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Clinical Study

Reconstructions of Traumatic Lacrimal Canalicular Lacerations: A 5 Years Experience

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Abstract. *Background:* The aim of this study is to evaluate the demographic and epidemiological data, clinical features and surgical outcomes of lacrimal canalicular lacerations. *Methods:* The charts of all patients who applied to our emergency department with eyelid laceration from 2008 to 2013 were reviewed retrospectively. Demographic and epidemiological data, clinical characteristics, treatment outcomes, simultaneous injuries and complications of patients who underwent canalicular laceration repair surgery were analyzed. *Results:* A total of 556 patients were identified with an eyelid laceration, and in 42 (7.55%) of these patients 44 lacrimal canalicular lacerations were detected. The average age was 26.16±18.42 (range 5 to 78) years and mean follow-up time was 17.62±6.62 months (range 12-42 months). The male-to-female ratio was 5.3-1. The lower canaliculus was involved in 33 patients (78.57%), the upper in 7 patients (16.6%), and 2 patients (4.76%) had bicanalicular involvement. The most common etiology of canalicular laceration was assault ($n = 16$, 38.1%) followed by traffic accidents ($n = 8$, 19.05%). In 28 patients (66.67%) surgery was performed within 24 hours and in 14 patients (33.33%) surgery was performed between 24 hours and 6 days. In 32 patients (76.2%) direct anatomosis and in 10 patients (23.8%) indirect anastomosis was performed. Tubes were removed after a mean time of 5.8±2.8 months. Anatomic success was 96.87%, while functional success was 92.85%. Complications were detected in 3 cases: two patients had early tube extrusions and in patient had punctal slits. *Conclusion:* Reconstruction of traumatic lacrimal canalicular lacerations with stenting gives good results at long-term follow up. The Mini-Monoka tube is a safe, simple, effective method with few complications.

Keywords: Lacrimal canalicular laceration; Mini Monoka

1. Introduction

Eyelid injuries commonly occur as a result of blunt or sharp periocular injuries and may involve canalicular lacerations, especially when the medial canthal region is affected. All age groups of patients maybe affected; children and teenagers are at especially high risk [1–3]. The main aim of treatment in these cases is stenting the injured system temporarily to reduce the risk of obstruction of the canalicular system. Various surgical treatment techniques and materials for intubation have been previously described, such as Crawford (bicanalicular) and Ritleng (bicanalicular) intubation systems and Mini Monoka stents (unicanalicular).

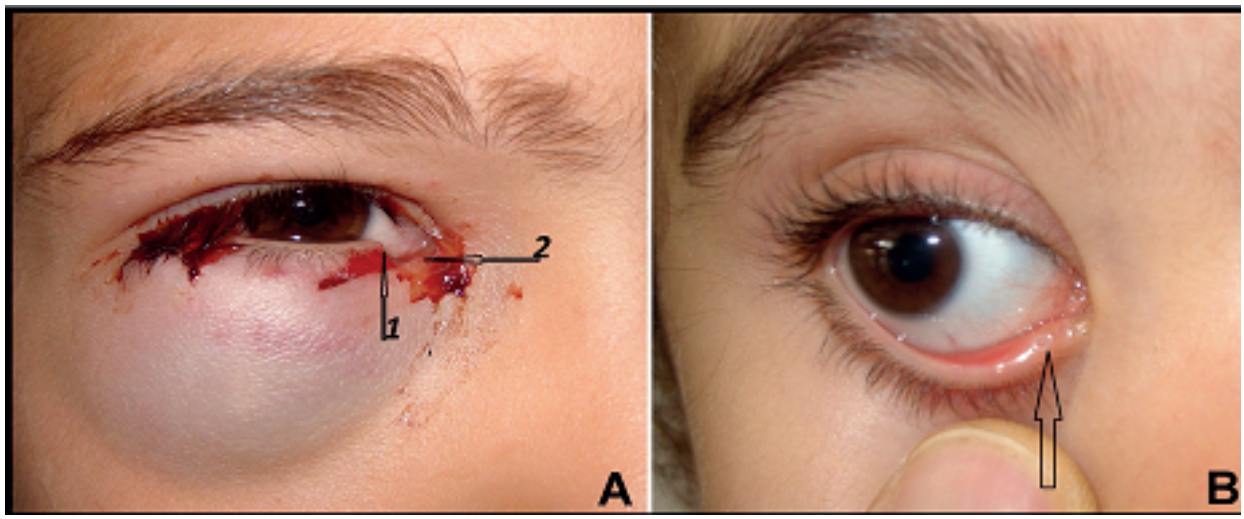

Figure 1: (A) 5-year-old female with right lower canalicular laceration caused by blunt trauma. Note the periorbital edema and ecchymosis.(1st arrow indicates proximal canalicular end, 2nd arrow indicates distal canalicular end), (B) Postoperative appearance of Mini-Monoka monocanalicular stent in situ. (1 month later).

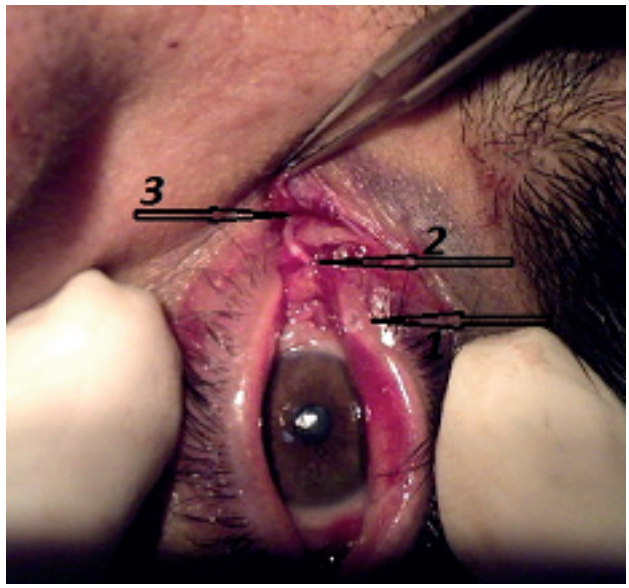

Figure 2: 48-year-old male patient with left upper canalicular laceration. Pericanalicular re-anastomosis was performed because canalicular laceration was near the lacrimal sac. (1st arrow: punctum 2nd arrow: proximal canalicular end 3rd. Arrow: Mini Monoka in distal canaliculus.

The purpose of this study is to present the clinical, epidemiological, demographic and clinical characteristics, and treatment outcomes at long-term follow up patients who had undergone canalicular laceration repair surgery in a tertiary healthcare center.

2. Methods

The medical records of all patients who applied to our emergency department between 2008 and 2013 with an eyelid injury were retrospectively reviewed. Forty two out of 556 patients were diagnosed with a lacrimal canalicular laceration and had undergone canalicular laceration surgical repair. The study was conducted in accordance with the tenets of the Declaration of Helsinki by obtaining written consent from all patients, and the approval of the local ethical review board. Epidemiological and demographic data, clinical characteristics, treatment outcomes, time from injury to surgery, simultaneous injuries and complications were analyzed. Patients whose follow-up time was less than 6 months and whose tube had still not explanted were excluded from this study. Lacrimal laceration was diagnosed with an identifying probe at the proximal lumen of the canalicular

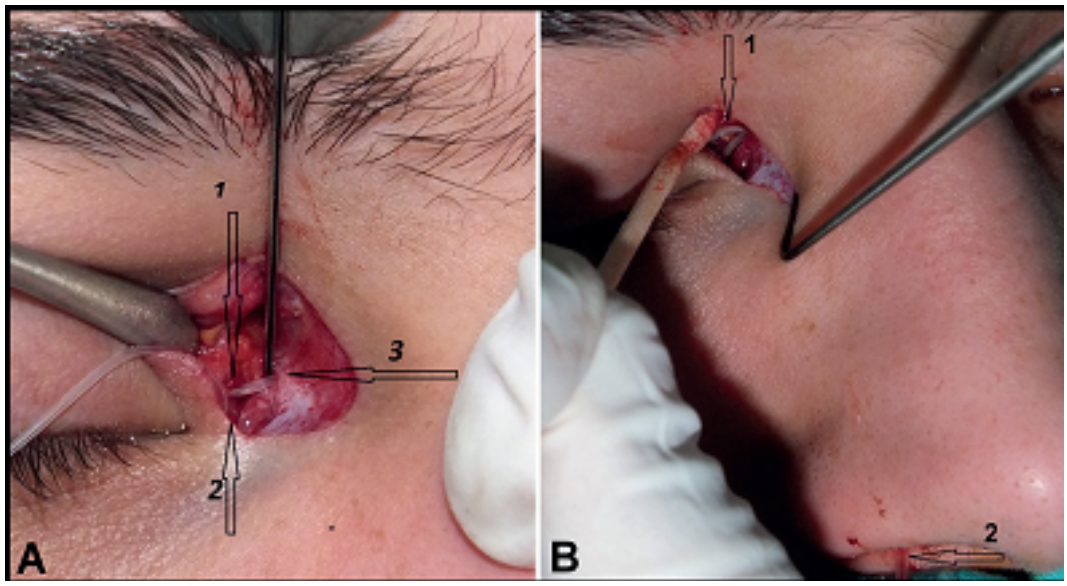

Figure 3: (A) 20-year-old male with right bicanalicular laceration caused by sharp trauma. 1st and 3rd arrows indicate the Ritleng intubation system placed at the proximal and distal ends of the upper canaliculus. 2nd. arrow: Inserting the tube from the proximal end of the lower canaliculus to the distal end with Ritleng probe, (B) Image of the Ritleng tube taken from the nostril (1st arrow), which was inserted through the lower and upper canalicular system of the same patient. (2nd arrow).

tear or avulsion place after inserting it via the punctum. This examination was performed in the examination room with adult patients, and under general anesthesia on pediatric patients. In adult patients, if they could tolerate it, surgery was performed under local and monitored anesthesia with intravenous sedation; in all pediatric patients and in adult patients who refused local anesthesia, surgery was performed under general anesthesia. All surgeries were performed by the same surgeon under an operating microscope.

We preferred to repair monocanalicular lacerations using unicanalicular stenting tubes (Mini Monoka) as our first choice Figure 1A and 1B. We trimmed the stent 10 mm to avoid the retrograde migration of the stent, and then inserted the stent without the aid of an instrument under an operating microscope. In cases in which we could not identify the distal end of the lacrimal canaliculus, trepan blue dye was introduced into the uncut canaliculus' punctum while we observed the flow of the dye from the cut end of the laceration and located the distal end of the canaliculus. If we still could not locate the medial end of the lacerated canaliculus, we used a round-tipped pigtail probe and chose to insert a bicanalicular annular silicon tube. In this technique, to avoid touching the uninvolved canaliculus, and creating a false passage, we took care not to force the pigtail probe; we moved it slowly and gently while inserting and rotating it. In patients who were suspected to have low lacrimal drainage system trauma such as orbita medial wall fractures, or nose fractures, or in cases with bicanalicular lacerations we preferred to insert a Ritleng tube with an aid of a Ritleng probe. In these cases we aimed to intubate the whole lacrimal system with this technique Figure 3A and 3B.

In all cases after intubation of the canalicular system, direct canalicular anastomosis was performed with two 7-0 polyglactin sutures; in 2/3 of the proximal canaliculus lacerations, indirect anastomosis was performed by suturing the pericanalicular tissue with two 7-0 polyglactin sutures in 1/3 distal canalicular lacerations Figure 2. Skin wounds were closed with interrupted 6-0 polyglacrtin sutures. All patients were prescribed topical eye drops four times a day, which contain a steroid and an antibiotic (Tobradex eye drops, Alcon Laboratories Inc.), and were told not to rub their eyes in order to prevent early tube extrusion. Skin sutures were removed at the first postoperative week, with follow-up visits planned for the postoperative first week, first month, third month, sixth month and yearly. All patients' stents were planned to be removed at the sixth month follow-up visit. Anatomic success was assessed by diagnostic probing with a hard stop and irrigation through the passage in all adult patients. Anatomical success could not be assessed in all pediatric patients. In those cases, only functional success was determined. Absence of epiphora was defined as functional success.

3. Results

Of all the patients who applied to our emergency department, 556 patients were diagnosed with an eyelid laceration. Forty-two (7.55%) of the 556 patients were diagnosed with a lacrimal canalicula laceration and underwent canalicular laceration repair surgery. The average age of these forty-two patients was 26.16±18.42 (range 5 to 78) years, mean follow-up time was 17.62±6.62 (range 12 to 42) months.

Table 1: Distribution of lacrimal canalicular lacerations according to age group.

Age (Years)	Male	Female	Total	%
0-10	6	2	8	19
11-20	8	2	10	24
21-30	9	2	11	26
31-40	4	1	5	12
41-50	2	1	3	7
51-60	1	1	2	5
>60	2	1	3	7
Total	32	11	42	100

Table 2: Distribution of affected lacrimal canaliculus.

Affected lacrimal canaliculus	**N**	%
Right lower lid	19	43
Left lower lid	16	37
Right upper lid	5	11
Left upper lid	4	9

The male-to-female ratio was 5.3-1. (Table 1) The lower canaliculus was involved in 33 patients (78.57%), the upper in 7 patients (16.6%), and 2 patients had bicanalicular involvement (4.76%). (Table 2) Monocanlicular laceration was detected in 40 (40/42, 95.28%) patients, and bicanalicular laceration in two (2/42, 4.76%) patients. The most common etiologies were assaults and motor vehicle crashes. (Table 3) Simultaneous ocular injuries occured in 14 patients (14/42, 33.33%). (Table 4) In 28 patients (66.67%), surgery was performed within 24 hours and in 14 patients (33.33%) surgery was performed between 24 hours and 6 days. Surgery was performed under general anesthesia for 16 patients (38.1%), and under local anesthesia for 26 patients (61.9%). In 32 patients (76.2%) direct anastomosis and in 10 patients (23.8%) indirect anastomosis was performed. In 36 patients (85.71%) Mini Monoka stenting was performed, whereas 3 patients (7.14%) were treated with bicanalicular annular silicon tube intubation and 3 patients (7.14%) were treated with Ritleng tube placement. Mean duration of the stent was 5.8±2.8 months (range: 7 days-10 months). In two of our pediatric patients Mini Monoka stents extruded prematurely. One of these occured at the first week following surgery, and the lacrimal pasage was completely blocked in this case. The second stent extrusion occurred in the 2^{nd} week, and in this case canalicular patency was obtained at the follow-up. Mean follow-up time was 17.62±6.62 (range 12 to 42) months. At the last follow- up visit, we were able to perform irrigation of the lacrimal passages in 32 out of 42 patients, and 31 (96.87%) of them showed patency of the nasolacrimal passage. (Outcomes of all cases are summarized in Table 5.) We could not perform irrigation of the nasolacrimal passage in all patients, especially in peadiatric patients. Functional success was assesed in a total of 39 patients (92.85%).

Table 3: Etiology of lacrimal canalicular lacerations.

Reasons for lacrimal canalicular lacerations	**n**	%
Assault/Fight/Body contact injury	14	**33**
Motor vehicle crashes	10	24
Fall to ground	6	14
Sharp objects (door handle, pen, knife, cable, toys, glass bottle)	6	14
Blunt objects (stone, ball)	2	5
Hook-like objects (coat hanger, dough roller)	2	5
Work accident	2	5

Table 4: Simultaneous ocular and periorbital injuries.

Associated ophthalmic injuries	
Bulbar conjunctival lacerations	5
Corneal epithelial erosions	4
Hyphema	2
Traumatic uveitis	1
Globe rupture	1
Pupil sphincter rupture	1
Full thickness horizontal upper eyelid Laceration	1
Orbital medial wall fracture	2
Nose fracture	2

Table 5: Postoperative results and complications.

Anatomic success	31/32(96.87%)
Functional success	39/42(92.85%)
Time of tube removal	**Patients**
7th day	1
15th day	1
3th-6th month	35
>6 month	5
Mean duration of stent (5.28 months)	
Postoperative complications	
Premature Mini-Monoka stent extrusion	2
Punctal slits	1

4. Discussion

Lacrimal canalicul lacerations usually occur with eyelid lacerations. The literature on the epidemiology of canalicular lacerations is limited. Herzum et al. reported a 16% rate of lacrimal drainge system involvement in 180 patients with eyelid injuries [1]. Naik et al. reported a 36% rate of lacrimal drainge system involvement in 66 patients with eyelid injuries [2]. In this study we detected canalicular lacerations in 42 patients, with a rate of 7.55% among 556 eyelid lacerations. This difference in rates could be attributable to the small series sizes of the previously reported studies.

Kennedy et al., in their study of 222 patients, reported that mean age was approximately 20 years and a male gender predominance was noted. Similar to the literature, in this

study lacrimal system injuries occurred most frequently in the first three decades, with a mean age of 26.16±18.42 years, with a male predominance. We also detected that the lower eyelid was most often involved, with a rate of 58%; this finding is similar to the previous literature [3].

In this study the most common causes of injuries were assaults, motor vehicle accidents, falling and trauma from a sharp object, in order of decreasing frequency. Earlier studies have reported dog bites, blouse hook fasteners, metal rod injuries, bicycle handle injuries, and motorcycles accidents as the most frequent etiologies [2–4]. We think that this difference is related to the socio-economic and cultural levels of the studied populations, as well as the countries and geographical regions where the studies were conducted.

Previously, the incidence of simultaneous globe injuries in association with eyelid injuries was reported to be between 20% and 44%. In our study, similar to the literature, we detected simultaneous globe injuries in 14 patients (33.33%). Eight of these 14 patients had upper eyelid involvement. This finding was similar to the literature [2].

Several authors have reported that early surgical intervention is one of the key indicators of success in canalicular repair. Several authors have recommended that surgery take place as early as possible after trauma. Naik et al. reported a high functional success rate (100 %) in a study of 24 patients who had monocanalicular intubation with Mini-Monoka stents within a mean interval of 32 hours (1 hour to 14 days) [2]. We aimed to perform the surgery as early as possible, and in 28 cases we found it possible to perform the repair surgery in the first 24 hours. The mean time interval from injury to surgery was 23.1±26.9 hours, which is similar to the literature [2].

The main purpose of treatment is to repair the lacerated canaliculus by stenting the damaged lacrimal system. Surgical procedures usually aim to perform an anastomosis within the lacerated canaliculus, and to intubate this canalicular system until the re-epithelisation of the canalicula. Surgical procedures can be divided into two groups: monocanalicular intubation and bicanalicular intubation. Different materials have been used for intubation including Crawford stents, Ritleng tubes, silicone tubes, and Quickert-Dyrden systems. Various surgical techniques have been described for stenting the lacrimal canalicular system. We avoided the use of bicanalicular silicone tubes because of the potential risk of iatrogenic damage to the uninvolved canaliculus and nasolacrimal lumen, and the technical difficulty of placing the stents [5]. Canalicular slitting, granuloma formation, superior loop dislocation, infection and corneal abrasion are the reported complications of bicanalicular intubation of the lacrimal canalicular system. We preferred bicanalicular annular silicon tubes in cases where we could not succeed in inserting the Mini-Monoka tube, and we prefered Ritleng tubes in cases with potential trauma to the low lacrimal drainage system and in cases with bicanalicular lacrimal canalicula lacerations.

Monocanalicular intubation with a Mini-Monoka stent is a less invasive alternative method to the bicanalicular method, which has been popular since 1992. The procedure is simple to perform, avoids injury to the uninvolved canalicula, and does not require any nasal manipulation or endoscopic assistance. Premature stent extrusion is reported as a major disadvantage associated with this technique. Previously success rates with the Mini-Monoka were reported between 58%-100%; in our study the functional success rate was 92.85% and the anatomical success rate was 96.87% [2, 6–11]. Premature stent extrusion and stent migration are the major disadvantages of this technique and can result in a poor surgical outcome. Anastas et al. reported premature extrusion in 29% and stent migration in 14% of 13 cases [12]. Over-dilation of the punctum is a risk factor for stent migration [13]. We think that stent length is one of the causes of migration. Long stents may migrate with the elevation of the pressure in the lacrimal sac. We trimmed the stent 10 mm to avoid retrograde migration of the stent. Punctal dilators with small-gauge instruments will prevent excessive punctal dilation. In addition, patient education plays an important role in preventing premature tube protrusion. We detected premature stent migrations in two cases, which were both pediatric patients. It may be that other canalicular entubation techniques should be preferred for pediatric patients.

Direct microsurgical re-anastomosis of the canalicular epithelium or indirect anastomosis is recommended for the satisfactory repair of canalicular lacerations [14–20]. We preferred direct microsurgical re-anastomosis in cases having lacerations 2/3 of the distance to the punctum, and pericanalicular re-anastomosis in cases with lacerations 1/3 of the distance to the lacrimal sac. In canalicular lacerations that are deep and close to the lacrimal sac, it is impossible to perform a direct anastomosis.

Optimum time for removal of lacrimal stents is still inconclusive. More time with the stent is important for the healing process and epithelization of the lumen of the lacrimal canalicula. Most authors have recommended durations of canalicular stenting ranging from 3 to 12 months [9, 21, 22]. Conlon et al. studied the histology of canalicular lacerations following intubation on an animal model, and showed that the optimum time for removal of the tube was 12 weeks in an animal model [23]. In our study, we planned for the explantation at 6 months. One of the unsuccessful results was obtained in a patient who had a stent extrusion at the 7th day; the other patient was explanted at the 10th month. In addition, in one patient the stent extruded at the 15th day, and at a follow-up visit we obtained a patent passage in this patient. It does not mean that epithelization and complete wound healing of the lacrimal canalicula laceration can be done in 15 days, but it was an interesting finding for us. We suggest and aim to remove the stents in 6 months.

This study has several limitations. First, the Ritleng tube implanted and bicanalicular annular silicon tube implanted groups contained a small number of cases, so we were

not able to compare the success rate of these groups. A prospective, randomized comparative study is needed with different treatment modalities, which would avoid this limitation.

In conclusion, eyelid lacerations at the medial chantal region may involve the lacrimal canalicula, and we think that findings of this study will help to determine the prevention strategies and clinical management of lacrimal lacerations. Reconstruction of lacrimal canalicula lacerations requires stenting. We suggest that the Mini-Monoka monocanalicular stent is a simple, minimally invasive and effective tool for reconstruction of traumatic monocanalicular lacerations. Postoperatively educating patients about not rubbing eyes should be considered, to avoid early extrusion. The pigtail probe is essential when the medial end of the lacerated canaliculus cannot be located. This technique avoids damage to the uninvolved canaliculus, and creating a false passage, by not forcing the pigtail probe. While inserting it with rotation, surgeons should push slowly and gently. In addition, Ritleng tubes are safe and easy to implant for bicanalicular lacerations.

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