

External versus Endoscopic Dacryocystorhinostomy for Acquired Nasolacrimal Duct Obstruction in a Tertiary Referral Center

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Purpose: To compare success rates of external dacryocystorhinostomy (DCR) and endoscopic endonasal DCR for acquired nasolacrimal duct obstruction (NLDO).

Design: Retrospective, comparative, nonrandomized clinical study.

Participants: One hundred forty-three patients (176 surgeries) operated for acquired NLDO.

Methods: A review of electronic medical records of patients with acquired NLDO who underwent DCR at the Jules Stein Eye Institute from 1999 to 2004 was performed. Data regarding the lacrimal drainage system, comprehensive eye examination, surgical outcome, and postoperative nasal endoscopy were analyzed.

Main Outcome Measures: Surgery failure was defined as (1) no marked improvement in tearing or any episode of postoperative dacryocystitis, (2) inability to irrigate the lacrimal system postoperatively, and (3) postoperative nasal endoscopy with scarring in the intranasal osteotomy or no visualization of fluorescein dye. Postoperative nasal endoscopy was performed in all failed cases and in >50% of all patients.

Results: One hundred forty-three patients (48 male and 95 female; mean age, 63 years) underwent 176 DCR surgeries for acquired NLDO. Success was achieved in 135 cases (76.7%), and failure in 41 (23.3%). Of the 41 failed cases, anatomical obstruction at the fistula site was found in 20 (49% of failed cases), whereas functional failure with no evidence of obstruction was found in 21 (51%). Surgery revision was performed in 22 cases (12.5%), but it was successful in only 9 (5.1%); patients who failed the first revision were likely to fail additional revisions ($P = 0.02$). History of facial trauma was associated with surgery failure. In our patients, endoscopic DCR (86 cases) had a significantly higher success rate than external DCR (90 cases), 84% versus 70% ($P = 0.03$). Complications included 1 patient with nose bleeding on the first postoperative day that resolved with nasal packing and 2 patients with sump syndrome that resolved after endoscopic revision.

Conclusions: The success rate of DCR for acquired NLDO in our group of patients was 77%, lower than reported in previous studies, with endoscopic surgery showing better results. Success rates of revision surgery were relatively low (<50%), and patients who fail the first revision are not likely to benefit from additional revisions. *Ophthalmology* 2005;112:1463–1468 © 2005 by the American Academy of Ophthalmology.

Dacryocystorhinostomy (DCR) has been touted as the standard procedure for acquired nasolacrimal duct obstruction (NLDO). It can be performed through a cutaneous incision, traditionally referred to as external DCR, or via a transnasal approach under either direct visualization or endoscopic guidance. In both approaches, the lacrimal sac mucosa is connected to the nasal mucosa above the level of the mechanical obstruction at the nasolacrimal duct.^{1–6}

External DCR is performed in a standardized fashion: a skin incision is made, the lacrimal bone is removed, and the sac mucosa is connected to the nasal mucosa over a silicone stent. Endoscopic or endonasal DCR, however, though maintaining the same surgical principles, has been described in numerous variations.^{3,6–10} Some simply involve removal of the nasal mucosa; the creation of a bony opening at the level of the lacrimal bone using a bone rongeur,¹¹ power drill,¹² or laser⁷; and then stripping the lacrimal sac to create a direct fistula from the sac to the nose. Others perform a more complicated surgery by creating a flap from both nasal mucosa and lacrimal sac bridging the bony opening.^{13–15} Creation of mucosal flaps does not seem to increase the success rate of endoscopic DCR.¹⁵ The latter technique, though successful, can be technically challenging and time consuming.

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The reported success rate of both procedures is 80% to 95%, with similar success for external and endoscopic approaches.^{1,8,16} However, monitoring the success of DCR is difficult due to lack of standardization of outcome. Many investigators advocate monitoring the rhinostomy using postoperative endoscopy.^{17,18} Dye application to the conjunctival fornix during endoscopy and visualization of the dye at the osteotomy (functional endoscopic dye test) site has been shown to be useful in assessing rhinostomy patency.^{8,19} The purpose of the current study was to evaluate the functional and anatomic success of DCR surgeries performed at a tertiary referral center and to compare the outcome between external and endoscopic DCRs.

Materials and Methods

A retrospective electronic medical record review of all patients who underwent surgery for acquired NLDO at the Jules Stein Eye Institute from January 1999 to June 2004 was performed. All patients underwent a comprehensive ophthalmic examination along with irrigation of the nasolacrimal drainage system and an intranasal examination. Patients were excluded if tearing was due to canalicular obstruction or lower eyelid malposition or if postoperative follow-up was <4 months. Surgery, external or endoscopically performed, was based on surgeon preference; all surgeries were performed by 2 of the authors (RAG, JDM). Institutional review board approval was obtained.

Postoperatively, patients were examined at 1 week, 1 month, and every 3 months thereafter; the silicone stent was removed 2 to 3 months after the operation.

Failure was defined as any of the following: (1) no improvement in tearing symptoms or any episode of postoperative dacryocystitis, (2) inability to irrigate the lacrimal system postoperatively, and (3) postoperative nasal endoscopy with scarring in the intranasal surgical site or no dye with fluorescein application in the conjunctival fornix (functional endoscopic dye test).⁹ Success was defined as marked improvement in tearing—that is, patients did not report additional episodes of tearing postoperatively. Postoperative nasal endoscopy was performed in all failed cases and in >50% of all patients. Patients with scar formation at the osteotomy site underwent surgical endoscopic revision in the operating theater. A silicone stent was replaced at the time of surgical revision.

Surgical Technique

The external and endoscopic DCRs were performed in a standardized fashion, as described in detail elsewhere.¹ One difference from the aforementioned description of endoscopic DCR is that we did not use a vitrectomy light pipe to visualize the level of the desired incision. The nasal mucosa was stripped, and lacrimal bone was removed lateral to the anterior tip of the middle nasal turbinate. Preoperatively, the sac was filled with a cast impression material (hydrophilic vinyl polysiloxane [Reprosil, Dentsply International, York, PA]) that was visualized and removed once the sac was opened under endoscopic guidance.

Statistical Analysis

The paired-samples *t* test was used to calculate the change in preoperative and postoperative parameters such as visual acuity and intraocular pressure. Independent-samples *t* test and χ^2 non-parametric analysis were used to compare numerical variables and proportions, respectively, between successful and failed cases and

Table 1. Demographics of 143 Patients Who Underwent 176 Dacryocystorhinostomy (DCR) Surgeries for Acquired Nasolacrimal Duct Obstruction (NLDO) at the Jules Stein Eye Institute, January 1999 to June 2004

Age (yrs) (mean \pm SD)	63 \pm 19
Gender [N (%)]	
Male	48 (34)
Female	95 (66)
Medical history [N (%)]	
Dacryocystitis	84 (47.7)
Sinus disease	20 (11.4)
Facial/orbital trauma	11 (6.3)
Dry eyes	16 (9.1)
Surgery [N (%)]	
External DCR	90 (51)
Endoscopic DCR	86 (49)
Stent [N (%)]	
Crawford	100 (57)
Atrion stent tube	72 (41)
Postoperative nasal endoscopy [N (%)]	89 (57)
Stent removal (wks) (mean \pm SD)	9.3 \pm 6.9
Follow-up time (mos) (mean \pm SD)	7.0 \pm 5

SD = standard deviation.

between external and endoscopic DCRs. The Fisher exact test was used to examine the probability of success after revision surgery. Kaplan–Meier survival analysis was used to calculate cumulative survival in patients undergoing external versus endoscopic DCRs. Binary logistic regression was used to calculate the odds ratio (OR) for surgical failure. Conversion of Snellen acuity to logarithm of the minimum angle of resolution values was performed. Statistical analysis was carried out using Excel²⁰ and SPSS.²¹

Results

One hundred forty-three patients (48 male, 95 female; mean age, 63 years) underwent 176 DCR surgeries for acquired NLDO; 33 patients underwent bilateral surgery. Demographics of the study population are summarized in Table 1.

Success, defined as improvement in tearing along with free passage to irrigation or visualization of fluorescein dye aspiration in the nose by the functional endoscopic dye test, was achieved in 135 cases (76.7%), and failure in 41 cases (23.3%) (Fig 1). Of the 41 failed cases, anatomic obstruction at the fistula site, diagnosed by inability to irrigate fluid to the nose and scar visualization by nasal endoscopy, was found in 20 cases (49% of failed cases) (Fig 2), whereas functional failure with no evidence of obstruction was found in 21 cases (51%).

Surgery revision was performed in 22 cases (12.5%); in 20 cases (91%), endoscopic revision was performed, by scar excision with silicone intubation. External revision of the surgery was performed in 2 cases (9%). Revision of surgery was successful in only 9 cases (45%), there was failure in 11 cases (55%), and 2 cases had too short of a follow-up to determine success. Seven of the 9 successful cases involved a single revision, and 2 cases had success only after a second revision; patients who failed the first revision were likely to fail additional revision surgeries ($P = 0.02$, Fisher exact test). Hence, overall success after DCR and revision was 81.8%.

Of the 19 failed cases that did not undergo surgical revision, patent osteotomy was noticed in nasal endoscopy in 4; in an additional 4 no dye was observed in the functional endoscopic dye

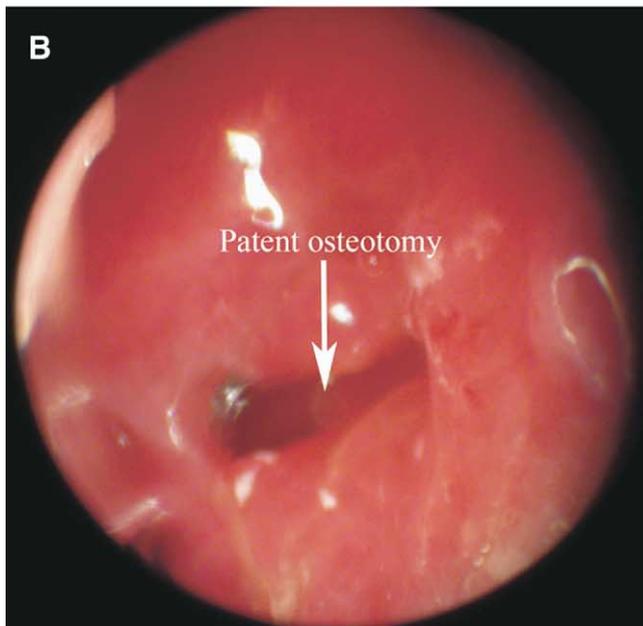
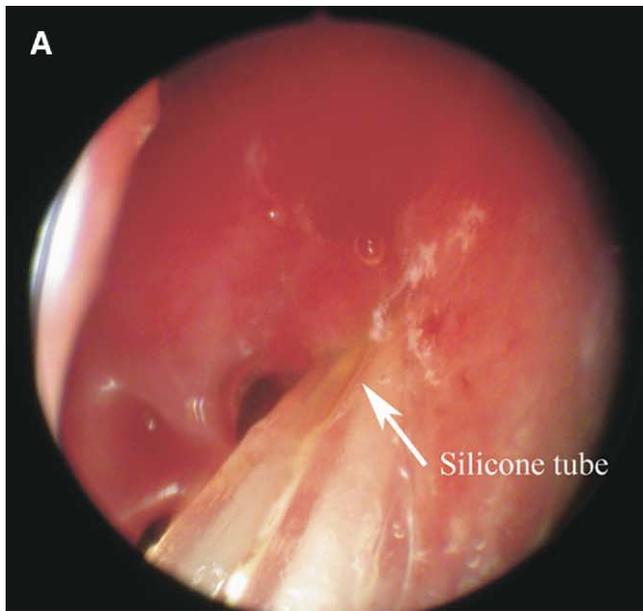


Figure 1. Postoperative diagnostic nasal endoscopy in an 82-year-old female who underwent endoscopic endonasal dacryocystorhinostomy for acquired nasolacrimal duct obstruction. **Top,** Before removal of silicone stent. **Bottom,** After stent removal.

test; 1 had recurrent pyogenic granuloma in the medial conjunctiva that was suspected to block tear drainage to the upper system; and 1 had persistent tearing despite patent osteotomy, most likely secondary to past radiation treatment for a neck mass.

When comparing failed cases and successful cases, patients who underwent successful surgery were less likely to report a history of facial trauma (3%, vs. 17% in failed cases; $P = 0.001$, χ^2) and more likely to undergo endoscopic DCR (53% vs. 44%, $P = 0.03$) and to have stent tube (Atrion Medical, Inc., Arab, AL) intubation (47% vs. 20%, $P = 0.006$); however, when using binary logistic regression to calculate ORs for failure, only type of surgery and stent used were statistically significant factors for surgery

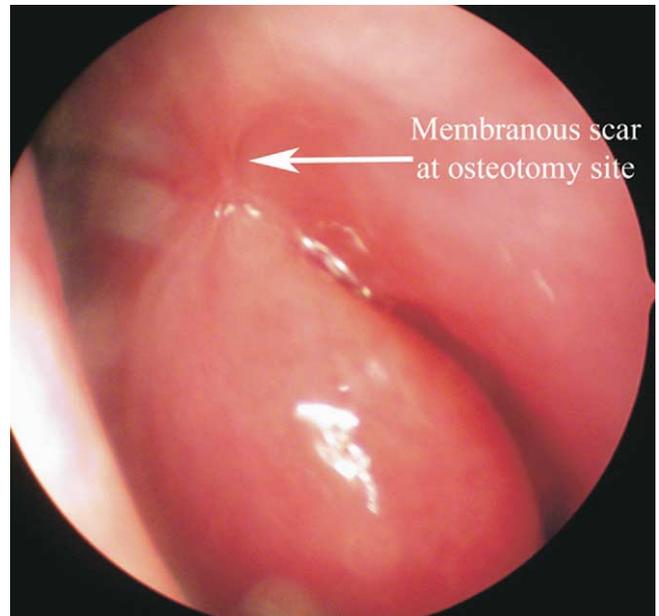


Figure 2. Postoperative diagnostic nasal endoscopy in a 47-year-old female who underwent endoscopic endonasal dacryocystorhinostomy for acquired nasolacrimal duct obstruction. Symptoms have not resolved due to membranous scar formation at the osteotomy site.

failure. Interestingly, other factors such as age, gender, duration of tearing, history of dacryocystitis or of sinus disease, and duration of silicone intubation did not differ between successful and failed cases.

When comparing outcomes of external DCR and endoscopic DCR (Table 2), baseline characteristics differed in the following:

Table 2. Comparison of Baseline Characteristics and Surgery Outcome for Patients Undergoing External Dacryocystorhinostomy (DCR) versus Endoscopic DCR at the Jules Stein Eye Institute, January 1999 to June 2004

	External	Endoscopic	P*
N (% of total 176 surgeries)	90 (51)	86 (49)	
Age (yrs) (mean \pm SD)	66 \pm 19	59 \pm 19	0.03
Gender [N (%)]			
Male	34 (38)	25 (29)	
Female	56 (62)	59 (69)	NS
Medical history [N (%)]			
Dacryocystitis	37 (41)	47 (55)	
Sinus disease	9 (10)	11 (13)	
Facial trauma	8 (9)	3 (3.5)	NS
Dry eyes	10 (11)	6 (7)	
Stent [N (%)]			
Crawford	85 (94)	15 (17)	
Atrion stent tube	2 (2)	70 (82)	<0.001
Stent removal (wks) (mean \pm SD)	8 \pm 6.3	6 \pm 7	0.04
Follow-up time (mos) (mean \pm SD)	7.2 \pm 5.5	6.7 \pm 4.7	NS
Success [N (%)]	63 (70)	72 (84)	0.03
Revision [N (%)]	16 (18)	6 (7)	0.03

NS = not significant; SD = standard deviation.

*Independent-samples t test was used to compare differences in numerical variables between groups, whereas nonparametric chi-square analysis was used to compare proportions between patients who underwent external DCR and patients who underwent endoscopic DCR.

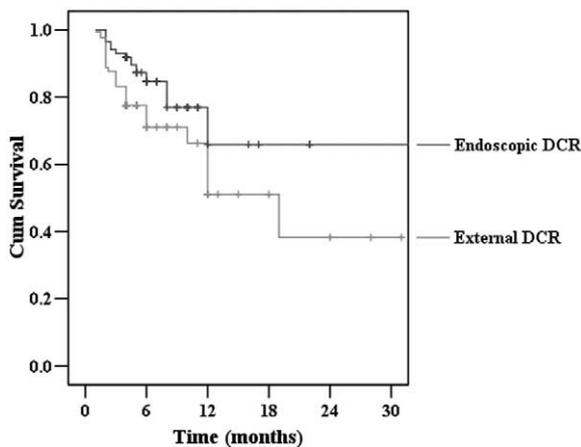


Figure 3. Cumulative (cum) survival plot (Kaplan–Meier) for 90 external dacryocystorhinostomy (DCR) surgeries compared with 86 endoscopic DCR surgeries at the Jules Stein Eye Institute, January 1999 to June 2004.

patients who underwent endoscopic DCR were younger (59 years, vs. 66 years for external DCR patients; $P = 0.03$, χ^2) and had an average shorter period of intubation postoperatively (6 vs. 8 weeks, $P = 0.04$). In our groups of patients, endoscopic DCR had a significantly higher success rate than external DCR (84% vs. 70%, $P = 0.03$) (Fig 3).

Visual acuity and IOP did not change postoperatively.

Complications included 1 patient with nose bleeding in the first postoperative day (the bleeding resolved with nasal packing for 24 hours), 1 patient with pyogenic granuloma that was treated with triamcinolone acetonide injection, and 2 cases of sump syndrome that were treated successfully with endoscopic revision. No cases of cerebrospinal fluid leak, orbital tissue damage, or uncontrolled bleeding occurred.

Discussion

Dacryocystorhinostomy for acquired NLDO in our center resulted in a success rate of 77%, lower than what is

reported in the literature. In our patients, endoscopic DCR was more successful than external DCR.

Our criteria for success did not include qualified or partial success, as described in previous studies.¹ We did not consider mild improvement in tearing as success, because patients were still bothered by tearing. Comparing published success rates of lacrimal surgery is a difficult task because different studies use different criteria.²² Guidelines²² published by the Royal College of Ophthalmologists suggest that lack of tearing 3 months after surgery is a good indicator of successful surgery. Therefore, we have used these guidelines for patients with at least 4 months' follow-up time postoperatively. These reasons may contribute to our relatively low success (77%) versus previously reported studies (up to 95%) (Table 3).^{1,9,10,13,15,22–24} A recent study demonstrated a decreased success, from 84% 3.6 months postoperatively to 70% at 3 years' follow-up. Many investigators advocate monitoring the rhinostomy using postoperative endoscopy.^{17,18} Dye application to the conjunctival fornix during endoscopy and visualization of the dye at the osteotomy (functional endoscopic dye test) site have been shown to be useful in assessing rhinostomy patency.^{8,19} In our study, postoperative diagnostic endonasal endoscopy with dye test was performed in all failed cases and in >50% of all cases.

Ten patients in our study (5.7%) are believed to have functional NLDO, defined as positive test dye in the nose with a patent osteotomy and no obstruction to lacrimal irrigation; this rate is reported to be 1.5% in previous works.⁸

In our study, intubation of the lacrimal system using a fat tube (Atrion stent tube) was associated with a success higher than that with the use of a Crawford stent; this, however, merely may be a reflection of the higher success achieved in endoscopic surgery where the fat tube was used more commonly. Interestingly, no correlation was found between duration of stent use and a higher success rate, although controversy exists in the literature in that

Table 3. Success Rate of External and Endoscopic Dacryocystorhinostomies (DCRs) in Previously Published Studies

	Dolman*		Yung and Hardman-Lea†	Durvasula and Gatland‡		Nussbaumer et al§	Fayet et al	Tsirbas et al¶		Massegur et al#	Mirza et al**	
	X	E–	E+	E + L	E+	E+	E+	X	E+	E+	X	E + L
No. of cases	153	201	191	33	70	201	300	24	31	96	49	76
Success	90%	89%	89%	71%	83%	90%	87%	96%	94%	92%	94%	64%
Follow-up (mos)	12		6		29	12	12	12	13	>6	9	12
Place	Vancouver		Ipswich	Essex		Ipswich	Paris	Adelaide		Barcelona	Newcastle	

E– = endonasal DCR under direct visualization; E+ = endoscopic DCR; E + L = endoscopic laser DCR; X = external DCR.

*Dolman PJ. Comparison of external dacryocystorhinostomy with nonlaser endonasal dacryocystorhinostomy. *Ophthalmology* 2003;110:78–84.

†Yung MW, Hardman-Lea S. Analysis of the results of surgical endoscopic dacryocystorhinostomy: effect of the level of obstruction. *Br J Ophthalmol* 2002;86:792–4.

‡Durvasula VS, Gatland DJ. Endoscopic dacryocystorhinostomy: long-term results and evolution of surgical technique. *J Laryngol Otol* 2004;118:628–32.

§Nussbaumer M, Schreiber S, Yung MW. Concomitant nasal procedures in endoscopic dacryocystorhinostomy. *J Laryngol Otol* 2004;118:267–9.

||Fayet B, Racy E, Assouline M. Complications of standardized endonasal dacryocystorhinostomy with unciformectomy. *Ophthalmology* 2004;111:837–45.

¶Tsirbas A, Davis G, Wormald PJ. Mechanical endonasal dacryocystorhinostomy versus external dacryocystorhinostomy. *Ophthal Plast Reconstr Surg* 2004;20:50–6.

#Massegur H, Trias E, Adema JM. Endoscopic dacryocystorhinostomy: modified technique. *Otolaryngol Head Neck Surg* 2004;130:39–46.

**Mirza S, Al-Barmani A, Douglas SA, et al. A retrospective comparison of endonasal KTP laser dacryocystorhinostomy versus external dacryocystorhinostomy. *Clin Otolaryngol* 2002;27:347–51.

regard. Some investigators noted lower success with early stent removal, whereas others failed to report such a correlation.^{16,25,26}

Advantages of endoscopic DCR include absence of skin incision, with possible related complications; preservation of the pump mechanism of the orbicularis oculi muscle²⁷; and less bleeding. The ability to address nasal or paranasal sinus abnormality at the same time,²⁴ limitation of injury to tissue at the osteotomy site, and faster rehabilitation were also noted. Drawbacks included longer operative time, technical difficulties, and specific instrumentation.^{6–8,16,27,28} Other studies, however, have found similar or even shorter operative times in external and endoscopic DCRs.^{1,29} External DCR is technically easier, with an unimpaired view of the surgical area³⁰ and well-defined landmarks allowing the creation of a wide bony window and the use of mucosal flaps to obtain an epithelialized DCR tract.^{1,24} It also enables lacrimal sac biopsy in cases of an abnormally appearing sac during surgery; this may be somewhat difficult using the endoscopic or endonasal approach, which is contraindicated in patients in whom there is suspicion of lacrimal system neoplasia,^{9,16,31} although with good instrumentation and surgical technique, a good biopsy of the lacrimal sac can be obtained.

Studies have suggested that external DCR is a more successful surgery than endoscopic or endonasal DCR; this may be secondary to good anatomic identification of the sac and mucosal lining, whereas the inside of the sac is not always visible in endoscopic surgery. For that reason, we have been using routinely an impression material forming a lacrimal sac cast that is injected into the sac preoperatively. Within minutes after injection, the material hardens and provides a cast of the upper drainage system; it is easily identified and removed after opening the sac under endoscopic guidance.³²

Published results for successful endonasal endoscopic DCR range from 63% to 99%,^{1,8,33–35} with endosurgical DCR being more successful than endolaser DCR.⁸ Despite a general belief that external DCR is more successful than endonasal DCR, a report by the American Academy of Ophthalmology in 2001 concluded that it was difficult to make a definite evidence-based determination about the relative efficacies of endonasal and external DCR because of deficiencies in the reported literature.¹⁶

A learning curve of the endoscopic procedure was demonstrated in several studies, with higher success in more experienced surgeons.^{10,36–38} Most studies, including ours, are not controlled for the anatomic tissue being removed or for the site of obstruction. Several studies showed that success rates of external and endoscopic DCR were significantly higher for common canalicular and lacrimal sac/duct obstruction than for canalicular obstruction, with a complete cure achieved in the latter in only 47% to 54%.^{22,39} The definition of success or end point may also differ, with the likelihood of lower success when subjective symptoms are taken into consideration.³⁰ Success depends upon creating a wide osteotomy and preservation of mucosa around the lacrimal window to reduce the chance of postoperative scarring and stenosis.^{6,10,22,40} Longer follow-up may be

associated with decreased success,^{9,39,41,42} although this finding is questioned in other reports.²²

Revision of DCR can be performed successfully via an endoscopic approach and usually requires scar excision at the osteotomy site and reintubation of the lacrimal system using a silicone stent. Reported success rates of endoscopic revision range from 70% to 90% using a single revision^{10,22}; we had a relatively low success rate of endoscopic revision, and <50% of the revised surgeries were successful. Patients who failed first revision were more likely to fail additional endoscopic revisions.

As many as 25% of patients may have concomitant nasal or sinus pathology such as septal deviation or nasal polyps, which can be addressed simultaneously at the time of endonasal surgery without affecting the functional outcome.^{14,23,24} Trimming the anterior portion of the middle turbinate and uncinectomy have also been performed concomitantly with endonasal DCR; surgery should be customized to the individual nasal anatomy.^{23,24,43}

Potential complications of external DCR include bruising, wound infection, cerebrospinal fluid leaking, punctal eversion, inadvertent incision of periorbita; endonasal DCR complications include damage to the nasal mucosa with scar formation, perirrhinostomy granuloma, orbital fat prolapse, transient damage to the medial rectus muscle with diplopia, secondary canalicular stenosis, canalicular cheese-wiring by the silicone stent, sump syndrome, recurrence of lacrimal mucocele, and adhesions between the ostium and the septum.^{1,8,43} Most complications for both external and internal DCRs are extremely rare. Complications that may result in surgery failure occur up to 3 months postoperatively.⁸ We had 1 case of postoperative bleeding that resolved with nose packing for 24 hours and 2 cases of perirrhinostomy granuloma that were treated with triamcinolone acetonide injection, both in patients operated via the endoscopic approach. There were also 2 cases of sump syndrome that resolved after endoscopic revision.

Pitfalls of our study stem from its retrospective design; postoperative nasal endoscopy with dye application was performed in only 57% of patients, and would have been a more accurate means of estimating functional outcome if performed in all cases. There was no standardization of osteotomy size performed in either the endoscopic or the external approach. A longer follow-up would have reduced our reported success rate. However, in our case series endoscopic endonasal DCR resulted in a higher success rate (83%) than that of external DCR (70%). Prospective studies are needed, with standardization of blockage site and osteotomy size and strict definitions of improvement and failure, preferably by functional endoscopic dye test, to evaluate more accurately this long-standing controversy.

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