• Clinical Research •

Management of chronic dacryocystitis cases after failed external dacryocystorhinostomy using endoscopic technique with a novel lacrimal ostium stent

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Abstract

● **AIM:** To demonstrate the outcomes of endoscopic endonasal dacryocystorhinostomy (En-DCR) with an novel lacrimal ostium stent (LOS) which was performed in patients with recurrent epiphora after failed external dacryocystorhinostomy (Ex-DCR) and analyze the causes of failed Ex-DCR.

● **METHODS:** From September 2015 and December 2017, the clinic data of 29 cases suffered from recurrent epiphora after failed Ex-DCR was reviewed. The LOS were implanted into the ostium at the end of the revisional surgery. The causes of failed Ex-DCR were analyzed before revisional surgeries. Outcome of revisional surgeries with the new device were evaluated as well.

● **RESULTS:** The major causes of failure of the external approach were synechiae formation in the nasal ostium (29/29), followed by inadequate removal of the bony wall (21/29), nasal synechiae formation between lateral wall of nose and middle turbinate (11/29), and the bone opening was not in good location (7/29). The rate of success after revisional surgery was 82.76%. Re-obstruction of the ostiums were found in 5 failed cases.

● **CONCLUSION:** Endoscopic approach with a novel LOS may be an effective procedure to manage recurrent epiphora after previous failed Ex-DCR surgery. Synechiae formation in the nasal ostium and inadequate removal of the bony wall were the major causes of failure of Ex-DCR.

● **KEYWORDS:** external dacryocystorhinostomy; failed; endoscopic technique; lacrimal ostium stent

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INTRODUCTION

Dacryocystorhinostomy (DCR) procedures are performed in cases of obstructed nasal drainage, reestablishing permanent drainage *via* the creation of a shorter artificial pathway within the nasal cavity[1]. Both external (Ex-) and endonasal (En-) DCR approaches have been employed since the development of the procedure in the late 19th Century[2]. Ex-DCR remains the gold-standard treatment for chronic dacryocystitis or obstruction of the nasal lacrimal duct, and it is the surgical procedure most commonly performed by ophthalmologists. When Ex-DCR success rates are estimated to range from 63%-97%, approximately 4%-13% of patients experience treatment failure and recurrent epiphora[3-4]. As it offers certain advantages over the Ex-DCR procedure including the ability to directly visualize the nasal anatomy, medial canthal tendon preservation to facilitate lacrimal pump function, and the lack of a cutaneous scar above the eyelid, the endoscopic En-DCR procedure has become increasingly popular in recent years[5]. Only a small number of studies to date have explored the use of an endoscopic approach to managing recurrent epiphora following failed Ex-DCR, with success rates reportedly ranging from 43%-90%[3,6-7]. As nasal ostium closure has been reported to be the primary cause of treatment failure in these causes, maintaining ostium patency is of paramount importance. In a recent report, a novel lacrimal ostium stent (LOS) was employed when conducting the En-DCR-based treatment of patients with a small lacrimal sac size, achieving an 88.9% success rate by ensuring that the ostium remained open[8]. In the present study, we explored the outcomes associated with LOS use when performing En-DCR revision surgery in patients suffering from recurrent epiphora following Ex-DCR failure, with an additional focus on the causes underlying Ex-DCR failure.

SUBJECTS AND METHODS

Ethical Approval The study was consistent with the Declaration

of Helsinki (2008), received authorization from the Eye Hospital of Wenzhou Medical University, and was approved by the Institutional Medical Ethics Committee of Wenzhou Medical University. All patients provided informed consent prior to study enrollment.

The present study was a retrospective analysis of patients evaluated from September 2015 to December 2017 in the Department of Orbital & Oculoplastic Surgery, Eye Hospital of Wenzhou Medical University (Zhejiang Province, China). Patients eligible for study inclusion were those experiencing the recurrence of epiphora following the failure of an Ex-DCR procedure. Ex-DCR failure was defined by the following: 1) a lack of any improvement in epiphora symptoms; 2) confirmed scarring and/or granuloma-based occlusion of the lacrimal sac ostium visible upon endonasal endoscopic examination or endoscopic dye test results revealing no dye and abnormal functional results; and/or 3) apparent obstruction of the lacrimal system evident upon irrigation. Patients were excluded from this study if they were <18 year of age, had follow-up data from a period <12mo in length, suffered from systemic diseases resulting in bleeding disorders or coagulopathy, suffered from severe nasosinusitis, or had any history of nasal trauma or primary nasolacrimal neoplasms.

Demographic data collected for each patient included age, gender, and symptom duration. Preoperative analyses included the recording of complaints of purulent secretions or persistent epiphora or purulent secretion, lacrimal irrigation, dye tests, nasal endoscopy, and computed tomography-dacryocystography (CT-DCG) imaging.

The LOS used for the present study was composed of silicone, with a smooth surface and a tripartite construction[9], including a hollow central tube to facilitate lacrimal drainage, an elliptical positioning plate, and four buckles to enable appropriate fixation (Figure 1). The positioning plate contained holes and was somewhat elastic, allowing for appropriate fixation between the middle turbinate and the exterior wall of the nasal cavity. The hollow central tube exhibited an inner diameter of 2 mm and an outer diameter of either 4, 6, or 8 mm, with this latter parameter ultimately determining the size of the stent. The elliptical positioning plate was 20 mm in diameter, and each fixation buckle was 2 mm long. LOS size selection was performed by comparing the size of the fully opened lacrimal sac to a suction tube with a diameter of 6 mm. When forward positioning of the middle turbinate was evident such that firm LOS fixation was difficult, the positioning plate was cut to better enable fixation.

En-DCR procedures were performed under general anesthesia using a 0° 4.0-mm endonasal endoscope (Karl Storz, Tuttlingen, Germany). A blade was used to cut a square mucosal flap 8-10 mm above the operculum of the middle turbinate

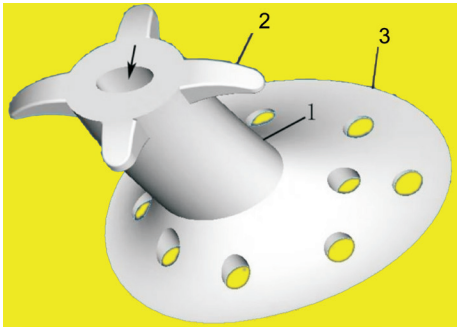

Figure 1 Computer-aided diagram corresponding to the novel lacrimal ostial stent design 1: A hollow central tube with an inner diameter of 2 mm (arrow) to facilitate lacrimal drainage and an outer diameter ranging from 4-8 mm; 2: Fixation buckles (2 mm in length); 3: Elliptical positioning plate (20 mm in diameter).

(Figure 2A). A microdebrider (XPS3000, Medtronic Xomed, MN, USA) with a diamond burr was used to thin the maxilla and maxillary frontal process if it was still present, followed by removal with a Kerrison rongeur (Figure 2B). When only small portions of the maxillary frontal process remained covering the dacryocyst, it was instead removed using a Kerrison rongeur, thereby exposing the entirety of the lacrimal sac medial wall. A probe was then inserted *via* the upper punctum to cause the medial sac to bulge such that it could be fully opened using a curved 9# MVR knife (EdgePlus Trocar Blade, Alcon, TX, USA; Figure 2C and 2D). Saline irrigation *via* the lower canalicular puncta was then used to assess patency, followed by the trimming and repositioning of the nasal mucosal flap such that it covered the exposed maxilla. Two Merogel pieces (Medtronic Xomed) that had been immersed in a dexamethasone solution (5 mg in 2 mL) were then stretched such that they covered the flat posterior lacrimal sac flap and the surface of the wound 1-2 mm surrounding the ostium as in our prior report[10]. The small ostium was then expanded by a surgical assistant who lifted the lacrimal probe medially and/or posteriorly, enabling LOS insertion (Figure 2E). An appropriate LOS was selected based upon the size of the ostium, with the four fixation buckles being carefully cut as surgically indicated and placed into the ostium under endoscopic visualization. Proper LOS positioning was defined based upon the visible outflow of irrigation fluid from the central tube within the LOS. When this was not observed, further LOS adjustment was performed as necessary. The positioning plate was then placed between the middle turbinate and the nasal cavity exterior wall to facilitate fixation (Figure 2F).

Postoperatively, patients were treated for two days with methylprednisolone (20 mg/kg·d) and ceftriaxone (2.0 g/d). In addition, for the first 3d after surgery, lacrimal syringing with dexamethasone and tobramycin was conducted once per day. Patients were directed to use pranoprofen eye drops (Senju

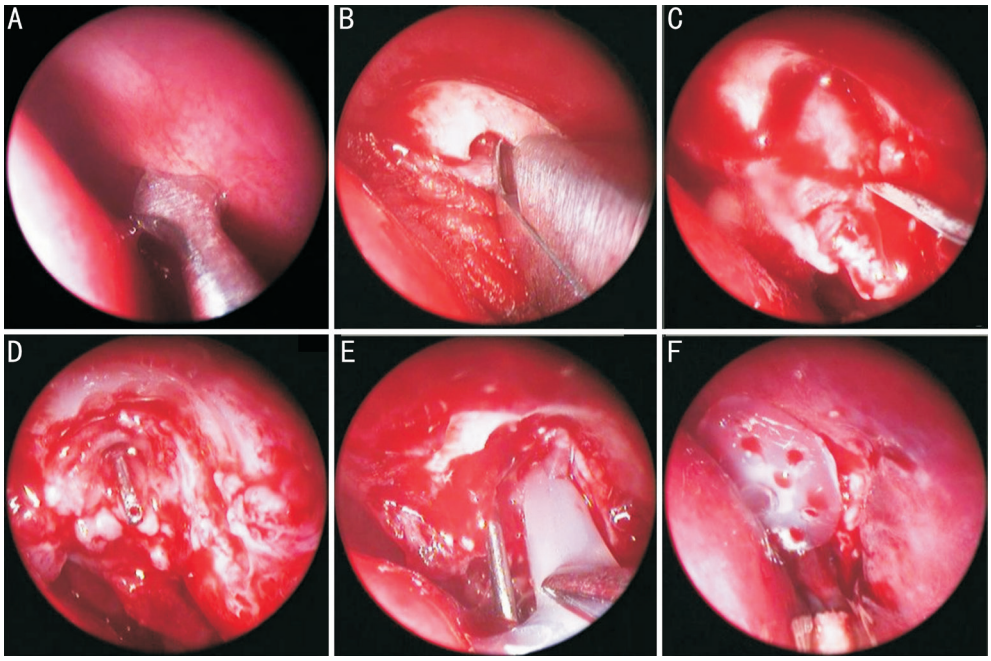

Figure 2 The surgical approach A: A blade was used to incise the lateral nasal mucosa proximal to the lacrimal sac fossa; B: A Kerrison rongeur was used to remove the maxilla and maxillary frontal process following thinning with a power bur; C: A lacrimal probe was used to guide the full opening of the lacrimal sac with an ultrasharp 9# MVR knife; D: The small ostium was expanded by a surgical assistant *via* the slight medial and/or posterior lifting of the lacrimal probe to facilitate LOS placement; E: An appropriately trimmed LOS was placed into the ostium under endoscopic visualization; F: Fixation was achieved by placing the positioning plate between the middle turbinate and the nasal cavity exterior wall.

Pharmaceutical Co., Ltd.) and 0.5% levofloxacin eye drops (Santen Pharmaceutical Co., Ltd.) four times each per day for a 4-week period. In addition, all patients were treated twice daily with intranasal Rhinocort Aqua Nasal Spray (Astra Zeneca, DE, USA). After remaining in the ostium for 3mo, the LOS was removed.

Patient follow-up was conducted at 1, 2wk, and 1, 2, 3, 6, and 12mo post-surgery. Remaining symptoms, purulent secretions, and epiphora were recorded at each follow-up visit. Intranasal ostium patency was assessed *via* lacrimal irrigation and endonasal endoscopic examinations. When there were complaints or evidence of recurrent obstruction, dye tests were performed.

Revision En-DCR success was defined by the absence of any postoperative purulence or epiphora with free-flowing irrigation through the lacrimal system, new ostial patency with a morphologically normal epithelized mucosal layer visible upon endoscopic assessment, and normal endoscopic dye test performance through the new ostium.

RESULTS

In total, 29 patients (29 eyes; 12 left eyes, 17 right eyes) were enrolled in the present study. Of these patients, 18 and 11 were female and male, respectively, with a mean age of 41.0±13.7y (range: 18-63y). All procedures were revision En-DCR due to prior failed Ex-DCR treatment. All participants reported preoperative epiphora, and underwent preoperative analyses including dye tests, lacrimal irrigation, CT-DCG imaging, and nasal endoscopic visualization revealing the presence of synechiae closure to the bony wall of the lacrimal sac in all patients. Moreover, inadequate medial sac wall removal was observed for 21 patients, while 11 exhibited nasal synechiae formation between the lateral nasal wall and the middle turbinate, 5 patients exhibited severe nasal septal deviation, and 7 exhibited a bone opening in a suboptimal location (Table 1). Preoperative Ex-DCR exam results are compiled in Table 2.

Table 1 Causes of previous external dacryocystorhinostomy failure

Characteristic	*n* (%)
Eye	
Right	17 (58.62)
Left	12 (41.38)
Causes of failure	
Synechiae formation in the nasal ostium	29 (100)
Inadequate bony wall removal	21 (72.41)
Nasal synechiae formation between lateral wall of the nose and the middle turbinate	11 (37.93)
Severe nasal septal deviation	5 (17.24)
Mistaken lacrimal sac localization	7 (24.14)

LOS size selection in the present study was based upon the diameter of the lacrimal sac, with an LOS with an outer diameter of 4, 6, and 8 mm being used for 8, 16, and 5 patients, respectively. Full epiphora and dacryocystitis resolution was

Table 2 Preoperative exam results for failed external dacryocystorhinostomy procedures

Parameters	Dye test	Lacrimal irrigation	CT-DCG	Nasal endoscopy
Synechiae formation in the nasal ostium	Positive	Obstruction	Lacrimal sac being enhanced	Synechiae formation
Inadequate bony wall removal	Positive	Obstruction	Lacrimal sac enhancement with residual bone covering the sac at the medial sac wall	Granulation and/or scar formation around the ostium
Nasal synechiae formation between lateral wall of the nose and middle turbinate	Positive	Obstruction	Lacrimal sac enhancement	Nasal synechiae formation
Severe nasal septal deviation	Positive	Obstruction	Lacrimal sac enhancement	The middle turbinate cannot be seen after nasal mucosa contraction
Mistaken in the localization of the lacrimal sac	Positive	Obstruction	Lacrimal sac enhancement with a complete inner bony wall of the sac	Nasal mucosa scar

CT-DCG: Computed tomography-dacryocystography.

Table 3 Outcomes and complications of the endonasal dacryocystorhinostomy with lacrimal ostium stent procedure

Outcome	*n* (%)
Full resolution of epiphora and dacryocystitis (Figure 3)	24 (82.76)
Failure	5 (17.24)
Membrane obstruction (Figure 4A-4C)	2 (6.90)
Granulation obstruction of the ostium (Figure 4D-4F)	3 (10.34)
Complication	-
Bleeding	1 (3.45)
Postoperative epistaxis	2 (6.90)

achieved for 24/29 patients in the present study (82.76%). In the remaining 5 cases, the procedure failed due to the obstruction of the opening by granulation tissue (3 patients) or membranes (2 patients). In these cases, CDCR or bypass surgery were recommended (Table 3, Figures 3-4).

No patients experienced severe complications such as visual changes, orbital hemorrhage, or orbital fat prolapse. One patient suffered from bleeding during bone removal, and this was effectively stopped *via* electric coagulation. In addition, two patients experienced postoperative epistaxis that was successfully treated in the outpatient room using cotton packing that had been soaked in a vasoconstrictive solution.

DISCUSSION

Appropriately managing chronic dacryocystitis following Ex-DCR failure remains challenging. Endoscopy can aid in the management of recurrent epiphora following Ex-DCR failure, with success rates ranging from 43%-90%[3,6-7]. In the present study, a novel LOS was utilized during the En-DCR procedure, achieving satisfactory outcomes including full epiphora and dacryocystitis resolution in 24/29 cases (82.76%).

A silicone LOS with a smooth surface to enable tear fluency was developed for this study. The LOS consisted of a central tube, an elliptical positioning plate, and four fixation buckles, with a range of outer LOS diameters (4, 6, 8 mm) to allow for the selection of a stent appropriate to the size of the lacrimal sac[8-9]. While this LOS could be readily inserted into patients under direct endoscopic visualization, firm LOS fixation was not possible in individuals in which the middle turbinate exhibited forward positioning. In these cases, the positioning plate must be cut to enable more reliable fixation, allowing the stent to expand and support the ostium without causing any damage to the lacrimal passageway. As such, this LOS is likely to induce lower levels of granulation or scar tissue formation as compared to a silicone tube. Just 10.34% of the patients in the present study exhibited scar or granulation formation, with this rate being lower than that reported in prior studies employing silicone tube-based intubation[3,7]. Importantly, this novel LOS had no impact on postoperative lacrimal drainage, with sustained tear fluency being beneficial to maintaining ostial patency. In our prior reports, this LOS has also been used to successfully maintain ostial patency in the context of small lacrimal sac size[8].

Ex-DCR failure can occur for multiple reasons. In the present study, the primary causes of such failure were found to include synechiae formation in the nasal ostium (29/29), inadequate bony wall removal (21/29), nasal synechiae formation between the lateral nasal wall and the middle turbinate (11/29), and mistaken lacrimal sac localization (7/29). Prior studies have similarly shown septal deviation, insufficient bony wall removal proximal to the lacrimal sac, technical error, granulation tissue formation, excess perioperative bleeding impairing the surgical field, and synechiae formation near the fistula opening to be major causes of operative failure[3,7,11].

Ostium synechiae were evident upon nasal endoscopic examination for all failed Ex-DCR cases in the present study cohort. The formation of granulation tissue generally precedes synechiae development[3,7,11]. Given that En-DCR can correct for granulation tissue and synechiae without causing additional scarring[3,7,11], it may represent an effective approach to treating patients in which prior Ex-DCR procedures have failed. However, in these cases, prior surgical scarring will reduce the size of the lacrimal sac, resulting in inevitable postoperative ostium closure and surgical failure, requiring further intervention to maintain ostium patency. In this study, a novel LOS was used to achieve such patency, leading to full epiphora and dacryocystitis resolution in 24/29 patients (82.76%). This stent is thus well-suited to use in patients in

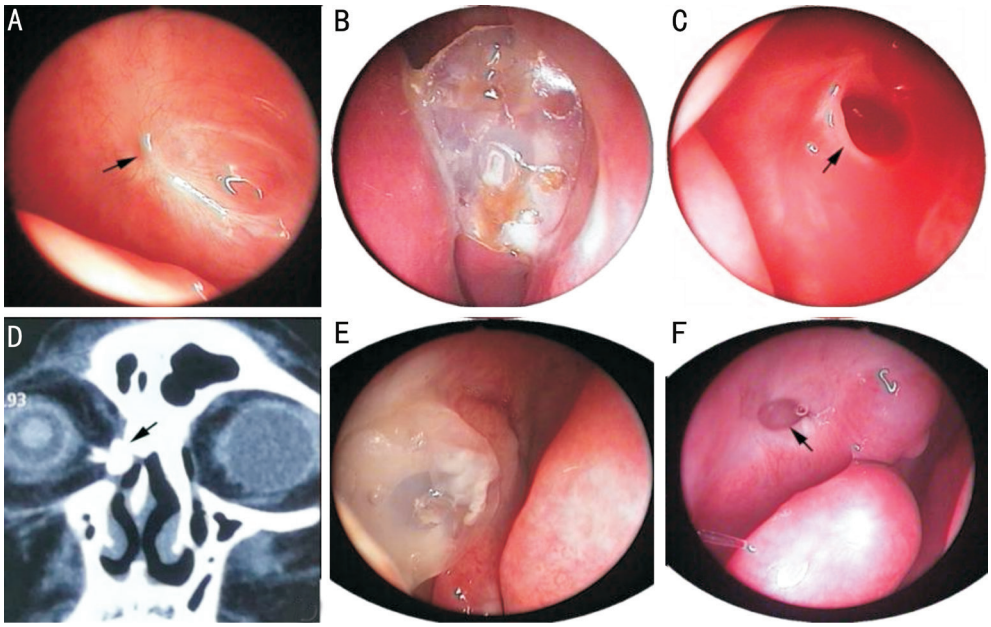

Figure 3 Representative successful cases A: Scar synechia formation occluding the lacrimal sac ostium (black arrow); B: Novel LOS placement in the ostium; C: Ostial patency (black arrow) and a morphologically normal epithelized mucosal layer at the 12-month follow-up time point; D-F: Another representative success case; D: CT-DCG-based detection of the lacrimal sac (black arrow); E: Ostium LOS placement; F: Ostial patency (black arrow) and a morphologically normal epithelized mucosal layer at the 12-month follow-up time point.

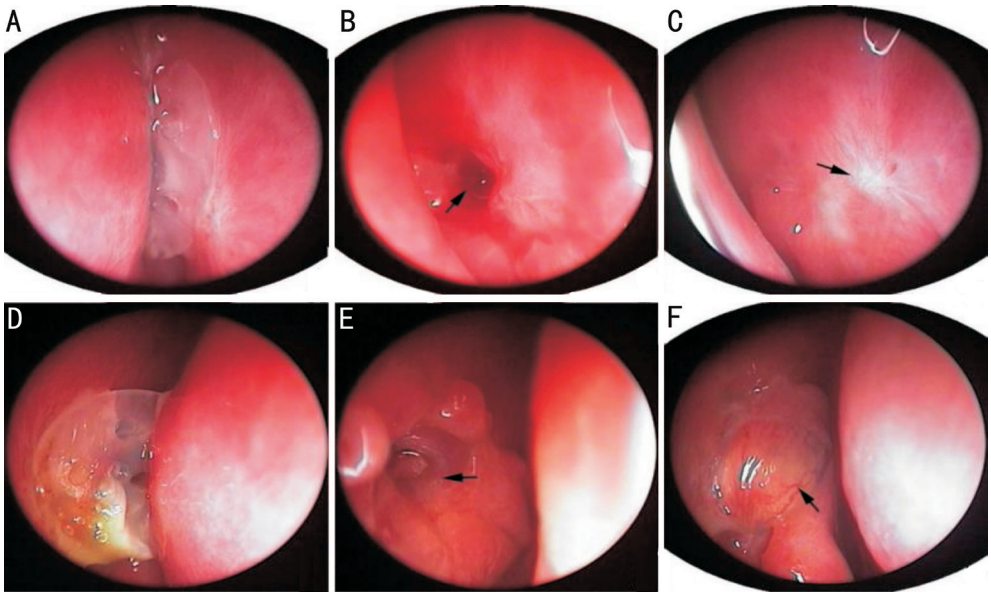

Figure 4 Representative failed cases A: Ostium LOS placement; B: Visible ostial patency upon LOS removal; C: Evidence of a membranous obstruction of the ostium (black arrow) at the 12-month follow-up time point; D-F: Another representative failed case; D: Ostial LOS placement; E: The open lacrimal sac ostium at 6mo post-surgery; F: Granulation tissue was detected occluding the ostium at the 12-month follow-up time point.

whom Ex-DCR has failed. Effectively removing granulation tissues surrounding the ostium is also important to reducing the odds of ostium synechiae and increasing success rates. Herein, patients were subjected to outpatient follow-up endoscopic examination, revealing granulation tissue around the ostium in 12 cases that was removed with mucous membrane scissors and suction, with such removal being performed two times in 4 patients.

Inadequate medial sac wall removal was observed in 21/29 patients. Several prior studies have reported insufficient bone removal to be a common cause of Ex-DCR failure[12]. Bhatia *et al*[12] assessed 29 failed Ex-DCR cases, revealing insufficient bone removal as a cause of operative failure in 21 cases in line with the present report. Many researchers have noted that incomplete opening generally results in mucocele formation, contributing to recurrent infection and associated

symptoms even in the context of ostium patency[13]. As such, we concluded that success rates can be maximized by ensuring a sufficiently large opening during revision En-DCR. By enabling direct endoscopic visualization of the operative site and nasolacrimal fistulae, we were thus able to maximize the ostium opening. In 9 patients, a portion of lacrimal bone was removed to ensure the ostium was sufficiently wide, thereby improving operative success rates.

Unexpected lacrimal sac localization is another common cause of Ex-DCR. We observed a suboptimal bone opening location in 7/29 patients in the present study cohort. Endoscopic visualization can better aid the operating surgeon in their efforts to open the lacrimal sac from within the nasal cavity, given that the site of the obstruction can be readily detected using a probe introduced *via* the upper punctum[14]. Moreover, all patients underwent preoperative CT-DCG imaging, thereby enabling the location of the sac with reference to the anterior ethmoid sinus, middle turbinate, and other proximal tissues.

Septal deviation has previously been reported to be associated with higher rates of Ex-DCR failure owing to the higher risk of synechiae formation between the middle turbinate and the lateral nasal wall[2,11]. Such nasal synechiae formation was evident in 11 cases in the present study, but appropriate endoscopic visualization enabled the separation of these synechiae during this procedure. Severe nasal septal obstruction was observed for 5/11 cases, resulting in the narrowing of the nasal cavity towards the obstructed side of the lacrimal duct. In all of these patients, an operation to restore the septum was performed at the start of the En-DCR protocol, as we believe this approach can aid in improving revisional En-DCR success rates.

There are several advantages to the En-DCR procedure as compared to Ex-DCR[3,7,11]. These include the lack of additional scar tissue formation, a reduction in bleeding and hospitalization duration, a better ability to manage dacryocystomy fistulae, the reduction of medial eye canthus lesion structures, and the maintenance of orbicular muscle-mediated lacrimal pumping activity. Only one patient in the present study cohort experienced bleeding during bone removal, and hemostasis was achieved *via* electric coagulation in this case. Postoperative epistaxis occurred in two patients in the present study cohort, and was resolved in the outpatient room *via* packing with cotton soaked in a vasoconstrictive solution.

In total, 5 patients in the present study cohort experienced recurrent epiphora following revision surgery and were considered failed cases. All 5 of these patients exhibited either a scarred or small lacrimal sac visible upon review of preoperative exam results and En-DCR procedure videos. Small lacrimal sacs can markedly reduce success rates for both Ex-DCR and En-DCR procedures. Consistently, Hammoudi and Tucker[15] reported significantly higher rates of operative success for patients with a large lacrimal sac opening (93%) as compared to patients in which this opening was small (71%). The formulation of granulation tissue and scarring as a result of prior Ex-DCR procedures can further reduce the size of the lacrimal sac. As such, we believe that scarring and small lacrimal size were primary causes of failure in the present study.

This study is limited by its small sample size and lack of a control group. Additional prospective studies are thus warranted to explore the value of En-DCR procedures with LOS intubation in cases where prior Ex-DCR intervention has failed.

In summary, a success rate of 82.76% was achieved in the present study, and complication rates remained low. As such, we conclude that the use of LOS intubation when conducting En-DCR procedures represents a viable approach to revision surgery for patients experiencing recurrent epiphora following a prior failed Ex-DCR procedure.

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