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A new method for locating the proximal lacerated bicanalicular ends in Chinese preschoolers and long-term outcomes after surgical repair

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Abstract

This report is to explore the long-term outcomes of surgical repair of bicanalicular lacerations in Chinese preschool patients. In this report, 12 patients with bicanalicular lacerations were studied between September 2010 and September 2015. The distance from the punctum to the distal canalicular lacerated end was recorded before surgery to classify different types of trauma. All patients underwent surgical repair of the lacerated canaliculi by 1 surgeon within 48 hours after the trauma occurred. After treatment, the lesions were divided into 3 types according to the distance from the punctum to the distal lacerated canalicular end as follows: lateral, medial, and the central. Based on this classification, each lacerated canaliculus was successfully repaired. Nearly half of the lesions (46%) were lateral, 42% were central, and 12% were medial. The average time for locating the proximal lacerated end of the canaliculus was 3.33 ± 1.52 minutes (range, 1.0–7.0 minutes). The follow-up time ranged from 6.0 months to 4.5 year (median, 25 months). Our study showed that 96% (23) of the canaliculi were completely patent. One lateral lesion presented with residual outdoor epiphora in cold weather secondary to left lower canalicular stenosis. All 12 patients had excellent cosmetic results. Our study displayed a surgical management based on the 3 types of lesions helped to find the proximal lacerated end of the canaliculus, and provided excellent long-term outcomes of drainage function.

Abbreviations: DCR = dacryocystorhinostomy, FTEL = full-thickness eyelid lacerations, LC = lower canaliculus, UC = upper canaliculus.

Keywords: bicanalicular laceration, canaliculus, eyelid trauma, laceration, preschoolers, proximal cut end

1. Introduction

Lacrimal canalicular laceration is frequently associated with eyelid injuries in children with mid-facial trauma.[1] If not appropriately corrected, the canaliculus can undergo stenosis, causing lacrimal drainage dysfunction with epiphora; therefore, emergency surgical treatment is recommended.[2] It is widely acknowledged that the key to a successful surgical repair of canalicular lacerations is to find the proximal lacerated end quickly and exactly.[3,4] Once this is found, the remaining

surgical procedure is fairly simple. For decades, various methods have been described by which to find the proximal lacerated canalicular end, including probing the upper canaliculus (UC), pigtail probing, or injecting a bubble or colored opaque solution [3–6]; however, many of these techniques are time-consuming during surgery and are focused mainly on monocanalicular lacerations, which requires that the ipsilateral canaliculus be intact. Bicanalicular lacerations are more of a surgical challenge, presenting most commonly with symptomatic epiphora if not properly corrected.[7] In 2012, we reported that a lacerated canaliculus could be classified into 1 of 3 types —lateral, central, and medial—according to the distance between the punctum and the distal lacerated end[8]; however, the long-term outcome was unclear.

This study aimed to evaluate the long-term outcomes of surgical repair of bicanalicular lacerations in pediatric patients based on the 3 classification types of lacerated canaliculi.

2. Materials and methods

2.1. Patients

Twelve preschool patients hospitalized for the surgical repair of bicanalicular lacerations at the Ninth People's Hospital, Shanghai JiaoTong University School of Medicine (Shanghai, China) between September 2010 and September 2015 were included in the study. Inclusion criteria were as follows: bicanalicular lacerations, no previous lacrimal history, trauma <48 hours, and no previous treatment. The exclusion criteria were as follows: additional lacerations involving the punctum, lacrimal sac, and/or nasolacrimal duct or congenital and/or acquired lacrimal stenosis and/or obstruction.

Table 1

Basic information on the 12 patients.

Patient number	Sex	Age, y	Affected side	Cause	Concurrent conditions	DPDCE, mm	
						UC	LC
1	M	5	R	Blunt	FTEL	5	5
2	M	3	R	Sharp	FTEL and LAI	5	3
3	M	4	R	Blunt	FTEL and LAI	6	9
4	M	3	R	Blunt	FTEL	5	6
5	M	3	L	Traffic	FTEL and LAI	2	3
6	F	3	L	Sharp	FTEL and PGI	4	5
7	M	4	L	Sharp	FTEL and LAI	1	1
8	M	5	L	Traffic	FTEL	2	3
9	M	4	R	Traffic	FTEL	3	3
10	F	5	R	Blunt	FTEL	5	8
11	M	6	L	Traffic	FTEL and LAI	6	8
12	F	5	L	Sharp	FTEL	4	5

DPDCE = distance between the punctum and the distal cut end, F = female, FTEL = full-thickness eyelid laceration, L = left side, LAI = levator aponeurosis injury, LC = lower canaliculus, M = male, NA = none, PGI = penetrating global injury, R = right side, UC = upper canaliculus.

Demographic data collected from each patient comprised age, sex, etiology, time since surgery, affected side, distance between the punctum and the distal lacerated end of the canaliculus (superior and inferior), and concurrent trauma (e.g., partial or full additional eyelid laceration, levator detachment inducing ptosis, globe injury). Concurrent conditions, including eyeball injuries, eyelid lacerations, medial canthal tendon laceration, and levator aponeurosis dehiscence, were simultaneously repaired. All patients in this study signed an informed consent form before enrollment in the study, and permission was obtained from the ethical committee of the Shanghai Ninth People's Hospital, Shanghai JiaoTong University School of Medicine.

2.2. Lacrimal system evaluation

Evaluation of the lacrimal system was done before surgery. We can estimate that the lacrimal system is involved when the laceration of the eyelid is very close to the medial canthus. Under general anesthesia, further examination of the lacrimal system was done by lacrimal irrigation using a 2.0-mL syringe of 0.9% saline solution. If the liquid flowed from the wound, a lacrimal probe (size 5) was used to confirm the position of the distal lacerated end of the lacrimal canaliculi, and the distance from the punctum and the distal lacerated end was recorded.

2.3. Trauma classification and surgical procedure

Lacerated canaliculi were divided into 3 types according to the distance between the punctum and the distal lacerated end of the canaliculus.[8] In brief, the lateral type referred to breakage within the first 4.0 mm of the punctum, central type was defined as a laceration between 5.0 and 7.0 mm from the punctum, and medial type was considered as trauma >8.0 mm from the punctum. Based on the classification, the proximal lacerated ends were identified with the OPMI Visu 150 surgical microscope (ZEISS, Germany, 5× magnification), and the time from the onset of surgery to finding the proximal lacerated end was recorded.

After both lacerated ends were identified, a punctum dilator was used to enlarge the puntum and bicanalicular silicone tube intubation was done with 1.0-mm-diameter, 20-cm-long silicone tube with a probe at both heads (FREDA, Shandong, China). The proximal and distal lacerated ends were subsequently anastomosed with 3 pairs of 6–0 absorbable sutures around the canalicular tube (Johnson & Johnson, New Brunswick, NJ).

Any additional eyelid injuries were repaired after the lacrimal intubation was completed. The eyelids were left in the correct anatomical position to prevent lid malposition and epiphora. In cases of levator dehiscence, a 6–0 double armed, regular absorbing polyglactin suture (Johnson & Johnson) was used to anatomically reattach the levator to the tarsal plate. For 1 case with globe injury, the globe wound repair was performed during the first stage of surgery to protect intraocular contents and decrease the risk of endophthalmitis. A post-surgery intravenous antibiotic was used to prevent infection.

Post-surgery follow-up visits were recorded at 1.0 week and 1.0, 3.0, 6.0, and 12 months. Postsurgery canalicular obstruction was defined as the incidence of reflux during lacrimal irrigation and the presence of symptomatic epiphora indoors.

3. Results

Twelve patients (9 males; average age, 4.17 years; range, 3–6 years) underwent surgical repair of unilateral bicanalicular lacerations. Causes of injury included sharp trauma (fell and hit eyelid on a sharp broken glass or bowl, n = 4), blunt trauma (hit eyelid on a door handle, n = 4), and complex trauma (traffic accident, n = 4), each accounting for 33% of the patients. There were 24 lacrimal canalicular lacerations in the 12 patients as follows: 11 (46%) lateral, 10 (42%) central, and 3 (12%) medial. Current conditions were as follows: 12 patients had full-thickness eyelid lacerations, 5 had ptosis from injuries to the upper levator aponeurosis, and 1 had a penetrating globe injury (Table 1). Different surgical approaches were taken to find the proximal end of the lacerated canaliculus according to the classified types.

In the lateral type, the proximal lacerated end would be between the conjunctiva and the tarsal plate. In the central type, the canaliculi often go deep into the orbicularis muscle; therefore, it would be necessary to probe deeper into that muscle to find it. In the medial type, the canaliculi are under the inner canthal tendon and into the lacrimal sac; therefore, the area under the inner canthal tendon or around the capsule fascia, a fibrous tissue layer around the lacrimal sac, was searched (Fig. 1A–C).

Using this classification system, the proximal lacerated ends of all 24 canaliculi were found within an average time of 3.33 ± 1.52 minutes (range, 1–7 minutes) (Table 2). Bicanalicular stent intubation was performed on all 12 patients, and all 12 patients
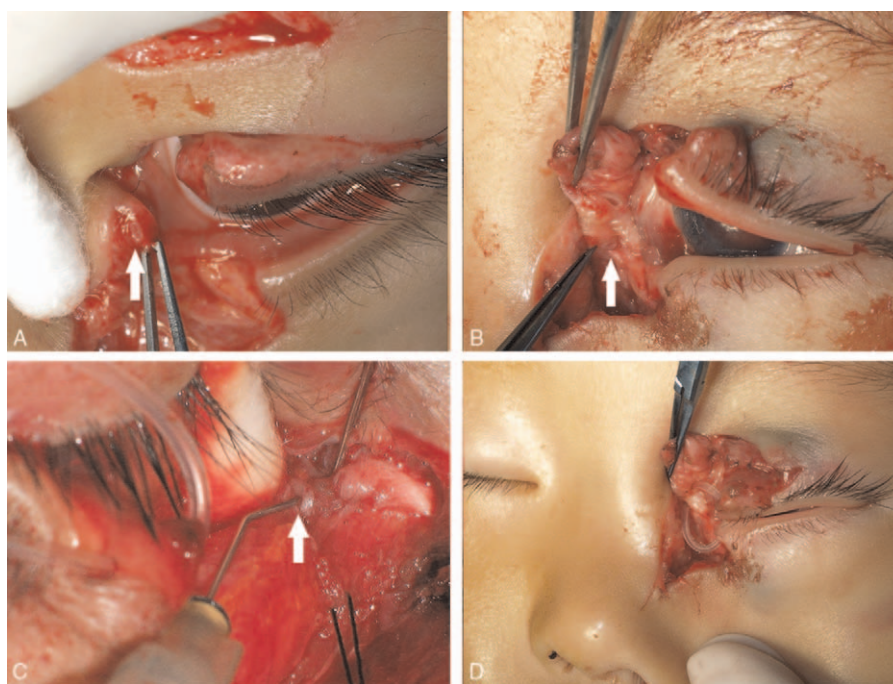
Figure 1. Three types of canalicular lacerations. The proximal lacerated ends of the lower canaliculi are designated by white arrows. (A) Bicanalicular lateral lacerations. (B) Central laceration of the lower canaliculus and lateral laceration of the upper canaliculus. (C) Medial laceration of the lower canaliculus and central laceration of the upper canaliculus. (D) Intubation of a bicanalicular silicone stent for the 1B patient.

underwent repair of eyelid lacerations, 4 underwent repair of injured levator aponeuroses, and 1 underwent repair of a corneal and scleral rupture.

The follow-up period ranged from 6.0 months to 4.5 years (median, 25 months). One month after surgery, all 12 cases maintained patent lacrimal ducts. Three months after surgery, lacrimal irrigations showed that 23 of the 24 patients (96%) had good tear drainage function with patent lacrimal passages. There were no complaints of epiphora in 11 patients.

One case of the lateral type (No .8) had incomplete reflux of the lower canaliculus (LC) with outdoor epiphora in cold weather, but there was no epiphora most of the time. We considered that stenosis of the LC was caused by scar formation and contraction. We discussed possible surgical options with the patient's parents; however, they felt that the occasional epiphora (<5 times a day) was tolerable and chose no further intervention.

At the final follow-up visit, there were fewer changes in the lacrimal passage conditions in any of the 12 patients than at 3.0 months after surgery. In addition, concurrent conditions, such as eyelid laceration, ptosis, and medial canthal ligament injury, were successfully repaired or corrected (Fig. 2).

4. Discussion

Canalicular laceration is common in mid-facial trauma, and frequently presents with other periorbital injuries, such as eyelid lacerations, eyeball injury, and nasal bone fracture.[9] The most common consequence in child patients is tear drainage dysfunction and mid-facial deformity, and patients might suffer from epiphora, pain, ptosis, lower eyelid ectropion, medial canthal deformity, or other conditions. Early intervention (within 48 hours) is strongly encouraged to restore the anatomy and

Table 2

Duration of time taken during surgery to locate the proximal lacerated end and assess the canalicular status.

No.	Time to locate the proximal lacerated end of UC/LC, min	Epiphora		Lacrimal irrigation outcomes	
		Pre	Final follow-up	Pre	Final follow-up
1	5/3	Y	N	Reflux of UC and LC	Patent
2	2/3	Y	N	Reflux of UC and LC	Patent
3	4/7	Y	N	Reflux of UC and LC	Patent
4	5/6	Y	N	Reflux of UC and LC	Patent
5	2/3	Y	N	Reflux of UC and LC	Patent
6	2/3	Y	N	Reflux of UC and LC	Patent
7	1/1	Y	N	Reflux of UC and LC	Patent
8	3/2	Y	Outdoor epiphora	Reflux of UC and LC	Incomplete reflux of LC
9	4/3	Y	N	Reflux of UC and LC	Patent
10	3/5	Y	N	Reflux of UC and LC	Patent
11	3/5	Y	N	Reflux of UC and LC	Patent
12	2/3	Y	N	Reflux of UC and LC	Patent

LC = lower canaliculus, N = no, No = number, pre = preoperative, UC = upper canaliculus, Y = yes.

Figure 2. Two-year-old patient with a lateral laceration of the lower canaliculus, central laceration of the upper canaliculus, full-thickness eyelid laceration, and injury of the levator aponeurosis of the right eye. (A) Preoperative view. (B) Exposure of the operating field with a traction suture. (C, D) The same patient 1 year and 4 years after surgery. Satisfactory outcomes were realized for both tear drainage function and eyelid appearance.

function, as well as to reduce the incidence of postsurgery complications and recurrence. Patients with combined upper and lower canalicular lacerations have more of an increased risk of developing postsurgery symptomatic epiphora than those with only lower canalicular lacerations, making this condition the most difficult type to treat.[7,10] Many methods and skills on how to find the proximal lacerated end of the canaliculus, such as upper canalicular probing, pigtail probing, and injecting a bubble or colored opaque solution, have been reported in previous articles.[3–6] Clearly, direct probing or injecting air or colored opaque solution into the UC cannot be performed on lacerated tissue. The use of a pigtail probe has been discouraged because of the potential to damage the common canaliculus or uninjured area, risking creation of a false passage.[10,11]

Retrograde intubation of the canaliculi during dacryocysto-rhinostomy (DCR) is a new solution to bicanalicular obstruction with epiphora, which was subjectively relieved in 73% of lacrimal systems[12]; however, this surgery increases scarring of the inner canthus skin when using a standard DCR approach and canaliculostomy. Some researchers have reported their experiences with repairing bicanalicular lacerations, but few have discussed the skills or methods by which to search for the proximal lacerated ends of the bicanalicular.[13–16]

This study demonstrated that bicanalicular lacerations in preschoolers can be divided into 3 types—lateral, medial, and central—according to the distance from the punctum and the lacerated canalicular end. Based on these 3 types, finding the proximal lacerated end of the canaliculus during surgery has been highly successful and has resulted in excellent long-term outcomes of drainage function as well as cosmetic appearance.

These classifications have an anatomic basis. The lacrimal canaliculus is approximately 10-mm long with inconsistent surrounding soft tissues along its total length. The farther from the lacrimal punctum, the softer the tissues that surround the canaliculus. Hwang[17] reported that the section of canaliculus 4.0 mm from the punctum is closer to the mucocutaneous junction than the sections 5.0 to 7.0 mm from the punctum. The common canaliculus opens into the lacrimal sac nearly perpendicularly and is covered by solid fibrous tissue.[18] The results of our previous study showed that, of the 3 classification types, the patients with a canalicular injury near the punctum had the highest incidence of postsurgery obstruction.[8] We suggested that different tissues surrounding the canaliculus might be a factor in different incidences of postsurgery canalicular obstruction. We conferred this hypothesis in this case study in that the only postsurgery obstruction of the canaliculus was in the lateral group.

It took an average of 3.33 ± 1.52 minutes to locate the proximal lacerated end of the canaliculus during surgery, which was $>2.0 \pm 1.1$ minutes reported by Cho et al[4] and the final follow-up examination showed a patency rate of 96% in the 24 canaliculi. We presume that the main reason lies in the fact that bicanalicular lacerations are more difficult to handle than monocanalicular repairs because there is no intact opposing canaliculus to assist in repair surgery.

Bicanalicular intubation can help to accurately reduce the medial canthal ligament, and the repair of injuries to the levator aponeurosis and the eyelid is crucial because ptosis can affect normal vision development in preschool children.

The application of the new classification of the lacerated canaliculi is clinically promising for improving surgical efficiency and long-term outcomes; therefore, it appears to be a potential alternative for the surgical repair of bicanalicular lacerations after serious eyelid trauma.

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