Management of Functional Epiphora in Patients With an Anatomically Patent Dacryocystorhinostomy

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IMPORTANCE Approximately 5% to 10% of patients continue to experience persistent epiphora following an anatomically successful dacryocystorhinostomy (DCR) for nasolacrimal duct obstruction or stenosis.

OBJECTIVE To investigate the management and success rate of so-called “functional failure” of DCR for nasolacrimal duct obstruction by experienced lacrimal surgeons.

DESIGN, SETTING, AND PARTICIPANTS Multicenter retrospective case series including 5 Australian and New Zealand centers. Participants included 61 patients (71% women [n = 46]; mean age, 66 years) with functional epiphora after 65 DCRs (69% transnasal) who were recruited over a mean of 7.6 years. Inclusion criteria included confirmed preoperative diagnosis of nasolacrimal duct obstruction or stenosis, age greater than 18 years, recurrent or persistent epiphora after DCR, an anatomically successful DCR, and follow-up longer than 6 months. Exclusion criteria included evidence of lacrimal hypersecretion, eyelid malposition, and punctal or canalicular abnormalities.

MAIN OUTCOMES AND MEASURES The number, type, timing, and success of all clinical interventions performed for the management of functional epiphora after DCR.

RESULTS Epiphora recurred a mean of 8.9 months after primary DCR; 89% of the cases (n = 58) had evidence of a patent ostium and 100% were patent on lacrimal irrigation. Intubation with a lacrimal stent was performed in 82% of the cases at the time of surgery, and all stents were removed a mean of 8 weeks postoperatively. Epiphora was reported immediately following DCR in 32% (n = 21) of the cases and within 6 weeks after removal of the stent in 31% (n = 20); late recurrence (>12 months after DCR) developed in 37% (n = 24) of the cases. In a total of 15% of the cases, participants declined any treatment following DCR. The remainder underwent a mean of 1.3 interventions (range, 1-3) during a mean of 23 to 41 months after primary DCR, following which 72% (n = 47) of the cases had a successful outcome: 12% (n = 8) failed to achieve improvement, and the patients declined further intervention. Thirty-nine interventions (60%) were intubation with a silicone stent with a 54% success rate. Almost half of those undergoing intubation elected to keep the stent permanently; 34% (n = 22) had an eyelid-tightening procedure with 50% success, and 15% (n = 10) required a Lester-Jones tube despite patent canaliculi, with a success rate of 90%.

CONCLUSIONS AND RELEVANCE Functional epiphora after DCR among patients with preoperative nasolacrimal duct obstruction or stenosis appears to be uncommon. Benefits can be achieved in most patients with intubation (transient or permanent) or eyelid tightening. More than one procedure is often required.

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Dacryocystorhinostomy (DCR) is an effective surgical treatment for nasolacrimal duct (NLD) obstruction (NLDO), and both transnasal and external approaches yield a success rate greater than 90%. However, some patients continue to experience persistent epiphora after anatomically successful DCR, despite the absence of other causative factors, such as eyelid malposition or ocular surface disorders, so-called “functional failure.” The rates of functional failure following external DCR have been reported as 4.8% and 25%,3-6 and 1.7% to 4.6% with primary and 3.2% to 12% with revision endonasal DCR.7-9

There have been few reports on the treatment of anatomically successful but functionally failed DCR surgery in patients with NLDO or NLD stenosis. Our aim in the present study was to investigate the management of functional failure by experienced lacrimal surgeons and their rates of success.

Methods

This was a multicenter retrospective case series. Patients were recruited from a total of 1621 cases over a mean of 7.6 years (range, 3-12 years) who had undergone external or endoscopic transnasal DCR across 5 Australian and New Zealand centers under the care of 5 experienced lacrimal surgeons (P.J.W., B.S., G.W., A.M., and D.S.).

The inclusion criteria were (1) age greater than 18 years; (2) confirmed diagnosis of NLDO or stenosis, based on lacrimal imaging with or without radiologic confirmation on dacryocystogram (DCG) and/or dacryoscintillogram (DSG) or the presence of a mucocele; (3) recurrent or persistent and symptomatic epiphora after DCR (Munk score, 2-4 [Munk score: 0, no epiphora; 1, occasional epiphora requiring wiping less than twice a day; 2, wiping 2-4 times per day; 3, wiping 5-10 times per day; and 4, wiping >10 times per day or continuous tearing]);10; (4) anatomically successful DCR, defined as patency on lacrimal irrigation with or without a positive endoscopic fluorescein dye test result, endoscopic examination of the ostium, or radiologic evidence of a patent ostium; and (5) follow-up of longer than 6 months after DCR. Exclusion criteria included (1) evidence of lacrimal hypersecretion due to ocular surface disease, trichiasis, or other symptoms; (2) facial nerve palsy; (3) lower eyelid or punctal malposition or laxity of sufficient severity to contribute to epiphora (lower eyelid distraction test score of >10 mm or abnormal lower eyelid snap test result); (4) punctal or canalicular obstruction or stenosis, demonstrated preoperatively or intraoperatively; or (5) incomplete medical records.

Nasolacrimal duct obstruction was defined as complete resistance to saline lacrimal irrigation as evidenced by 100% regurgitation from the same or opposite punctum or the presence of a lacrimal sac mucocele with or without DCG evidence of obstruction of the NLD or DSG evidence of pre sac delay. Nasolacrimal duct stenosis was defined as significant but not complete reflux or resistance to flow on lacrimal irrigation supported by definite narrowing of the NLD on DCG or evidence of post sac delay on DSG.

The following data were collected from a review of the patient’s medical records: age, sex, transnasal or external DCR, whether lacrimal intubation with a silicone stent was performed at surgery, the time from DCR to removal of the stent, and time to recurrence of epiphora. The latter was defined as (1) immediate, if there had been no resolution of symptoms after DCR; (2) following removal of the stent, if epiphora recurred within 6 weeks of stent removal; or (2) late, if epiphora had recurred more than 12 weeks after DCR.

After transnasal or external DCR, patients were initially seen 3 to 4 weeks postoperatively. All patients were examined by the senior study investigators (P.J.W., B.S., G.W., A.M., and D.S.) and underwent preoperative and postoperative lacrimal irrigation and nasal endoscopy, with or without lacrimal imaging, using DCG and/or DSG.

Lacrimal intubation was performed with a solid silicone tubing 0.80 mm in diameter. Four main outcome measures were investigated to evaluate the management of functional epiphora after DCR: (1) number, (2) type, (3) timing, and (4) success rate of each clinical intervention. All patients were asked about symptoms of epiphora postoperatively and after each intervention. Success following an intervention was defined as subjective resolution or significant improvement of epiphora equivalent to a Munk score of 0 or 1.10

This study followed the tenets of the Declaration of Helsinki and was approved by the institutional research and ethics board of all 5 centers. A waiver of informed consent was granted because of the retrospective design of the study.

Statistical Analysis

Differences in proportions for continuous, normally distributed data were determined using an unpaired, 2-tailed t test and χ² test and, for nonparametric data, the Wilcoxon rank-sum test and Fisher exact test were used. Statistical analyses were performed using SigmaPlot, version 12.5, for Windows (Systat Software, Inc).

Results

Sixty-one patients with functional epiphora following 65 external or endoscopic transnasal DCRs (59 unilateral and 3 bilateral) were recruited. The incidence of functional epiphora among patients with only NLDO or stenosis undergoing DCR was 3% ([95% CI] 1%-5%) based on data from all 5 centers, which involved a total of 2127 patients. The incidence of functional epiphora was similar in patients after endoscopic DCR (3.2%) and external DCR (2.7%) (P = .65). All cases had recurrent or persistent and symptomatic epiphora, with a Munk score of 2 to 4, but the NLDOs were fully patent, with no resistance on lacrimal irrigation and/or a positive endoscopic dye test result. The mean (SD) age of patients was 66 (12) years (range, 18-88 years), and 71% (n = 46) were female.

Sixty-two percent (n = 40) of the cases had a preoperative diagnosis of NLD stenosis and 38% (n = 25) had NLDO. Lacrimal imaging was performed preoperatively in 48% (n = 31) of the cases. Dacryoscintillogram, performed in 30 cases,
showed NLD stenosis in 63% of the cases (n = 19) and NLDO in 37% of the cases (n = 11); DSG, performed in 31 cases, demonstrated post sac delay in 74% (n = 23). Primary transnasal endoscopic DCR was performed in 69% (n = 45) of the cases, and 31% (n = 20) underwent external DCR. Intubation with a silicone bicanalicular lacrimal stent was performed in 82% of the cases (n = 53) at the time of surgery. Three of the 5 surgeons routinely used intubation at the time of primary DCR. The silicone stent was removed in all cases at a mean of 8 (5) weeks (range, 3-24 weeks) after DCR.

Overall, symptomatic epiphora recurred at a mean of 8.9 months after DCR. A positive result of an endoscopic dye test occurred in 89% of the cases (n = 58), and 86% (n = 56) had evidence of a patent ostium on endoscopic examination; 100% were patent on lacrimal irrigation. Twenty percent (n = 13) of the cases had lacrimal imaging after primary DCR; 14% (n = 9) underwent DCG showing the presence of dye in the nasal cavity, and 12% (n = 8) had DSG showing a delay in the passage of tears into the nasal cavity compared with the contralateral side.

Epiphora was reported immediately after primary DCR in 32% of the cases (n = 21); within 6 weeks of removal of the silicone stent in 31% (n = 20), with a mean of 5 weeks (range, 2-6 weeks); and late recurrence, defined as 12 or more weeks after DCR, in 37% (n = 24). The onset of epiphora in the late recurrence group was a mean of 22 months (range, 3-120 months) after primary DCR. There was no significant difference in the time to recurrence in cases with a lacrimal stent (9.5 months) compared with those without the stent (6.5 months) (P = .56).

Each patient underwent a mean of 1.3 interventions (range, 1-3 interventions) over a 23- to 41-month period (range, 1.5-84.0 months) after primary DCR (a total of 86 interventions), following which 59% of interventions (51 of 86) and a successful outcome (Munk score, 0-1) and 12% (8 of 65) failed to improve (Munk score, 2-4) and declined further intervention.

Figure 1 shows the number of patients who underwent 1, 2, or 3 interventions; the proportion who received successful treatment or went on to have further intervention; and the number of patients who declined further treatment at each stage. After a mean total follow-up of 34 months (range, 6-132 months) and 3 interventions, 3 patients (5%) remained symptomatic and declined further treatment. Of the 65 cases, 52% (n = 34) underwent 1 intervention, 20% (n = 13) underwent 2 interventions, and 12% (n = 8) underwent 3 interventions. In 15% of the cases (n = 10) patients declined any further treatment after primary DCR. The success rates were 55% after the first intervention (30 of 55 cases), 57% (12 of 21) after the second intervention, and 63% (5 of 8) after the third intervention. Table 1 reports the outcomes in all 65 cases.

Table 2 reports the timing and type of procedures performed at each intervention and their success rates. As a primary intervention the most commonly performed procedures were (1) lacrimal intubation (27 [42%]: 15 [23%] underwent reintubation with a bicanalicular lacrimal silicone stent and 12 [18%] underwent secondary intubation [received a stent for the first time]), (2) lower eyelid tightening (15 [23%]), and (3) use of corticosteroid nasal spray (5 [8%]).

Intubation was performed in 82% of the cases (n = 53) at the time of primary DCR; 90% of external DCRs and 78% of endonasal DCRs (P = .24). All stents were removed a mean of 8 weeks postoperatively. In all, 60% (n = 39) of the cases underwent re-intubation or secondary intubation as part of epiphora management (Table 2) and 2 of the 39 cases (5%) had 2 intubations. The 18% (n = 12) who were not intubated at the time of the primary DCR were subsequently intubated (at the first intervention) and 4 of these 12 cases (33%) went on to have insertion of a Lester-Jones tube (LJT) (second intervention). Lacrimal intubation was 54% successful in managing functional epiphora. At a mean of 34 months (range, 6-132 months) after primary DCR, 46% of the cases (18 of 39) retained a lacrimal stent, for a mean of 8 months (range, 2-20 months), with the patients electing to keep the stent on a permanent basis. There was no significant difference in the success rate between cases that were primarily intubated (26% [14 of 53]) and those that were not (33% [4 of 12]) (P = .64) or those that underwent external (65% [13 of 20]) vs endonasal (76% [34 of 45]) DCR (P = .39).

Although patients with significant eyelid laxity were excluded from the study, lower eyelid tightening was performed after primary DCR for lesser degrees of laxity (6-10 mm of lower
eyelid distraction) in 34% of the cases (n = 22). The mean age of patients undergoing eyelid tightening was 68 years. Lower eyelid tightening successfully treated functional epiphora in 50% of the cases. There was no statistically significant difference between the mean time to insertion of a silicone stent (28 months) and lower eyelid tightening (23 months) (P = .60).

Insertion of an LJT was performed in 15% (n = 10) of the cases and was, overall, 90% successful in treating functional epiphora. The LJT was selected as the first intervention after primary DCR for functional epiphora when the patient had no evidence of eyelid laxity (eyelid distraction test <5 mm and normal snap-back test), punctal malposition, or lacrimal hypersecretion. There were 4 patients in this group with a mean age of 58 years, they were significantly younger than the whole study group (P < .001). Revision DCR surgery and intubation was performed in 2 cases to further enlarge a patent ostium; in both cases it was effective in relieving epiphora. Other interventions are reported in Table 2.

Three cases in 2 patients remained symptomatic after 3 surgical interventions: one patient with bilateral and the other with unilateral NLD stenosis who had undergone external DCR and lacrimal intubation. In all 3 cases the stents were removed at 3 months and epiphora recurred 3 months later (late failure).

One patient received bilateral lower eyelid tightening at 6 months, reintubation with a stent at 18 months, and a second eyelid tightening at 42 months. The other patient received corticosteroid nasal spray at 6 months after primary DCR, lower eyelid tightening at 12 months, and reintubation at 24 months. Four patients declined further treatment after one unsuccessful intervention; 2 of these had a preoperative diagnosis of NLD stenosis and underwent lower eyelid tightening and the other 2 had NLD with secondary lacrimal intubation. In both of these latter cases the stent was subsequently removed at 6 weeks and the patients remained symptomatic. One patient with NLD stenosis declined further treatment after 2 unsuccessful interventions; the first was secondary lacrimal intubation and the second was insertion of an LJT.

### Discussion

Successful management of functional epiphora following an anatomically successful DCR was achieved in 72% of the 65 cases and required 1 to 3 clinical interventions over a period of 6 months to 3 years. The mean success rate of each intervention was 58%. Thirty-nine interventions (60%) were silicone stent intubation, with a 54% success rate. Almost half of the patients undergoing intubation elected to keep the tubes permanently. No significant adverse effects, such as granuloma formation, corneal abrasions, stent breakage, punctal damage, or infections, were reported as a result of long-term stent placement. Eyelid-tightening procedures, performed in 34% of the patients, were successful in 50% of the cases. The degree of eyelid laxity in this group of patients was mild, because significant malposition or laxity of the eyelid or punctum, was excluded from the study. Nevertheless the patients appeared to have benefited from tightening of even mild degrees of eyelid laxity. An LJT was required by 15% of the pa-

### Table 1. Outcome of Clinical Interventions 34 Months After Primary Dacryocystorhinostomy

<table>
<thead>
<tr>
<th>No. of Interventions</th>
<th>No. (%) of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Successful</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>30 (46)</td>
</tr>
<tr>
<td>2</td>
<td>12 (18)</td>
</tr>
<tr>
<td>3</td>
<td>5 (8)</td>
</tr>
<tr>
<td>Failed</td>
<td></td>
</tr>
<tr>
<td>1-3</td>
<td>8 (12)</td>
</tr>
<tr>
<td>Declined</td>
<td>10 (15)</td>
</tr>
</tbody>
</table>

### Table 2. Incidence and Success Rate of Clinical Interventions for Functional Epiphora After Dacryocystorhinostomy

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>No. (%)a</th>
<th>Total b [% of All Interventions]b</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intubation with silicone stent</td>
<td>16 (27)</td>
<td>39 (60) [45]</td>
</tr>
<tr>
<td>Reintubation</td>
<td>10 (15)</td>
<td>22 (34) [26]</td>
</tr>
<tr>
<td>Secondary intubation</td>
<td>2 (3)</td>
<td>6 (9) [7]</td>
</tr>
<tr>
<td>Lower eyelid tightening</td>
<td>4 (6)</td>
<td>10 (15) [12]</td>
</tr>
<tr>
<td>Corticosteroid nasal spray</td>
<td>0 NA</td>
<td>2 (3) [2]</td>
</tr>
<tr>
<td>Insertion of Lester-Jones tube</td>
<td>1 (2)</td>
<td>1 (2) [1]</td>
</tr>
<tr>
<td>Revision DCR and intubation</td>
<td>0 NA</td>
<td>2 (3) [2]</td>
</tr>
<tr>
<td>Punctoplasty</td>
<td>0 NA</td>
<td>2 (3) [2]</td>
</tr>
<tr>
<td>Carunculectomy</td>
<td>0 NA</td>
<td>1 (2) [1]</td>
</tr>
<tr>
<td>Excision of pyogenic granuloma</td>
<td>0 NA</td>
<td>1 (2) [1]</td>
</tr>
<tr>
<td>Division of adhesion anterior to</td>
<td>0 NA</td>
<td>1 (2) [1]</td>
</tr>
</tbody>
</table>

Abbreviations: DCR, dacryocystorhinostomy; NA, not applicable.

a The time (range) from DCR to intervention 1 was 23 (1.5-120) months, to intervention 2 was 31 (4-84) months, and to intervention 3 was 41 (18-84) months.

b Interventions were performed in a total of 65 cases and 86 interventions.
tients despite patent canaliculi, and had a success rate of 90%. In 86% of the patients the size and intranasal appearance of the ostium was examined endoscopically, which gives additional anatomic information that cannot be appreciated by lacrimal syringing or using the fluorescein dye test.

The design of this multicenter retrospective series poses obvious limitations. The surgeons have differing strategies, choices, and timing of interventions for the management of functional epiphora in this setting. In addition, this study did not contain a control group. Furthermore, despite our inclusion and exclusion criteria it is possible that patients had more than one factor leading to epiphora preoperatively. However, the patients described here are representative of the casemix of everyday practice. Differences in surgical techniques among surgeons may have introduced further variation in this study population, in particular the choice of transnasal endoscopic or external DCR.

Sahlin and Rose5 retrospectively reported on treatment outcomes in 22 patients with functional epiphora after DCR; 2 patients received endonasal corticosteroids without symptomatic improvement. Six (27%) had further surgery for continued symptoms: punctoplasty (n = 1), lower eyelid ectropion repair (n = 2), placement of an LJT (n = 1), upper eyelid blepharoplasty (n = 1), and another DCR (n = 2); symptoms improved only in the patient who underwent a second DCR. Kim et al11 studied silicone intubation in patients with anatomic success, but functionally failed, external DCR and achieved 100% success in 13 patients.

In one study,12 magnetic resonance imaging dacryocystography was used to evaluate the signal intensity at the site of DCR ostium after instillation of artificial tears into the conjunctival fornix before and after blinking. The results showed that watery epiphora following an anatomically patent DCR was associated with reduced postblinking signal intensities compared with asymptomatic controls, implying a defective “lacrimal pump” mechanism despite the lack of obvious causative factors. This was in agreement with another study,4 which showed a statistically significant association between fluorescein transit test time of less than 45 seconds (the time from instillation of fluorescein into the conjunctival fornix to its free flow from the osteotomy site) and subjective success following DCR.

A study13 comparing the tear flow rate using lacrimal scintillography in patients who had successful DCR and patients with LJT found tear flow in all patients to be considerably slower when they were in a supine position, implying that gravity also plays a role in tear drainage. Eyelid function and blinking were also found to be important to DCR and LJT functioning. Orbicularis oculi action and eyelid blinking are required to create sufficient hydrostatic pressure to overcome the natural resistance of the lacrimal outflow system and thereby facilitate adequate tear flow. Less than half of lacrimal outflow system resistance arises from the nasolacrimal duct, this being eliminated following DCR, leaving more than half of the resistance from the punctae and canaliculi.14

Previous studies have reported that, although tear outflow may be altered following DCR,13 the lacrimal pump activity is probably preserved, although differences have been found between the transnasal and external techniques.15,16 A study15 was conducted using magnetic resonance imaging dacryocystography 6 months after transnasal endoscopic DCR (n = 4) and external DCR (n = 4). The results showed the signal intensity at the site of DCR ostium after instillation of artificial tears into the conjunctival fornix to be significantly increased after blinking in both the external and transnasal DCR cases, and was greater in the transnasal than in the external DCR group. Another study16 using manometric measurements of the lacrimal sac pressure concluded that the lacrimal pump is still functional following DCR and that the suction power mechanism may be more effective after transnasal DCR than after external DCR. However, lacrimal manometry is interventional and thus may not reflect physiologic lacrimal outflow.

The mechanism of epiphora may also be correlated with the time of onset following primary DCR; for instance, late cases may be the result of supervening factors such as increased eyelid laxity; however, in the present study we found no statistically significant difference between the mean time to insertion of a silicone stent and lower eyelid tightening. We speculate that a defective lacrimal pump mechanism may be responsible for persistent epiphora after DCR; however, because of the retrospective design of this study, we are unable to draw conclusions about mechanisms of DCR failure in this setting.

Equally, although we are not able to derive a treatment algorithm from this retrospective study, we offer a management guide for functional epiphora after DCR based on the experience of senior lacrimal surgeons managing this challenging clinical problem (Figure 2). Correction of any eyelid laxity is...
recommended followed by a trial of transient lacrimal intubation, although the exact length of time of intubation (several weeks to several months) remains unknown and should be the subject of further study. If symptoms recur after stent removal, consideration can be given to permanent silicone stent intubation, provided stent-related complications do not occur. The data from our series and evidence from other studies\textsuperscript{14,17} suggest that stents seem to be reasonably tolerated in the long term. To avoid having to perform further procedures one could consider simultaneous eyelid tightening and intubation as a first step. Insertion of an LJT would be recommended as a final step.

**Conclusions**

Functional epiphora after DCR among patients with preoperative NLDO or stenosis appears to be uncommon, and successful treatment in most patients can be achieved with intubation (transient or permanent) or eyelid tightening. More than one procedure is often required. Prospective randomized clinical studies designed to assess the long-term success of specific interventions in the management of functional epiphora following DCR are needed.