

Factors Associated with Conjunctival Erosions after Ahmed Glaucoma Valve Implantation

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Abstract

Purpose: To investigate the frequency of conjunctival erosions in a series of patients who underwent Ahmed valve implantation in a tertiary referral center and to study risk factors associated with the conjunctival erosions.

Methods: This is a single-center, retrospective case-control study of all patients who underwent Ahmed valve implantation between October 2006 and July 2016 at the Kresge Eye Institute in Detroit, Michigan. The series consisted of 306 eyes (277 patients) that underwent Ahmed valve implantation. The rate of conjunctival erosions was determined. Univariate, bivariate, and Cox-proportional hazard analyses were performed to identify factors associated with conjunctival erosions.

Results: During the study period, 23 erosions occurred in 306 eyes (7.52%). Aphakia was significantly more common in eyes with erosions ($P < 0.05$). Aphakia ($P = 0.02$), uveitic glaucoma ($P = 0.03$), and longer post-operative use of topical steroids ($P < 0.04$) significantly increased the risk of erosions based on the Cox model. There were similar rates of erosions with each type of patch graft. No conjunctival erosion was observed after using the modified scleral tunnel method ($n = 10$).

Conclusions: The overall erosion rate was 7.52% in our series. Uveitic glaucoma, aphakia, and longer post-operative use of topical steroids were significantly associated with conjunctival erosions.

Keywords: Ahmed Valve; Conjunctival Erosion; Glaucoma

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INTRODUCTION

Glaucoma drainage device implantation has been traditionally reserved for patients with uncontrolled glaucoma who have failed previous trabeculectomies or those with a high likelihood of trabeculectomy

failure (such as patients with neovascular and uveitic glaucoma). However, based on the five-year outcomes in the Tube Versus Trabeculectomy Study, tube shunt surgery has a higher success rate in contrast to trabeculectomy, whereas the former is associated with a similar reduction in intraocular pressure (IOP) and use of additional medical therapy in comparison to the latter.^[1] One of the surgical complications is conjunctival erosion and exposure of the tube or plate, which is a risk factor for endophthalmitis.^[2] The reported frequency of conjunctival erosion ranges from 2-8%.^[3-9] There are

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few proposed mechanisms of tube exposure, including the mechanical force of the eyelid, immune-mediated processes leading to the melting of the patch graft, and poor perfusion with secondary ischemic damage to the conjunctiva.^[7,10,11] However, additional influences may increase the risk of conjunctival erosion and exposure of the tube.

To prevent conjunctival erosion, the glaucoma drainage device can be placed under a partial-thickness scleral flap or covered with a patch graft. In 1987, donor sclera was first described as a successful patch graft for covering the tube.^[12] Since then, the pericardium, dura mater, fascia lata, cornea, amniotic membrane, and porcine intestinal submucosa have been used.^[12-18] Each material has its advantages and disadvantages with respect to the success rates, cost, availability, and cosmetic appearance. For instance, donor pericardium or dura can be costly and may trigger immune-mediated inflammation, whereas Tutoplast pericardium and dura have the advantage of sterility in contrast to donor pericardium and dura.^[7] In this article, our aim is to report the frequency of conjunctival erosions in a series of patients who underwent Ahmed valve implantation in a tertiary referral center and to study the risk factors associated with conjunctival erosions. Our series evaluating conjunctival erosions in subjects with Ahmed valves had a large sample size and is the first to report aphakia as a risk factor for conjunctival erosions.

METHODS

This was a single-center, retrospective, interventional case series of patients who were treated at the Kresge Eye Institute in Detroit, Michigan, USA. The institutional review board at Wayne State University approved the study protocol. We included all adult patients (age 18 years or older) who underwent Ahmed valve implantation at the Kresge Eye Institute between October 2006 and July 2016. Patients with no accessible pre-operative information and those who had post-operative follow-up of less than one month were excluded from the study. The following pre-and post-operative data were collected from the patients' electronic medical records: age, race, sex, history of systemic diseases, history of ocular diseases, type of glaucoma, IOP (mm Hg), best-corrected visual acuity (BCVA, LogMAR), number and type of glaucoma medications, lens status, previous glaucoma laser and incisional procedures, and previous other ophthalmic procedures. Glaucoma laser procedures included selective laser trabeculoplasty, argon laser trabeculoplasty, and laser peripheral iridotomy. Glaucoma surgical procedure included prior trabeculectomy, ExPRESS shunt implantation, Ahmed valve implantation, or a combination of these. Intraoperative data collected included the model of Ahmed valve implant, location of implantation, patch graft material, any concomitant

surgical procedures, and intraoperative complications. All surgeons used a similar technique for the insertion of FP7 and M4 tubes (New World Medical, Inc., Rancho Cucamonga, California) into the anterior segment, with the end of the plate placed approximately 8-10 mm posterior to the limbus. The surgeons at Kresge Eye Institute used similar techniques; for the Ahmed valve implantations with a patch graft, the tube was inserted 3-4 mm behind the limbus. PC7 tubes were inserted into the posterior segment. Regarding the conjunctival erosion, we recorded time of onset from the surgical procedure, location of erosion, and whether the erosion was repaired. Post-operative data were collected at months 1, 3, 6, 9, and 12, and then at 6-month intervals until 48 months.

At the surgeon's discretion, a modified scleral tunnel technique was used to cover the tube in some cases. Patients who underwent the modified scleral tunnel procedure were included in the "cover" group in Tables 1 and 2. A scleral tunnel was initiated 3-4 mm from the limbus using a paracentesis blade to create a half-thickness incision of less than 1 mm in width. Then, a bent 22-gauge needle mounted on a viscoelastic cannula was advanced. The needle was passed bevel-up to a partial thickness through the sclera superficially enough for its track to remain visible. At the limbus, the tangential direction was changed to make the needle enter the anterior chamber on a track parallel to the iris plane. Viscoelastic was injected at the same time of retracting the needle in order to lubricate the tube entrance.

Statistical analyses were performed using SPSS version 23 (SPSS Inc., Chicago, IL, USA). A *P* value of <0.05 was considered statistically significant. The Kolmogorov-Smirnov test was used to verify the normal distribution of the study outcomes. Chi square test and *t*-test were used to compare pre-and post-operative measures in a bivariate analysis. Cox-proportional hazard analysis was performed to determine the association between conjunctival erosion and various demographic, clinical, and surgical factors. All demographic, clinical, and surgical variables were included in the model. The cumulative probability of conjunctival erosion was analyzed using Kaplan-Meier life-tables.

RESULTS

A total of 327 Ahmed valve implantations were performed in 316 eyes of 287 patients between October 2006 and July 2016 at the Kresge Eye Institute. A total of 306 eyes from 277 patients (138 [49.82%] females and 139 [50.18%] males) met the eligibility criteria and were included in this study. There was no statistically significant difference in the mean (\pm standard deviation [SD]) age (years) between the non-erosion (59.69 [\pm 15.80]) and the

Table 1. Baseline demographic and clinical characteristics among eyes with conjunctival erosions and those without conjunctival erosions

Study parameters	All	Non-erosion group	Erosion group	P
Number of eyes (patients)	306 (277)	283 (255)	23 (22)	N/A
Race, n (%)				
White	36 (13.00)	33 (12.94)	3 (13.64)	0.95
African-American	220 (79.42)	203 (79.61)	17 (77.27)	
Other*	21 (7.58)	19 (7.45)	2 (9.09)	
Lens status, n (%)				
Phakic	142 (46.41)	137 (48.41)	5 (21.74)	<0.01
Pseudophakic	140 (45.75)	128 (45.23)	12 (52.17)	
Aphakic	24 (7.84)	18 (6.36)	6 (26.09)	
Type of glaucoma, n (%)				
POAG	90 (29.41)	83 (29.33)	7 (30.43)	0.96
Neovascular glaucoma	92 (30.07)	85 (30.04)	7 (30.43)	
Angle-closure glaucoma	38 (12.42)	35 (12.37)	3 (13.04)	
Uveitic glaucoma	47 (15.36)	43 (15.19)	4 (17.39)	
Other [†]	39 (12.74)	37 (12.09)	2 (0.65)	
Preoperative IOP, mean±SD (95% CI)	34.77±15.27 (33.05-36.49)	34.86±15.39 (33.06-36.66)	33.70±13.91 (27.68-39.71)	0.73 [§]
Preoperative number of glaucoma medications, mean±SD (95% CI)	3.16±1.08 (3.04-3.29)	3.17±1.09 (3.04-3.30)	3.09±0.95 (2.68-3.50)	0.73 [§]
Previous glaucoma laser procedure, n (%)				
Yes	91 (29.74)	84 (29.68)	7 (30.43)	0.90
No	215 (70.26)	199 (70.32)	16 (69.57)	
Previous glaucoma surgical procedure, n (%)				
Trabeculectomy	47 (15.36)	43 (15.19)	4 (17.39)	0.71
ExPRESS shunt	17 (5.56)	17 (6.01)	0 (0.00)	
Ahmed valve	9 (2.94)	8 (2.83)	1 (4.35)	
Combined	6 (1.96)	6 (2.12)	0 (0.00)	
None	227 (74.18)	209 (73.85)	18 (78.26)	
Ahmed valve model, n (%)				
FP7	256 (83.66)	240 (84.81)	16 (69.57)	0.13
M4	26 (8.50)	23 (8.13)	3 (13.04)	
PC7	24 (7.84)	20 (7.07)	4 (17.39)	
Tube cover material, n (%)				
Tutoplast pericardium	226 (73.85)	210 (74.20)	16 (69.57)	0.52
Cornea	29 (9.48)	26 (9.19)	3 (13.04)	
Alloderm	29 (9.48)	28 (9.89)	1 (4.35)	
Other [‡]	22 (7.19)	19 (6.72)	3 (13.04)	
Ahmed valve location, n (%)				
Superior	289 (94.44)	268 (94.70)	21 (91.30)	0.49
Inferior	17 (5.56)	15 (5.30)	2 (8.70)	
Concomitant surgical procedures, n (%)				
Cataract	71 (23.20)	67 (23.68)	4 (17.39)	0.67
Vitrectomy	11 (3.59)	9 (3.18)	2 (8.70)	
Cataract and vitrectomy	19 (6.21)	18 (6.36)	1 (4.35)	
Other§	14 (4.58)	13 (4.59)	1 (4.35)	
None	191 (62.42)	176 (62.19)	15 (65.22)	
Preoperative prostaglandin use, n (%)				
Yes	223 (72.88)	203 (71.73)	20 (86.96)	0.11
No	83 (27.12)	80 (28.27)	3 (13.04)	

Contd...

Table 1. Contd...

Study parameters	All	Non-erosion group	Erosion group	P
Postoperative prostaglandin use (3 months), n (%)				
No use	158 (51.63)	147 (51.94)	11 (47.83)	0.92
<3 months	35 (11.44)	32 (11.31)	3 (13.04)	
≥3 months	113 (36.93)	104 (36.75)	9 (39.13)	
Postoperative topical steroid use, n (%)				
<3 months	157 (51.31)	144 (50.88)	13 (56.52)	0.23
3 months-<6 months	69 (22.55)	67 (23.67)	2 (8.70)	
≥6 months	80 (26.14)	72 (25.44)	8 (34.78)	

*Hispanic, Middle Eastern, Asian; †Traumatic and mixed-mechanism glaucoma, glaucoma associated with anterior segment anomalies, phacomorphic glaucoma, pigmentary glaucoma, pseudoexfoliative glaucoma; ‡Scleral-flap, amniotic membrane, fascia lata, and no cover; §Synchiolysis, AC washout, bleb revision, express shunt explant, endolaser; ||χ²; †t-test. N/A, not applicable; CI, confidence interval; POAG, primary open-angle glaucoma; IOP, intraocular pressure

erosion (63.27 [±15.12]) group ($P = 0.26$, t test). Nine eyes from nine patients had undergone previous Ahmed valve implantation. One of these nine eyes was observed to have a conjunctival erosion after the second Ahmed valve shunt implantation. No prior erosions were observed. None of the original shunts were removed. During the study period, 23 erosions occurred in 306 eyes (7.52%). The erosion locations were over the tube in 17 (73.91%) cases, over the genu in 2 (8.70%) cases with the PC7 models, over the plate in 2 (8.70%) case, over the genu and plate in 1 (4.34%) case, and over the tube and plate in 1 (4.34%) case. All patients who had conjunctival erosions underwent surgical repair of the exposed area. No patients in the erosion group developed endophthalmitis. The demographic and clinical characteristics of the patients are shown in Table 1. The mean (± SD) follow up was 30.14 (±30.05) months in the non-erosion group and 39.78 (±38.20) months in the erosion group ($P > 0.05$). Figure 1 illustrates the Kaplan-Meier analysis for the percentage of implants without erosions over time. The mean ± SD and the median time to erosion was 10.84 ± 16.60 months and 5.83 months (range 0.3-48 months), respectively [Figure 1].

Table 1 shows study variables in all eyes and in the erosion and non-erosion groups. Bivariate analysis showed that there was no statistically significant difference between the two groups with respect to gender, race, prevalence of hypertension and diabetes, and type of glaucoma ($P > 0.05$ for all). There was no statistically significant difference in the mean preoperative visual acuity (LogMAR) between the non-erosion (1.61) and the erosion (1.95) group ($P = 0.16$, t test). In addition, the preoperative IOP and number of IOP-lowering medications, number of previous glaucoma laser and incisional procedures, number of previous panretinal photocoagulation procedures, Ahmed valve model, Ahmed valve location, and rate of pre-and post-operative prostaglandin use were

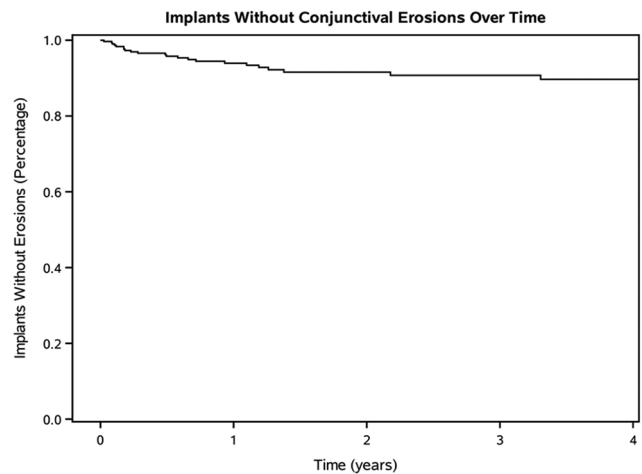


Figure 1. Kaplan-Meier graph of the percentage of implants without erosions over time.

not significantly different between eyes with and without conjunctival erosions ($P > 0.05$ for all). The erosion group had significantly more aphakic eyes in contrast to the non-erosion group ($P < 0.01$) [Table 1]. In addition, the Cox-proportional hazard analyses showed that aphakia was significantly associated with erosion (hazard ratio [HR], 7.80; $P = 0.02$) [Table 2]. Tutoplast pericardium was the most common (76.4%) patch graft used in our series [Table 1]. There was no statistically significant difference in the frequency of conjunctival erosions among the various types of patch graft materials ($P = 0.52$) [Table 1]. The Cox-proportional hazard analysis showed that uveitic glaucoma was significantly associated with erosions (HR, 6.87; $P = 0.03$) [Table 2]. In addition, the Cox-proportional hazard analysis revealed that post-operative use of steroids for more than 3 months (hazard ratio, 4.20; $P = 0.04$) and 6 months (HR, 8.02; $P = 0.005$) were significantly associated with erosions [Table 2]. We did not observe any conjunctival erosion in eyes

Table 2. Cox proportional-hazard analysis of conjunctival erosion and different demographic, clinical and surgical factors

Variables	Hazard ratio	95% CI	P
Age	1.02	0.98-1.06	0.42
Gender			
Reference: Male			
Female	1.94	0.59-6.35	0.27
Race			
Reference: African American			
Caucasian	0.43	0.08-2.48	0.35
Other*	1.85	0.27-12.55	0.53
Type of glaucoma			
Reference: POAG			
Neovascular glaucoma	3.19	0.62-16.48	0.17
Uveitic glaucoma	6.87	1.16-40.54	0.03
Angle-closure glaucoma	1.05	0.15-7.40	0.96
Other†	0.46	0.07-3.08	0.42
Lens status			
Reference: Phakic			
Pseudophakic	3.09	0.65-14.74	0.16
Aphakic	7.80	1.38-44.11	0.02
Hypertension			
Reference: No hypertension			
Yes	0.33	0.10-1.11	0.07
Diabetes mellitus			
Reference: No diabetes mellitus			
Yes	0.87	0.25-2.99	0.83
Previous glaucoma laser procedure			
Reference: No laser procedure			
Yes	1.71	0.55-5.28	0.35
Previous glaucoma surgery			
Reference: No surgery			
Yes	0.71	0.159-3.20	0.84
Previous PRP			
Reference: No PRP			
Yes	0.71	0.16-3.20	0.66
Preoperative BCVA, logMAR	1.32	0.81-2.17	0.27
Preoperative IOP, mm Hg	1.01	0.96-1.05	0.82
Preoperative number of medications	0.80	0.43-1.49	0.48
Preoperative prostaglandin			
Reference: No use			
Yes	3.52	0.62-19.88	0.15
Ahmed valve location			
Reference: Inferior			
Superior	6.33	0.78-51.02	0.08
Concomitant surgical procedures			

Contd...

Table 2. Contd...

Variables	Hazard ratio	95% CI	P
Reference: No surgical procedures			
Cataract	1.12	0.25-5.10	0.88
Vitrectomy	0.09	0.05-1.96	0.13
Cataract and vitrectomy	0.33	0.02-5.28	0.43
Other‡	0.33	0.02-5.08	0.43
Tube cover material			
Reference: Tutoplast pericardium			
Cornea	1.43	0.22-9.15	0.70
Alloderm	0.30	0.02-4.08	0.37
Other§	1.25	0.55-2.49	0.99
Ahmed valve model			
Reference: FP7			
M4	2.11	0.29-15.30	0.46
PC7	6.78	0.42-110.10	0.18
Postoperative prostaglandin use			
Reference: No use			
≤ 3 months versus	1.05	0.176-6.28	0.96
>3 months versus no use	2.09	0.547-7.97	0.28
Postoperative steroid use			
>3 months versus ≤ 3 months	4.20	0.02-0.92	0.04
>6 months versus ≤ 6 months	8.02	3.32-732.72	0.005

*Hispanic, Middle Eastern, Asian; †Traumatic and mixed-mechanism glaucoma, glaucoma associated with anterior segment anomalies, phacomorphic glaucoma, pigmentary glaucoma, pseudoexfoliative glaucoma; ‡Synchiolysis, AC washout, bleb revision, express shunt explant, endolaser; §Scleral-flap, amniotic membrane, fascia lata, or no cover. N/A, not applicable; CI, confidence interval; POAG, primary open angle glaucoma; IOP, intraocular pressure; PRP, panretinal photocoagulation

that had undergone tube insertion through a scleral tunnel (*n* = 10).

DISCUSSION

In this single-center, retrospective case-control series, we studied the frequency of conjunctival erosions in a series of patients who underwent Ahmed valve implantation between October 2006 and July 2016 at the Kresge Eye Institute. We also evaluated the associations between conjunctival erosion and various demographic, clinical and surgical factors.

We found the overall erosion rate was 7.52% in our series, which is consistent with reported erosion rates in previous studies.^[3-9] However, compared to patients in other studies, our group of patients tended to develop conjunctival erosions sooner, with the majority developing erosions within one year of the surgical procedure.^[3-9,19] It is not clear why this was the case, but may it be unique to our patient group, which was 80% comprised of African-American patients. It may also be

due to the surgical techniques, including the choice of location of the patch graft placement.

Systemic conditions such as diabetes may lead to the ischemia of the conjunctiva and potentially lead to delayed healing of the conjunctiva, making it more prone to develop an erosion.^[20] Our study did not find diabetes to be a risk factor for conjunctival erosions. Similarly, several other studies have not found diabetes to be a risk factor for erosions.^[4,6,21,22] However, Chaku et al found significantly less number of diabetic patients in the exposure group in contrast to that in the control group, but diabetes was a significant risk factor only in univariate analysis.^[19] Huddleston et al found that diabetes is associated with a worse outcome after initial shunt exposure repair and a shorter time between repair and re-exposure.^[11] In addition, we did not find an increased risk of erosions with hypertension, which is consistent with findings from other studies.^[4,19,21,22]

Ocular conditions associated with inflammation or vascular compromise can be another risk factor contributing to conjunctival erosions. Chaku et al reported that inflammation before tube exposure is a significant risk factor for tube exposure.^[19] Koval et al found neovascular glaucoma to be a risk factor for erosion, whereas Levinson et al did not find the type of glaucoma to be a risk factor.^[8,22] In our study, we did not observe any statistically significant difference between the study groups with respect to the type of glaucoma in the bivariate analysis. However, the Cox proportional-hazard analysis revealed that uveitic glaucoma significantly increased the risk of conjunctival erosion in our study. This is not surprising given that prolonged ocular inflammation can lead to pathological changes in the conjunctival epithelium and in goblet cell density.^[23]

Previous and concomitant ocular surgical procedures have been reported as risk factors for erosions because they may cause thinning or scarring of the conjunctiva. Trubnik et al reported that undergoing a concomitant surgical procedure with the glaucoma drainage device implantation could significantly increase the risk of erosion.^[4] Their study found the frequency of concomitant surgery was 35.7% in the erosion group versus 17.4% in the non-erosion group ($P = 0.02$). Byun et al reported that the number of previous ocular surgical procedures was significantly associated with conjunctival erosions.^[21] In their study, they found that patients who had not undergone any ocular surgical procedure had an erosion rate of 4.5% in contrast to 30.3% in patients who had undergone more than one previous surgical procedure. In addition, Koval et al found that combined surgery and previous trabeculectomy were risk factors for conjunctival erosions.^[22] Our study did not find concomitant cataract extraction or vitrectomy to be a statistically significant risk factor for erosion. We also did not find that a history of previous glaucoma

laser treatment, incisional procedures, or other ocular surgical procedures to be statistically significant risk factors for conjunctival erosions. Likewise, Chaku et al did not detect any significant difference in the number of previous surgical procedures between the tube exposure and the matched control groups.^[19] Thus, the role that additional ocular surgery has on the rate of erosions is unclear.

Our study found that aphakia was significantly more common in the erosion group. In addition, the Cox proportional-hazard analysis revealed that aphakia was associated with an increased risk of conjunctival erosions. Chaku et al reported that lens status was not a risk factor for erosions.^[19] The proportion of PC7 valves implanted via the pars plana was higher in aphakic eyes in contrast to that in pseudophakic and phakic eyes. In those aphakic eyes that were observed to have conjunctival erosions, there were a higher proportion of patients with angle-closure and mixed-mechanism glaucoma that likely reflects more advanced ocular disease, and this may explain the higher rates of conjunctival erosions observed. In addition, we hypothesize that the genu plate on the PC7 model may exert additional mechanical forces beneath the conjunctiva that may play a role in mechanically induced erosions. However, the overall conjunctival erosion rate in PC7 models did not statistically differ from that in other models [Tables 1 and 2].

Levinson et al compared the pericardium, sclera, cornea, and "other" and found no significant difference in the erosion rate among these grafts.^[8] Smith et al compared the sclera, dura, and pericardium and found that no material was more prone to erosions.^[7] Tutoplast pericardium was the most commonly used cover material in our series. The erosion rate for Tutoplast was 7.08%, which is consistent with previously reported rates of 5-9%.^[4,5,8,24] Tutoplast can consist of the pericardium, dura, or sclera donor material. The material goes through a multi-step sterilization method that includes cleaning the tissue with saline solution; this process reduces the tissue to its fibers and mineral components via osmotic destruction of the cell to remove potential bacteria, viruses, and antigens bound to cell membranes.^[25] Thus, we believe that Tutoplast material may not provide the same mechanical coverage over the tube and plate as allografts from donor banks. However, there was no statistical difference among the different patch grafts used, and non-Tutoplast grafts comprised 23.6% of the patch covers used in the current series. In our study, there were three conjunctival erosions in the cornea graft group; this was an erosion rate of 10.34%, which was higher than that reported by Wigton et al (1.9%), Spierer et al (2.2%), and Ekici et al (1.8%).^[24,26-28] We used split-thickness donor cornea allografts from the eye bank. Review of patient records indicate that two of the three conjunctival erosions occurred over an area

that was not covered by the cornea allograft because the diameter of the graft was smaller than the length of the tube. In addition, alloderm, an acellular dermal matrix patch graft, has been shown to have a low frequency of conjunctival erosions, 3.45% ($n = 1$). This warrants further investigation of alloderm and its association with conjunctival erosion after the implantation of valves. We also had an experience with the scleral tunnel technique for covering the tube ($n = 10$). There was no erosion in the scleral tunnel group although the small sample size likely does not represent the true rate of erosions. This technique will likely play an important role in future drainage device implantation because the Center for Medicare and Medicaid Service has declined to provide reimbursements for scleral reinforcement using a graft procedure (Current Procedural Terminology code 67255) in ambulatory surgical centers. Ma et al reported no conjunctival erosions in their series of thirty-six patients who underwent a modified scleral tunnel technique to cover the tube after a mean follow-up of twenty-two months.^[29] We believe the modified scleral tunnel technique will become widely adopted for covering most Ahmed valve implantations. However, in cases who have undergone previous glaucoma surgery and those who have scleral thinning and/or conjunctiva thinning, the cover material will still play an important role in reducing conjunctival erosions.

Location of the implant can also be a risk factor for conjunctival erosions. Some studies have shown that inferior implants were more likely to erode than superior implants. It has been hypothesized that conjunctival erosions were more likely to occur in the inferior quadrant due to the shorter recess in the inferior fornix and the smaller area of the conjunctiva to cover in implant.^[30] Pakravan et al found that complications – such as implant exposure necessitating removal, cosmetically unappealing appearance, and endophthalmitis – were observed at a higher rate in inferior implants (25%) in contrast to that in superior implants (5.2%). In addition, Levinson et al reported a marginally significant higher rate of erosion in the inferior implants in comparison to that in superior implants.^[8] Our data showed a statistical trend towards increased rate of conjunctival erosions in inferior implants versus superior implants [Tables 1 and 2]. Thus, it is possible if our sample had a larger number of inferior implants, the inferior location would have been shown to be a risk factor for conjunctival erosions.

Topical steroid drops are commonly used after surgery, and have been shown to impair wound healing.^[31] Furthermore, Chaku et al found that a higher proportion of patients were using topical steroids at the time of conjunctival exposure in contrast to that in the non-erosion matched control group at the nearest time point after device implantation.^[19] In our series, we showed that the relative risk of developing erosions was significantly higher in patients who had

used post-operative steroids for a longer duration, and the relative risk may be dependent on the duration of topical steroid use as shown in Table 2. To the best of our knowledge, no study has found a causal relationship between duration of topical steroids use and conjunctival erosions. Our results are important as patients can be on chronic topical steroids post valve implantation, and physicians should consider tapering post-operative topical steroids when clinically indicated to avoid increasing the risk of conjunctival erosions.

There are limitations in our study due to its retrospective nature. There was a difference in the mean follow-up between the non-erosion and the erosion group. The study included patients from multiple surgeons; however, all surgeons used a similar technique for the implantation of the Ahmed valve. In summary, we found the overall erosion rate was 7.52% in our series. We also found aphakic lens status was significantly associated with conjunctival erosions in the bivariate and Cox-proportional hazard analyses. In addition, uveitic glaucoma and longer post-operative use of topical steroids were significantly associated with conjunctival erosions in the Cox-proportional hazard analyses. The type of patch graft used did not affect the observed conjunctival erosion rates. Graft-free Ahmed valve implantation through a scleral tunnel will likely be an alternative method to reduce the risk of conjunctival erosions. Nonetheless, in complex cases (revisions, sclera, and/or conjunctival thinning) that may preclude the use of the scleral tunnel technique, the cover material will be important in preventing conjunctival erosions. Further prospective studies are warranted to evaluate different factors – including various types of graft, intraoperative techniques, and topical medications – contributing to conjunctival erosion in order to decrease the rate of complications following tube implantation.

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Conflicts of Interest

There are no conflicts of interest.

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