• Clinical Research •

# Old canalicular laceration repair: a retrospective study of the curative effects and prognostic factors

*Fang Bai[1,2], Hai Tao[2], Yan Zhang[2], Peng Wang[2], Cui Han[2], Yi-Fei Huang[1], Ye Tao[1]*

[1]Department of Ophthalmology, General Hospital of Chinese PLA, Beijing 100853, China
[2]The Lacrimal Center of Ophthalmology, Armed Police General Hospital of China, Beijing 100039, China
**Co-first authors:** Fang Bai and Hai Tao
**Correspondence to:** Yi-Fei Huang and Ye Tao. Department of Ophthalmology, General Hospital of Chinese PLA, Fu Xing St, Beijing 100853, China. huangyf301@163.com; toy1011@163.com
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## Abstract

**• AIM: To investigate the epidemiology and surgical outcomes of old canalicular laceration and analyze the variables impacting on the prognosis of reparation.**

**• METHODS: A retrospective review of all old canalicular laceration repairs from Jan. 1, 2008 to Dec. 30, 2015 was performed. Analyzed data included demographics, mechanisms of injury, the time from injury to repair, causes for delayed repair, old associated injuries, the types of surgery, and the effects of repair using canaliculus anastomosis combined with bicanalicular stent intubation.**

**• RESULTS: Totally 148 patients with old canalicular laceration received surgical repair and were enrolled. The mean age at presentation was 32.52 years old (ranged from 3 to 63 years old). The 110 patients (74.32%) were male and 127 patients (85.81%) were adults (≥18 years old). The old upper, lower, and bicanalicular lacerations were found in 5 (3.38%), 39 (26.35%), and 104 patients (70.27%), respectively. The mechanism of old injury was primarily due to motor vehicle accidents (*n*=53, 35.81%). The mean time from injury to repair was 43.61mo (ranged from 1 to 360mo). Associated old ocular and orbit injuries were found in 65 patients (43.92%), and chronic dacryocystitis in 18 patients (12.16%). The main cause of delayed repair was that doctors or patients didn't pay attention to the canalicular laceration because of the concurrent severe injuries (*n*=71, 47.97%). Totally 136 patients (91.89%) with old canalicular laceration underwent canaliculus anastomosis combined with bicanalicular stent intubation. In all of them, 20 patients (13.51%) were combined with dacryocystorhinostomy. In these cases, 132 patients (97.06%) attained anatomic success, 121 patients (88.97%) reported no epiphora (functional success), 11 patients (8.09%) reported significant epiphora anesis (functional improvement), and 4 (2.94%) reported no significant anesis (functional failure). Rates of anatomic success and functional success were significantly correlated with different canaliculus involved. However, rates of anatomic success and functional success were not significantly affected by the time from injury to repair.**

**• CONCLUSION: The canalicular anastomosis combined with bicanalicular stent intubation could act as an effective therapeutics for old canalicular laceration.**

**• KEYWORDS**: old canalicular laceration; canalicular repair; bicanalicular stent

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## INTRODUCTION

Canalicular lacerations are commonly caused by trauma in the eyelids and periorbital area, and occurred in 16% of eyelid lacerations[1-2]. Canalicular lacerations are involved in 70% of lacrimal duct injuries and the lacrimal sac and/or nasolacrimal duct in 30% in lacrimal system[2]. Fayet *et al*[3] reported that canalicular lacerations were associated with a 20% incidence of eye globe injuries. The needs for repair of canalicular lacerations remain to be controversial. Most researchers proposed that canalicular lacerations should be repaired urgently to avoid postinjury epiphora[4-7].

In China, because of the uneven economy and medical conditions, primary canalicular lacerations in many patients were not repaired on time, and most of them have to undergo operations to repair old canalicular lacerations and solve serious postinjury epiphora. Although there was a great deal of studies on the epidemiology, urgent repair techniques, stents and urgent repair outcomes of primary canalicular lacerations[8], little data is available on those of old canalicular lacerations.

The canalicular anastomosis combined with bicanalicular or monocanalicular stent intubation are used for primary canalicular lacerations repair[2]. Unlike primary canalicular lacerations, the surgical techniques of old canalicular

lacerations combined with eyelid scar and deformity are more complicated. Moreover, bicanalicular stent was reported the potential risk[5,9] and several complications[8]. Consequently, general ophthalmologist may be more interested in monocanalicular stent intubation. However, bicanalicular stents can provide tension of lacerated ends, and it might be more suitable for old canalicular laceration repair.

In this study, we described the epidemiology of old canalicular lacerations managed at the Lacrimal Center of Ophthalmology, Armed Police General Hospital of China and reported the surgical outcomes of old canalicular laceration repair using canalicular anastomosis combined with bicanalicular stent intubation.

## SUBJECTS AND METHODS

**Subjects** With the approval of the Ethics Committee of Armed Police General Hospital of China, a retrospective study of all patients with old canalicular lacerations repair at the Lacrimal Center of Ophthalmology, Armed Police General Hospital of China, from Jan. 1, 2008 to Dec. 30, 2015 was performed. All people voluntarily joined this study with informed consents.

All included patients who had suffered primary canalicular laceration and had not gotten urgent repair operation in time, underwent old canalicular laceration repair to solve severe postinjury epiphora in 1mo after trauma. Exclusion criteria included the lack of adequate follow up (<3mo), preinjury epiphora and pyorrhea.

**Operation Technique and Follow-up** All patients were underwent CT three-dimensional reconstruction for the lacrimal duct examing the lacrimal and canthal area and ultrasound biomicroscopy for some patients were done before operation. The patients underwent canalicular anastomosis combined with bicanalicular stent intubation or reconstruction lacrimal duty combined with stent intubation. The old medial cut-edge of canaliculus was sought after cut-though scar or lacrimal sac during operation. Once the cut-edge was found, a bicanalicular stent was placed in superior and inferior canaliculi and two cut-edge were anastomosed using one-stitch anastomosis through the skin with 5-0 silk suture. If the cut-edge couldn't be identified, monocanaliculus reconstruction with conjunction-flap transposition and bicanalicular stent intubation or conjunctivodacryocystostomy and lacrimal duct stent intubation were done. All repairs were performed by the same oculoplastic surgery professor. Adults were under local anesthesia and pediatric patients were under general anesthesia. Patients were asked postoperative follow-up and irrigation of canaliculi using anti-inflammatory drugs once a month. The standard of stent removal was absence of epiphora or epiphora anesis, patent canaliculus on irrigation and the time maintained with stent between 3 to 6mo. All patients were interviewed by telephone and got irrigation canaliculi recently for assessing the long-term consequences of repairing the old canalicular injuries and patient satisfaction. The data collected for analysis included general information and demographics of patients, mechanism and canaliculus involved, time from injury to surgery, concurrent old ocular injury, primary management after injury, types of current operation and stent which were used, duration of follow up, complications, and timing of stent removal and whether they still had epiphora after removal stent and epiphora degree.

A patent canaliculus on diagnostic probing (soft to sac) was defined as anatomic success (patency), whereas absence of epiphora, even with environmental stressors, in >3mo after stent removal, was defined as functional success. Moreover still epiphora but significant anesis was defined as functional improvement. Anatomic success (patency) for bicanalicular laceration was anatomic patency of both upper and lower canaliculi.

**Statistical Analysis** Descriptive statistics, including the mean, standard deviation and range were calculated for different variables. Fisher's exact test was used to analyze clinical outcomes. The SPSS software was used (version 19.0, IBM, Chicago, IL, USA) for statistical analysis. Differences were considered statistically significant at $P<0.05$.

## RESULTS

Of all the 161 patients who had undergone old canalicular laceration repair, 148 patients met the inclusion criteria and were enrolled. The mean age of the patients was 32.52 years old (ranged from 3 to 63 years old). In these patients, 110 (74.32%) were male and 127 (85.81%) were adults (≥18 years old). The old upper, lower, and bicanalicular lacerations were found in 5 (3.38%), 39 (26.35%), and 104 patients (70.27%), respectively (Table 1).

The causes for old canalicular laceration were numerous. Motor vehicle accidents was the leading cause of injury with 53 (35.81%), and followed by hard object injury ($n$=40, 27.03%). The mean time from injury to this repair was 43.61mo (ranged from 1 to 360mo). The 78 (52.70%) patients was between 1mo to 12mo, 39 (26.35%) patients was between 1 to 5y, and 31 (20.95%) patients was after 5y. The urgent repair with single suturing surrounding tissues of canaliculi after injury were performed in 144 (97.30%) patients, while no management were done in 4 (2.70%) patients. The main cause of delayed repair was that doctors or patients didn't pay attention to the canalicular laceration because of the concurrent severe injuries ($n$=71, 47.97%). Associated old ocular and orbit injuries were found in 65 patients (43.92%), and chronic dacryocystitis in 18 patients (12.16%) (Table 1).

Totally 136 patients (91.89%) with old canalicular laceration underwent canaliculus anastomosis combined with bicanalicular stent intubation. In all of them, 20 patients (13.51%) were combined with dacryocystorhinostomy including 18 patients with chronic dacryocystitis and 2 patients with common canalicular laceration (Figures 1 and 2). Only 1 patient (0.68%)

**Table 1 Parameters of old canalicular lacerations**

| Parameters | *n* (%) |
|---|---|
| Male | 110 (74.32) |
| Age (median, range), a | 32.52 (32.5, 3-63) |
| Adult (≥18a) | 127 (85.81) |
| Canaliculus involved | |
| Upper | 5 (3.38) |
| Lower | 39 (26.35) |
| Upper and lower | 104 (70.27) |
| Associated old ocular or orbit injuries | |
| None | 83 (56.08) |
| Old concomitant orbit fracture without repair | 37 (25) |
| Post-repair of orbit fracture | 5 (3.38) |
| Post-ophthalmectomy | 4 (2.7) |
| Old optic neuropathy | 1 (0.68) |
| Chronic dacryocystitis | 18 (12.16) |
| Mechanism of injury | |
| Motor vehicle accidents | 53 (35.81) |
| Hard object injury | 40 (27.03) |
| Sharp instrument injury | 22 (14.86) |
| Dog bites | 14 (9.46) |
| Boxing injury | 9 (6.08) |
| Avulsion injury | 8 (5.41) |
| Injury related to aesthetic surgery | 1 (0.68) |
| Explosion injury | 1 (0.68) |
| Urgent repair | |
| Suturing surrounding tissues of canailculi | 144 (97.3)[1] |
| No management | 4 (2.7) |
| The causes of delayed repair | |
| Patients refused | 32 (21.62) |
| Not found the cut ends | 39 (26.35) |
| Not focus on canalicular laceration | 71(47.97) |
| Time from injury to repairs (median, range), mo | 43.61 (8.5, 1-360) |
| 1-12mo | 78 (52.70) |
| 1-5a | 39 (26.35) |
| More than 5a | 31 (20.95) |

[1]One patient was performed Jones tube placement.

had severe old monocanaliculus injury which couldn't be identified. This patient received the monocanaliculus reconstruction with conjunction-flap transposition and bicanalicular stent intubation.

There were 11 patients (7.43%) with severe old bicanalicular injuries that couldn't be identified and repaired, 10 patients (6.76%) underwent conjunctivodacryocystostomy with labial mucosa transplantation, 1 patient (0.68%) underwent conjunctivodacryocystostomy with conjunctiva-flap transposition (Table 2).

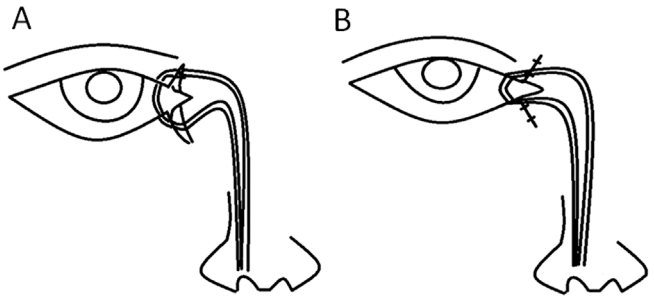


**Figure 1 A diagram depicting the intubation of bicanalicular stent into the lacerated bicanaliculus** A: Pre-anastomosis; B: Post-anastomosis.

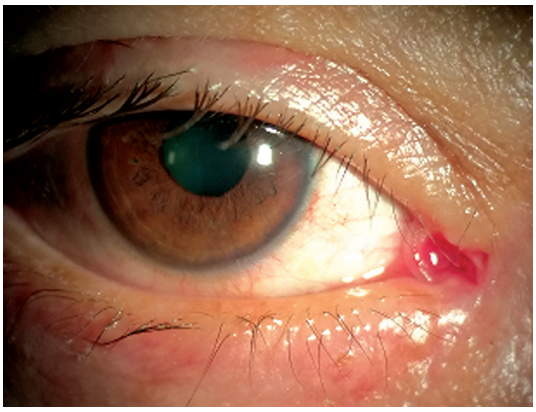

**Figure 2 Slit-lamp photograph of a patient with old common canalicular laceration after bicanalicular stent intubation (4wk after surgery).**

The mean time of bicanalicular stent removal was 5.1mo (median 5mo, ranged from 30d to 6mo). There was 1 patient with stent prolapse and loss in 1mo. Three patients were removed stent relatively earlier (<3mo, mean 1.5mo, ranged 1 to 2.1mo) because of severe punctal or canalicular slitting. After 3mo of stent removal, the 4 patients had still epiphora but anesis, and 2 patients had clear limitation on irrigation (anatomic failure) and the other 2 patients did not have limitation (anatomic success).

At following-up visits, patients were performed irrigation and asked about epiphora. After 3mo of stent removal, in the all 136 patients, 132 (97.06%) patients got anatomic success, 121 (88.97%) reported no epiphora (functional success), 11 (8.09%) reported still epiphora but significant anesis (functional improvement), and 4 (2.94%) reported no significant anesis (functional failure). There were 4 patients who did not get anatomic success, including 1 patient with old upper canalicular laceration, 1 patient with old bicanalicular lacerations and 2 patients with old lower canalicular laceration. Anatomic success rate in bicanaliculi was the highest at 98.91% compared with 94.87% in lower canaliculus and 80% in upper canaliculus ($P$=0.04). The canaliculus involved in relation to functional success and improvement was statistically significant ($P$<0.05). Anatomic success rate was 97.22% ($n$=70) in patients with 1-12mo time interval between

**Table 2 Type of surgery and time of removal stent**

| Parameters | *n* (%) |
|---|---|
| Type of surgery | 148 |
| Canaliculus anastomosis and bicanalicular stent intubation | 136 (91.89)[1] |
| Canaliculus reconstruction with conjunctiva-flap transposition and bicanalicular stent intubation | 1 (0.68) |
| Conjunctivodacryocystostomy with labial mucosa transplantation and placement of monocanalicular stent intubation | 10 (6.76) |
| Conjunctivodacryocystostomy with conjunctiva-flap transposition and placement of monocanalicular stent intubation | 1 (0.68) |
| Time of removal stent in the cases of canaliculus anastomosis and bicanalicular stent intubation (range), mo | 5.1 (1-6)[2] |

[1]Totally 116 patients received single canaliculus anastomosis and bicanalicular stent intubation, 20 patients received canaliculus anastomosis with dacryocystorhinostomy and bicanalicular stent intubation; [2]Three patients who had severe punctal and canalicular slitting were removed stent between 1-2.1mo, 1 patient lost the stent in 1mo.

**Table 3 Outcomes of canaliculus anastomosis and bicanalicular stent intubation** *n* (%)

| Parameters | Patients | Anatomic success | Functional success | Functional improvement |
|---|---|---|---|---|
| Canaliculus anastomosis and bicanalicular stent intubation | 136 (100) | 132 (97.06) | 121 (88.97) | 11 (8.09) |
| Canaliculus involved | | | | |
| Upper | 5 (3.68) | 4 (80) | 4 (80) | 0 |
| Lower | 39 (28.68) | 37 (94.87) | 31 (79.49) | 5 (12.82) |
| Upper and lower | 92 (67.65) | 91 (98.91) | 86 (93.48) | 6 (5.43) |
| *P* | - | 0.04 | 0.04 | 0.01 |
| Time from injury to surgery | | | | |
| 1-12mo | 72 (52.94) | 70 (97.22) | 65 (90.28) | 6 (8.33) |
| 1-5y | 37 (27.21) | 37 (100) | 34 (91.89) | 2 (5.41) |
| More than 5y | 27 (19.85) | 25 (92.59) | 22 (81.48) | 3 (11.11) |
| *P* | - | >0.05 | >0.05 | >0.05 |

injury and surgery, 100% (*n*=37) with 1-5y, and 92.59% (*n*=25) longer than 5y. Functional success rate was 90.28% (*n*=65) 91.89% (*n*=34), and 81.48% (*n*=22), respectively (*P*>0.05) (Table 3).

## DISCUSSION

In China, there are many patients with primary canalicular lacerations didn't receive repair operation in time. Firstly, medical conditions are unbalanced in China. The standard operating rooms are not always available and the doctors couldn't acquire formal training in these areas with poor medical conditions. Repair of canalicular laceration couldn't be performed in time. Secondly, some patients do not wish to spend extra expense in this surgery just to avoid possible posttraumatic epiphora. Thirdly, whether patients should receive the repair surgery of urgent canalicular lacerations remains to be controversial. Many ophthalmologists aren't interested in repairing urgent canalicular lacerations. In their opinions, the functional success rate of repair canalicular laceration is low and many patients without repair canalicular laceration after injury maintain asymptomatic. Therefore, when patients suffer from severe concurrent injuries, doctors and/or patients always neglect primary canalicular laceration repair. Consequently, there are numerous patients with old canalicular laceration in China. Some of them with severe epiphora have to accept the surgery of repair old canalicular laceration to solve this problem.

Several studies on primary canalicular injuries found a similar trend and showed that the single lower canalicular involvement was the most common, followed by single upper canalicular involvement and bicanalicular involvement[8,10-12]. However, the degree of impaired tear drainage after obstruction of monocanaliculus and importance of the upper and lower canaliculus in lacrimal drainage is controversial[13-14]. In this study, patients with old bicanalicular involvement were most common (70.27%). All patients suffered from severe epiphora after canalicular injuries without canalicular anastomosis and stent intubation on time. An indirect evidence suggested that lower canaliculus was more important than upper canaliculus in overall lacrimal drainage, and the obstruction of bicanaliculi could lead to epiphora more easily than monocanaliculus, the lower more easily than upper canaliculus. That might be the reason why old bicanalicular laceration was most common in this study. Additionally, in our study, old lower canalicular laceration was more common than old upper canalicular laceration because the primary lower canaliculus would be more easily involved at urgent situation.

In several studies, canalicular lacerations repair were performed within 1d to 2wk[1,8,12]. Most studies reported the poor results with late repair of canalicular lacerations[4,8]. In this study, all old canalicular lacerations were performed repaired from 1mo to 20y after injury, and most cases (52.7%) were performed within 1 to 12mo after injury. However, the difference between those earlier and later repair in terms of the anatomic and functional success rate or functional improvement rate wasn't significant.

Traumatic chronic dacryocystitis is secondary to nasolacrimal duct injury and always happened 4wk after trauma. That is why it is frequently found in old lacrimal duct traumatic, but not in urgent traumatic. In this study, 18 patients suffered from traumatic chronic dacryocystitis.

The monocanalicular versus bicanalicular stent remains to be controversial[7,14-17]. One of the perceived disadvantages of bicanalicular stent is the risk of potential injury to uninvolved canaliculus[5,9] and several complications including punctal or canalicular slitting, granuloma formation, and chronic nasal irritation. In the present study, 3 patients had severe punctal or canalicular slitting. However, one potential advantage of bicanalicular stent is the ability to maintain distal tension while the surrounding soft tissue is repaired. That is very important for old canalicular lacerations repair. It would be beneficial for the connection between the proximal and distal canaliculus breakages[5,9]. Bicanalicular stent would be more suitable for old canalicular lacerations.

Primary dacryocystorhinostomy isn't often performed at urgent canalicular lacerations. However, literatures advised that it could be performed if the urgent lesion of lacrimal duct involved a common canaliculus or lacrimal sac[6]. In this study, dacryocystorhinostomy was performed at 18 patients who had traumatic chronic dacryocystitis with injury of lacrimal sac or nasolacrimal duct and 2 patients with canalicular lacerations. The stents were in place for 3 to 6mo, the canaliculus heal and form an epithelialized channel around the stent and there would be a channel when the stent is removed[18].

There is no consensus regarding the exact duration of canalicular stent to achieve long-term canalicular patency. However, the majority of studies still tend to propose for longer duration[5,8,12,19-21]. In this study, bicanalicular stents were maintained for 5.1mo. Our standard of stent removal was absence of epiphora or epiphora anesis and patent canaliculus on irrigation between 3 to 6mo. But there were 4 patients who have anatomic failure. Of these 4 patients, 2 patients had canalicular block at site, and 2 patients had serious stenosis. The stents of these 2 patients with serious stenosis were removed early (1mo). Therefore, the failure to achieve canalicular patency might be correlated with the time of stent removal.

We defined functional success as the lack of postoperative epiphora and anatomic success as softly diagnostic probing to sac. Most studies showed that primary canalicular laceration repair with canalicular stent intubation could retain a high success rate (from 58% to 100%) in avoiding posttraumatic epiphora[9,19-20,22-25]. Compared with urgent canalicular laceration, old canalicular laceration repair is knottier and success rate would be lower in most opinions. Lower success rate should be ascribed to two reasons: firstly, severe scar surrounding canaliculus, deformity of eyelid and canthus could result in displacement of lacerated canaliculus; Secondly, severe derogative canaliculi could not be found, and need to reconstruct tear drainage.

This study concentrated on 136 cases of repair canalicular lacerations using canalicular anastomosis and bi-canalicular stent intubation with dacryocystorhinostomy or not. Compared with previous studies[5,8-9,11,14,23-24] about urgent canalicular lacerations with anatomical success rate (25%-94.1%) and functional success rate (58%-100%), this study had higher anatomical success rate (97.06%) and lower functional success rate (88.97%). The former study is based on the prophylactic surgery, and this study is based on the therapeutic surgery. The functional success in urgent canalicular lacerations maybe overestimated operation results because many patients were asymptomatic even if canalicular block, but for old canalicular lacerations were underestimated. In this study, functional effective rate (functional success and functional improvement) has reached 97.06%. In this study, CT three-dimensional reconstruction of the lacrimal duct and ultrasound biomicroscopy were performed to clarify the location of canalicular lacerations and the lever of canalicular injury before surgery. Taking advantages of these examinations, the appropriate surgical approach was selected. Patients received regular follow-up after surgery. Once precursor of punctal and canalicular slitting or severe canalicular stenosis were found, anti-inflammatory drug and canalicular dilatation would be performed timely. Thus, higher anatomical success rate of this study was associated with preoperative adequate examination, the appropriate surgical approach, surgical experience of operators and standardized postoperative follow-up.

In this study, there are 4 patients of anatomic failure, including 2 patients who suffered removal stent early (severe canalicular stenosis, 1 patient who suffered from recurrent allergic conjunctivitis (canalicular block in site, with old lower canalicular lacerations), and 1 patient who suffered from recurrent iridocyclitis (extensive canalicular block, with old upper canalicular lacerations). We conjectured that extensive canalicular block and recurrent iridocyclitis might be the outcome of systemic disorders. Moreover, long-term topical medications toxicity might be one reason of extensive canalicular block. Therefore, failure to achieve canalicular patency might be correlated with the early removal of stent,

recurrent allergic conjunctivitis, and recurrent iridocyclitis. Patients with severe canalicular stenosis (anatomic failure) might suffer from epiphora anesis.

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