

Preliminary study on the efficacy of lacrimal duct reconstruction with pedicled conjunctival flap in the treatment of severe lacrimal canalicular obstruction with conjunctivochalasis

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Abstract

• **AIM:** To determine the efficacy and safety of pedicled conjunctival lacrimal duct reconstruction in the treatment of severe obstruction of superior and inferior lacrimal canaliculi with conjunctivochalasis.

• **METHODS:** This study was performed as a retrospective analysis of patients who received conjunctival dacryocystorhinostomy with pedicled conjunctival flap reconstruction combined with tube intubation due to severe superior and inferior lacrimal canalicular obstruction with conjunctivochalasis from January 2019 to October 2019. The clinical data included the degree of preoperative epiphora and postoperative relief, preoperative examination of lacrimal duct computed tomography and ultrasound biomicroscopy, postoperative evaluation of lacrimal duct function by chloramphenicol taste and fluorescein dye disappearance test, etc. Syringing was carried out to determine the reconstruction and patency of the lacrimal duct.

• **RESULTS:** All 9 patients (9 eyes) had severe canalicular obstruction with conjunctivochalasis. The patients included 4 males and 5 females aged between 47-65y with an average age of 52.2±6.7y. At 3mo follow-up, the tube was removed and the patients were followed for a further 3mo. After tube removal, 6 patients showed no epiphora. These patients also had positive chloramphenicol tastes

and normal fluorescein dye disappearance test results. Two patients had epiphora. Also, syringing showed partial patency of the reconstructed lacrimal duct. One patient had no improvement in epiphora with negative chloramphenicol taste and fluorescein dye disappearance test results and obstruction of the reconstructed lacrimal duct. The total effective rate of the operation was 8/9, with no serious complications.

• **CONCLUSION:** Pedicled conjunctival lacrimal duct reconstruction conjunctival dacryocystorhinostomy is safe and effective for superior and inferior canalicular obstruction with conjunctivochalasis.

• **KEYWORDS:** epiphora; severe lacrimal canalicular obstruction; conjunctival dacryocystorhinostomy; pedicled conjunctival flap reconstruction; conjunctivochalasis

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INTRODUCTION

Patients with severe obstruction of upper and lower lacrimal canaliculi usually have severe epiphora symptoms, and long-term epiphora can lead to or aggravate conjunctivochalasis^[1-5]. Conjunctivochalasis refers to a group of lesions in which the bulbar conjunctiva accumulates in folds between the eyeball and the lower eyelid margin, inner and outer canthus, resulting in ocular superficial lacrimal abnormalities^[6]. Conjunctivochalasis (≥III) is characterized by obvious symptoms such as ocular surface epiphora, which relaxes the conjunctiva between the eyeball and the lower eyelid margin to form multilayer folds, and partially relaxes the conjunctiva to span the lower eyelid margin during in situ eyes, which can block the lower lacrimal point opening at the inner canthus^[7] (Figure 1). The treatment of severe obstruction of upper and lower lacrimal canaliculus is one of

the difficulties in ophthalmic clinic^[8-9]. Recent studies have explored the potential of lacrimal duct bypass surgery by implantation of bypass tubes and other surgical methods^[10-12]. However, the popularization and application of lacrimal duct bypass prosthesis are limited because of its disadvantages such as easy shedding and inflammatory reaction^[13-14]. The studies^[15-17] reported a conjunctival dacryocystorhinostomy combined with bypass tube intubation, using autologous labial mucosa or saphenous vein tissue as the lining of the graft. This method was used to reconstruct the tear discharge channel between lacrimal lake and the nasal cavity. However, the procedure is complicated, grafts was difficult to obtain and the procedure causes local damage to the area that the tissue being taken. And the surgery was difficult to perform without the use of transnasal endoscope. In this study, the pedicled bulbar conjunctiva was taken as the graft material in the surgery, and the lacrimal duct was reconstructed between the lacrimal sac and the nasal cavity to treat the patients with severe obstruction of the upper and lower lacrimal canaliculi combined with conjunctivochalasis. The materials were easily obtained, and no other injuries to the surrounding tissues. After 6mo of follow-up, good results 9 were achieved.

SUBJECTS AND MEHTODS

Ethical Approval This study included data from 9 patients (9 eyes) that were all recruited under written informed consent consistent with the principles of the Helsinki Declaration. This study was approved by insert details of the Third People's Hospital of Dalian Ethics Committee, the approval number: 2018-KT-005.

Retrospective Series of Case Studies The clinical data were collected from patients with severe obstruction of superior and inferior canaliculi in the Ophthalmology Department of the Third People's Hospital of Dalian from January 2019 to October 2019. The inclusion criteria were as follows: 1) patients with severe epiphora (due to complete obstruction or the absence of canalicular combined with conjunctivochalasis \geq III^[6-7] (Figure 1) and nasolacrimal duct obstruction who underwent conjunctivaldacryocystorhinostomy with pedicled conjunctival flap reconstruction, 2) patients with follow-up for >6 mo, and 3) patients with complete clinical data.

The exclusion criteria were as follows: 1) Patients suffering from other eye diseases that may affect the efficacy of surgery such as allergic conjunctivitis and iritis; 2) The patient declined to participate in the study.

Methods The clinical data of 9 patients (9 eyes) were collected and analyzed including the basic demographic characteristics, the degree of preoperative epiphora and postoperative relief, preoperative eye examination results, preoperative lacrimal duct examination results, postoperative

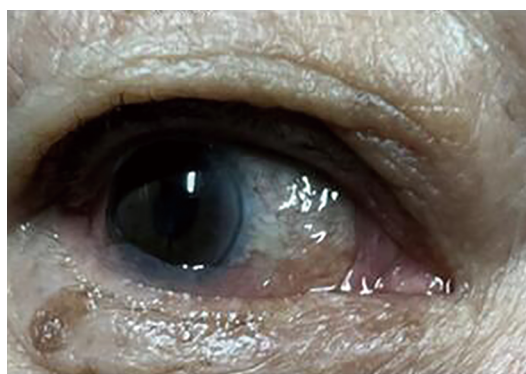


Figure 1 Patients with severe epiphora and conjunctivochalasis \geq III.

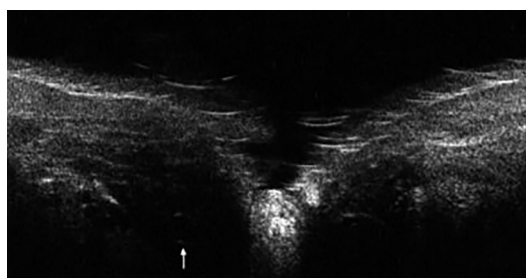


Figure 2 Lacrimal canaliculi (arrow).

evaluation of lacrimal duct function, the operation process, and postoperative complications.

Preoperative examination Eye examinations were conducted to exclude other related eye diseases. Epiphora score, lacrimal duct irrigation, orbital computed tomography (CT) and lacrimal canaliculi ultrasound biomicroscopy (UBM; Figure 2) examination were performed to determine the degree of lacrimal duct obstruction, and the degree of conjunctivochalasis \geq III. Data concerning the dacryocyst, nasolacrimal duct, sinuses, and the surrounding tissue structures were also collected. Nasal endoscopy was performed to determine the status of the nasal structures and nasal mucosa. A routine systemic examination was performed to exclude other systemic diseases that may affect the suitability for surgery.

Surgical method The operation was performed according to the following procedure.

- 1) The patient was in the supine position, disinfected and draped in a routine manner. Nasal block anesthesia of inferior trochlear, anterior ethmoidal nerve and infraorbital nerve was then performed.
- 2) A 12 mm long curved incision was made 5 mm away from the medial canthus and parallel to the crista lacrimalis anterior. This was bluntly expanded to 22 mm and the lower 1/2 of the medial canthus ligament was incised. The lacrimal sac was incised to reveal the inner punctum area of lateral wall of the lacrimal sac. A canaliculi retrograde examination was performed along the inner punctum using a pigtail probe to determine the extent of obstruction of the superior and

inferior canaliculi. The nasolacrimal duct was examined using a Bowman probe to confirm obstruction of the nasolacrimal duct.

3) An oval shaped bone window was made on the anterior and inferior wall of the lacrimal fossa. A longitudinal incision was made in the nasal mucosa and a longitudinal incision was also made in the corresponding position in the mucosa of the lacrimal sac to create the anterior and posterior mucosal flaps of the lacrimal sac and nasal mucosa. The posterior flap of the lacrimal sac and nasal mucosa was sutured with 7/0 absorbable suture.

4) Part of the lacrimal caruncle tissue was removed and an 8 mm long longitudinal incision was made on the bulbar conjunctiva of the lacrimal lake next to the lacrimal caruncle. The midpoint of the incision was at the same level as the inferior punctum and the conjunctival incision of the lacrimal lake was trimmed into a vertical oval. The lower middle direction of the lacrimal fossa formed a subcutaneous tunnel between the lacrimal lake and the lacrimal fossa reaching the dacryocystorhinostomy (Figure 3).

5) At the inferior nasal side of the operated eye, about 3 mm below the corneal limbus, the lax bulbar conjunctiva was prepared into a pedicled bulbar conjunctiva flap in 12×7 mm² crescent shape, using medial canthus as the base. A 2.2 mm diameter silicone lacrimal duct stent was inserted into a coil of epithelial tissue facing the lacrimal duct stent and sutured with 10/0 absorbable suture material (Figure 4). The tube was implanted with the tubular conjunctival tissue in the tunnel through the dacryocyst nasal anastomosis to the nasal cavity. This formed a channel between the lacrimal lake of the medial canthus conjunctiva and the lacrimal sac (Figure 5). The upper and lower tissues of the reconstructed passage were sutured with the medial canthus conjunctiva and the lateral wall of the lacrimal sac using 10/0 absorbable suture.

6) An elastic drainage strip was implanted into the anastomosis to the nasal cavity. The top of the drainage strip was sutured subcutaneously with mattress suture through the top of the lacrimal sac with the puncture out from the inner side of the arcus superciliaris. This was then ligated onto a small cotton pad.

7) The lower part of the bulbar conjunctival flap was trimmed and sutured with 10/0 nonabsorbable suture in an apposition way to form the conjunctival sac.

8) The anterior flap of the lacrimal sac and the nasal mucosa were sutured with 5/0 nonabsorbable suture and suspended with the skin. The skin incision was then sutured with a mattress suture.

Postoperative processing 1) Postoperative medications. All of the patients were given intravenous antibiotics twice a day after surgery for 3d. Antibiotic and local eye drops were

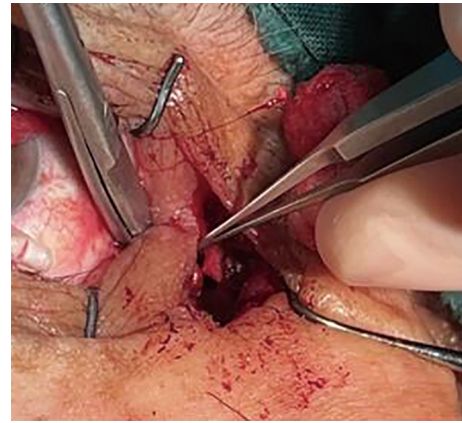


Figure 3 A subcutaneous tunnel was formed between the lacrimal lake and the lacrimal fossa, leading to the dacryocystorhinostomy.

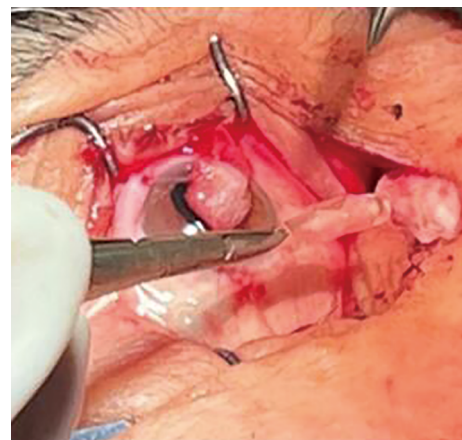


Figure 4 Silicone lacrimal duct stent was inserted into a coil of epithelial tissue facing the lacrimal duct stent and sutured with 10/0 absorbable suture material.

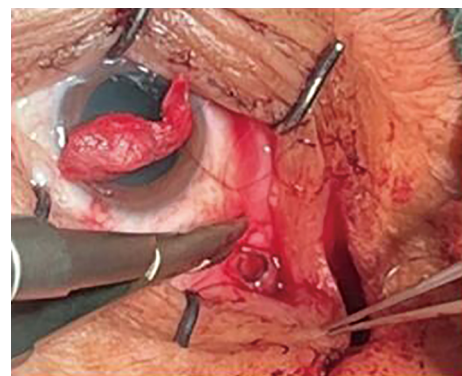


Figure 5 A tube with tubular conjunctival tissue is placed into a tunnel through the dacryocyst nasal anastomosis to the nasal cavity, and a channel is formed between the lacrimal lake of the inner canthus conjunctiva and the dacryocystosis.

administered for after the operation. 2) Postoperative re-examination. One week after surgery, the nasal drainage strips and skin incision sutures of the inner canthus were removed. The area was irrigated using a gentamicin+dexamethasone injection. Modified Munk's scoring system was used to evaluate improvements in epiphora at 1, 2, 3, and 6mo after the

operation. Conjunctival healing was observed using a slit lamp microscope and healing of nasal mucosa was examined by nasal endoscopy. The position of the tube was also examined (Figures 6 and 7). Irrigation was performed to assess the patency of the duct and the tube was removed 3mo after the operation.

At 1, 2, and 3mo after removing the tube, improvements in epiphora were evaluated by irrigating to assess the patency of the duct (Figure 8). Conjunctival healing was observed, and patency was evaluated by the chloramphenicol taste and the fluorescein dye disappearance tests (Figure 9).

At 1, 2, and 3mo after the tube removal, the relief of epiphora were evaluated by irrigating to assess the patency of the duct (Figure 8), the chloramphenicol taste test and the fluorescein dye disappearance test (Figure 9), and the patency of the lacrimal duct was evaluated.

Evaluation criteria of curative effect The curative efficacy of the procedure was assessed using a previously reported system^[16]. 1) Cured: The symptoms of epiphora disappeared consciously, chloramphenicol taste test (+), fluorescein dye test was normal (the time when dye solution appeared in nasal cavity was less than 5min), and the lacrimal duct irrigation was smoothly. 2) Improvement: Patients usually with no obvious epiphora, but mild tearing on exposure to wind. The time of chloramphenicol taste test and fluorescein dye test is slightly prolonged, and the time of dye solution appearing in nasal cavity is 6–20min. When lacrimal duct was irrigated, the solution can enter nasal cavity. 3) Ineffective: epiphora was not improved and the chloramphenicol taste and fluorescein dye disappearance tests were negative values indicating that the reconstructed lacrimal duct was obstructed.

RESULTS

Basic Characteristics of the Patients The study included 9 patients (9 eyes) of which 6 were male (4 eyes) and 5 were female (5 eyes). The cases were aged between 47–65y and had an average age of 52.2±6.7y.

Improvements in Postoperative Epiphora and Evaluation of Lacrimal Duct Function Three months after the removal of the tube, 6 patients (6 eyes) including 2 males (2 eyes) and 4 females (4 eyes), had complete absence of epiphora indicating that the reconstructed duct was patent. Also, the chloramphenicol taste and fluorescein dye disappearance tests were positive and the duct was normal (Figure 5). In these cases, the time for the appearance of the nasal dye solution was <5min and (6 eyes) of the patients were cured. Two patients (2 eyes) had improved epiphora that included 1 male (1 eye) and 1 female (1 eye). In these cases, the irrigation showed the reconstructed duct was partially patent and the times of the chloramphenicol taste and the fluorescein dye disappearance tests were slightly prolonged. Also, the time for the appearance



Figure 6 The medial canthus conjunctival opening in the inner lacrimal duct was reconstructed and the lacrimal duct was irrigated with the probe 1mo after the operation.



Figure 7 The position of the stent tube was observed using a nasal endoscope 2mo after the operation.



Figure 8 The nasal opening of the reconstructed lacrimal duct was observed 3mo after the removal of the stent tube.



Figure 9 An image of the fluorescein dye disappearance test 3mo after the removal of the stent tube.

Table 1 Summary of the follow-up times and epiphora after tube removal *n=9 (eyes)*

Postop. time (mo)	Case (n=9)			Total
	Disappeared	Improvement	No improvement	
1	7	2	0	9
2	6	3	0	9
3	6	2	1	9

Table 2 Follow-up times and lacrimal duct irrigation after tube removal *n=9 (eyes)*

Postop. time (mo)	Case (n=9)			Total
	Unobstructed	Narrow	Obstruction	
1	8	1	0	9
2	7	2	0	9
3	6	2	1	9

of the dye solution in the nasal cavity was 6–20min. The 2 patients had lacrimal stoma stenosis caused by granulated hyperplasia of the lower opening of the reconstructed lacrimal duct at 1 and 2mo after removal. One female patient (1 eye) showed no improvement in epiphora and the lacrimal duct was completely scarred by reconstruction and occlusion. These observations suggested that the lacrimal duct tube should be re-expanded (combined with laser enlargement of the lacrimal duct). However, the patient was not retreated due to personal reasons. The procedure was effective in 8 out of 9 patients. The postoperative epiphora conditions and inspection of lacrimal duct function after the operation are summarized in Tables 1 and 2.

Postoperative Complications On the first day after operation, 2 cases (2 eyes) with obvious bleeding at the nasolacrimal stoma, and the bleeding stopped after intramuscular injection of hemostatic needle and dripping nasal mucosa contraction drug. One month after the operation, the tube prolapsed in 1 patient (1 eye) and the patient tube was immediately admitted to hospital. The patient was told to avoid rubbing their eyes to ensure that the tube did not prolapse and tear drainage function was not affected. Three months after the operation, 2 patients (2 eyes) had obvious epiphora and a large number of white fat clot-like objects were observed in the tube that was found to be obstructed when the lacrimal duct was irrigated. A probe with a similar inner diameter to the tube was used to physically examine the blockage and epiphora were significantly improved. During follow-up at 1 or 2mo after the removal of the tube, 2 patients (2 eyes) had stenosis caused by hyperplasia of the granuloma at the lower opening of the reconstruction of the nasal side of the lacrimal duct. After the granuloma was removed, the patients were received daily local massage at the inner canthus corner with nasal spraying using a glucocorticoid spray. This was used to promote tear discharge and prevent the occlusion of the stoma. The patients were also received regular reviews (Table 3).

Table 3 Postoperative complications and follow-up times

Postop. complication	No. of cases (n=9)						Total
	Postop. 1d	Postop. 1mo	Postop. 3mo	1mo after the tube removal	2mo after the tube removal	Total	
Nasal bleeding	2	0	0	0	0	2	
Stent tube removal	0	1	0	0	0	1	
Stent tube obstruction	0	0	2	2	0	2	
Polyps at the reconstruction opening of the lacrimal passages	0	0	0	1	1	2	
Total	2	1	2	2	1	7	

DISCUSSION

The treatment of severe obstruction of superior and inferior canaliculi remains challenging currently, and the main methods include conjunctival dacryocystorhinostomy, autologous tissue transplantation lacrimal duct reconstruction and transnasal endoscopic autologous tissue transplantation lacrimal duct reconstruction^[18-20]. Jones^[21] first reported conjunctival dacryocystorhinostomy Jones tube implantation. Also, in 1965^[22] it was reported that implantation of a Jones tube between the lacrimal lake of the medial canthus conjunctival sac and nasal cavity could be used to reconstruct the tear discharge passage in the treatment of severe obstruction of the superior and inferior canaliculi. Several studies^[23-25] have reported improvements to the surgical procedure. However, The tube caused local irritation and discomfort to the patient^[26-27]. In addition, since there was no epithelial tissue in the reconstructed lacrimal duct, a true canalization cannot be formed. When the bypass tube falls off, the reconstructed lacrimal duct will be completely obstruction reducing the success rate of the operation^[28-29].

Tao *et al*^[15] and Liu *et al*^[16] demonstrated that autogenous labial mucosa and great saphenous vein tissues can be used as lining grafts to perform conjunctival dacryocystorhinostomy with skin incisions or nasal endoscopy. This approach can be used to reconstruct the tear drainage passage between the lacrimal lake of the inner conjunctival sac and the nasal cavity and has good clinical efficacy. Transnasal endoscopic dacryocystorhinostomy using autologous tissue transplantation. In lacrimal duct reconstruction was prone to complications such as granulation tissue obstruction of the bone foramen and nasal mucosal adhesion^[30]. It is also difficult to use in nasal operations that require extensive endoscopic surgery. Moreover, the selection of materials is complex as scar hyperplasia may occur after the operation at the selected site of the labial mucosa. This may limit oral activity and restrict diet choices within 1wk after the operation. For approximately 1–2wk after the operation, the lower limbs had limited activity and the skin scaring was above the medial malleolus of the lower leg. These features are not easily accepted by women. Furthermore, some patients may have small vein diameters and the materials for lacrimal duct reconstruction may not ideal. Long-term follow-up of patients with lacrimal duct reconstruction after large saphenous vein catheterization showed that the inner canthus was prone to redness and swelling, and the reconstructed lacrimal duct was prone to stenosis and contracture^[31-32]. In addition, the great saphenous vein is a lumen structure that is in contact with blood for long periods. This may cause contraction due to the changes in the environment after being transplantation into the reconstructed lacrimal duct.

Severe obstruction of the superior and inferior canaliculi leads

to long-term retention of tears in the conjunctival sac and overexpression of matrix metalloproteinases in tears^[33-36]. It can also cause the accumulation of a large number of degrading enzymes, and dissolution of collagen fibers and deformation of elastic fibers in the bulbar conjunctiva. Consequently, many patients developed conjunctivochalasis which is also a cause of epiphora, ophthalmoxerosis and ocular surface dysfunction that can aggravate epiphora^[7]. The factors may synergize to cause abnormal pathological circulation of tears on the ocular surface leading to dysfunction of tear drainage, and aggravation of epiphora. Crescent excision of the lax conjunctiva is an effective method for the treatment of conjunctivochalasis^[37-40]. In this study, the pedicled lax bulbar conjunctiva under the nasal side of the eye that had operated on was extracted as the transplantation material. A lacrimal duct was reconstructed between the lacrimal lake and nasal cavity using the medial canthus conjunctiva to treat severe obstruction of superior and inferior canaliculi and conjunctivochalasis. This procedure has the advantages of easily obtaining materials with direct blood supply through the pedicle and can reduce the rate of rejection after transplantation^[15-16]. Also, cutting the lax bulbar conjunctiva allows the harvesting of transplantation material for lacrimal duct reconstruction and the treatment of conjunctivochalasis. Conversely, this procedure is limited as patients with normal conjunctival tissue in which the bulbar conjunctival flap is used as the material for lacrimal duct reconstruction, the conjunctival flap may be small, or overcutting may make it difficult to repair in the local donor tissue flap area. Therefore, before the operation, patients with conjunctivochalasis \geq III should be selected.

During the process, the conjunctivochalasis can be treated at the same time to minimize the disappearance or shallowness of the lower eyelid vault and reduce the probability of complications such as atretoblepharia. As the spherical conjunctiva is a single layer of epithelial tissue that is thin, it can receive insufficient support after transplantation making the operation difficult.

In this study, an 8-mm-long longitudinal incision was made on the bulbar conjunctiva at the lacrimal lake adjacent to the caruncle and the midpoint of the incision was at the same level as the lower puncta. The conjunctiva incision at the lacrimal lake was trimmed into a vertical oval shape as the upper opening of the reconstructed lacrimal duct was equivalent to the lower punctum position. This was performed to facilitate lacrimal drainage. At the same time, a subcutaneously inclined tunnel (approximately 30°–45° to the nasal cavity) was reconstructed between the lacrimal lake and the dacryocyst fossa, and the dacryocystorhinostomy rhinostomy site was obtained. Based on previous studies, when the tunnel is tilted 30°–45°, tears are more likely to drain due to gravity. Inner

canthus conjunctiva-nasal lacrimal duct reconstruction is beneficial due to the siphon and gravity effects of lacrimal duct reconstruction. Eye movement and blinking can change the pressure in the fornix which supports the tear pump mechanism of the eye and acts as a tear drainage mechanism to relieve the symptoms of epiphora^[15-16].

The main purpose of using the pedicle bulbar conjunctiva or autogenous lip mucosa and saphenous vein tissue as the material for lacrimal duct reconstruction is to facilitate the use of epithelial tissues as linings and bypass tube as temporary scaffolds. Also, the reconstructed lacrimal duct with epithelial tissue can be formed after tube removal. The tube with tissue must be guaranteed to be in the inner canthus-nasal tunnel during the operation. When making the reconstructed lacrimal duct, the epithelial tissue facing the bypass tube side was curled into a tubular shape to wrap the tube, and then the upper and lower ports of the reconstructed lacrimal duct were fixed with sutures.

Reconstruction of the lacrimal duct between the lacrimal lake and the nasal cavity of the medial canthus conjunctiva with the lax pedicled bulbar conjunctival flap as the graft material is a viable procedure. This can be used to obtain material and direct the blood supply through the pedicle to increase the success of transplantation. Also, the epithelial tissue lining formed a tear drainage duct that close to physiological lacrimal duct characteristics.

The procedure is safe and effective in the treatment of severe obstruction of the superior and inferior canaliculi combined with conjunctivochalasis. This operation could be used not only to treat the severe obstruction of upper and lower lacrimal canaliculi, but also to treat conjunctivochalasis at the same time, which is an effective surgical method that of “Kill two birds with one stone”. If it combined with transnasal endoscopy technique, the curative effect should be improved and it should be more acceptable to patients.

Our results suggest that reconstruction of the lacrimal duct with a pedicled bulbar conjunctival flap may be effective in the treatment of severe obstruction of superior and inferior lacrimal canaliculi combined with conjunctivochalasis. The results presented in this study are preliminary and require further validation.

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