specific complications and parents preferred minimally-invasive surgery, a second dacryocystitis was performed. All these eyes required DCR. Regarding to this, there might be evidence that a second endoscopic intervention is not valuable. However, this cannot be proofed here as patient number is too small.

Although all of the children included in our study were treated at least two times before a cure rate of 83.7% was reached. We can also report ten cases of successful use in children younger than 12 months. Furthermore, we offer a broad spectrum of indications: CNLDO, removing of intrasaccal foreign bodies, lacrimal fistula, amniotocoele, and presaccal pathologies. For all these disorders dacryocystitis was beneficial in a diagnostic and/or a therapeutic respect. In one patient intracanalicular granulomatous tissue after trauma was treated by endoscopic laser dacryoplasty (Figure 1a). The use of the therapeutic endoscope (probe diameter of 1.1 mm) was uneventful. Otherwise (diagnostic) endoscope was effectively used for mechanical opening of the stenosis under visual control. If the procedure was not successful as a therapy it still provided worthwhile diagnostic information concerning the existing pathology. We used it for localization of foreign bodies or orifice of lacrimal fistula (Figure 1b) and to describe the shape of the stenosis (Figure 1c). Assisted by the endoscope, foreign bodies could be removed through the canaliculus using forceps (Figure 1d).

Using dacryocystitis in children we expected a significant lower rate of false passage as the accurate opening is possible by visual control. Hence, it provided a better understanding of the existing anatomy and pathology. A benefit of seeing the kind and shape of stenosis gives advantages in planning consecutive therapeutic steps. If a bony stenosis is apparent DCR is indicated. Another advantage is the possibility to fragment dacryoliths. Anatomy can be saved and preserved as it is a minimally-invasive technique. Nevertheless there are several limitations. The anatomical conditions of children might be limiting. Dacryocystitis should never be forced. As microtrauma might be caused, intubation for saving the lacrimal pathway should be applied regularly. Using this technique surgeons need to have a long experience in adults. The possibility to switch to another procedure should be available.

Meanwhile some studies exist showing that dacryocystitis of children is possible and safe. Nevertheless, it cannot be regarded as a standard therapy. Therefore we would advise this intervention as a supplementary procedure after unsuccessful probing and DCR is an option to be considered. With the use of dacryocystitis the rate of DCR might be lowered. Severe complications did not occur and the complication rate was not higher than in adults. Further trials are needed to investigate the clinical benefit for children.

## Disclosure

The authors report no conflicts of interest in this work. None of the authors has any financial or proprietary interest in any material or method mentioned.

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