

Outcome of Lacrimal Canalicular Injury Repaired with Bi-Canalicular Silicone Stent

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ABSTRACT

Background: Lacrimal canalicular injury is a common ophthalmic emergency requiring timely surgical repair. Bi-canalicular silicone stents are widely used to maintain canalicular patency, prevent scarring, and support reepithelialization during healing. However, anatomical and functional outcomes following stent repair remain an area of ongoing investigation.

Objective: To evaluate the anatomical and functional outcomes of lacrimal canalicular lacerations repaired with bi-canalicular silicone stents.

Methods: A prospective observational study was conducted at the National Institute of Ophthalmology, Dhaka, between April 2024 and September 2025. Fifty-three patients with canalicular lacerations underwent repair using bi-canalicular silicone stents. Anatomical success was defined as patency on irrigation with a hard stop using Bowman's probe (size 1), while functional success was defined as absence of epiphora at the latest follow-up. Patients were assessed at 1 week, 1 month, and 3 months postoperatively.

Results: The mean patient age was 34.5 ± 15.9 years, with 24 (45.2%) aged 18–27 years; 44 (83.0%) were male. Lower canalicular involvement was most common (67.9%). Road traffic accidents accounted for 67.9% of injuries. Anatomical success was achieved in 45 (84.9%) patients, while functional success was observed in 42 (79.2%). Anatomical success was significantly associated with lower canalicular involvement ($p=0.033$) and surgery within 24 hours ($p<0.001$). Functional success was higher among patients aged 18–27 years ($p=0.003$) and those operated within 24 hours ($p<0.001$).

Conclusion: Bi-canalicular silicone stents provide favorable outcomes in canalicular laceration repair. Early intervention and younger age significantly improve anatomical and functional success.

KEYWORDS: Lacrimal canalicular injury, Bi-canalicular stents, Anatomical success, Functional success.

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INTRODUCTION

Background of the Study

Lacrimal canalicular injuries represent the most frequent trauma to the lacrimal drainage system, with the lower canaliculus being particularly vulnerable.^[1] These injuries constitute a significant proportion of ocular emergencies and are commonly encountered in children and young adults.^[2] Epidemiological data suggest that approximately 16% of

eyelid lacerations involve canalicular disruption, with bicanalicular lacerations accounting for 6–24% of cases, while monocanalicular lacerations comprise nearly 72% of lower canaliculus injuries.^[1] The predominant etiologies include road traffic accidents, sports-related trauma, dog bites, and violence-associated injuries.^[3] Untreated canalicular injuries may progress to scarring, stenosis, and chronic inflammation, often resulting in

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persistent epiphora that can become irreversible.^[2] Timely surgical intervention—preferably within 48 hours of trauma—has been shown to reduce the likelihood of missed canalicular ends and improve functional outcomes.^[4]

The principal aim of canalicular repair is restoration of both anatomical integrity and functional tear drainage. Conventional approaches include canalicular anastomosis with mono- or bicanalicular stent intubation.^[1,4] Monocanalicular stents, which are self-retaining at the punctum and can be inserted under local anesthesia, are effective in simple lacerations but less suitable in complex adnexal or orbital trauma, particularly when the injury extends to the lacrimal sac entrance.^[5]

By contrast, bicanalicular silicone stents provide a closed-loop system that stabilizes the medial canthus, preserves punctal alignment, and prevents eyelid eversion.^[6,7] Bicanalicular intubation has demonstrated high success rates, offering adequate tension across lacerated ends and facilitating medial canthal tendon repair.^[4] Silicone stents are favored for their inert properties, flexibility, and ease of removal without general anesthesia.^[7,8]

Despite these advances, surgical outcomes remain variable. Prognosis is influenced by factors such as the extent of laceration, timing of repair, presence of concomitant ocular or facial injuries, and patient adherence to postoperative care.^[9–11] Anatomical success is defined by structural restoration of the canalicular system, whereas functional success is determined by resolution of epiphora.^[12] Notably, anatomical success does not always equate to functional success, underscoring the complexity of managing canalicular trauma.^[9]

Rationale of the Study

The repair of lacrimal canalicular injuries is a vital aspect of ophthalmic trauma management. Inadequate treatment can result in chronic epiphora, visual disturbances, cosmetic deformities, and a significant reduction in quality of life. Bi-canalicular stenting has emerged as a widely adopted technique for canalicular repair; however, there remains a need for comprehensive evaluation of its short- and long-term outcomes, particularly with respect to anatomical restoration and functional tear drainage.

This study is designed to address that gap by systematically assessing the effectiveness of bi-canalicular stenting in a defined patient population. By analyzing both anatomical success and functional recovery, the findings will contribute to the existing body of evidence on lacrimal system injury management. Furthermore, the results have the potential to guide future surgical practices, enhance clinical decision-making, and ultimately improve patient care and outcomes.

Research Question

What are the anatomical and functional outcomes of bi-canalicular stent intubation in the surgical repair of lacrimal canalicular injuries among patients presenting with ocular trauma?

Objectives of the Study

Primary Objective

- To evaluate the anatomical and functional outcomes of bi-canalicular stent intubation in the surgical repair of lacrimal canalicular injuries.

Secondary Objectives

- To assess the anatomical restoration by Sac Patency Test
- To determine the functional outcomes by Jones Test

MATERIALS AND METHODS

Study design: Prospective observational study

Study period: From April-2024 to September-2025

Study place: This study was carried out in the National Institute of Ophthalmology and Hospital (NIO&H), Dhaka.

Study population: This study was carried out on patients presenting with lacrimal canalicular injuries who underwent repair using a bi-canalicular silicone stent in the National Institute of Ophthalmology and Hospital (NIO&H), Dhaka.

Inclusion Criteria

- Adults aged 18 years and older.
- Patients with unilateral or bilateral lacrimal canalicular injury, scheduled for surgical repair with a bi-canalicular stent.

Exclusion Criteria

- History of previous lacrimal surgery or trauma in the same eye.
- Presence of systemic conditions known to impair wound healing (e.g., uncontrolled diabetes, autoimmune disorders).
- Concurrent ocular infections or severe ocular surface disease.
- Associated globe rupture.

Sample size

Sample size was calculated by applying formula and found to be 48.4. After adding **10% non-response**, the final sample size was **53 patients**. Therefore, a total of 53 patients were taken for this study.

Sample technique: Consecutive sampling technique was used

Study Variables

Independent Variables

- Age at the time of surgery
- Gender
- Laterality (right or left eye)
- Affected canaliculus (upper, lower, or both)
- Duration of injury prior to surgical intervention
- Cause of injury

Dependent Variables

- **Surgical outcome**, assessed by:
 - **Anatomical restoration** using the Sac Patency Test

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- **Functional outcome** using the Jones Dry Eye Test

Operational Definitions

- **Anatomical success:** Defined as canalicular patency confirmed by irrigation with saline solution.
- **Functional success:** Defined as the absence of epiphora, assessed using the Jones Test.

Study Procedure

This prospective observational study was conducted at the National Institute of Ophthalmology & Hospital (NIO&H), Dhaka, between January 2024 and July 2025. Following ethical approval, a total of 53 patients with lacrimal canalicular injury scheduled for surgical repair with a bi-canalicular silicone stent in the Emergency Department of NIO&H were enrolled. Written informed consent was obtained from all participants prior to inclusion.

Demographic and clinical data were collected, including age, gender, laterality (right or left eye), duration of injury prior to surgery, and cause of injury. Each patient underwent a comprehensive preoperative ocular examination. Diagnosis of canalicular laceration was confirmed by inserting a probe into the punctum to identify disruption at the proximal lumen of the canalicular tear or avulsion site.

All surgical procedures were performed under local anesthesia using an operating microscope. The repair involved intubation of the lacrimal canalicular laceration with a bi-canalicular silicone stent. Postoperative care was standardized, and patients were followed up at 1 week, 1 month, and 3 months after surgery. At each visit, anatomical

outcomes were assessed by sac patency testing, and functional outcomes were evaluated using the Jones Test.

Data Analysis

All collected data were analyzed using the Statistical Package for the Social Sciences (SPSS), version 26. Descriptive statistics were applied to summarize patient characteristics: means and standard deviations were calculated for continuous variables, while frequencies and percentages were used for categorical variables.

Associations between qualitative variables were assessed using Fisher's Exact Test. A p-value of <0.05 was considered statistically significant, and all p-values were reported as two-sided. Results were presented in tabular form to ensure clarity and ease of interpretation.

Ethical Considerations

Prior to commencement, the study protocol was reviewed and approved by the Ethical Review Committee of the National Institute of Ophthalmology & Hospital (NIO&H), Dhaka. All participants were informed of the objectives, methodology, and purpose of the study in clear and understandable language. Potential benefits and possible risks were explained, and written informed consent was obtained from each participant voluntarily, without coercion, before data collection.

Confidentiality of all patient information was strictly maintained, and data were used solely for research purposes. Participants were assured of their right to withdraw from the study at any stage, even after providing consent, without any impact on their clinical care.

RESULTS

Table-I: Distribution of the patients by age & gender (n=53)

Age (in years)	Frequency	Percentage
18-27	24	45.2
28-37	11	20.8
38-47	9	17.0
48 and above	9	17.0
Mean $\pm$ SD	34.5 $\pm$ 15.9	
Gender		
Male	44	83.0
Female	9	17.0

Among the 53 patients enrolled, 24 (45.2%) were between 18–27 years of age, while 11 (20.8%) fell within the 28–37 year age group. The overall mean age was 34.5 $\pm$ 15.9 years. Of the total cohort, 44 (83.0%) were male and 9 (17.0%) were female.

Table II: Distribution of the patients by laterality (n=53)

Laterality	Frequency	Percentage
Right	20	37.7
Left	33	62.3

Out of the 53 patients, 20 (37.7%) had injury on the right eye while the rest 33 (62.3%) had injury on the left eye.

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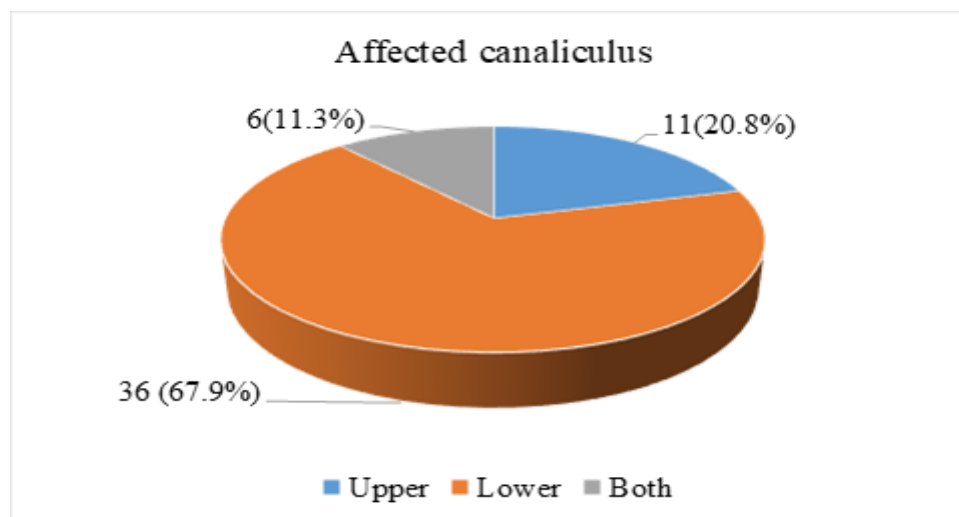


Figure-1: Distribution of the patients by affected canaliculus (n=53)

The lower canaliculus was affected in 36 patients (67.9%), the upper canaliculus in 11 patients (20.8%), and both canaliculi in 6 patients (11.3%).

Table III: Distribution of the patients by duration of injury (n=53)

Duration of injury (in hours)	Frequency	Percentage
Within 24 hours	44	83.0
Within 48 hours	4	7.5
Beyond 48 hours	5	9.4
Median [IQR]	16.0 [10.0, 24.0]	

Surgery was performed within 24 hours of injury in 44 patients (83.0%), within 48 hours in 4 patients (7.5%), and beyond 48 hours in 5 patients (9.4%). The median duration from injury to surgery was 16.0 hours.

Table IV: Distribution of the patients by outcome of surgery (n=53)

Outcome of surgery	Frequency	Percentage
Anatomical success	45	84.9
Functional success	42	79.2

Anatomical success was attained in 45 patients (84.9%), and functional success in 42 patients (79.2%).

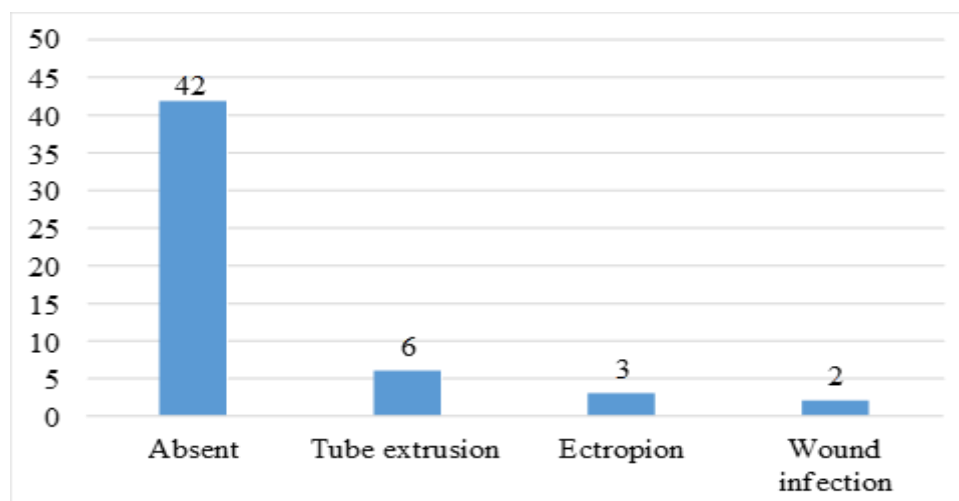


Figure 2: Distribution of the patients by complication of surgery (n=53)

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Complications were absent in 42 patients (79.2%), while 11 patients (20.8%) developed postoperative complications. Tube extrusion occurred in 6 patients (11.3%), ectropion in 3 (5.7%), and wound infection in 2 (3.8%)

Table V: Association between independent variables and anatomical success

Criteria	Anatomical success		p value
	Absent (n=8)	Present (n=45)	
Age group (in years)			
18- 27	3 (37.5%)	21 (46.7%)	
28-37	1 (12.5%)	10 (22.2%)	
38-47	0 (0.0%)	9 (20.0%)	p=0.056a
48 and above	4 (50.0%)	5 (11.1%)	
Gender			
Male	6 (75.0%)	38 (84.4%)	
Female	2 (25.0%)	7 (15.6%)	p=0.611a
Laterality			
Right	3 (37.5%)	17 (37.8%)	
Left	5 (62.5%)	28 (62.2%)	p=0.999a
Affected canaliculi			
Upper	2 (25.0%)	9 (20.0%)	
Lower	3 (37.5%)	33 (73.3%)	p=0.033a
Both	3 (37.5%)	3 (6.7%)	
Duration of injury			
Within 24 hours	2 (25.0%)	42 (93.4%)	p<0.001a
Within 48 hours	2 (25.0%)	2 (4.4%)	
Beyond 48 hours	4 (50.0%)	1 (2.2%)	

a=Fisher Exact test

Higher anatomical success was observed in lower canalicular involvement (p=0.033) and in surgeries performed within 24 hours of injury (p<0.001)

Table VI: Association between independent variables and functional success

Criteria	Functional success		p value
	Absent (n=11)	Present (n=42)	
Age group (in years)			
18- 27	4 (36.4%)	20 (47.6%)	p=0.003a
28-37	1 (9.1%)	10 (23.8%)	
38-47	0 (0.0%)	9 (21.4%)	
48 and above	6 (54.5%)	3 (7.1%)	

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Gender			
Male	9 (81.8%)	35 (83.3%)	
Female	2 (18.2%)	7 (16.7%)	p=0.999a
Laterality			
Right	3 (27.3%)	17 (40.5%)	
Left	8 (72.7%)	25 (59.5%)	p=0.503a
Affected canaliculi			
Upper	3 (27.3%)	8 (19.0%)	
Lower	5 (45.5%)	31 (73.8%)	p=0.088a
Both	3 (27.3%)	3 (7.1%)	
Duration of injury			
Within 24 hours	2 (18.2%)	42 (100.0%)	p<0.001a
Within 48 hours	4 (36.4%)	0 (0.0%)	
Beyond 48 hours	5 (45.5%)	0 (0.0%)	

a=Fisher Exact test

Higher functional success was observed in patients aged 18–27 years, while failure predominated in those aged 48 years and above ($p=0.003$). Functional success was universal among patients treated within 24 hours, whereas surgery beyond 48 hours was significantly associated with failure ($p<0.001$).

DISCUSSION

Canalicular lacerations are recognized as ophthalmic emergencies. Inadequate wound healing may result in canalicular obstruction, leading to symptomatic epiphora, particularly in cases involving the lower canaliculus.^[13] The present prospective observational study aimed to evaluate the outcomes of lacrimal canalicular injuries repaired using bi-canalicular stents. Anatomical success was achieved in 84.9% of patients, while functional success was observed in 79.2%. Anatomical success was significantly associated with lower canalicular involvement and surgical intervention within 24 hours of injury. Functional success was more frequent among patients aged 18–27 years and in those undergoing surgery within 24 hours.

The mean age of patients in this study was 34.5 (± 15.9) years, with 45.2% belonging to the 18–27-year age group. Comparable studies reported similar findings: in India, the mean age was 30.0 (± 16.2) years; in Cameroon, 33.0 years;^[14] and in China, 39.6 (± 20.0) years.^[15] Young adults appear more susceptible to canalicular injuries, likely due to

increased exposure to road traffic accidents, occupational hazards, and assaults.^[16]

In this study, 83.0% of patients were male, consistent with findings from other reports.^[17–21] Male predominance in canalicular injury studies may reflect higher engagement in high-risk or aggressive behaviors.^[22]

Most patients (62.3%) had left-eye involvement. Monocanalicular lacerations accounted for 88.7% of cases, while 11.3% were bicanalicular. Similar distributions have been reported elsewhere.^[17–19] Global trends confirm the predominance of left-eye involvement and lower canalicular lesions.^[15,14] Anatomical vulnerability of the lower canaliculus during frontal trauma and the tendency for right-handed aggressors to strike the left side of the victim's face may explain these findings.^[14]

The median injury-to-surgery interval was 16.0 hours, slightly higher than the 14.4 hours reported by Guo et al.,^[19] who included patients with injuries up to 48 hours. In the present study, most patients underwent surgery within 24 hours. Early presentation may be attributed to the tertiary care setting, specialized facilities, efficient referral pathways, and heightened awareness of advanced care availability. The presence of 24/7 emergency services further facilitated prompt management.

Road traffic accidents were the leading cause of injury (67.9%), followed by physical assault (24.5%) and falls (7.5%). Similar etiological patterns have been documented in other studies.^[19–21]

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Although no consensus exists regarding the optimal duration of stent placement for long-term canalicular patency, many surgeons advocate prolonged intubation.^[23–25] Extended stenting (3–12 months) is believed to support epithelization and healing of the canalicular lumen. In this study, stents were retained for three months in all patients.

Anatomical success was achieved in 45 patients (84.9%). Higher success rates have been reported: Cai et al.^[21] 99.3%, Guo et al.^[19] 98.6%, Han et al.^[15] 95.9%, and Mansour & Ezzeldin^[26] 96.9%. These differences may reflect earlier surgical intervention (within 48 hours) in those studies. Conversely, Singh et al.^[17] reported a lower success rate (74.4%), possibly due to varied stent types (Mini-Monoka, 20G silicone, and bicanalicular annular stents).

Functional success in the present study was 79.2%, within the range reported in prior studies (72.3–100.0%).^[22] Cai et al.^[21] reported 87.2%, Guo et al.^[19] 83.8%, and Han et al.^[22] 86.1%. Stents provide mechanical support and act as scaffolds for epithelial growth, maintaining canalicular patency and facilitating both anatomical and functional restoration.^[27]

Functional success was lower than anatomical success in this study. This discrepancy may be explained by the fact that patency on irrigation does not always equate to effective tear drainage. Factors such as lacrimal pump dysfunction, scarring, punctal malposition, or subtle outflow obstruction may impair function despite anatomical repair.^[28]

Postoperative complications were absent in 79.2% of patients. Tube extrusion was the most common complication (11.3%), all occurring in patients with road traffic injuries, likely due to extensive pericanalicular tissue damage. Han et al.^[15] reported extrusion in 9 patients (2.66%), while other studies documented rates between 5.9% and 23.2%.^[23,29–33,21] Ectropion (5.7%) and wound infection (3.8%) were also observed, consistent with findings from Cai et al.^[21] and Han et al.^[15]

Multiple factors influence repair outcomes, including the extent and site of laceration, intubation material, stent duration, and surgical technique.^[15] In this study, anatomical success was significantly higher in lower canalicular injuries and in patients treated within 24 hours, consistent with previous reports.^[23,21] Delayed repair reduces success due to scar tissue formation, which complicates identification of the severed canalicular ends.^[21]

Functional success was significantly higher in patients aged 18–27 years, whereas failures were more common in those aged ≥48 years. Reduced success in older patients may be attributed to age-related lacrimal pump weakness and eyelid laxity, which compromise tear drainage despite anatomically patent canaliculi.

CONCLUSION

Favorable outcomes were achieved with bi-canalicular silicone stenting for canalicular laceration repair. Anatomical success was significantly associated with lower canalicular involvement and early surgery within 24 hours, whereas

functional success was significantly higher in younger patients (18–27 years) and with shorter injury-to-surgery duration.”

RECOMMENDATIONS

Early surgical repair of canalicular lacerations with bi-canalicular silicone stenting is recommended to ensure favorable anatomical and functional outcomes. Prompt intervention within 24 hours of injury is particularly advisable in younger patients and in cases of isolated canalicular involvement to optimize surgical success.”

LIMITATIONS OF THE STUDY

- There was no comparative group
- Pediatric patients were excluded from the study

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