

Nasolacrimal recanalization as an alternative to external dacryocystorhinostomy for treating failed nasolacrimal duct intubation

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Abstract

To compare the surgical duration and clinical outcomes of nasolacrimal recanalization versus external dacryocystorhinostomy (DCR) in the treatment of failed nasolacrimal duct intubation.

This is a retrospective, comparative, and interventional study. We evaluated the outcomes of 66 consecutive patients undergoing either nasolacrimal recanalization (n=32) or DCR (n=34) in a tertiary lacrimal disease referral center. Length of surgical duration, clinical outcomes, and rate of recurrence at 18 months postoperatively were compared.

The mean surgical duration was 18.5 minutes (range, 15–25 minutes) for nasolacrimal recanalization and 48.2 minutes (range, 45–61 minutes) for DCR, respectively ($P < 0.001$). The rate of success was 84.4% in the recanalization group and 85.3% in the DCR group, respectively ($P = 0.91$). The time to recurrence was 2.6 ± 1.1 months in the recanalization group and 5.6 ± 2.1 months in the DCR group ($P < 0.001$). Five failed cases in each group received a secondary DCR surgery with the same resolution rate (40%). The absence of ocular discharge at baseline was a significant predictor for a successful outcome in the recanalization group ($P = 0.04$) but not in the DCR group ($P = 0.63$).

Nasolacrimal recanalization is an effective, safe, and time-saving alternative to DCR for the treatment of failed nasolacrimal duct intubation. Clinicians should be cautious in patients with discharge.

Abbreviations: DCR = dacryocystorhinostomy, FNDI = failed silicone nasolacrimal duct intubation.

Keywords: external dacryocystorhinostomy, failed silicon nasolacrimal duct intubation, nasolacrimal duct obstruction, nasolacrimal recanalization

1. Introduction

Nasolacrimal duct obstruction is a common disease of the lacrimal apparatus that presents with excessive tearing, ocular discomfort, and blurred vision.^[1] The most common surgical

approaches used to treat this condition are: lacrimal duct probing, silicone tube nasolacrimal intubation, nasolacrimal balloon dilation, and external or endonasal dacryocystorhinostomy (DCR).^[2] Although DCR has a success rate of 85% to 95%, it is not exempt of complications, such as facial skin scarring,

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copious hemorrhage, and damage to the medial canthal anatomy.^[3] The use of nasolacrimal intubation with silicone as an alternative approach to DCR is under debate due to its poor rate of success, usually 50% or less.^[4–7] However, given its simple and timesaving technique and its low cost, intubation with silicone is widely used to treat patients with partial or complete nasolacrimal duct obstruction.^[2,8,9] In patients with failed silicone nasolacrimal duct intubation (FNDI), DCR is often the recommended therapeutic approach.

Nasolacrimal recanalization is a recently introduced surgical procedure to treat patients with nasolacrimal duct obstruction that consists of retrograde removal of obstructing tissues using electrocauterization.^[10] In a comparative study, nasolacrimal recanalization was proved to be an effective and simple approach to treat nasolacrimal duct obstruction with a success rate of 93.1%, compared to 91.1% of DCR.^[11]

To the best of our knowledge, there are no studies reported in the literature that evaluate the efficacy of recanalization in the treatment of FNDI. In the current study, we presented a comparative analysis of the clinical outcomes after nasolacrimal recanalization and DCR in 66 patients with FNDI.

2. Methods

In this study, we retrospectively reviewed the medical records of consecutive patients with FNDI who were referred for surgical management to the Shanghai Eye and ENT Hospital Lacrimal Clinic between May 2012 and May 2015. The study was approved by the Institutional Review Board and the Medical Ethics Committee and was conducted in adherence to the tenets of the Declaration of Helsinki. Written informed consent was obtained from all the participants.

We collected information on patients' demographics, symptoms, clinical signs, surgical duration, and clinical outcomes. The inclusion criteria were: patients undergoing either external DCR or nasolacrimal recanalization; age ≥ 18 years; a diagnosis of primary acquired nasolacrimal duct obstruction before silicone intubation surgery and the silicone intubation has been removed; and a diagnosis of FNDI for at least 2 months before recanalization surgery. Diagnosis of FNDI was made if, after comprehensive nasolacrimal probing, recurrence of epiphora or mucoid discharge was detected and complete nasolacrimal obstruction (failure of nasolacrimal irrigation and dye disappearance testing) was present. We excluded patients with: acute dacryocystitis; suspicion of lacrimal system malignancy; significant nasal pathology; previous lacrimal surgery with the exception of silicone intubation; canalicular obstruction; history of severe hypertension or cardiac disease; or a follow-up time of less than 18 months.

2.1. Surgical procedure

External DCR was performed under local anesthesia in a standard fashion.^[3] Nasolacrimal recanalization was performed as previously reported.^[10] Briefly, nasolacrimal probing and intranasal endoscopic exams were performed. Then, a high-frequency electrocautery probe (Gaia Medical Technology, Shenzhen, China) was inserted into the nasolacrimal duct via the upper punctum. The tip of the probe passed through the nasolacrimal duct and entered into the inferior meatus and had a hard stop, followed by slow, retrograde electrocauterization (120–150 W power with 500 kHz frequency) until the probe can rotate in 360°, meaning that the tip of the probe had reached the

upper opening of the nasolacrimal duct. The entire procedure was repeated as needed during the same session until the probe passed freely through the nasolacrimal duct.^[10] The silicone tube was inserted and tied with several knots in both groups. Postoperatively, patients received topical tobramycin 0.3% and dexamethasone 0.1% eye drops 3 times per day for the 1st 2 weeks, and topical tobramycin 0.3% eye drops 3 times per day for 2 more weeks. The lacrimal passage was irrigated with tobramycin 0.3% and dexamethasone 0.1% solution weekly during the 1st 2 weeks after surgery. Three months after surgery, the silicone tube was removed by cutting the silicone tube between the puncta and by either blowing the nose or by extracting the tube from the nose with forceps under intranasal endoscopy.

At the final follow-up, clinical outcomes for both procedures were categorized as: successful, defined as complete disappearance of signs and symptoms; or failed, partial improvement, no improvement, or worsening of symptoms. Intraoperative and postoperative complications were recorded.

In cases of bilateral FNDI, only the 1st surgery was considered for analysis. We used the Mann–Whitney *U*, Student *t*, and Chi-square tests to compare the mean differences between the 2 studied groups. All the variables were entered into a univariate logistic regression analysis one at a time, and those variables with a *P* value lower than 0.2, for its relationship with an outcome of complete resolution, were entered into the final multivariate logistic regression analysis. A 2-sided *P* value of less than 0.05 was considered statistically significant. Data were analyzed with the statistical software package SPSS 22.0 for Windows (IBM; Chicago, IL).

3. Results

During the selected study period, a total of 95 cases of failed nasolacrimal duct intubation were referred to the Shanghai Eye and ENT Hospital Lacrimal Clinic. Data from 66 patients were available after excluding patients with canalicular obstruction ($n=11$), multiple lacrimal surgeries ($n=8$), and a follow-up time shorter than 18 months ($n=10$). The mean age of the studied cohort was 51.1 ± 8.0 years (range, 31–72), and 53 patients (80.3%) were female, 10 cases were bilateral, and a total of 32 patients (48.5%) underwent nasolacrimal recanalization. After dividing patients in nasolacrimal recanalization and DCR groups, both groups were comparable in terms of age, sex, laterality, number of bilateral-cases, duration of the disease, and the presence of discharge (Table 1).

As shown in Table 2, the average duration of the surgical procedure was significantly shorter with recanalization (18.5 minutes; range 15–25), compared to DCR (48.2 minutes; range 45–61) ($P < 0.001$). After 18 months of follow-up, surgical success was achieved in 27 patients in the recanalization group (84.4%) and in 29 patients in the DCR group (85.3%) ($P = 0.91$). In cases where nasolacrimal obstruction recurred, the mean time to recurrence was 2.6 ± 1.1 months in the recanalization group and 5.6 ± 2.1 months in the DCR group ($P < 0.001$). None of the patients who suffered recurrence presented canalicular obstruction. Cases with failed procedures (5 in each group) received a secondary DCR surgery, and the rate of resolution was the same in both groups (40%). There were no reports of severe intraoperative or postoperative complications.

The multivariate linear regression model revealed that the absence of ocular discharge at baseline was a significant factor predicting a successful outcome in the recanalization group ($P = 0.04$), but not in the DCR group ($P = 0.63$). Age, sex, duration of the disease, bilateral cases, right/left eye, and the duration of the

Table 1
Demographic data of FNDI in 66 cases.

Parameters	Recanalization (n=32)	DCR (n=34)	P
Age, years	50.6±8.7 (range, 31–67)	51.5±7.2 (range, 36–72)	0.777
Sex			0.851
Male	6 (18.8%)	7 (20.6%)	
Female	26 (81.3%)	27 (79.4%)	
Laterality			0.632
Right	16 (50.0%)	19 (55.9%)	
Left	16 (50.0%)	15 (44.1%)	
Onset			0.917
Unilateral	27 (84.4%)	29 (85.3%)	
Bilateral	5 (15.6%)	5 (14.7%)	
Time since onset, months	5.2±2.1 (range, 2–9)	5.2±1.8 (range, 2–10)	0.938
Signs			0.800
Discharge	15 (46.9%)	17 (50.0%)	
No discharge	17 (53.1%)	17 (50.0%)	

DCR=external dacryocystorhinostomy, FNDI=failed nasolacrimal duct intubation.

surgical procedure were not associated with the outcome in either group (Table 3).

4. Discussion

Our findings show that the efficacy of nasolacrimal recanalization for the treatment of failed nasolacrimal duct intubation is comparable to DCR, which is considered the gold standard for nasolacrimal duct permeabilization.^[12,13] As an advantage, nasolacrimal recanalization reduces the surgical time by more than 50%, and in case of failure clinicians can switch to a primary DCR without any additional risks or complications.

Our findings confirm that DCR is safe and effective to treat nasolacrimal duct obstruction. Leong et al^[13] reported that the rate of success after DCR varies between 65% and 100% compared to 84% to 94% after nasal endoscopic DCR. Another study showed better rates of success with external DCR than with endoscopic DCR.^[12] It is reported that facial cutaneous scars, lacrimal pump dysfunction, and disruption of the medial canthal anatomy can occur after DCR.^[11,14] A potential alternative to systematically overcome these relatively common complications is to restore the obstructed nasolacrimal duct without performing a bypass draining system, as is the case with DCR external and endoscopic procedures. For this purpose, Chen et al^[10] developed nasolacrimal recanalization as a technique for the permeabiliza-

Table 2
Surgical time, clinical outcomes of FNDI patients.

Parameters	Recanalization (n=32)	DCR (n=34)	P
Surgical time, minutes	18.8±2.5 (range, 15–25)	59.2±14.5 (range, 45–61)	<0.001
Outcomes			0.917
Success	27	29	
Failure	5	5	
Time to recurrence, month	2.6±1.1 (range, 1–3)	4.8±1.3 (range, 3–6)	<0.001
Second DCR surgery			n/a
Success	2	2	
Failure	3	3	

DCR=external dacryocystorhinostomy, FNDI=failed nasolacrimal duct intubation, n/a=not applicable.

Table 3
Univariate and multivariate regression analysis on potential factors that influence surgical success for FNDI patients.

Parameter	Recanalization (n=32)		DCR (n=34)	
	Univariate	Multivariate	Univariate	Multivariate
Age	0.345	–	0.752	–
Sex	0.938	–	0.972	–
Laterality	0.628	–	0.445	–
Onset eyes	0.170	0.256	0.110	0.112
Onset time	0.040	0.104	0.160	0.210
Discharge	0.020	0.040	0.630	–
Surgical time	0.574	–	0.709	–

DCR=external dacryocystorhinostomy, FNDI=failed nasolacrimal duct intubation.

tion of nasolacrimal duct obstruction while preserving the physiological tear passage to the greatest extent.

Based on the current study, the success rate by nasolacrimal recanalization in cases of FNDI is comparable to that by DCR. Nasolacrimal recanalization not only removes fibrosis and obstructed tissues, but also may eliminate pathogenic microorganisms hosting in the nasolacrimal duct through electrocauterization.^[10] Lacrimal duct infection is associated with the development of nasolacrimal duct obstruction, although the exact mechanism is still unknown.^[6,7] The creation of a new and wide functional lumen that restores normal tear drainage, and direct elimination of pathogenic microorganisms by electrocauterization may have contributed to reducing postsurgical risk of infection, inflammation, and obstruction recurrence. Further studies are required to elucidate the specific factors that are responsible for the comparably high success by nasolacrimal recanalization as external DCR.

Even though about 15.6% of cases required a secondary surgical approach, the vast majority of the recanalization procedures (84.4%) were successful. The rates of failed cases were similar between the 2 groups, with comparable rates of resolution after a secondary DCR. Interestingly, recurrence of nasolacrimal obstruction occurred within 3 months in the recanalization group, while in the DCR group it occurred on average at 6 months postoperatively or later. Post-DCR recurrence time in this study was similar to previous reports, usually 6 months or more.^[3,15,16] Based on previous reports, and given that canalicular obstruction was ruled out in the cases of failed DCR, scarring of the osteotomy site, contact granuloma, and incision scar formation are likely to be the main causes of failure in the current study.^[17–19] Meanwhile, in the cases of failed recanalization, probing and intranasal endoscopic exams revealed that the obstruction continued to be located in the nasolacrimal duct. Resistance during the probing exam in these cases suggested scarring within the nasolacrimal duct as the main cause for recurrence. We speculate that the different time from surgery to recurrence between the 2 procedures may be related to the width of the nasolacrimal lumen left after each procedure, with narrower lumens in the recanalization cases prone to being obstructed earlier due to scarring.

Our data also show that absence of discharge at baseline is a predictive factor of surgical success in the recanalization group but not in the DCR group. Only a few articles have explored the risk factors for failure of external DCR. Lee et al^[20] reported that age, sex, duration of disease, history of chronic dacryocystitis, width of nasal cavity, and vertical size of bony ostium were not associated to failure of external DCR. Our data show that

presence of discharge before surgery elevated the rate of recurrence, which could be an indication of presence of infection in the dacryocyst and/or the nasolacrimal duct, is correlated with the higher recurrence. During recanalization, application of electrocauterization can be only applied to the nasolacrimal duct, supporting the possibility that in some cases pathogenic microorganisms within the dacryocyst can be left untouched. These untreated lesions may account for some of the recurrent cases by facilitating postoperative subacute or chronic dacryocystitis, which lead to inflammation and scarring.

Some of the main limitations of this study are related to its retrospective nature. Prospective and randomized allocation of patients with FNFI to each 1 of the 2 compared surgical procedures with close postsurgical follow-up, including nasolacrimal probing in the 1st postoperative months, would be ideal to determine some of the main differences between both procedures' outcomes. Additionally, microbiological analysis of nasolacrimal secretion may provide more information explaining its influence on the outcomes of recanalization but not on DCR. Finally, comprehensive anatomical evaluation or histological sampling during secondary DCR in failed cases, from both groups, would provide valuable insights into the causes of failure.

In conclusion, nasolacrimal recanalization is an effective and time-saving alternative for treating patients with FNFI. Clinicians should be cautious in recommending this approach for patients with active discharge. Prospective and randomized studies are required to confirm the safety and efficacy of this surgical approach.

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References

- [1] Tucker N, Chow D, Stockl F, et al. Clinically suspected primary acquired nasolacrimal duct obstruction: clinicopathologic review of 150 patients. *Ophthalmology* 1997;104:1882–6.

- [2] Patel BC. Management of acquired nasolacrimal duct obstruction: external and endonasal dacryocystorhinostomy. Is there a third way? *Br J Ophthalmol* 2009;93:1416–9.
- [3] Hartikainen J, Grenman R, Puukka P, et al. Prospective randomized comparison of external dacryocystorhinostomy and endonasal laser dacryocystorhinostomy. *Ophthalmology* 1998;105:1106–13.
- [4] Anderson RL, Edwards JJ. Indications, complications and results with silicone stents. *Ophthalmology* 1979;86:1474–87.
- [5] Liu D, Bosley TM. Silicone nasolacrimal intubation with mitomycin-C: a prospective, randomized, double-masked study. *Ophthalmology* 2003;110:306–10.
- [6] Psilas K, Eftaxias V, Kastanioudakis J, et al. Silicone intubation as an alternative to dacryocystorhinostomy for nasolacrimal drainage obstruction in adults. *Eur J Ophthalmol* 1993;3:71–6.
- [7] Tabatabaie SZ, Heirati A, Rajabi MT, et al. Silicone intubation with intraoperative mitomycin C for nasolacrimal duct obstruction in adults: a prospective, randomized, double-masked study. *Ophthalmol Plast Reconstr Surg* 2007;23:455–8.
- [8] Mimura M, Ueki M, Oku H, et al. Indications for and effects of Nunchaku-style silicone tube intubation for primary acquired lacrimal drainage obstruction. *Jpn J Ophthalmol* 2015;59:266–72.
- [9] Zhang JX, Deng HW, Yan B, et al. [A novel retrograde intubation procedure for treatment of nasolacrimal duct obstruction]. [*Zhonghua Yan Ke Za Zhi*] *Chin J Ophthalmol* 2007;43:806–9.
- [10] Chen D, Ge J, Wang L, et al. A simple and evolutionary approach proven to recanalise the nasolacrimal duct obstruction. *Br J Ophthalmol* 2009;93:1438–43.
- [11] Leong SC, Karkos PD, Burgess P, et al. A comparison of outcomes between nonlaser endoscopic endonasal and external dacryocystorhinostomy: single-center experience and a review of British trends. *Am J Otolaryngol* 2010;31:32–7.
- [12] Huang J, Malek J, Chin D, et al. Systematic review and meta-analysis on outcomes for endoscopic versus external dacryocystorhinostomy. *Orbit* 2014;33:81–90.
- [13] Leong SC, Macewen CJ, White PS. A systematic review of outcomes after dacryocystorhinostomy in adults. *Am J Rhinol Allergy* 2010;24:81–90.
- [14] Dolman PJ. Comparison of external dacryocystorhinostomy with nonlaser endonasal dacryocystorhinostomy. *Ophthalmology* 2003;110:78–84.
- [15] Baig R, Khan QA, Ahmad K. Long-term outcome of primary external dacryocystorhinostomy. *J Coll Physicians Surg Pak* 2013;23:641–4.
- [16] McMurray CJ, McNab AA, Selva D. Late failure of dacryocystorhinostomy. *Ophthalmol Plast Reconstr Surg* 2011;27:99–101.
- [17] Knisely A, Harvey R, Sacks R. Long-term outcomes in endoscopic dacryocystorhinostomy. *Curr Opin Otolaryngol Head Neck Surg* 2015;23:53–8.
- [18] Elmorsy SM, Fayk HM. Nasal endoscopic assessment of failure after external dacryocystorhinostomy. *Orbit* 2010;29:197–201.
- [19] Watkins LM, Janfaza P, Rubin PA. The evolution of endonasal dacryocystorhinostomy. *Surv Ophthalmol* 2003;48:73–84.
- [20] Lee MJ, Khwarg SI, Choung HK, et al. Associated factors of functional failure of external dacryocystorhinostomy. *Can J Ophthalmol* 2014;49:40–4.