

Use of Silicone Tubes to Repair Canalicular Lacerations via a Novel Method

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Abstract

Purpose: To develop a novel method to repair canalicular lacerations using silicone tubes.

Methods: A total of 47 adult patients (47 eyes) with canalicular lacerations were collected from the outpatient department from November 2010 to December 2012. The age ranged from 16 to 53 years. Among the 47 eyes, 37 had lower canalicular lacerations, 6 had upper canalicular lacerations, and 4 had bi-canalicular lacerations. A soft probe was made using a stainless steel acupuncture needle, which was inserted into the lumen of the proximal part of the catheter to increase its rigidity. The probe was then inserted into the lacrimal sac and nasolacrimal duct. After retrieval of the catheters, the two ends of the silicone tube were securely tied (end to end) to the catheters. The silicon tube outside the nostril formed a U-shape. The catheters were then pulled upward until the silicone tube was completely located in the canalicular system. The catheters were cut off of the silicone tube near the site of the connection. The two ends of the silicone tube were cut short, ~2mm out of the lacrimal punctum, and tied securely, end to end. The length of the tube between the upper and lower punctum was adjusted to ensure that no tension was present in the medial cathus, and the suture was removed through the nostril. The silicone tube was removed 3–10 months after this novel canalicular intubation procedure (NCI).

Results: All cases were anatomically rehabilitated after surgery. The silicone tube was removed after implanted in 3–10 months (mean 4.5 ± 1.3 months), the average follow-up time was 11.8 months after removal. In total, 45 eyes in all 47 eyes (95.74%) were free from obstruction. Among them, 41 eyes (91.11%) achieved complete success (completely disap-

pearance of epiphora after tube removal), 4 eyes (8.89%) achieved partial success (irritation occurs under stimulation conditions, such as wind or cold conditions), 4 eyes showed postoperative tearing, with three eyes having inferior lacrimal duct laceration, and one eye with superior canalicular laceration. Apart from two cases (4.26%) suffering inferior punctum splitting, no other associated issues occurred with the silicone tube or iatrogenic injury and lacrimal complications.

Conclusion: For adult patients with canalicular laceration, the NCI was an effective, atraumatic surgery, which has fewer complications than traditional canalicular suture. (*Eye Science* 2013; 28:195–200)

Keywords: canalicular lacerations; silicon tube; repair; intubation

Introduction

Canalicular laceration injuries are a common trauma in the lacrimal system. Finding the site of a canalicular laceration is the key step in the surgical treatment of canalicular laceration. Based on the canalicular anatomy seen under the microscope during the operation, the damaged end is now easier to identify^{1,2}. In order to ensure the restoration of normal function, placement of a silicone tube was recommended during the operation to help in the healing process^{3,4}. Temporary silicone intubation can prevent lacrimal duct obstruction during recovery.

An advantage of silicone intubation is that it can reconstruct the normal anatomy of the canalicular system rather than forming a false passage or bypass⁵. Many different surgical methods are used to fix the canalicular laceration as a probe inserted into the sili-

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cone tube, such as a pigtail^{6,7}. However, these methods have some limitations and drawbacks. Therefore, finding a more effective, minimally invasive method to treat canalicular laceration is very necessary. Hence, on the basis of previous studies, we describe an improved method for an intubation procedure (NCI) for the treatment of canalicular laceration.

Materials and methods

Patients

A total of 47 adult patients with canalicular laceration (47 eyes, 35 males, 12 females) were collected from outpatient department from November 2010 to December 2012, aged 16-53 years (mean age 33.56 years old). Time from damage to the canalicular surgery was about 2 hours to 7 days. The diagnosis of patients with canalicular laceration was based on the results of eye examinations. A total of 37 eyes (78.72%) had inferior lacrimal duct laceration, 6 eyes (12.77%) had superior canalicular laceration, and 4 eyes (8.51%) had bicanalicular lacerations (Table 1). Each patient before surgery signed an informed consent and underwent a preoperative systemic examination to rule out serious heart disease and nasal disease.

Table 1 The types of the canalicular lacerations

Type of injuries	Cases(<i>n</i>)	Percentages (%)
Lower canalicular lacerations	37	78.72
Upper canalicular lacerations	6	12.77%
Bicanalicular lacerations	4	8.51

Surgical methods

Silicone tube intubation: On the basis of previous studies on the "soft lacrimal probe"⁸, an epidural catheter was inserted from the front (with a blind-side part) cut at the side of the hole about 15 cm, then acupuncture needles were inserted into the lumen to increase its hardness (Figure 1).

Before surgery, 2% lidocaine as a local infiltration anesthesia was placed in the lacrimal system and the inferior nasal passages were treated with 0.5% proparacaine hydrochloride eye drops and 1% ephedrine procaine solution twice. Two "soft lacrimal probes" were prepared for the inferior lacrimal duct intubation. A silicone tube (head end with a 0.30

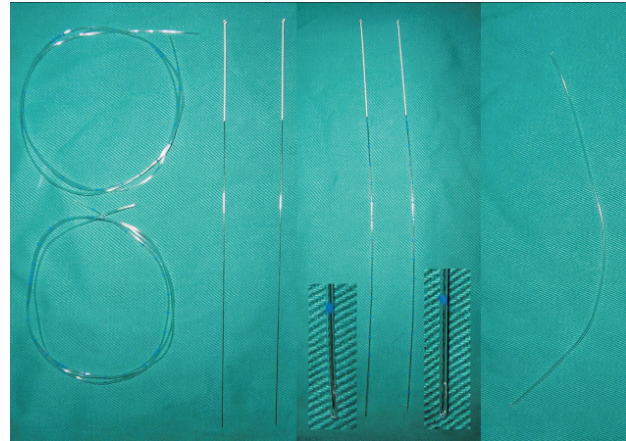


Figure 1 The consist of a soft probe. It includes a segmental epidural catheter (10 cm of the proximal part) and a stainless steel acupuncture needle (the needle point was cutoff and the tip was burnished).

mm diameter, 0.6 mm outer diameter of the middle; therefore, much smaller than the middle part of the head end) was used as the lacrimal stent. In positioning the canaliculus ends, two epidural anesthesia tubes were inserted through the punctum, lacrimal duct, lacrimal sac, and nasolacrimal duct into the lacrimal system. In addition, the epidural catheter was inserted into the punctum and the proximal end of the canalicular laceration > 15 cm, but the distance between the lacrimal punctum and the cut end of the canalicular lacerations was < 5 mm.

Single-canalicular intubation: A "soft lacrimal probe" was inserted from the superior/inferior punctum to inferior nasal meatus, and then the acupuncture needle was fixed, and the catheter was pulled down until it was exposed outside the punctum 2–3 cm. The acupuncture needles were then pulled out and the catheters were retrieved under nasal endoscopy (Figure 2).

Dual canalicular intubation: According to the method described above, two "soft lacrimal probes" were inserted into the lacrimal system. The two silicone tubes outside the nostril then formed a U-shape. The catheters were pulled upward through the lacrimal system until the silicone tube was completely located within the canalicular system. The silicone tubes were cut off near the site of the connection. Then, the NCI was established and 5–0 silk sutures were passed through the pericanalicular tissue in a hori-

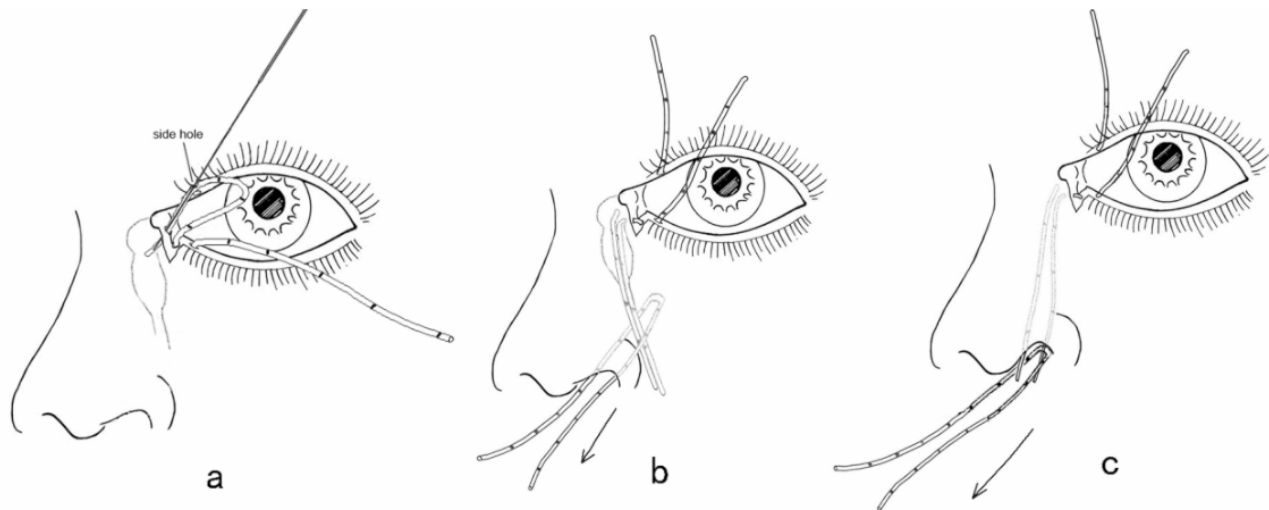


Figure 2 The sketch of single canalicular intubation. The blind tip of the epidural catheter was put through the lacrimal punctum and the proximal of the canalicular laceration more than 15cm while the distance between the lacrimal punctum and the cut end of the laceration was less than 5 mm. Then, the acupuncture needle was placed through side hole to form "soft lacrimal probe". (b) A snare device made from an epidural tube was inserted into the inferior meatus of the nasolacrimal duct. Next, the catheters were inserted into the snare device. (c) Then, the snare device was pulled smoothly, and the catheters were retrieved easily with the aid of a nasal endoscope.

zontal mattress fashion. The length of the tube between the superior and inferior punctum was adjusted to ensure that no tension was removed through the nostril. All patients were administered tobramycin eye drops, qid, for one week. The skin suture was removed 1 week after the surgery (Figure 3).

Postoperative treatment

The silicone tube was removed usually after 3–10 months post-operation while the patients had no tears or irritation. A drop of 0.5% procaine was instilled into the conjunctival sac. The loop between the upper punctum and joint was cut and pulled out from the medial canthus and then the lacrimal passage was irrigated with antibiotic solution.

Results

During the surgery, the novel canalicular intubation (NCI) was successfully performed in all eyes, and without any intraoperative complications. The silicone tubes were left in place for 3–10 months (mean 4.5 ± 1.3 months). All silicone tubes were successfully removed in the outpatient department. The average follow-up time after tube removal was (10.1 ± 4.19) months (range 8–24 months).

Our studies determined that 45 eyes in all 47 eyes

(95.74%) were free from obstruction. Among them, 41 eyes (91.11%) achieved complete success (completely disappearance of epiphora after tube removal). Four eyes (8.89%) achieved partial success (irritation occurs under stimulation conditions, such as wind or cold conditions), 4 eyes showed postoperative tearing, with three eyes with inferior lacrimal duct laceration, and one eye with superior canalicular laceration. Two patients (4.26%) showed lower punctum splitting 1 month after the surgery, and the tubes in these patients were removed prematurely. No occurrence of other complications was observed in this study (Table 2).

Discussion

Compared with the internal and external tissues, the canaliculi in the lids were easy to tear cause of the small amount of connective tissue⁹. Therefore, when subjected to blunt or sharp injuries, eyelid lacrimal duct injury is prone to cause localized defect or epiphora. Repairing the cut ends of the canaliculus must be done as soon as possible. With the development of microsurgery, positioning injury canalicular lacerations has become easier. However, if the damage is severe or prolonged, positioning the

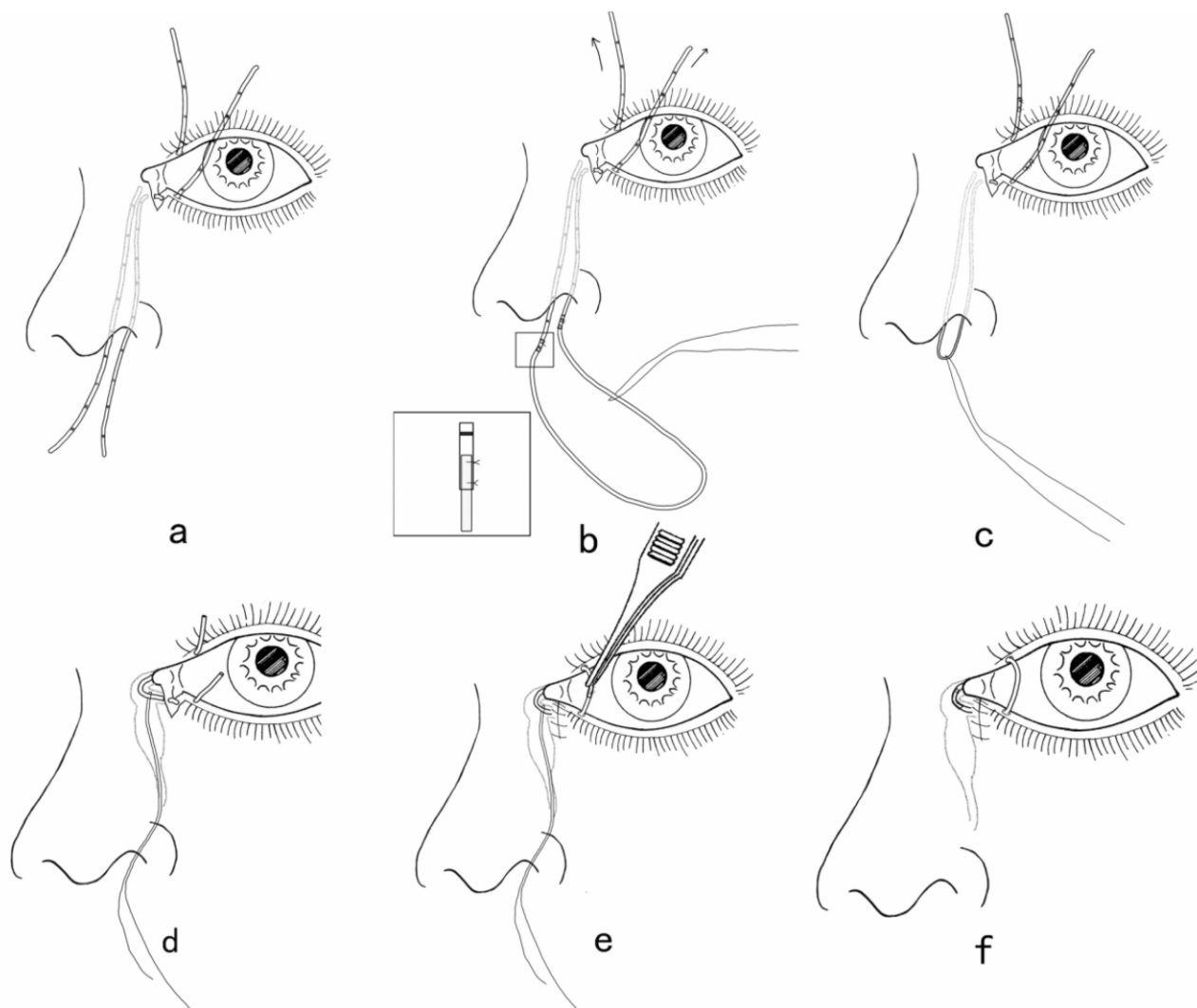


Figure 3 The sketch of bicanalicular intubation. (a) Two catheters are inserted into the lacrimal system. (b) The silicon tube outside the opening of the nostril is formed into a U-shape. Then, a 1-0 silk suture (20 cm long) is coiled around the U-shaped silicon tube outside the nostril. (c) The catheters are pulled upward through the nasolacrimal duct, the lacrimal sac, the canaliculus and out from the inferior/superior punctum until the silicon tube is completely located in the canalicular system. (d) The two ends of the silicone tube are cut short, approximately 2 mm out of the punctum, and tied securely with two pieces of 5-0 silk suture (end to end). (e) The length of the tube between the upper and lower punctum is adjusted to ensure that no tension is present in the medial canthus. (f) The location of the silicone tube after this novel canalicular intubation procedure (NCI).

Table 2 The therapeutic effect of the modified bicanalicular intubation

Therapeutic effect	Cases	Percentages (%)
Completely successful	41	97.14
Partially successful	4	
Unsuccessful	2	2.86
Complications (postoperative tearing)	4	8.51

cut end of the canaliculus can be difficult. Our previous studies⁵ have been carried out using a "soft lacrimal probe" method to locate the cut end of the

canaliculus more quickly and easily than is possible with the traditional method. The system includes an epidural catheter with a blind end (about 2.0 cm from the end of the side hole), a stainless steel acupuncture needle (epidural catheter can be inserted into the distal end to increase its hardness) with a syringe (can be injected 0.3% tobramycin eye ointment).

All surgeries were performed by one surgeon who utilized the novel soft probe. When the laceration occurred medially, identifying the medial end of the canaliculus was difficult, and a novel soft probe was

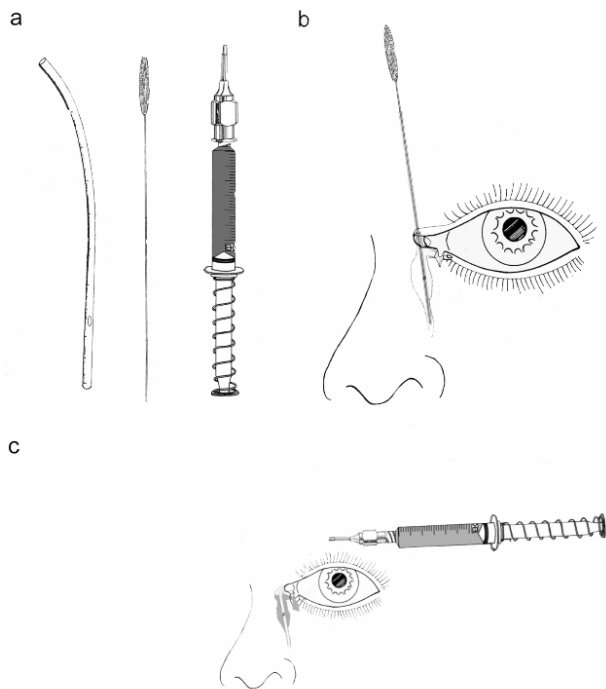


Figure 4 The novel method to identify the cut end of the canalicular. (a) A soft probe (5 cm long) is used to locate the lacerated medial cut end. (b) The probe is passed from the uninjured punctum and the canalicular to the proximal end of the nasolacrimal duct through the common canalicular and the lacrimal sac. (c) The acupuncture needle is removed, and oculentum is injected simultaneously until it is emitted from the injured canalicular distal end (once the lacrimal sac is full).

inserted through the dilated ipsilateral intact punctum (for isolated inferior lacrimal duct lacerations, the uninjured upper punctum was used, and vice versa). The probe was passed through uninjured punctum and lacrimal duct to the distal end of the nasolacrimal duct through the common canalicular and the lacrimal sac. Then, the acupuncture needle was removed, and eye ointment was injected simultaneously so that it would be emitted from the injured canalicular distal end immediately after it filled the lacrimal sac.

The injured canalicular needs stenting of the hold-fast to prevent lacrimal duct obstruction. Silicone is the most commonly used tubing material, and many surgical techniques have described how to insert the silicone tube to treat canalicular lacerations. These methods can be divided into single canalicular intubation and double canalicular intubation¹⁰. Recent

studies have shown that the Mini-Monoka stent implantation extrusions occurred in a month and with an 11.1% extrusion rate, especially in superior canalicular lacerations. Therefore, this technique is not used on patients with combined upper and lower canalicular lacerations¹⁰. Bicanalicular intubation (BCI), which was developed by Crawford¹¹ and Guibor¹², involves the passage of the tube through the inferior and superior puncta and through the nasolacrimal drainage system into the nose, leaving a loop of tubing extending between the inferior and superior puncta.

Because the method is simple, safe, effective, and minimally invasive, it has been widely adopted by many ophthalmologists. It can reduce the tension of the sutured tissue, it can be used at the site of wound healing, and it is especially suitable for superior/inferior lacrimal duct lacerations. However, the traditional bicanalicular stent has some disadvantages, including the potential for damage to the normal nasolacrimal duct and Hasner valve. To avoid these drawbacks, some recent developments have been reported in the treatment, such as using a probe positioning pig tail^{13,14}, but it may cause potential damage to normal or undamaged canalicular, leading to formation of a false channel, especially double canalicular laceration.

Overcoming the shortcomings of traditional BCI-based methods to improve the use of silicone tubes is increasingly important. Our previous study introduced good results without iatrogenic injury^{3,6}. However, the disadvantage still remains, when silicone tubes involved epidural catheter blind side, retrograde traction is often caused by damage of the lacrimal. In addition, when the soft probe directly passed through the lacrimal punctum and traumatic canalicular, then entered the lacrimal sac vertically, a potential risk existed for splitting of the normal lacrimal punctum and canalicular tearing. In this study, we introduced a novel canalicular intubation to treat canalicular lacerations.

Compared with previous studies, NCI can achieve a higher success rate. This may be due to many factors. First, as shown in Figure 3a, when the soft probe passed directly through lacrimal punctum and injured canalicular and vertically through the

lacrimal sac, it does not create tension between the punctum of normal lacrimal canaliculus and the proximal canaliculus. Therefore, this method can ensure clinical success and the integrity of the lacrimal punctum and proximal canaliculus. Secondly, canalicular restenosis is the most common cause of surgical failure. In order to reduce the damage to the canaliculus and lacrimal puncta, the tip of the silicone tube used in the connection of the silicone tube and the epidural catheter was smaller than the lumen of the epidural catheter. Therefore, when the epidural catheter was pulled up to drive retrogradely through the canaliculus, no iatrogenic injury occurred (Figure 4).

Third, the silicone tube was only used with a soft probe, which minimized trauma to the healthy canalicular system rather than bypassing in the lacrimal drainage passage. These characteristics explain why the technique was minimally invasive and had fewer complications⁵.

Finally, in the NCI, the silicone tube was placed to reconstruct the canalicular lacerations and was isolated from the lacrimal canaliculus intubation without disturbing the normal nasolacrimal duct and the Hasner valve. This ensures the normal function of the nasolacrimal duct and nasal cavity. Therefore, the NCI could reduce the potential for discharge reflux from the nasal cavity along the tube.

In short, NCI is a new, effective treatment method for the treatment of canalicular lacerations. It can effectively recanalize the canalicular lacerations and restore the normal anatomical and physiological function of the lacrimal system. NCI has a satisfactory success rate, it is minimally invasive, and it is associated with fewer complications. Therefore, it is a promising method for treating canalicular lacerations.

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