Original Article

Endonasal endoscopic nasolacrimal duct dissection for primary nasolacrimal duct obstruction

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Abstract:

PURPOSE: The purpose of this study is to describe the results of endonasal endoscopic nasolacrimal duct dissection (EE-NLDD); a surgical technique used for the treatment of primary nasolacrimal duct obstruction (NLDO).

MATERIALS AND METHODS: Before the operation, the patency of the nasolacrimal duct (NLD) was evaluated through irrigation and probing. The EE-NLDD surgical procedure involved the removal of the bony structure covering the NLD. The NLD mucosa was dissected and marsupialized with nasal mucosa, creating a mucosa-covered ostium. The bone surrounding the lacrimal fossa and lacrimal sac mucosa was preserved throughout procedure. The postoperative anatomical and functional outcomes were evaluated through irrigation, endonasal endoscopic fluorescein dye test, and subjective descriptions of the patients.

STUDY DESIGN: This is a retrospective chart review study which included all patients with primary NLDO treated with EE-NLDD surgical technique from February 2012 to July 2016 in Taipei Medical University Shuang Ho Hospital by a single surgeon (YD, Shen).

RESULTS: The mean follow-up time for the 39 patients (43 eyes) was 14.7 months (range: 0.5–46 months). Anatomical patency was achieved in all patients. Under endonasal endoscopy, fluorescein dye was observed at the internal orifice after the dye was instilled into the conjunctival sac in all patients. The complete resolution of the epiphora was reported in 36 patients (39 eyes) and two patients (2 eyes) exhibited an improvement of the epiphora after surgery. However, one patient (2 eyes) reported persistent bilateral epiphora without improvement even under solid evidence of anatomical patency. No major complications were noted intraoperatively or postoperatively.

CONCLUSIONS: The results suggested that the EE-NLDD is a safe and effective procedure and has a success rate comparable with that of conventional endonasal dacryocystorhinostomy.

Keywords:

Dacryocystorhinostomy, endonasal endoscopy, epiphora, nasolacrimal duct obstruction

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Introduction

Dacryocystorhinostomy (DCR) is currently the preferred treatment for nasolacrimal duct obstruction (NLDO). Although external DCR performed through cutaneous incision was once considered the standard therapy, recent studies have indicated that the endoscopic DCR has a success rate comparable with that of the external approach.[1,2] Moreover, the endoscopic DCR is gaining popularity due to factors such as the absence of surgical scars, reduced damage to the lacrimal pumping system, and short postoperative recovery time.[3,4]

Although the anatomical success rate is high for both the external and endoscopic DCR, functional failure still occurs in patients with anatomical success. These patients still experience persistent epiphora even if the lacrimal system is patent under

irrigation after the DCR. This phenomenon, called sump syndrome, is presumably caused by a persistent pouch in the residual lacrimal sac after DCR.[5] To avoid this problem and improve functional outcomes, we modified the conventional endoscopic DCR by creating an ostium between the nasal cavity and the nasolacrimal duct (NLD), rather than between the nasal cavity and the lacrimal sac, to avoid the backflow from the pouch. In our procedure, the mucosa of the NLD was dissected and marsupialized with the nasal mucosa to create this ostium. From February 2012, we began applying this technique to all patients with primary NLDO without a history of acute dacryocystitis. In the case of patients with a history of acute dacryocystitis, substantial scarring might cause an obstruction in the lacrimal sac, and we believed that opening the sac was necessary in these cases. This study evaluated the anatomical and functional outcomes of this modified procedure.

Materials and Methods

Overview

From February 2012, we began using the endonasal endoscopic nasolacrimal duct dissection (EE-NLDD) surgical technique for all patients with primary NLDO without a history of acute dacryocystitis. The present study is a retrospective chart review of all these patients. The procedures were performed by a single oculoplastic surgeon (Yun-Dun Shen) at Taipei Medical University, Shuang Ho Hospital between February 2012 and July 2016.

This study received approval from the institutional review board of Taipei Medical University. We collected patient data comprising age, sex, affected eye, symptoms, comorbidities, patency of the lacrimal system, postoperative endonasal endoscopic (EE) image findings, postoperative complications such as epistaxis and surgical site infection, and follow-up duration. Patients aged younger than 20 years and those who failed to complete the postoperative evaluation were excluded from this retrospective study.

Preoperative evaluation

All patients complained of preoperative epiphora. A complete physical examination was performed to confirm the diagnosis of NLDO. Lacrimal irrigation revealed fluid reflux, and no fluid reached the nasal cavity. Upon lacrimal probing, the probe reached the bone of the lacrimal fossa, and a hard stop was encountered, confirming the patency of the common canaliculus.

Surgical techniques

All EE-NLDD were performed using the following techniques: the operation was performed under general anesthesia. A topical decongestant was applied to the nasal cavity, and the lateral nasal wall was infiltrated using 2 mL of 2% lidocaine with 1:80,000 epinephrine. The entire operation was performed using a 0° or a 30° 4 mm endoscope, depending on the intraoperative circumstances. A No. 15 scalpel was used to fashion a mucosal flap starting from the insertion of the middle turbinate on the lateral nasal wall (the axilla of the middle turbinate). This mucosal incision was performed along the frontal process of the maxilla to the insertion of the inferior turbinate [Figure 1a].

A suction freer elevator was used to lift the mucosal flap, maintaining the dissection under the mucoperiosteum [Figure 1b]. The dissection was extended posteriorly to the insertion of the uncinate process. The mucosal flap was tucked around the anterior end of the middle turbinate to avoid interference with further dissection.

The hard bone of the frontal process of the maxilla, overlying the NLD, was removed with a Kerrison 45° upbiting punch from the insertion of the middle turbinate insertion [Figure 1c] to the insertion of the inferior turbinate, which corresponded to the anatomical location of the NLD [Figure 1d]. An angled (15°) diamond burr attached to a microdebrider (Straightshot® M4 Microdebrider, Medtronic USA, Jacksonville, FL, USA) was used to polish the raw bone surface for facilitating the attachment of the mucosal flap. The thick bone overlying the lacrimal sac remained untouched.

Furthermore, a Bowman lacrimal probe was used to tent the medial wall of the mucosal NLD. This was then opened from the junction of the sac and the NLD to the insertion of the inferior turbinate using a right-angled DCR spear knife (Medtronic USA, Jacksonville, FL, USA) [Figure 1d and e], thereby creating the longest possible anterior and posterior flaps in the vertical dimension. A DCR sickle knife (Medtronic USA, Jacksonville, FL, USA) was used to make the anterior, superior, and inferior releasing cuts, after which microscissors were used to create releasing cuts in the posterior flap [Figure 1f]. A pair of sharp, through-biting, straight Blakesley forceps was then used to trim the redundant nasal mucosal flap, which was then approximated with the anterior flap of the NLD [Figure 1g]. Lacrimal bicanicular silicone tubes were inserted through the superior and inferior canaliculi and then through the lacrimal sac into the opened NLD [Figure 1g]. Oxidized cellulose (Sugicel®, Ethicon, USA) was placed over the raw surface of the osteotomy to decrease the possibility of postoperative bleeding and to hold the flaps in place.

Postoperative care and follow-up

Oral antibiotics (Cephalexin) were given for 5 days postoperatively for infection prophylaxis. Topical
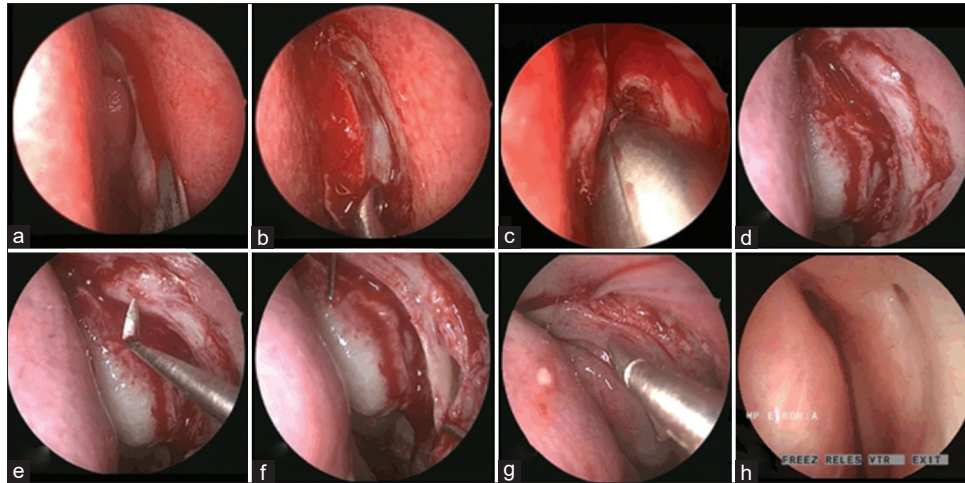
Figure 1: Intraoperative endonasal endoscopic view of nasolacrimal duct dissection. (a) Mucosal incision site: from frontal process of the maxilla to the insertion of inferior turbinate. (b) Frontal process of maxilla was exposed. (c) Frontal process of the maxilla was removed with a Kerrison 45° upbiting punch. (d) Whole nasolacrimal duct was exposed from middle to inferior turbinate. (e) Nasolacrimal duct was dissected with spear knife. (f) Nasolacrimal duct mucosa was fully opened and exposed. (g) Nasal mucosa was approximated with nasolacrimal duct mucosa. Lacrimal bicanalicular silicone tubes were inserted through the superior and inferior canaliculi into the lacrimal sac. (h) Osteotomy was created at the level of the nasolacrimal duct, and the orientation was approximately vertical

antibiotics (Levofloxacin ophthalmic solution 0.5%) and topical steroid (Prednisolone acetate 1% suspension) were initiated immediately after surgery and administered four times per day for 2 weeks. Postoperatively, the patients had at least one follow-up at our clinic after discharge to remove the lacrimal bicanalicular silicone tube and to determine the anatomical patency. Endonasal endoscopy was performed during the follow-up to determine the status and function of the ostium. All patients underwent routine saline irrigation of the lacrimal system at follow-up. Any discomforts that developed after surgery were inquired about and recorded.

Outcome measurement

Anatomical surgical success was defined as the patency of the lacrimal system with an irrigation test at follow-up. The functional outcome was evaluated with the following technique. At postoperative follow-up, fluorescein dye was instilled into patients' conjunctival sac, and the osteotomy sites were inspected with an endonasal endoscope. The functional outcome was also evaluated according to the patients' subjective experience after surgery and classified into three categories: no improvement, improvement after surgery, and complete resolution of epiphora. Functional success was defined as the presence of the fluorescein dye in the nasal cavity after a few blinks and the complete resolution of the epiphora postoperatively.

Results

The EE-NLDD procedure was performed in 43 eyes of 39 patients (8 men, 31 women; mean age: 54.9 years; range: 28–76 years). The mean follow-up time was 14.7 months (range: 0.5–46 months).

All the patients maintained anatomical success postoperatively. The functional success was confirmed under endoscopic examination by the presence of the fluorescein dye in every patient. Thirty-six patients (39 eyes) reported the complete resolution of the epiphora and two patients (2 eyes) reported an improvement of the epiphora after surgery. However, one patient (2 eyes) reported persistent bilateral epiphora with no improvement despite the solid evidence of anatomical patency (fluorescein dye was noted over the orifice and the nasal cavity).

No major complications were observed intraoperatively or postoperatively. Postoperative epistaxis subsided completely in 1 week after the EE-NLDD in all patients and no patient required further management. No surgical site infection was noted. Granulated tissue growth at the osteotomy site was noted through endonasal endoscopy evaluation in one patient, which regressed over time and did not obstruct the osteotomy.

Discussion

In the past decade, endoscopic DCR has shown promising results in the treatment of primary NLDO.[1,2,4] To avoid an external scarring, patients can consider endoscopic DCR as a reasonable treatment option.

Although the endoscopic DCR preserves the lacrimal pumping function and feasibility of correcting intranasal pathologies, anatomical failure may still occur. The causes for anatomical failures include the false localization of the lacrimal sac, granulated tissue formation, membranous obstruction of the osteotomy site, retained bony spicules, inadequate removal of the sac, and synechia between

the lateral nasal wall and the middle turbinate.[5-7] Fortunately, most of the factors causing failure can be avoided using the improved surgical techniques and surgical instruments that are available currently. Overall, anatomical success was achieved in most patients who received endoscopic DCR surgeries.[6,7]

Despite its high anatomical success rate, endoscopic DCR can still fail functionally. In a few patients, despite patent lacrimal system confirmed by the irrigation test, the patients still experienced persistent epiphora after the operation. Sump syndrome was considered as one of the causes of functional failures in cases with anatomical success. Sump syndrome is characterized by fluid accumulation in a residual lacrimal pouch.[5] In these cases, although the lacrimal irrigation and dye disappearance test both exhibited normal results, tears trapped in the sac could still backflow and present as epiphora.[8,9] Multiple factors, such as the height of the ostium, might cause sump syndrome.[10,11] In our procedure, osteotomy was performed at the NLD level, which was positioned inferiorly to that of the standard endoscopic DCR. Therefore, the development of the pouch could be avoided and tears could be diverted directly into the nasal cavity.

Multiple studies on endoscopic DCR have proposed that the complete opening of the lacrimal sac is the key factor for success.[6,7] For endoscopic DCR, localization of the lacrimal sac under endoscopy is essential. Wormald *et al*. analyzed 47 computed tomographic dacryocystograms of the patients and determined that a major portion of the lacrimal sac was situated superior to the axilla of the middle turbinate.[12] Therefore, to completely expose the lacrimal sac, the removal of the maxillary bone superior to the axilla was necessary. In the EE-NLDD, the upper limit of the maxillary bone removal was marginally inferior to the axilla of the middle turbinate. Thus, most of the lacrimal sac remained untouched throughout the procedure. In contrast to the previously proposed theory, where the lacrimal sac had to be completely opened to function satisfactorily, our dissection was intentionally limited only to the NLD. Without opening the lacrimal sac, our procedure still achieved a very high rate of anatomical and functional success, suggesting that the opening of the lacrimal sac might be unnecessary, provided that no obstruction exists superior to the junction of the sac and the NLD.

Several studies have demonstrated that the lacrimal sac has a unique pumping function, through which tears are drained in a coordinated movement. The fornix of the lacrimal sac moves in the craniolateral direction, and the orbicularis oculi muscle contracts to create a wrung-out force, which clears the tears accumulated in the lacrimal sac.[13,14] Although the movement of the

lacrimal sac wall may be small, it is likely to move the lacrimal fluid downward.[15] Therefore, removing the bone around the lacrimal sac in the standard endoscopic DCR procedure may interfere with the function of the orbicularis muscle that was attached around the lacrimal fossa (Horner's muscle). Therefore, if the lacrimal sac is intact and the bony structure around the lacrimal fossa is left undisturbed, as in our procedure, superior functional outcomes can be achieved because the pumping function of the lacrimal sac is preserved.

Endoscopic DCR is usually combined with silicone tube insertion, and the orientation of the silicone tube in the nasal cavity may influence the healing process with the mucosal marsupialization. Since the medial wall of the lacrimal fossa is removed and the lacrimal sac is opened in standard endoscopic DCR, the silicone tube is placed in a horizontal orientation in the osteotomy, and the marsupialization of the mucosa may occur at the level of the common canaliculus. In our procedure, because the lacrimal sac and the medial wall of lacrimal fossa were intact, and the osteotomy was created at the level of the NLD, the orientation of the silicone tube in the nasal cavity was approximately vertical. Consequently, the mucosal marsupialization in our procedure occurred at a lower level and in a more vertical orientation [Figure 1h] than that in conventional endoscopic DCR. Theoretically, a vertically oriented ostium drains tears more suitably because of gravity; thus, sump syndrome is less likely to occur if the ostium is at a lower level.

In a series investigated by Welham and Wulc, 111 of the 208 failures were due to inadequate size or inappropriate location of the ostium.[10] Due to the belief that inadequate osteotomy is a critical cause of DCR failure, most surgeons have focused on the complete exposure of the lacrimal sac in conventional endoscopic DCR. To achieve the complete exposure, the osteotomy must reach the top of the sac, which is located a few millimeters above the anterior attachment of the middle turbinate.[16] In this scenario, an intranasal burr is usually required because the bone above the middle turbinate axilla is thick and very difficult to remove with only a sphenoid punch. However, in our series, we intentionally left the medial wall of lacrimal sac intact, thus obviating the requirement of using a power system.

The exact location of the obstruction site in the NLDO has not been completely studied. One study using dacryoendoscopy located the obstruction site in either the most proximal part or the most distal part of the NLD,[17] which contrasts with the observations in our procedure. Because we opened the NLD from the most proximal part to the inferior turbinate, most of the NLD mucosa could be inspected. The scar formation area at the mucosa is presumably the obstruction site. We observed that the

scar could form anywhere in the part of the NLD that we opened, and the scar was usually released with the endoscopic scissors and the sickle knife to facilitate the opening of the mucosal flap. Because we routinely opened the most proximal part of the NLD, we believe that the obstruction site in all NLDO cases can be bypassed.

However, our procedure has some limitations. An obstruction in the lacrimal sac prevents the application of our technique. Therefore, preoperative evaluation is important. If patients have a history of acute dacryocystitis, our procedure cannot be utilized because adhesion may be present in the lacrimal sac. Furthermore, in our procedure, the lacrimal sac could not be inspected thoroughly to exclude a possible pathology in the lacrimal sac. Therefore, if a lacrimal sac tumor is suspected, this procedure should not be used. A standard external or endoscopic DCR might be more suitable for patients with suspected tumor or with a history of acute dacryocystitis.

Our modified surgical procedure yielded encouraging results in both the anatomical and functional outcomes (anatomical success rate: 100% and functional success rate: 90.7%) as compared with conventional endoscopic DCR (anatomical success rate: 93.2%–96.9%[1,6] and functional success rate: 82.4%–95.7%[1,2,6,7]). However, this study included only a preliminary report of 23 cases. The lack of a comparison group, with surgery performed using the standard endoscopic DCR, was a limitation of the study. Furthermore, numerous confounding factors existed that can interfere with the final outcome due to different surgical equipment and techniques. Further studies with a randomized comparison group are required for a more substantial conclusion.

Conclusions

In summary, this study suggested that the EE-NLDD is a safe and effective procedure, and its success rate is comparable with that of conventional endoscopic DCR.

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Conflicts of interest
The authors declare that there are no conflicts of interests of this paper.

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