

# Endoscopic dacryocystorhinostomy with bicanalicular silicone tube intubation for treating chronic dacryocystitis secondary to nasolacrimal duct stent incarceration

Shan Lan<sup>1</sup>, Jin-Qiang Yu<sup>2</sup>, Feng Ke<sup>2</sup>, De-Kun Li<sup>2</sup>, Bo Yu<sup>3</sup>, Zhen-Kai Liu<sup>2</sup>

<sup>1</sup>Department of Radiology, Renmin Hospital, Hubei University of Medicine, Shiyan 442000, Hubei Province, China

<sup>2</sup>Department of Ophthalmology, Renmin Hospital, Hubei University of Medicine, Shiyan 442000, Hubei Province, China

<sup>3</sup>National Clinical Research Center for Ocular Diseases, Eye Hospital, Wenzhou Medical University, Wenzhou 325027, Zhejiang Province, China

**Correspondence to:** Bo Yu. National Clinical Research Center for Ocular Diseases, Eye Hospital, Wenzhou Medical University, Wenzhou 325027, Zhejiang Province, China. yubo312@126.com; Zhen-Kai Liu. Department of Ophthalmology, Renmin Hospital, Hubei University of Medicine, No.39 Chaoyang Zhong Lu, Shiyan 442000, Hubei Province, China. eyelzk2020@163.com

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## Abstract

• **AIM:** To investigate the feasibility of endoscopic dacryocystorhinostomy (En-DCR) with bicanalicular silicone tube intubation for treating chronic dacryocystitis secondary to nasolacrimal duct stent (NDS) incarceration.

• **METHODS:** En-DCRs were performed on 44 chronic dacryocystitis patients (46 eyes) secondary to NDS incarceration from April 2016 to October 2022. The granuloma and scar tissues were separated, and the removal of NDS incarceration was achieved during the surgery; the flap of the lacrimal sac was trimmed and anastomosed with nasal mucosal, a bicanalicular silicone tube was implanted, and lacrimal size and condition were assessed. The tube was removed 3mo after surgery. During the final follow-up of 12mo when the surgery was completed, the complications and the rates of surgical success were assessed.

• **RESULTS:** This study covered 40 patients (42 eyes). Intraoperatively, it was found that the lacrimal sac became small, and the sac wall had granulation and scar tissue attached to the incarcerated NDS in all eyes. At 12mo after surgery completed, the rates of the functional and anatomical success reached 80.95% (34/42) and 83.33%

(35/42), respectively. Under the effect of intranasal ostial closure, seven eyes failed to achieve anatomical success. No serious complications (e.g., visual impairment, sinusitis, and orbital fat prolapse) was observed.

• **CONCLUSION:** With the success rate over 80% and no serious complications, En-DCR with bicanalicular silicone tube implantation is effective in treating chronic dacryocystitis secondary to NDS incarceration.

• **KEYWORDS:** endoscopic dacryocystorhinostomy; bicanalicular silicone tube; nasolacrimal duct stent; incarceration

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## INTRODUCTION

Nasolacrimal duct obstruction (NLDO) and chronic dacryocystitis have been reported as the most common ophthalmic disease of lacrimal duct obstruction<sup>[1-2]</sup>. Although dacryocystorhinostomy (DCR) surgery, e.g., external method dacryocystorhinostomy (Ex-DCR) and endoscopic transnasal method dacryocystorhinostomy (En-DCR), is a golden surgical method for treating this obstruction, nasolacrimal duct stents (NDS) have been used for treating NLDO and chronic dacryocystitis, with advantages of being amenable to performance on an outpatient basis, with high safety, with cost-effectiveness, and being minimally invasive<sup>[3-6]</sup>.

The efficacy of NDS is not encouraging. Long-term follow-up has shown that the probability of surgical failure or recurrence is up to 80%<sup>[7-9]</sup>. In addition, incarceration of NDS is not uncommon, with a reported incidence over 20%<sup>[7-10]</sup>. This NDS incarceration is often associated symptoms including epiphora and purulence, bloody secretions, medial canthal swelling, and even acute dacryocystitis and orbital cellulitis<sup>[9,11]</sup>.

For patients with NDS incarceration, direct pulling out the NDS from the inferior meatus becomes very difficult, leading

to avulsion of lacrimal sac and nasal mucosa as well as severe pain and bleeding<sup>[11]</sup>. For patients with NDS incarceration, DCR has been generally recommended and accepted. Ex-DCR was adopted for the removal of incarcerated NDS<sup>[12-13]</sup>. However, it was difficult to carefully separate the adhesion of the lacrimal sac mucosa and incarcerated NDS due to the unclear surgical field caused by bleeding, resulting in extensive damage of lacrimal sac mucosa. The above-mentioned extensive mucosa damaging results in difficulties in lacrimal flap making and anastomosis with nasal mucosa flap, which would easily cause ostium closure after surgery. In addition, the reduction of dacryocyst volume due to scar contraction in the lacrimal sac also leads to a low success rate of surgery<sup>[8,11]</sup>. En-DCR is more progressively employed since it outperforms Ex-DCR and is emerging as the preferred procedure in the management of NLDO and chronic dacryocystitis<sup>[5,14]</sup>. Directly illuminating the 4- to 6-fold magnification-based endoscopes show convenience and can facilitate the recognition and the meticulous removal of fibrotic tissues that minimally jeopardize the lacrimal sac mucosal, notably showing convenience in meticulous preparation of flaps of the lacrimal sac, such that nasal mucosal flaps can be precisely anastomosed with the lacrimal sac<sup>[11]</sup>. Currently, whether En-DCR is effective in cases who are subjected to chronic dacryocystitis that is secondary to incarcerated NDS has been rarely investigated. The bicanalicular silicone tube has been extensively employed in the En-DCR surgery procedure. Articles reported that the bicanalicular silicone tube intubation can improve the ratio of successful DCR surgery, in terms of patients exhibiting inappropriate lacrimal sac flap or small lacrimal sac<sup>[11,15-16]</sup>.

Thus, this study aimed at exploring En-DCR results with bicanalicular silicone tube implantation for patients who are subjected to chronic dacryocystitis that is secondary to incarcerated NDS.

## SUBJECTS AND METHODS

**Ethical Approval** This retrospective study gained approval from the Ethics Committee of the Renmin Hospital of Hubei University of Medicine (No.Sym-2023-035), conforming to Declaration of Helsinki principles. All patients signed informed consent.

Consecutive 44 patients (46 eyes) conformed to the inclusion criteria for diagnosis of chronic dacryocystitis secondary to NDS incarceration and selected to undergo surgical treatment of En-DCR with bicanalicular silicone tubes implantation at the Hubei University of Medicine from April 2016 to October 2022. Previous medical interventions, clinical presentations, lacrimal duct irrigation, nasal endoscopy examination and computerized tomography dacryocystography (CT-DCG) were performed for diagnosis confirmation. Moreover, the

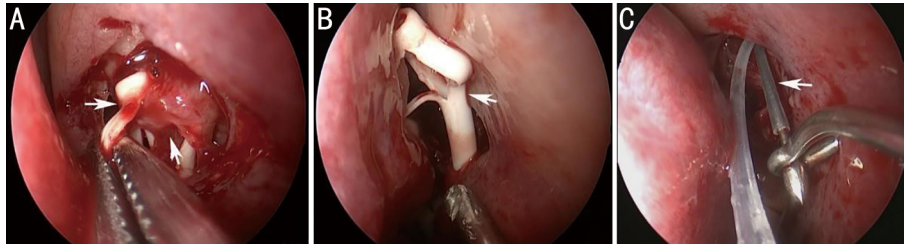
obstruction place of the lacrimal duct was assessed by the same radiologist (Lan S) blinded to patient clinical status in accordance with the CT-DCG.

Patients conformed to the exclusion criteria when they had histories of En-DCR or Ex-DCR surgery previously, showed stenosis or obstruction of the lacrimal canaliculus or common lacrimal canaliculus, had lid malposition, had severe sinusitis and severe nasal septum deviation, history of lacrimal duct system tumor, with systemic autoimmune disease, follow-up period <12mo and had tube prolapse in 3mo after surgery.

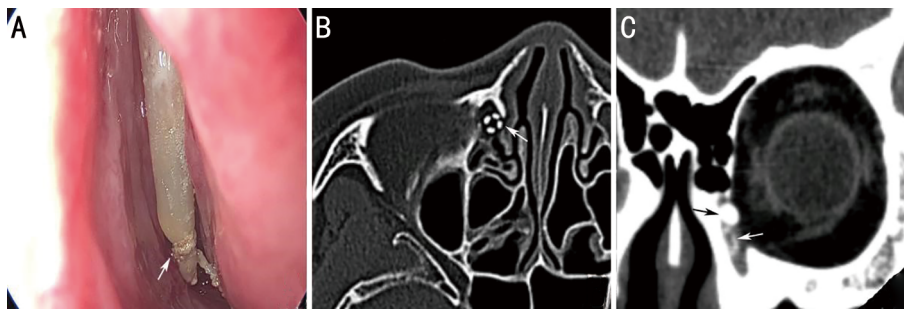
**Surgical Procedures** With the use of a 0° 4.0-mm endonasal endoscope (Karl Storz, Tuttlingen, Germany), the patients in this study were subjected to En-DCR under general anesthesia, completed by the same ophthalmologist (Liu ZK). The nasal mucosa was contracted with cotton pieces infiltrated with epinephrine for 2min. The steps of En-DCR surgery are briefed in the following<sup>[11,17-18]</sup>. Step 1, the nasal mucosa of the lacrimal sac fossa was incised by a stripper with attraction to expose the lacrimal-maxillary suture. Step 2, using a Kerrison rongeur (Jinzhong, Shanghai, China), the removal of the maxilla's frontal process was achieved for exposing the lacrimal sac's entire medial wall. Step 3, a lacrimal probe is inserted from the upper punctum for supporting the lacrimal sac's medial wall, and the lacrimal sac was incised following the anterior border of the bone window with the use of a curved 9# microvitrectomy (MVR) knife (EdgePlus Trocar Blade, Alcon, TX, USA) to expose the incarcerated NDS. Step 4, the adhesion of the NDS and the lacrimal sac was cut and then separated rigorously, and the NDS was removed from the newly formed ostium (Figure 1A, 1B). Step 5, the MVR knife was adopted to fully open the inferior lacrimal sac part's medial wall; the granuloma and scar tissues in the sac were separated and then removed; next, the upper part of the lacrimal sac was opened following the guidance of the probe. Afterward, the posterior lacrimal sac flap was trimmed and then anastomosed with the nasal mucosal flap. Step 6, a bicanalicular silicone tube was implanted in the ostium from the inferior punctum and the superior punctum; in the nasal cavity, the tube ends were bound (Figure 1C). At last, 2 pieces of examethasone-soaked absorbable gelatin sponge were used to fill the ostia.

Postoperative care comprised administering Intranasal Rhinocort Aqua Nasal Spray (Astra Zeneca, Wilmington, USA) 2 times per day within a period of 2mo in the overall subjects. Moreover, topical steroid eye drops (0.02% fluorometholone; Santen Pharmaceutical Co, Ltd) and topical antibiotics (0.5% levofloxacin; Santen Pharmaceutical Co, Ltd) were employed three times daily within a period of 2wk.

The follow-up at twelve months, six months, three months, two months, one month, two weeks, and one week was carried out



**Figure 1** Intraoperative endoscopic views of the endoscopic dacrycystorhinostomy in a patient with nasolacrimal duct stent incarceration A: The adhesion of the nasolacrimal duct stent and the lacrimal sac was exhibited (arrow); B: The nasolacrimal duct stent was separated and removed from the newly formed ostium (arrow); C: A bicanalicular silicone tube was inserted into the ostium (arrow).



**Figure 2** Preoperative nasal endoscopic and computerized tomography examination A: As indicated by the result of nasal endoscopy, the distal end of the nasolacrimal duct stent had a location in the inferior nasal meatus; B: The head of an incarcerated nasolacrimal duct stent was arranged within the junction of lacrimal sac and nasolacrimal duct (arrow); C: The head of a nasolacrimal duct stent was arranged within the lower part of lacrimal sac (white arrow), and the upper part of the lacrimal sac was showed (black arrow).

separately after the surgery. At the respective follow-up visit, patients were assessed for evidence of purulent secretions and epiphora, and they were subjected to nasal endoscopy, lacrimal irrigation, and dye tests. In addition, the symptom of epiphora was assessed in accordance with the Munk *et al*'s<sup>[19]</sup> scale. To be specific: Level 0 refers to no epiphora; Level 1 refers to occasional epiphora with a requirement for dabbing less than twice daily; Level 2 refers to epiphora with a requirement for dabbing 2-4 times/day; Level 3 refers to epiphora with a requirement for dabbing 5-10 times/day; Level 4 refers to epiphora with a requirement for dabbing >10 times/day; Level 5 refers to constant tear flow. Bicanalicular silicone tubes were removed 3mo after surgery in an outpatient clinic. Anatomical success represents the resolution of infection and a patent ostium on irrigation and endoscopic examination. The functional success represents the resolution of infection and epiphora (Munk score was 0 or 1), as well as dye's free flow within ostium on the functional endoscopic dye experiment.

## RESULTS

Three patients (three eyes) were excluded due to loss of follow-ups and 1 patient (1 eye) was excluded due to tube prolapse 1mo after surgery. Lastly, 40 patients (42 eyes) were generally covered. Among the above-mentioned 40 patients, 15 were males and 25 were females, 19 cases were affected right eyes and 23 cases were affected left eyes. The age of all cases ranged from 24 to 70y (49.88±10.89). The duration previous NDS intubation was 6 to 36mo (12.76±7.14). All

involved patients complained of epiphora and purulence prior to surgery. In addition, three patients (three eyes) with bloody secretions overflow from the lacrimal punctum, three patients (three eyes) with occasional bloody secretions from nasal cavity, five patients (five eyes) with medial canthal swelling and 11 patients (12 eyes) with discomfort in the inner canthus or nasal cavity. As indicated by the result of nasal endoscopy, NDS distal end had a location within the inferior nasal meatus (Figure 2A). CT-DCG suggested that all patients displaying obstruction in the lacrimal sac and the head of NDS were placed in the lower lacrimal sac part, or the junction of lacrimal sac and nasolacrimal duct (Figure 2B, 2C).

The removal of three types of NDS exhibiting a variety of head shapes, covering ball (10 cases), umbrella (15 cases), and barb (17 cases) was achieved during surgeries (Figure 3). The NDS associated complications - bloody secretions, medial canthal swelling and discomfort - were all completely relief after surgeries at the first time of follow up.

With a follow-up of 12mo postoperative, 35 cases achieved anatomical success outcome in accordance with the set criteria, with an anatomical success rate of 83.33% (35/42). However, one eye had epiphora (Munk Level 3) with anatomical patency existing, triggering in a functional success rate of 80.95% (34/42; Figure 4). Anatomical failure occurred due to intranasal ostial closure in 7 patients. Among the above-mentioned 7 failed eyes, three eyes caused by granuloma formation and 4 eyes caused by scar formation.

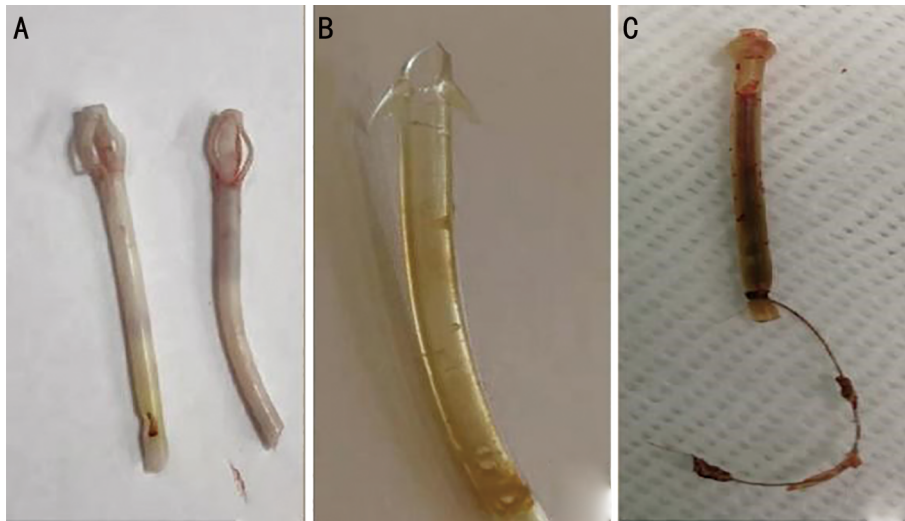


Figure 3 Three types of nasolacrimal duct stent with three different head shapes, including umbrella (A), barb (B), and ball (C).

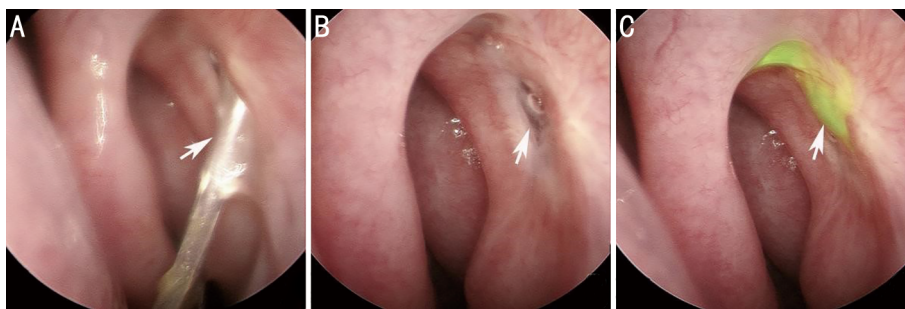


Figure 4 A success case viewed by endoscopic examination A: Silicone tube implantation within the ostium (arrow); B: Ostial patency with an epithelized mucosal layer with a normal appearance (arrow); C: The results of normal functional endoscopic dye experiment (arrow).

Bleeding occurred when the frontal process of the maxilla was removed in three patients, and was stopped using hemostatic bone wax or intraoperative electric coagulation. One patient experienced postoperative epistaxis in the day after surgery, and successfully treated in the outpatient room using cotton pack soaked in a vasoconstrictive solution. No complications such as orbital fat prolapse, cerebrospinal fluid leakage, sinusitis, and visual impairment were identified in this study.

#### DISCUSSION

At the very beginning, NDS was made by metal. But the poor flexibility and elasticity made it hard to be inserted and taken out, thus to limit its clinical usage<sup>[20]</sup>. Plastic could have better flexibility and be used as a material of NDS. However, the high fragility of plastic could still increase the occurring of difficult NDS removal and NDS residual. The high rigidity of plastic would increase discomfort as well<sup>[21]</sup>. In recent years, polyurethane was used as the material of NDS due to its good flexibility, elasticity and softness. Since then, the NDS has been commonly used for NLDO<sup>[6-7,10,13,22]</sup>.

The success rate of NDS intubation in cases with NLDO in 1y after surgery ranges from 85% to 90%, similar to that of DCR<sup>[6]</sup>. However, the success rate tends to decline with the extension of follow-up time<sup>[7,9,11]</sup>. Kim *et al*<sup>[10]</sup> suggested that the long-term success rate of NDS intubation drops to 31%

at 2y after surgery and 14% at 3y after surgery. Moreover, to fix the NDS in the lacrimal duct and facilitate the drainage of tears, the head of the NDS is always enlarged with heads of different shapes and the body of the NDS is made with hollow. The above-mentioned designs may have led to NDS incarceration, which cannot be removed from the nose based on endoscopy<sup>[6-7,10-11]</sup>. In this study, a total of three types of hollow incarcerated NDS with three types of head shapes (*i.e.*, barb, umbrella, and ball) were removed during En-DCRs.

CT-DCG suggested that all patients showed obstruction in the lacrimal sac, and the head of NDS was placed in the lower part of lacrimal sac or junction of lacrimal sac and nasolacrimal duct. Moreover, the lacrimal sac mucosa scar at or below the obstruction site was identified intraoperatively. Existing research has suggested that small dacryocyst serves as a vital cause of surgical failure in DCR<sup>[11,17]</sup>. In a separate study of 134 patients, Hammoudi and Tucker<sup>[23]</sup> found that a small intraoperative lacrimal sac opening was linked to a higher risk of failure relative to that associated with a large opening (71% vs 93%). In patients with small dacryocystos, opening the upper part of the dacryocystos (above the level of the common canalicular) can improve the success rate of surgery, which is one of the keys to surgery<sup>[11,23-24]</sup>. During the operations in this study, it was found that the upper part of

the lacrimal sac with intact mucosa, so the upper part of the lacrimal sac was opened in all patients.

After each lacrimal sac had been opened, any instances of scarring or granulation tissue formation were carefully examined by intraoperative endoscopy. There were a lot of fibrous scars and granulation tissue adhesion between the mucous of the lacrimal sac and the head of incarcerated NDS. After separation and removal of the incarcerated NDS, some scar and granulation tissue remained in the dacryocyst were separated and removed as well. The changes in the lacrimal sac may be associated with the following factors. First, the process of NDS intubation caused damage to the dacryocyst mucosa since the head of the NDS is usually made larger than nasolacrimal duct to fix. Second, the NDSs are made into a hollow tube shape for tear drainage and the enlarged head with different shapes (barb, inverted triangle, diamond, shuttle, and balloon and so on), the above-mentioned designs are easily leads to the growth of granulation tissue and thus further cause stent incarceration. Due to mucosal injury caused by intubation, mucosal hyperplasia, and growth into the head of NDS resulted in NDS obstruction, and then secondary infection occurred. The stimulation of inflammation and infection further aggravated the proliferation of scar and granulation formation, resulting in pain, secretion overflow and other related complications. In this study, all involved patients complained of epiphora and purulence prior to surgery. In addition, three patients with bloody secretions overflow from the lacrimal punctum, three patients with occasional bloody secretions from nasal cavity, five patients with medial canthal swelling and 12 patients with discomfort in the inner canthus or nasal cavity. And all the above-mentioned NDS associated complications all completely relief after surgeries.

Ex-DCR could be a good choice for cases with re-obstruction of nasolacrimal duct with failed NDS treatment after NDS removing which was confirmed by various previous studies<sup>[12-13]</sup>. However, in this study, there are a large amount of scar and granulation formatted in the lacrimal sac area in cases with NDS incarceration. On that basis, severe adhesion would exist between lacrimal sac mucosa and NDS, such that extensive bleeding can be triggered when an attempt was made to separate this adhesion. Besides, the lacrimal sac and nasal mucosa are easy to damage in the Ex-DCR procedure under the effect of the unclear surgical field arising from extensive bleeding, and the difficulty in anastomosis of the lacrimal sac flap and the nasal mucosa can be increased. All the above-described factors can result in surgical failure. Endoscopic approaching is capable of offering a better surgical view for its illuminating system and amplification system, such that it exhibits the capability of separating the adhesion between NDS and lacrimal sac with minimal damaging of dacryocyst

mucosa. The lacrimal sac flap can be made more delicately and more effectively anastomosed with the nasal mucosal flap simultaneously. In this study, the adhesion between NDS and lacrimal sac by separated an MVR knife, and the NDS was removed from the ostium rather than the inferior nasal meatus to reduce mucosal damage. After NDS removing, the inferior part of the lacrimal sac was fully opened and the granuloma and scar tissues in the sac were separated and removed. All the above-mentioned procedures are done to minimize damage to the dacryocyst mucosa. In addition, during surgery, we opened the upper part of the lacrimal sac. The purpose of this procedure was to expose as much of the normal lacrimal sac mucosa as possible for anastomosis with the nasal mucosa, which may improve the post-operative success rate.

The bicanalicular silicone tube is widely used in lacrimal duct operation. It implanted into the nasal cavity from the superior and inferior puncta and through the ostium. In DCR surgery, it is generally recommended in patients with small lacrimal sacs, scar lacrimal sacs, improper lacrimal sac flaps<sup>[15,17,25]</sup>. Although previous research has suggested that a novel type of NDS which can be cut according to the size of the lacrimal sac has a good effect on the treatment of dacryocystitis incarcerated by NDS, this stent has not been reported else, so it is difficult to widely used in clinical practice<sup>[11]</sup>. In this study, En-DCR with bicanalicular silicone tube in the treatment of chronic dacryocystitis secondary to NDS incarceration with a high success rate over 80%, and in addition, the tube associated complications such as peripunctal granulation, postoperative infection, canalicular laceration, and punctual adhesions were not occurred during the following up. The most used bicanalicular silicone tube maybe deserves to be recommended for the good postoperative effect achieved.

In this study, anatomical failure occurred due to intranasal ostial closure, consistent with existing research<sup>[5,14,17,24-25]</sup>. Among the above-mentioned seven anatomical failed eyes, three eyes arising from granuloma formation at the ostium, as well as four eyes attributed to scar formation at the ostium. The incidence of complications was significantly low. Only three patients had uncontrollable bleeding with epinephrine cotton pads for 2min after the removal of the frontal process of the maxilla, and electrocoagulation or bone wax were adopted for stopping the bleeding. One patient developed nasal bleeding in the day after surgery, and was resolved with a cotton packing soaked in a vasoconstrictive solution in outpatient room. During the follow up, no serious complications were identified (e.g., orbital fat prolapse, cerebrospinal fluid leakage, sinusitis, and visual impairment).

En-DCR with bicanalicular silicone tube implantation in chronic dacryocystitis with NDS incarcerated achieved good curative effect with success rate over 80%, probably correlated

with the following reasons. 1) Under magnification of 4-6 times of the endoscopic, the adhesion was separated, the damage of mucosa of lacrimal sac was minimized, and the preservation of intact lacrimal sac mucosa was maximized. 2) The upper part of the lacrimal sac at the lever of common canalicular was opened to expose a maximal amount of the normal dacryocystitis mucosa for anastomosis with the nasal mucosa. 3) Bicanalicular silicone tube play a certain role in the formation of ostomy openings for small and scar lacrimal sacs. This study was subjected to several limitations. First, a retrospective study was conducted in this study without any comparison. Second, the sample size of this study was small. All the above-mentioned limits our findings.

In conclusion, the patients with chronic dacryocystitis incarcerated by NDS were subjected to En-DCR with bicanalicular silicone tube implantation while achieving a high success rate, and a low complication rate was achieved. This surgery procedure should be recommended in patients with incarcerated NDS.

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