Mitomycin-C Trabeculectomy versus Ahmed Glaucoma Implant in Pediatric Aphakic Glaucoma

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Purpose: To compare the outcomes and complications of mitomycin-C trabeculectomy (MMC-T) versus the Ahmed glaucoma implant (AGI) for treatment of pediatric aphakic glaucoma.

Methods: In a randomized clinical trial, 30 eyes of 28 children <16 years of age who had undergone anterior lensectomy-vitrectomy for congenital cataract were assigned to MMC-T (15 eyes of 13 children) or AGI (15 eyes of 15 children). Surgical success was classified as complete (IOP 6-21 mmHg without any antiglaucoma medication) and partial (IOP 6-21 mmHg with ≤2 topical antiglaucoma agents) in the absence of any sight-threatening complication or need for further glaucoma surgery, stable cup/disc ratios and visual loss ≤2 Snellen lines. Overall success was defined as the sum of complete and partial success.

Results: Mean patient age was 9.1±4.1 and 10.9±5.1 years in the MMC-T and AGI groups, respectively (P=0.29). After a mean follow up of 14.8±11 and 13.1±9.7 months; complete, partial and overall success rates were 33.3%, 40% and 73.3% in the MMC-T vs 20%, 66.7% and 86.7% in the AGI groups, respectively (P= 0.361). Complication and failure rates were 40% and 26.7% in the MMC-T group vs 26.7% and 13.3% in the AGI group, respectively (P= 0.439).

Conclusion: MMC-T and AGI seem to be comparable in terms of success and complications as the initial surgical procedure in pediatric aphakic glaucoma. Choice of either technique depends on surgeon's experience and conjunctival quality and mobility.

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INTRODUCTION

Aphakic glaucoma is a major complication following congenital cataract surgery with rates ranging from zero to 41% based on different reports with variable follow up periods.[1-6] This complication is initially managed using intraocular pressure (IOP) lowering agents; surgical intervention is usually reserved for cases unresponsive or intolerant to medical therapy.[7]

There is no consensus on the optimal surgical approach to pediatric aphakic glaucoma; the two commonly used surgical methods are trabeculectomy and glaucoma drainage implants. Trabeculectomy was introduced in 1967 for the first time and continues to be performed

by approximately the same technique nowadays, except for the adjunctive use of mitomycin C (MMC) intraoperatively as an antifibrotic agent.[7] MMC was initially used to improve the success rate of trabeculectomy in 1983,[8] but has received widespread acceptance since 1991.[9] The Ahmed glaucoma implant (AGI) was approved by the FDA in 1993 and has been a widely used drainage device during recent years. It was first limited to cases of failed trabeculectomy or other forms of glaucoma surgery, however it has gradually become accepted as first line of treatment in certain types of glaucoma such as aphakic glaucoma.[10]

The aim of this study was to compare MMC trabeculectomy (MMC-T) with AGI as the initial surgical procedure for medically uncontrolled aphakic glaucoma following congenital cataract extraction in pediatric patients.

METHODS

From April 2003 to April 2005, children less than 16 years of age who were referred to Labbafinejad Medical Center for aphakic glaucoma were evaluated for eligibility. All patients had previously undergone anterior lensectomy-vitrectomy and primary posterior capsulotomy for congenital cataracts. Eyes with glaucoma refractory to medical therapy (at least two topical antiglaucoma medications) were enrolled. Exclusion criteria included eyes with cataracts secondary to persistent hyperplastic primary vitreous or intrauterine infections, and any previous ocular surgery other than anterior lensectomy-vitrectomy.

After obtaining informed consent from the guardians, eligible eyes were randomly assigned to MMC-T or AGI. All glaucoma operations were performed by attending physicians of the Glaucoma Service. Patients were followed for at least six months postoperatively except for failed cases who could have had shorter follow up periods. Postoperatively, all eyes were treated with topical antibiotics for 5-7 days and 1% betamethasone eye drops every 4 hours which was tapered and discontinued over 4-6 weeks. Postoperative follow up visits were scheduled on days 1, 2, 3, 7, 14, and 30, monthly up to three months and every 3 months thereafter. Examinations were performed under general anesthesia when needed. Additional medications such as systemic steroids and cycloplegic agents were used in eyes with excessive postoperative inflammation or flat anterior chambers (AC).

Visual acuity was determined using standard E charts or by fixation patterns in nonverbal children. Snellen visual acuity was converted to logarithm of minimum angle of resolution (LogMAR) for statistical analysis. IOP was measured using the Goldmann applanation tonometer (Haag-Streit, Bern, Switzerland) or the Tonopen (Medtronic, USA).

Outcomes of surgery were classified to complete success (final IOP 6-21 mmHg without antiglaucoma medication) or partial success (IOP 6-21 mmHg with a maximum of two topical antiglaucoma agents) provided that there was no need for further glaucoma surgery, no sight-threatening complication, no increase in cup-disc ratio and no visual loss greater than two Snellen lines. Otherwise, the procedure was considered failed. The sum of complete and partial success was defined as total success. Data was analyzed using unpaired and paired *t* tests to compare mean values between and within groups, respectively and Chi square test to compare frequency values with significance level set at 0.05.

Surgical Technique

MMC-T

A limbus based peritomy was made 8 mm posterior to the limbus and the sclera was shaved and lightly cauterized with low power bipolar cautery. MMC (0.2 mg/ml) was applied to the sclera and the opposing conjunctival surface for 2 minutes using soaked cellulose sponges. After irrigation with 50 ml of normal saline solution, a triangular half-thickness scleral flap with 3 mm edges was created and a trabeculectomy block measuring 1×1 mm was

excised followed by peripheral iridectomy. The scleral flap was stabilized by two permanent and one releasable sutures using 10-0 nylon. After assuring sufficient leakage from the site of trabeculectomy, the conjunctiva and Tenon were sutured using a single running mattress suture with 10-0 nylon. The releasable suture was released after 72 hours depending on bleb morphology and vascularity and level of IOP. In eyes with optimal bleb and IOP, the releasable suture was retained for 3 months.

AGI

A conjunctival incision was made 4 mm posterior to the limbus in the superotemporal quadrant. After dissecting conjunctiva and Tenon, MMC (0.2 mg/ml) was applied to the adjacent surfaces of the sclera and conjunctiva using a soaked sponge for 2 minutes which was then irrigated by 50 ml of normal saline solution. The plate of the AGI was fixed to the sclera 8 mm posterior to the limbus with two 7-0 silk sutures. A half-thickness scleral flap was created approximately 2 mm posterior to the limbus at the site of insertion of the tube which was trimmed and inserted parallel to the iris plane 1-2 mm into the AC. A donor scleral patch was placed over the tube and sutured to the sclera with 10-0 nylon. Finally conjunctiva and Tenon were approximated using a running 10-0 nylon suture.

RESULTS

This randomized clinical trial included a total of 30 eyes of 28 patients including 15 eyes of 13 children (six male and seven female) with mean age of 9.1±4.1 (range 2-16) years in the MMC-T group and 15 eyes of 15 children (12 male and three female) with mean age of 10.9±5.1 (range 1.5-16) years in the AGI group. Mean age at the time of lensectomy was 4.6±2.5 months in the MMC-T group vs 4.4±2.8 months in the AGI group. The two groups were not different regarding age at the time of lensectomy and age at enrollment into the trial. Mean follow up period was 14.8±11.0 months in the MMC-T group and 13.1±9.7 months in the AGI group with a range of 6-36 months in both groups.

Table 1 summarizes final outcomes of surgery in the study groups. Although complete success and failure rates were higher in the MMC-T group, intergroup differences were not statistically significant for any comparison. All cases of failure in the MMC-T group were due to a nonfunctional bleb which occurred after a mean period of six months postoperatively. Failure in the AGI group was due to massive suprachoroidal hemorrhage which occurred within two weeks after surgery.

Table 1 Distribution of eyes based on the results of surgery in both groups

Results	No. (%)	
	MMC-T	AGI
Complete success	5 (33.03)	3 (20.0)
Partial success	6 (40.0)	10 (66.7)
Total success	11 (73.3)	13(86.7)
Failure	4 (26.7)	2 (13.3)
Total	15 (100)	15 (100)

MMC-T, mitomycin C trabeculectomy; AGI, Ahmed glaucoma implant

• P=0.338, Chi square test

Pre- and postoperative IOP of the patients are presented in table 2. No significant difference existed between the two groups regarding pre- and postoperative IOP, however IOP decreased significantly in both groups at final follow up.

Table 2 Pre- and postoperative intraocular pressure

	Me ± SD (mm Hg)		P value
	Preoperative	Final	(Paired t-test)
MMC-T group	30.9±10.7	14.7±3.9	0.001
AGI group	31.1±7.6	16.6±6.4	0.002
P value (t-test)	0. 97	0.45	

M,mean; SD, standard deviation; MMC-T, mitomycin C trabeculectomy; AGI, Ahmed glaucoma implant

Eyes with complete or partial success had a mean IOP of 31.0±10.7 and 31.0±7.5 mmHg preoperatively which decreased significantly to

14.7±4.0 and 16.0±6.4 mmHg at final follow up in the MMC-T and AGI groups, respectively; however the differences between two groups were not significant pre- or postoperatively. Overall, the number of antiglaucoma medications decreased from 3.2±0.5 preoperatively to 1.3±1.4 postoperatively (P<0.001). Mean pre- and postoperative number of antiglaucoma medications in the partial success subgroups were 3.0±0.6 and 1.6±0.5 (P= 0.1) in the MMC-T group versus 3.3±0.5 and 1.6±0.5 (P=0.03) in the AGI group, respectively. Mean pre- and postoperative best-corrected visual acuity (BCVA) were 0.84±0.54 and 0.73±0.56 LogMAR in the MMC-T group versus 0.74±0.31 and 0.77±0.5 LogMAR in the AGI group, respectively. There were no statistically significant differences between and within the two groups in terms of BCVA, pre- and postoperatively.

Complications occurred in six eyes (40%) in the MMC-T group and in four eyes (26.7%) in the AGI group (P=0.439). Table 3 summarizes the types of complications and their management together with the final outcome.

Table 3 Complications, managements and outcomes

Complications	No. (%)	Management and outcome
MMC-T group (15 eyes)		
Choroidal effusion	4 (26.7)	Choroidal tap leading to recovery
Vitreous hemorrhage	1 (6.7)	No management, spontaneous recovery
Endophthalmitis	1 (6.7)	Intravitreal and topical antibiotics resulting in recovery
AGI group (15 eyes)		
Choroidal effusion	2 (13.3)	Choroidal tap leading to recovery
Suprachoroidal hemorrhage	2 (13.3)	Choroidal tap+ PPDV+ shunt removal in one case which resulted in resolution and IOP control; and twice choroidal tap in another case with no recovery.

MMC-T, mitomycin-C trabeculectomy; AGI, Ahmed glaucoma value, PPDV, pars plana deep vitrectomy; IOP, intraocular pressure

DISCUSSION

The success rates of glaucoma surgery for pediatric glaucoma vary widely and have been reported from 52 to 95% for trabeculectomy[11-17] and from 44 to 95% for aqueous drainage implants.[18-26] Coleman et al[18] reported success rates of 78% at one year and 61% at two years for AGI in pediatric aphakic glaucoma. Corresponding figures were 70% and 63% in the report by Djodeyre et al.[26] Blanco et al[27] reported success rates of 88% and 33% for MMC-T in phakic and aphakic pediatric glaucoma respectively. Corresponding figures reported by Freedman et al[13] were 64% and 29% besides an overall success rate of 52.4% (73% in children older than one year and 30% in infants aged less than one year). One study compared shunt procedures with trabeculectomy for management of pediatric glaucoma in children less than two years of age and reported cumulative success probability of 87±5% vs 36±8% after one year and 53±12% vs 19±7% after six years, respectively.[28]

Although the above-mentioned studies deal with pediatric glaucoma, they are heterogenous in terms of inclusion criteria, underlying cause of glaucoma, previous glaucoma procedures, definition of success and follow up duration. To the best of our knowledge, the present study is the first to compare MMC-T and AGI as the primary procedure in pediatric aphakic glaucoma confined to eyes with congenital cataracts. Total success rates were 73.3% in the MMC-T group vs 86.9% in the AGI group (P=0.338). These figures are difficult to compare to other studies. The small difference in success rates observed with these two surgical procedures may be due to case selection in this study which was confined to pediatric aphakic

glaucoma following congenital cataract surgery which is in contrast to other studies which included pediatric glaucoma of various causes.

In the current study, a significant proportion of eyes in the AGI group required anti-glaucoma medications (66.7% were categorized under partial success) which is similar to other reports.[10,18,20] Mean IOP reduction was 16 mmHg in the MMC-T group vs 14 mmHg in the AGI group. Corresponding figures were 18 mmHg reported by Kirwan et al[29] for AGI and 9 vs 12 mmHg in the trabeculectomy versus shunt groups as published by Beck et al.[28]

Mean BCVA did not change significantly in any of our groups postoperatively. This may be due to presence of amblyopia in the majority of these patients. Blanco et al[27] reported visual loss in one out of 21 cases in their study. One of the most important causes of postoperative visual loss is the occurrence of sight-threatening complications.

In a retrospective review of 19 children with pediatric aphakic glaucoma who underwent AGI by Kirwan et al[29], complications occurred in 32% including choroidal detachment, corneal touch, hypotony and tube dislocation. Blanco et al[27] performed trabeculectomy on 21 eyes of children aged less than 17 years and encountered postoperative complications in 4 eyes including choroidal effusion, retinal detachment, encapsulated bleb and hypotony. Beck et al[28] compared trabeculectomy with shunt devices in two groups of 46 eyes with pediatric glaucoma. Complications occurred in 31 eyes in the AGI group including corneal touch (21 eyes), cataract (5 eyes), corneal decompensation (4 eyes), vitreous hemorrhage (3 eyes), shallow AC (3 eyes), implant exposure (2 eyes), wound leakage and fibrous ingrowth (each in 1 eye) vs 17 eyes in the trabeculectomy group including choroidal effusion (4 eyes), shallow AC and delayed bleb leakage (each in 3 eyes), delayed onset ophthalmitis, cataract and corneal decompensation (each in 2 eyes) and chronic hypotony (one eye). Reoperations were required in 21 of 31 eyes in the AGI group and 3 of 17 eyes in the trabeculectomy group.

Although the rate of certain complications such as corneal touch is decreasing due to the increasing experience of glaucoma surgeons, postoperative hypotony remains the most important and common short term complication of shunt devices. This complication is less common with the AGI compared to other shunts.[29] We encountered hypotony in four eyes which resulted in failure of the AGI procedure in two cases but two other cases achieved successful outcomes with choroidal tap. Kirwan et al[29] recommended injection of SF_6 gas into the AC at the end of AGI surgery to prevent postoperative hypotony. They believed that this gas remains in the eye for 72 hours, allowing adequate time for aqueous production and IOP elevation.

Although MMC improves the success rate of trabeculectomy, it incurs potential complications such as wound leakage, delayed onset postoperative endophthalmitis and hypotony. The rate of postoperative endophthalmitis has been reported from 7 to 14% in different studies.[12,13,26,30-33] In our study, complications occurred in six eyes in the MMC-T group including choroidal effusion in four eyes and endophthalmitis and vitreous hemorrhage, each in one eye. Cases of choroidal effusion improved after choroidal tap. The eye with endophthalmitis was treated successfully using intravitreal and topical antibiotics and the vitreous hemorrhage resolved spontaneously. The differences between the MMC-T and AGI group in term of postoperative complications were not statistically significant in our study, which can be due to small sample size; however the differences seem clinically significant regarding type and nature.

Pediatric aphakic glaucoma is an uncommon condition and our narrow inclusion criteria allowed enrollment of a homogenous sample of 30 eyes in three years. Based on the results of this study, both MMC-T and AGI have acceptable success rates in the management of pediatric aphakic glaucoma. The choice of surgical technique depends on surgeon's experience and conjunctival motility.

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