

Outcomes and risk factors for failure of trabeculectomy with mitomycin C in children with traumatic glaucoma - A retrospective study

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Purpose: To determine surgical outcomes and risk factors for failure of trabeculectomy with mitomycin C (TMMC) in pediatric traumatic glaucoma. **Methods:** Children who underwent TMMC post trauma from January 2014 to December 2019 were reviewed. Demographic features, ocular findings, and surgery details were noted. Surgical success was defined as achieving intraocular pressure (IOP) within 6–21 mm Hg. **Results:** Seventy-one eyes of seventy patients underwent TMMC. The mean age of the patients was 11.28 ± 3.63 years with a male/female ratio of 13:1. The median time from trauma to IOP rise was 13 days. The majority of the patients ($n = 64$, 90.1%) had close globe injury. Baseline IOP was 39.3 ± 10.5 mm Hg. Results of the surgery were noted at the last visit. Cumulative success was noted in 51 (71.8%) eyes, while 20 (28.2%) eyes were labeled failures. Mean IOP reduced from 39.3 ± 10.5 to 14.5 ± 8.1 mm Hg. Mean visual acuity improved from 2.3 ± 0.93 to 1.19 ± 1.08 logMAR. Post surgery, the mean follow-up of the patients was 20.3 ± 11.4 months. Age <6 years (RR 3.6), elevated IOP at 1 month after TMMC (RR 2.19), and hypotony within a week of surgery (RR 1.81) were found as independent risk factors of surgical failure. **Conclusion:** TMMC is effective in reducing IOP in traumatic glaucoma. Young age and inability to control IOP within normal ranges in the immediate period after surgery are important risk factors of failure.

Key words: Mitomycin C, needling, pediatric glaucoma, trabeculectomy, traumatic glaucoma

Ocular trauma remains the most common cause of preventable monocular blindness across the world in all age groups.^[1,2] Corneal injuries, glaucoma, cataract, posterior segment, and optic nerve-related pathologies are commonly implicated for vision loss after injury.^[3] Glaucoma is often difficult to diagnose in younger children due to a lack of cooperation. The United States Eye Injury Registry noted 2.7% of glaucoma incidence after open globe injury (OGI).^[4] Several articles have shown a greater propensity to develop glaucoma after close globe injury (CGI), which can be as high as 20.6% in the pediatric population.^[5] Glaucoma is multifactorial in trauma cases. Damage to angle structures, peripheral anterior synechiae, lens-related factors, and intraocular hemorrhage are some of the important mechanisms postulated for the development of pediatric traumatic glaucoma.^[6]

Ozer *et al.*^[7] found hyphema, corneal injury, vitreous disturbance, and initial visual acuity <20/200 as risk factors requiring glaucoma surgery after trauma. However, factors predictive of favorable outcomes post filtration surgeries have not been elucidated in detail in children with traumatic glaucoma. Trauma significantly affects ocular anatomy; thus, results of trabeculectomy in other types of glaucoma cannot be extrapolated to this subgroup.

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Considering limited data regarding surgical outcomes in traumatic glaucoma in children, we retrospectively reviewed our database of children with traumatic glaucoma who underwent filtration surgery. The primary aim of the current study was to assess the outcomes of post-traumatic glaucoma in children who required trabeculectomy and secondarily, to analyze predictors of poor outcomes and final visual outcome post filtration surgery.

Methods

This was a single-center, retrospective, interventional, analytical study conducted at a tertiary eye care center in Central India. The study was conducted after getting clearance from the institutional review board and adhered to the tenets of the Declaration of Helsinki. Informed written consent was obtained from the parents of patients prior to all interventions.

The institutional database was searched to find patients who developed glaucoma secondary to blunt or penetrating trauma from January 2014 to December 2019. All consecutive patients of age less than 18 years who underwent trabeculectomy

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for uncontrolled intraocular pressure (IOP > 21 mm Hg) in traumatic glaucoma were included in the study. Patients who had undergone ocular surgery prior to a trauma episode that may have a risk for glaucoma, such as cataract/vitreoretinal surgery, were excluded from the study. Patients who got surgical treatment related to presenting trauma elsewhere were excluded. Patients having a follow-up of less than 1 year were excluded from the study.

Preoperative parameters included age, sex, object causing trauma, duration to consult at hospital post trauma (in days), and other relevant demographic characteristics. Injuries were classified according to the ocular trauma classification group.^[8] Detailed ocular examination was done and IOP was recorded using a Goldmann applanation tonometer or a Perkins tonometer (in uncooperative patients in supine position). IOP just prior to surgery with prescribed medications constituted the baseline value. Gonioscopy (single-mirror gonio lens, Ocular instrument, USA) was done in cooperative children with good corneal clarity. Uncooperative children were evaluated after mild sedation using syrup chloral hydrate (50 mg/kg single dose). Medical and surgical treatment given during the course of illness was documented.

It is often difficult to assess the visual field in children, particularly after trauma. Thus, we evaluated vertical optic disc cupping to detect the extent of the damage. Patients having ocular hypertension (>21 mm Hg) with optic nerve damage (inter eye difference of cup disc ratio > 0.2) were considered having traumatic glaucoma. B-scan was performed in cases having poor visualization and depression at optic nerve head in the presence of normal finding in the other eye was noted to confirm glaucoma.

Treatment and indications for filtration surgery

All the patients having ocular hypertension/glaucoma were initially given a trial of maximum tolerated anti-glaucoma medications (AGMs). Prostaglandin analogues were avoided in acute cases. Patients were also given topical steroids (prednisolone acetate 1% eyedrop/dexamethasone 0.1% eyedrop; dosage varied depending upon inflammation) during the acute phase of trauma. Patients with full chamber hyphema/corneal endothelial staining were advised gentle paracentesis and anterior chamber lavage. Eyes with hyphema and IOP of >30 mm Hg for 7 days or >50 for 5 days were also considered for anterior chamber (AC) wash. Failure to control IOP for 2 weeks after maximum AGMs ± AC wash in the presence of ongoing optic nerve damage (vertical cup: disc ratio > 0.2 than other eye) was the usual indication for filtration surgery.

Surgeries were performed by senior pediatric glaucoma surgeons having more than 15 years of surgical experience. Surgeries were performed under general/peribulbar anesthesia depending upon the cooperation level of the patient. All patients underwent fornix-based (triangular flap of 4 mm length with three interrupted sutures) trabeculectomy with mitomycin C (TMMC) for the control of IOP. MMC 0.04% was applied subconjunctivally for 2 min. Intravenous mannitol (1 g/kg) was given 30 min prior to surgery to reduce vitreous thrust and IOP as much as possible. The surgical procedures though performed in a standard usual manner required certain modifications as per the case. The surgical site was shifted temporally slightly if trauma affected the superior region adjacent to the

cornea (required only in two cases). Care was taken that such areas were still covered by the eyelid to prevent exposure and infection. Thorough anterior vitrectomy was done if necessary prior to making trabeculectomy opening. Depending upon associated comorbidity, cataract and vitreoretinal surgeries were also advised/performed.

Follow-up and management of IOP fluctuations

Postoperative treatment regimen included moxifloxacin (0.5%), prednisolone acetate (1%), and homatropine (2%) eyedrops; dosage and duration were modified in accordance with healing course and inflammation. To analyze IOP trends and surgical success outcomes, evaluations closest to postoperative days (POD) 1 and 7, at months 1, 3, and 6, and at 1 year and 6 months thereafter, were noted from the case sheets.

Management of postoperative hypotony (IOP <6 mm Hg) and elevated IOP is summarized in Figs. 1 and 2. Patients who presented with hypotony in the immediate postoperative period were assessed for leakage using the Seidel test. Positive test required resuturing of the conjunctiva (n = 1). If leakage was not found, steroids were reduced in frequency to encourage fibrosis, which in turn would increase resistance to aqueous outflow. Patients with chronic hypotony (more than 3 months) or with early signs of hypotony maculopathy were advised to undergo bleb revision/autologous blood infusion in the bleb.

Patients with high IOP were prescribed AGMs. The threshold to perform needling was lower, particularly when IOP was greater than 30 mm Hg. Gentle ocular massage through the lower lid was performed in patients with immediate IOP rise post needling. Failure of needling warranted repeat TMMC/glaucoma drainage device (GDD). AGM score was counted (1 score for each drug) prior to surgery and at the last follow-up visit.

Success criteria

Success of the surgery was calculated from the case sheet of the last follow-up visit. Patients were labeled having "complete success" when IOP was maintained between a pre-set upper limit of 21 mm Hg and a lower limit of 6 mm Hg.^[9] If AGMs were required to maintain IOP without further major surgical intervention, it was considered "qualified success." Both complete and qualified success were added to calculate the "cumulative success." Minor procedures such as bleb needling, bleb revision, and autologous blood infusion in the bleb were not considered failures. A need for repeat TMMC, GDD, or cyclophotocoagulation was considered as failure. Loss of vision attributable to glaucoma or from complications of filtration surgery was also considered as failure irrespective of IOP control.

The primary outcome measure was to note the success of TMMC to control IOP within specified limits at last follow-up (minimum 12 months). Secondary outcome measures were to find risk factors for failure of TMMC. These risk factors were 1) preoperative: age <6 years, male gender, poor visual acuity <4/200 logMAR, hyphema, AC reaction of grade 3/4, iris pathology (sphincter tear, posterior synechia, iridodialysis), cataract, vitreous hemorrhage, IOP rise after 6 months of trauma, baseline IOP >40 mm Hg, AR of >180°, zone 3 injury, open globe injury, prior surgical intervention other than TMMC; 2) postoperative: IOP <6 mm Hg at 1 week, IOP >21 mm Hg at POD 30, flat/cystic bleb.

Statistical analysis

Data were entered in Microsoft Excel 2013 (Microsoft Corporation). Microsoft Word was used to create tables and charts (Microsoft Corporation). Statistical analysis was performed using the data analysis tool pack of Microsoft Excel. Mean, median, and ranges with standard deviation were calculated for continuous variables. For categorical variables, frequency and percentages were calculated. T test was used to compare mean values between the first and last follow-up. Scatter graph was generated for IOP at baseline and at last visit.

Kaplan–Meier survival curves were created to graphically demonstrate success over the study period. Bivariate regression analysis was performed for more than 20 parameters to find risk factors of failure of TMMC. Those factors with $P < 0.20$ were also evaluated with multivariate logistic regression. $P < 0.05$ was considered statistically significant.

Results

In total, 197 patients were identified as having traumatic glaucoma during the study period; 94/197 patients (47.7%) underwent TMMC, of which 71 eyes of 70 patients had a follow-up of >1 year and were included in the analysis. IOP was maintained within the normal range in 28 (39.4%) eyes without any further medical/surgical intervention. Hypotony and elevated IOP were noted in 17 (23.9%) and 26 (36.6%) eyes, respectively. Table 1 shows the baseline and demographic characteristics of the cohort. Mean age of the patients was 11.2 years, with a significant male predilection (93%). Glaucoma was seen early and mostly after CGI.

Trauma most commonly occurred due to wooden objects in 32 (46%) eyes. Gonioscopy could be performed in 49 eyes and

showed angle recession (AR) in 38 (77.5%) eyes; 31/49 (63%) eyes had more than 180° AR.

Mean number of surgical interventions was 2.21/eye (range: 1–6). Apart from TMMC, AC wash for hyphema and cataract surgeries were performed in 7 (9.8%) and 34 (47.8%) eyes, respectively. Mean duration between AC wash and TMMC was 14.7 days. GDD was not required in any case. Post surgery, the mean follow-up of the patients was 20.3 ± 11.4 months. Complete success was observed in 40 (56.3%) cases. Qualified success was obtained in 11 (15.5%) eyes, while 20 (28.2%) eyes were labeled failures. In OGI, cumulative success was achieved in 5/7 (71%) cases. Statistically significant improvements were noted in mean IOP, BCVA, and AGM score ($P < 0.00001$) at last visit compared to the first presentation [Table 2]. At final visit, 23 (32%) patients had BCVA between 20/50 and 20/100. Seventeen (24%) patients improved to achieve BCVA better than 20/40.

Table 3 compiles the extensive list of parameters evaluated for plausible association with failure of TMMC. This table also shows associated ocular pathologies at the time of presentation. Age < 6 years (RR 3.6), elevated IOP at 1 month after TMMC (RR 2.19), and hypotony within a week of surgery (RR 1.81) were found as independent risk factors associated with failure.

IOP trends during the follow-up are shown in Fig. 3. Mean IOP remained relatively stable in the complete success category. Steep rise in IOP was noted at 1-month post-TMMC follow-up in the qualified success group, which was controlled with AGM/minor interventions. Mean IOP was quite low (5.8 mm Hg) at 1 week in patients who eventually failed due to low IOP. Scatter graph in Fig. 4 shows no improvement or worsening in three (4.2%) cases despite treatment, while another four (5.6%) cases had IOP reduced from baseline but still more than 21 mm Hg. Six (8.4%) cases had hypotony at last visit.

The Kaplan–Meier curve is shown in Fig. 5. Cumulative success was 95.7% at 1 month, 90.1% at 3 months, and 83.1% at 12 months follow-up. Success gradually reduced to 71.8% at last visit.

Needling was successful in five (35.7%) of 14 cases with or without AGM. Repeat TMMC was performed in six cases. AGM was still required in five of those cases to control IOP. In total, 19 (26.7%) complications were observed: wipeout syndrome in one, toxic anterior segment syndrome in one, full chamber hypohemia in one, bleb leak in one, hypotony maculopathy in four, decompression retinopathy in five, choroidal effusion in two, endophthalmitis in two, phthisis in one, and combined retinal detachment (RD) and choroidal detachment (CD) in one.

Discussion

Trauma is a common cause of secondary glaucoma in the pediatric population.^[6,10] Despite its considerable incidence, relevant studies are limited in the literature regarding the management. In this study, we described the outcomes of trabeculectomy with MMC in pediatric traumatic glaucoma. TMMC was most commonly required in CGI (64, 90.1%) cases as glaucoma was more common after blunt trauma. Cumulative success was achieved in 71.8% of cases after a mean follow-up of 20.3 months. Complications were noted in almost one out of four cases post surgery, indicating eventful follow-up

Table 1: Baseline demographic and general characteristics of the patients

Parameter	Value
Total patients and eyes affected	71 eyes of 70 patients
Laterality, <i>n</i> (%)	
Unilateral	69 (98.6)
Bilateral	1 (1.4)
Gender, <i>n</i> (%)	
Male	65 (93)
Female	5 (7)
Mean \pm SD (range), Age in years	11.28 \pm 3.63 (1-18)
Median time from trauma to consultation	11 days
Range	6 hours-365 days
Median time from trauma to IOP rise	13 days
Range	1 day-7 years
Onset of glaucoma post trauma, <i>n</i> (%)	
Early (within 4 weeks)	49 (69)
Intermediate (>4 weeks to 24 weeks)	14 (19.7)
Late (>24 weeks)	8 (11.3)
Type of injury, <i>n</i> (%)	
Open globe injury	7 (9.9)
Close globe injury	64 (90.1)
Zone of injury, <i>n</i> (%)	
1	9 (12.7)
2	25 (35.2)
3	37 (52.1)
Mean \pm SD (range), Follow-up in months	20.3 \pm 11.4 (12-62)

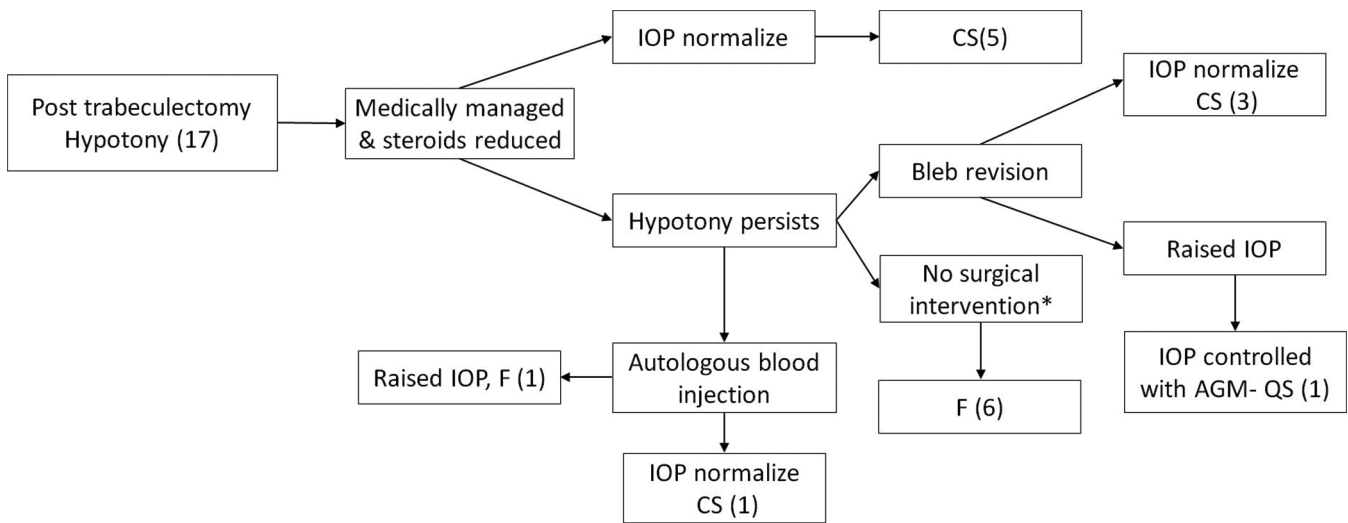


Figure 1: Flow chart depicting management of hypotony post trabeculectomy. IOP- intraocular pressure, AGM- antiglaucoma medication, CS- complete success, QS- qualified success, F- failure. *- No surgical intervention due to various reasons. One- phthisis, four unwilling due to very poor vision ranging PL/NPL, and one had recent onset without affecting vision

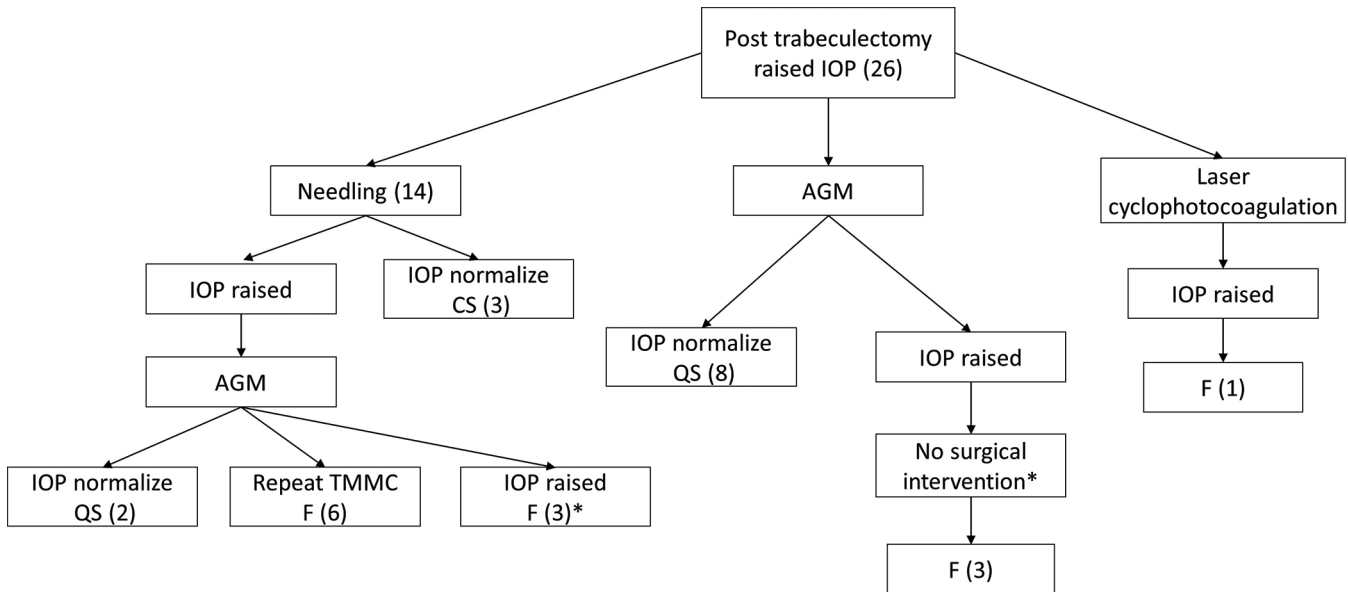


Figure 2: Flow chart for management of raised IOP post trabeculectomy. IOP- intraocular pressure, AGM- antiglaucoma medication, TMMC- trabeculectomy with mitomycin C, CS- complete success, QS- qualified success, F- failure. *-Needling/trabeculectomy was advised, but patients were either unwilling or lost to follow-up

courses. Despite this, a BCVA of 20/100 or better was achieved in 40 (56.3%) eyes.

Risk factors for development of glaucoma have been extensively studied in the past. AR of more than 180°, significant injury to iris, displacement of lens, hyphema, and higher baseline IOP are reported to be important risk factors for post-traumatic glaucoma.^[11-13] Although we did not assess these risk factors, many of these factors were noted in our cohort as well. AR > 180° was seen in 63% of cases. Hyphema, iris-related pathology, and traumatic cataracts were noted in 28 (39.4%), 35 (49%), and 43 (60.6%) eyes, respectively.

Glaucoma was noted very early in our series with a median time of only 13 days after trauma. Late glaucoma was noted

in 8 (11.3%) eyes. Three of seven (43%) eyes with OGI had delayed onset of glaucoma. Similar to our study, Kaur *et al.*^[16] reported early presentation of glaucoma after a mean duration of 1.67 weeks (12 days) in their series of pediatric traumatic glaucoma. Contrary to these results, many adult studies noted delayed onset of glaucoma ranging from 3 years to 16.5 years.^[14-16] It has been noted that the acute elevation of IOP after CGI, which lasts for a few days to weeks, can be controlled with AGMs alone in adults.^[16] However, the same was not reflected in our series. Almost half of our patients (47.7%) needed surgery for IOP control. This finding to some extent may be attributed to the fact that our hospital is a tertiary referral care center and predominantly receives more severe cases, which could not be managed with medical treatment

Table 2: Comparison of parameters: Baseline versus last follow-up

	Baseline	Last follow up	P
BCVA* Mean±SD (range)	2.3±0.93 (0-3.2)	1.19±1.08 (0-3.2)	<0.00001
Grade of visual acuity, n (%)			
≥ 20/40	3 (4.2)	17 (23.9)	<0.00001
20/50-20/100	6 (8.4)	23 (32.4)	
19/100-5/200	3 (4.2)	2 (2.8)	
4/200-LP	53 (74.6)	24 (33.8)	
No LP	2 (2.8)	4 (5.6)	
Undetermined	4 (5.6)	1 (1.4)	
IOP (mm Hg) Mean±SD (range)	39.3±10.5 (23-62)	14.5±8.1 (0-48)	<0.00001
Optic disc cupping Mean±SD (range)	0.52±0.23 (0.2-0.95)	0.49±0.22 (0.2-0.95)	0.44
AGM score Mean±SD (range)	2.6±0.56 (0-3)	0.52±0.93 (0-3)	<0.00001

BCVA - Best corrected visual acuity in logMAR, IOP - intraocular pressure, AGM - antiglaucoma medication, LP - light perception. *BCVA could be evaluated in 67 and 70 cases at baseline and last follow-up, respectively

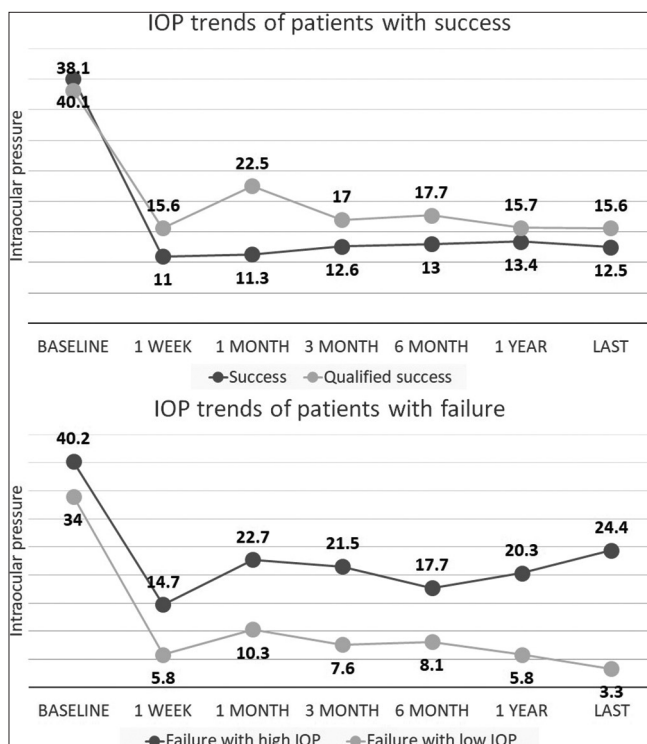


Figure 3: Intraocular pressure trends till last follow-up

alone elsewhere. This also explains higher baseline IOP, higher rate of TMMC, and poor efficacy of AGM in our cohort. It is important to note that such pediatric traumatic glaucoma cannot be directly compared to adult glaucoma regarding pathogenesis and IOP control. It is possible that some of our pediatric cases might have achieved normal IOP eventually with long-term medical management alone. However, mean IOP prior to TMMC in our cases was almost 40 mm Hg despite using possible maximum AGMs. It is clear that such high IOP would have led to permanent vision loss and even total blindness if surgical intervention was avoided in the hope for late resolution.

Few studies have evaluated the outcomes of trabeculectomy in children with traumatic glaucoma. In a study by Kaur *et al.*,^[6] out of 60 patients with ocular hypertension, only six

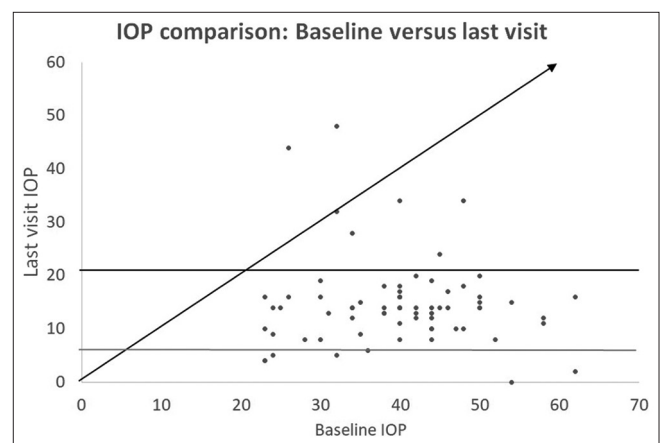


Figure 4: Scatter graph for intraocular pressure, baseline, and last follow-up

cases (10%) required glaucoma filtration surgery. Overall, a good IOP control was noted in 91.7% cases. However, details regarding surgery, complications, and visual outcomes were not discussed. Similarly, in a retrospective study by Kalamkar *et al.*^[5] on traumatic glaucoma in the pediatric age group, only 4 eyes out of 32 with ocular hypertension following trauma required trabeculectomy with MMC for control of IOP. Due to the limited number of eyes requiring trabeculectomy, it is difficult to study the outcomes of trabeculectomy from these two series.

Because of the paucity of data in the pediatric age group, we compared our results with adult studies. Mermoud *et al.*^[17] did a comparative study regarding the role of trabeculectomy in traumatic versus primary open-angle glaucoma cases. They achieved success in only 43% (15/35) cases after angle recession glaucoma. MMC was not used and bleb fibrosis was a major finding in failed cases. This study laid the foundation and recommended the use of antifibrotic agents in all cases with angle recession glaucoma. Mermoud *et al.*^[14] in another study investigated the role of trabeculectomy (47 procedures), Molteno single-plate implantation (20 procedures), and trabeculectomy combined with antimetabolite (20 procedures) in traumatic glaucoma. Success rate was better and the need for AGM was lower when antimetabolites were used. Trabeculectomy in their study had a success rate of almost 80%.

Table 3: Risk factors for failure of trabeculectomy

Risk factor	n (%)	Failure, n (%)	Relative risk	CI 95%	P	
					Bivariate	Multivariate
Age <6 years	6 (8.4)	5 (83)	3.6	2.04-6.38	<0.001	0.0001
Gender: male	65 (91.5)	19 (29)	1.43	0.23-8.65	0.69	-
Poor BCVA at presentation*	55 (77.5)	18 (33)	2.61	0.67-10.10	0.16	0.22
Hyphema	28 (39.4)	9 (32)	1.25	0.59-2.63	0.54	-
AC reaction: grade 3,4	16 (22.5)	5 (31)	1.14	0.49-2.66	0.75	-
Iris pathology**	31 (43.6)	12 (39)	1.93	0.90-4.14	0.08	0.12
Cataract	43 (60.6)	11 (26)	0.79	0.37-1.67	0.54	-
Vitreous hemorrhage	16 (22.5)	5 (31)	1.2	0.36-4.07	0.75	-
Delayed IOP rise (after 6 months of trauma)	8 (11.3)	4 (50)	1.96	0.87-4.43	0.10	0.16
Baseline IOP of >40 mm Hg	42 (59.1)	10 (24)	0.69	0.33-1.44	0.32	-
AR >180°#	31 (63)	7 (19)	0.62	0.28-1.36	0.23	-
Complete AR- 360°#	9 (18.3)	2 (22)	0.76	0.21-2.76	0.68	-
Zone 3	37 (52.1)	12 (32)	1.37	0.64-2.95	0.41	-
IOP of <6 mm Hg at POD-7	11 (15.5)	5 (45)	1.81	0.83-3.97	0.13	0.009
IOP of >21 mm at POD-30	14 (19.7)	7 (50)	2.19	1.07-4.45	0.03	0.01
Other surgery prior to TMMC	27 (38)	9 (33)	1.33	0.63-2.79	0.44	-
Open globe injury	7 (9.8)	2 (29)	1.01	0.29-3.49	0.98	-
Flat/cystic bleb	36 (50.7)	11 (31)	1.18	0.56-2.51	0.65	-

BCVA - best-corrected visual acuity, AC - anterior chamber, IOP - intraocular pressure, AR - angle recession, POD - postoperative day, TMMC - trabeculectomy with mitomycin C. *Vision <4/200 logMAR, **includes sphincter tear, posterior synechiae, Iridodialysis. #Gonioscopy could be performed in 49 eyes; percentages calculated from 49 eyes

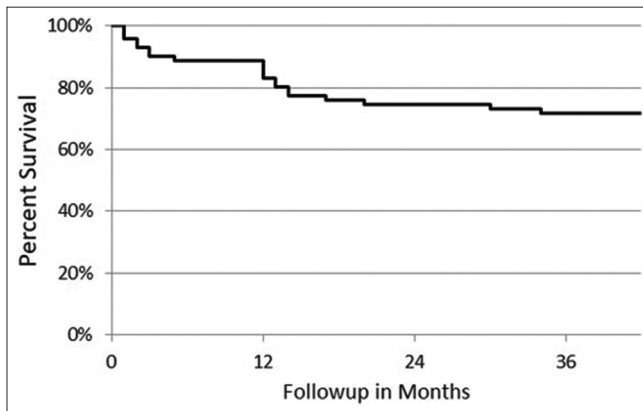


Figure 5: Kaplan–Meier curve showing the cumulative success of surgery

Manners *et al.*^[16] did TMMC in 43 cases of AR glaucoma. They achieved complete and qualified success in 77% and 85% cases, respectively, after 1 year. Success was reduced to 66% after 3 years. Although complete success was lower (56.3%) in our series, the cumulative success was 83%, which is comparable to that achieved by Manners *et al.*^[16]

Fibrosis in the peribleb area is a major cause of failure of trabeculectomy.^[17] Needling helps in severing fibrosed tissue and restores the aqueous flow. This minimally invasive technique helps in avoiding further major surgeries such as repeat trabeculectomy or GDD.^[18-20] We noted good IOP control in five out of 14 (35.7%) eyes that underwent needling in our series.

On analysis of multiple factors that can potentially affect the surgical outcomes, we found age <6 years and elevated

IOP at 1-month post trabeculectomy to be significantly associated with long-term failure of trabeculectomy. We also noted that hypotony at 1 week was associated with long-term failure due to low IOP. Our findings suggest a very narrow therapeutic index of surgery for long-term safety and efficacy. Not surprisingly, the factor with the strongest association with failure was younger age. Younger age is an established risk factor for failure of filtration surgery;^[21-23] it also explains the lower success rate of trabeculectomy in our series as compared to the adults. Type and zone of injury, other associated ocular pathologies, and bleb morphology were not associated with failure.

Mermoud *et al.*^[17] noted AR as an important risk factor for failure of trabeculectomy. In contrast, in our study, we did not find AR to be associated with an increased risk of failure. There could be a couple of reasons for this difference. One is that they compared the results of trabeculectomy in trauma cases with that in primary open-angle glaucoma, while we exclusively studied eyes with trauma. The second reason could be that we used MMC in all our cases, which might have helped in achieving better success in patients with AR.

Several complications (n = 19, 26.7%) were noted during the course of treatment. Important vision-threatening complications included two cases of endophthalmitis. Fortunately, endophthalmitis resolved with intravitreal antibiotics alone without any visual/structural damage. One patient having combined CD and RD lost vision completely. Another patient also lost vision due to the wipeout phenomenon. The patient had vision of light perception with a high IOP of 60 mm Hg and presented after 45 days of trauma. The patient had near-total cupping and advanced

glaucomatous damage was responsible for poor vision. After surgery, the patient lost the light perception also which could be attributed to "wipeout" or "snuff syndrome." The possible risk factors were high preoperative IOP and advanced glaucomatous damage for such rare phenomenon. Other notable complications included decompression retinopathy (5), hypotony maculopathy (4), and choroidal effusion (2), which were transient and did not influence the final visual outcome. These complications were noted within 1 month of surgery. Manners *et al.*^[16] noted hypotony in 4/43 (9.3%) cases, but only 1 case developed hypotony maculopathy; while Mermoud *et al.*^[17] did not come across maculopathy or decompression retinopathy in their study. Hypotony maculopathy occurs due to sudden scleral wall collapse causing redundancy in the retina and choroid.^[24] Decompression retinopathy also occurs due to the sudden lowering of IOP. Bansal *et al.*^[25] noted that preoperative IOP rise over a short period of time may be an important risk factor for its development. The majority of our cases also had an acute elevation of IOP and early onset of glaucoma. Moreover, AGMs were not able to control IOP preoperatively coupled with low scleral rigidity in pediatric cases. All these factors in toto could be held responsible for the high incidence of such complications noted in our series.

Talking about limitations, retrospective design is the first. We conceptualized our study to evaluate the role of TMMC in traumatic glaucoma. Thus, we could not analyze the risk factors for the development of glaucoma. Gonioscopy findings could not be recorded in all cases. We did not analyze factors influencing final visual outcomes. We could not analyze the role of glaucoma drainage devices. Open globe injury cases were also disproportionately less.

Conclusion

To conclude, this is one of the largest studies conducted in the pediatric population analyzing the outcomes of filtration surgery in the traumatic glaucoma subtype. Glaucoma may develop many years after trauma, which signifies the importance of long-term or even better, lifelong follow-up in such cases. Antiglaucoma medications are less likely to control acute IOP surge post trauma, as noted in our study. Good surgical outcomes can be expected by using mitomycin C. Younger age, coupled with hypotony and elevated IOP in the immediate postoperative period are risk factors for surgical failure. Repeat trabeculectomy can also be planned in failure cases, as is evident from our study.

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Conflicts of interest

There are no conflicts of interest.

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