Trabeculectomy and phacotrabeculectomy, with mitomycin-C, show similar two-year target IOP outcomes

Sanjay K. Murthy,* MD; Karim F. Damji,† MD, FRCSC; Yi Pan,† BSc, MSc; William G. Hodge,† MD, FRCSC

ABSTRACT • RÉSUMÉ

Background: To determine the efficacy and safety of trabeculectomy with mitomycin-C (trabMMC) compared with that of single-site phacotrabeculectomy with mitomycin-C (phacotrabMMC) in glaucoma patients at increased risk for filtering surgery failure.

Methods: Eighty-five consecutive eyes that underwent trabMMC and 105 consecutive eyes that underwent phacotrabMMC were retrospectively compared up to 2 years postoperatively with respect to intraocular pressure (IOP), number of glaucoma medications, and surgical complication rates. The primary outcome was the difference in the cumulative proportion of patients meeting the target IOP range at 2 years. Secondary outcomes included mean postoperative IOP, mean IOP drop from baseline, mean number of glaucoma medications, and surgical complication rates.

Results: Baseline characteristics were similar in the 2 groups and most patients had advanced glaucoma with a similar upper limit of the target IOP range (15.5 ± 2.6 mm Hg for trabMMC vs. 15.3 ± 2.1 mm Hg for phacotrabMMC, $p = 0.56$). Loss to follow-up was significant in both groups (almost 50% over 2 years). A statistically similar proportion of patients achieved their target IOP range at 1 and 2 years in both groups: the cumulative success rate at 2 years was 29.04% and 22.91% ($p = 0.44$) without add-on glaucoma therapy, 25.38% and 25.22% ($p = 0.60$) with the use of up to 2 glaucoma medications, and 30.01% and 25.17% ($p = 0.81$) with the use of any number of glaucoma medications, in the trabMMC and phacotrabMMC groups, respectively. Mean postoperative IOP was also similar between the 2 groups at almost all follow-up times up to 2 years (13.56 ± 4.92 mm Hg in trabMMC vs. 13.98 ± 4.74 mm Hg in phacotrabMMC at 2 years, $p = 0.67$). The mean IOP drop from baseline was significantly greater in the trabMMC group throughout the study period (–10.87 ± 8.33 mm Hg in trabMMC vs. –6.15 ± 7.01 mm Hg in phacotrabMMC at 2 years, $p = 0.003$); however, baseline IOP was also higher in the trabMMC group (26.1 mm Hg vs. 20.3 mm Hg, $p < 0.0001$). Serious postoperative complication rates were similarly low between the 2 groups.

From *the Department of Internal Medicine, University of Manitoba, Winnipeg, Man., and †the University of Ottawa Eye Institute, Ottawa, Ont.

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Correspondence to: Dr. Karim F. Damji, University of Ottawa Eye Institute, 501 Smyth Rd., Ottawa ON K1H 8L6; fax (613) 739-6139; kdamji@ohri.ca

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Interpretation: TrabMMC and phacotrabMMC may be equally safe and effective in bringing IOP to within an acceptable target range over 2 years in advanced glaucoma patients at increased risk for filtering surgery failure, although trabMMC appears to be associated with greater IOP lowering from baseline.

Contexte : Établir l'efficacité et la sécurité de la trabulectomie avec mitomycine-C (trabMMC) comparativement à celles de la phacotrabéculectomie dans un seul site avec mitomycine-C (phacotrabMMC) chez des patients atteints de glaucome à risque plus grand de faillite de l'intervention filtrante.

Méthodes : Nous avons comparé rétrospectivement la pression intraoculaire (PIO), la quantité de médicaments pour le glaucome et les taux des complications chirurgicales de 85 patients consécutifs qui avaient subi une trabMMC et 105 patients consécutifs qui avaient subi une phacotrabMMC. Le résultat principal a porté sur l'écart proportionnel cumulatif des patients ayant atteint la PIO cible après 2 ans. Les résultats secondaires ont porté sur la PIO moyenne post-opératoire, la baisse moyenne de la PIO à partir du début, la quantité moyenne de médicaments pour le glaucome et les taux de complication chirurgicales.

Résultats : Les caractéristiques de départ étaient semblables dans les 2 groupes : la plupart des patients avaient un glaucome avancé avec une limite supérieure semblable de PIO cible (15,5 ± 2,6 mm Hg pour la trabMMC vs. 15,3 ± 2,1 mm Hg pour la phacotrabMMC, p = 0,56). La réduction de l'échantillon pendant le suivi a été significative dans les deux groupes (près de 50 % en deux ans). La proportion des patients qui ont atteint l'écart de PIO cible après 1 et 2 ans était statistiquement semblable dans les deux groupes. Les taux cumulatifs de réussite après 2 ans étaient : de 29,04 % et 22,91 % (p = 0,44) sans ajout de thérapie pour le glaucome; de 25,38 % et 25,22 % (p = 0,60) avec l'utilisation d'au plus 2 médicaments pour le glaucome; et de 30,01 % et 25,17 % (p = 0,81) avec l'utilisation de toute quantité de médicaments pour le glaucome, pour les groupes de trabMMC et de phacotrabMMC respectivement. La PIO postopératoire moyenne a aussi été semblable entre les 2 groupes pendant presque tout le suivi jusqu'à 2 ans (13,56 ± 4,92 mm Hg pour les trabMMC c. 13,98 ± 4,74 mm Hg pour les phacotrabMMC à 2 ans, p = 0,67). La baisse moyenne de PIO depuis le début a été significativement plus grande dans le groupe trabMMC pendant toute la durée de l'étude (–10,87 ± 8,33 mm Hg chez les trabMMC c. –6,15 ± 7,01 mm Hg chez les phacotrabMMC à 2 ans, p = 0,003); toutefois, la PIO du début était aussi plus élevée dans le groupe trabMMC (26,1 mm Hg c. 20,3 mm Hg, p < 0,0001). Les taux de complications postopératoires graves ont été tout aussi faibles dans les deux groupes.

Interprétation : La trabMMC et la phacotrabMMC peuvent être également sécuritaires et efficaces pour amener la PIO à une cible acceptable sur une période de 2 ans chez les patients atteints de glaucome avancé qui sont à risque plus grand de faillite de l'intervention filtrante, bien que la trabMMC semble être davantage associée avec une baisse de PIO plus grande depuis le début.

Patients presenting with coexistent, visually significant cataract and glaucoma that are resistant to medical or laser therapy, or both, pose an interesting therapeutic problem. In this scenario, the potential benefit of delaying cataract surgery in order to improve the success of filtering surgery must be weighed against the drawback of having 2 separate operations and delaying visual rehabilitation, as well as the risks of trabeculectomy-induced cataract progression and bleb failure with subsequent cataract surgery. Conversely, performing cataract surgery to improve vision while delaying filtering surgery may cause accelerated

optic nerve damage secondary to transient or sustained elevation of postoperative intraocular pressure (IOP).[1] Accordingly, combined phacotrabeculectomy may be a more rational approach in such patients.

Nonetheless, opting for a combined procedure over isolated trabeculectomy must be carefully considered in glaucoma patients with advanced optic disc cupping or visual field loss, or both, as these patients may require strict IOP control below an upper limit in order to preserve their remaining visual field.[2] The theoretical argument is that the heightened inflammatory response of phacotrabeculectomy, relative to trabeculectomy alone, may cause increased scarring of the filtering bleb and poorer long-term filtration. In addition, there are other potential complications associated with cataract surgery, such as vitreous loss, that can predispose to bleb failure. It may be wise, therefore, to avoid cataract surgery in favour of isolated trabeculectomy in advanced glaucoma patients with a visually acceptable level of cataract.

As phacotrabeculectomy continues to gain popularity among ophthalmic surgeons, two important points need to be addressed: First, are trabeculectomy and phacotrabeculectomy equally effective in mid- to long-term IOP control? Second, do these two procedures have similar perioperative complication rates? Although numerous studies have demonstrated excellent IOP-lowering success and low complication rates with phacotrabeculectomy,[3–9] few studies have directly compared the efficacy and safety of phacotrabeculectomy with trabeculectomy alone.[10–15] Moreover, only 2 studies have compared these 2 procedures in the setting of intraoperative mitomycin-C, despite the widespread use of this agent to improve long-term IOP control.[10,11] Collectively, these studies have provided inconclusive results. Furthermore, no study, to our knowledge, has compared these 2 groups in terms of achieving target IOP, even though most glaucoma specialists currently gauge how aggressive they need to be with respect to filtering surgery and postsurgical management on the basis of a predetermined target IOP. One approach to setting a target IOP range is outlined in the Canadian consensus guidelines that have been previously published.[16]

Given the challenges reviewed above, we sought to determine the efficacy and safety of phacotrabeculectomy with mitomycin-C (phacotrabMMC) compared with that of trabeculectomy with mitomycin-C (trabMMC) in our patient population, consisting primarily of elderly persons at increased risk for filtering surgery failure, using achievement of target IOP as our primary measure of surgical success.

Methods

A retrospective cohort study was conducted on all glaucomatous eyes that underwent either trabeculectomy or phacotrabeculectomy with intraoperative mitomycin-C (MMC) by one surgeon (K.F.D.) at the University of Ottawa Eye Institute between August 1996 and June 2003. Patients under 10 years of age and those without a minimum of 3 months' follow-up data were excluded from the study, as were patients with other ocular conditions that could grossly interfere with accurate assessment of IOP, including Fuchs endothelial dystrophy and pseudophakic bullous keratopathy. Patients were not excluded on the basis of race, gender, or glaucoma type (except for congenital glaucoma patients).

Preoperative data on each eye were collected within the 3-month period before surgery and included IOP (by Goldmann applanation tonometry), upper limit of target IOP range (established using an approach similar to that reported by a Canadian Consensus working group16), and number of glaucoma medications (combination eye drops were counted as 2 medications). The same data were collected at 3, 6, 9, 12, 18, and 24 months postoperatively. Surgery-related complications were recorded for early postoperative (≤ 8 weeks postsurgery) and late postoperative (> 8 weeks postsurgery) time periods.

The primary outcome was difference in cumulative success rates at 1 and 2 years, determined by Kaplan–Meier analysis. Complete success rate was defined as the proportion of patients meeting their target IOP ranges without any glaucoma medications (i.e., eyes were counted as failures if they did not meet their target IOP range or if they required 1 or more medications in order to meet their target IOP range at any given time). Qualified success rate was divided into 2 groups: those who achieved their target IOP range with allowance of up to 2 glaucoma medications and those who achieved their target IOP with allowance of any number of glaucoma medications.

Secondary outcomes included difference in mean postoperative IOP, mean IOP drop from baseline, mean number of glaucoma medications, and rates of adverse postoperative complications. These complications included IOP spike on the first postoperative day (defined as IOP > 25 mm Hg), hypotonous

maculopathy (diagnosed by a drop in vision of 5 or more Snellen lines from preoperative levels, accompanied by macular striae, in the setting of hypotony), suprachoroidal hemorrhage, bleb leak (identified by a hole in the bleb wall accompanied by a Seidel-positive test), uveitis, and endophthalmitis. Hypotony was defined as IOP readings of < 6 mm Hg obtained on 2 separate days up to 2 months postoperatively or at least 1 such reading obtained more than 2 months postoperatively.

Statistical methods

Cumulative probabilities were determined by Kaplan–Meier survival analysis using the log-rank test to assess for statistical significance. Two-sided, unpaired Student *t* test was used to compare the 2 study groups on continuous variables. Chi-square test was used to compare proportions of categorical variables that may be associated with surgical intervention. A multivariate Huber linear regression model was built by using IOP reduction as the dependent variable and study group as the main independent predictor. The Huber linear regression model was necessary for analysis of nested models using the chi-square distribution for model testing. A p value of 0.05 or less was considered significant. Covariates assessed included age, sex, race, glaucoma type, type of anaesthetic, baseline IOP, and number of medications. Only age, sex, and glaucoma type were included in the multivariate analysis of the primary outcome measure. These variables and the number of glaucoma medications were included in the multivariate model for the secondary outcomes of difference in mean IOP and in mean IOP-lowering from baseline. All statistical analyses were performed using the STATA 7.0 software (StatCorp, College Station, Tex.).

Surgical Methods

The surgical protocol followed for trabMMC was as described by Stone and colleagues,[17] with the exception that the dissected scleral flap was parabolic (and in a few cases triangular or rectangular) rather than square, but of a similar size. All patients received a baseline of 1 min of 0.3 mg/mL MMC exposure. Additional minutes (up to a maximum of 5 min) were added on the basis of the number of risk factors for filtration failure, and 0.5 to 1 min were subtracted from the total time if the conjunctiva or Tenon's capsule, or both, was thin (Table 1).

Table 1—Duration of exposure to mitomycin-C by risk factor for filtering surgery failure*

Risk factor	Time of exposure to MMC, min
Age < 40 years	1
Race, black	1
Uveitis: controlled	1
uncontrolled	2
Neovascular glaucoma	2
Aphakia or pseudophakia	1
Trauma	1
Previous intraocular surgery	1
Previous failed trabeculectomy with mitomycin-C	4

Note: MMC = 0.3 mg/mL mitomycin-C.
*To a maximum of 5 min (see Methods section for details).

Our procedure for phacotrabMMC incorporated standard phacoemulsification surgery into the trabMMC procedure using a one-site technique via the scleral flap before creation of the trabeculectomy. Phacoemulsification of the lens material was undertaken using a fragmentation, or divide and conquer, approach.

RESULTS

All patient demographics are listed in Table 2. The majority of patients requiring surgery had advanced glaucoma (cup-to-disc ratio > 0.9 or visual field loss within 10 degrees of fixation, or both) that was resistant to medical or laser intervention, or both. The phacotrabMMC group was slightly older overall than the trabMMC group; however, this difference was not statistically significant. The majority of patients in both groups were white. No potential confounders were found to be significantly different between the study groups at an alpha of 0.10. As expected, when these variables were included in the multivariate analysis, none was found to predict a difference in outcomes between groups.

The Kaplan–Meier survival curves show a similar trend among the 2 groups throughout the 2 years of follow up, with the majority of failures occurring within the first 3 to 6 postoperative months (Figs. 1 to 3). There was no statistically significant difference in cumulative success rates between the 2 groups at 1 and 2 years in any of the 3 categories assessed (complete success and the 2 qualified success categories)

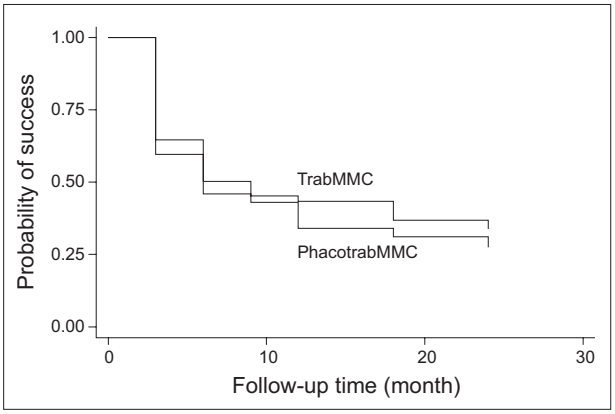

Fig. 1—Cumulative probability of success of trabeculectomy with mitomycin-C and single-site phacotrabeculectomy with mitomycin-C over 2 years without adjunctive glaucoma medications. Kaplan–Meier survival analysis by treatment: TrabMMC = trabeculectomy with mitomycin-C; PhacotrabMMC = single-site phacotrabeculectomy with mitomycin-C.

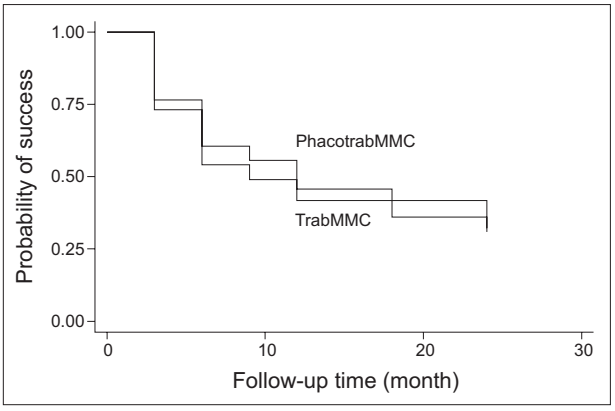

Fig. 2—Cumulative probability of success of trabeculectomy with mitomycin-C and single-site phacotrabeculectomy with mitomycin-C over 2 years with up to 2 glaucoma medications. Kaplan–Meier survival analysis by treatment: TrabMMC = trabeculectomy with mitomycin-C; PhacotrabMMC = single-site phacotrabeculectomy with mitomycin-C.

(Table 3). Preoperative IOP differed significantly between the 2 groups. Both groups had a similar upper limit of target IOP range. Mean postoperative IOP was statistically similar between the 2 groups throughout the 2 years of follow-up, except at 6 months, in which the phacotrabMMC group had a lower IOP (by 2.3 mm Hg) than the trabMMC group (Table 4).

The mean drop in IOP from preoperative level was significantly greater in the trabeculectomy group (by

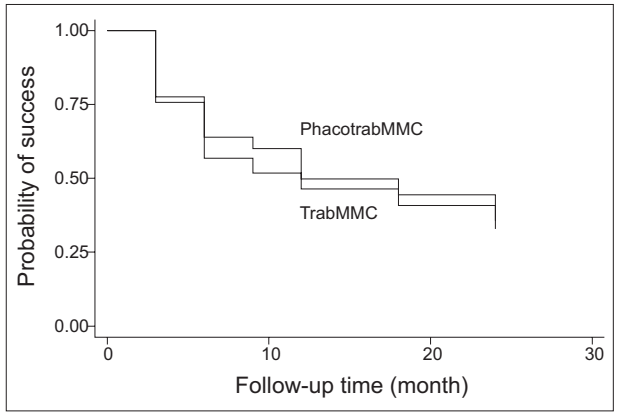

Fig. 3—Cumulative probability of success of trabeculectomy with mitomycin-C and single-site phacotrabeculectomy with mitomycin-C over 2 years with any number of glaucoma medications. Kaplan–Meier survival analysis by treatment: TrabMMC = trabeculectomy with mitomycin-C; PhacotrabMMC = single-site phacotrabeculectomy with mitomycin-C.

4 to 6 mm Hg) throughout the 2 years of follow-up (Table 5). The mean postoperative number of medications was similar between the 2 groups throughout 2 years, with both groups requiring a substantially lower number of medications than preoperatively at all follow-up times (Table 6).

The most commonly recorded complications of surgery in both groups were early and late hypotony and early hyphema, and these rates were fairly similar between the 2 groups. The trabMMC group showed a slightly higher incidence of day one IOP spike, while the phacotrabMMC group showed a slightly higher incidence of early corneal edema. All other complication rates were very low and were observed with similar frequency in both groups (Table 7).

Interpretation

The benefits of combined phacotrabeculectomy over a staged procedure (trabeculectomy followed by cataract surgery at a later date) for patients presenting with simultaneous glaucoma and cataract are compelling. These benefits include avoiding an extra operation, early visual rehabilitation, and decreased risk of future bleb failure. The choice of surgery is not obvious, however, in eyes with advanced glaucomatous optic disc or visual field changes, or both, wherein strict IOP control below a predetermined upper limit is of utmost importance to preserving visual field.[2] Indeed, the long-term effects on vision of increased perioperative inflammation, as well as

Table 2—Patient demographics

Patient characteristics	Surgery	
	TrabMMC	Phacotrab-MMC
Number of eyes	85	105
Mean patient age (years)	66.1 ± 16.7	73.1 ± 12.4
Sex		
Female	48	61
Male	37	44
Race		
White	74	101
Black	3	3
Other	8	1
Glaucoma type		
Primary open-angle	45	50
Chronic angle-closure	6	5
Pseudoexfoliative	5	26
Pigmentary	4	5
Normal-tension	5	5
Uveitis-induced	5	3
Neovascular	3	1
Other	12	10
Anaesthesia type		
Topical + sub-Tenon's	18	18
Peribulbar	63	83

Note: TrabMMC = trabeculectomy with mitomycin-C; PhacotrabMMC = phacotrabeculectomy with mitomycin-C.

Table 3—Cumulative success rates at 1 and 2 years based on the number of postoperative glaucoma medications*

Category	TrabMMC (%) *n* = 85	Phacotrab MMC (%) *n* = 105	*p* value
0 glaucoma medications			
1 year post-op	41.42	32.08	0.21
2 year post-op	29.04	22.91	0.44
≤ 2 glaucoma medications			
1 year post-op	40.00	44.53	0.83
2 year post-op	25.38	25.22	0.60
Any number of glaucoma medications			
1 year post-op	44.68	48.50	0.62
2 year post-op	30.01	25.17	0.81

*Probabilities and *p* values by Kaplan–Meier analysis and log-rank test.
Note: TrabMMC = trabeculectomy with mitomycin-C; PhacotrabMMC = phacotrabeculectomy with mitomycin-C.

potential complications associated with additional cataract surgery, are of significant concern in deciding whether to undertake a combined surgery in such eyes.

The results of this study suggest that trabMMC and single-site phacotrabMMC may be equally safe and effective up to 2 years of follow-up with respect to the cumulative proportion of patients meeting their target IOP range, irrespective of the number of glaucoma medications used. To our knowledge, this is the first study to use target IOP as a measure of success in this setting, and 1 of only 2 studies to demonstrate this finding in the setting of intraoperative mitomycin-C.[10] These findings are particularly relevant to current glaucoma practice and suggest that patients who suffer from both advanced or poorly controlled glaucoma and visually significant cataract may benefit most from a combined procedure, thereby avoiding 2 separate operations and delayed visual rehabilitation.

About 20% to 40% of failures occurred within the first 3 months after surgery, suggesting a need for more aggressive early postoperative management to keep IOP within the target range, such as with laser suture lysis or early add-on glaucoma medications. Surprisingly, the 2-year success rates with both procedures were very low (~25%), with or without the addition of glaucoma medications. We attribute such low success rates to the stringency with which the results were calculated; specifically, any patient that did not strictly meet their target IOP range was counted as a failure from that time point onwards throughout the remainder of the follow-up period, even if subsequent IOPs were well within the target range (as per Kaplan–Meier analysis), with or without add-on glaucoma medications. In practice, a clinician may not regard such minor intermittent fluctuations as true "failures", and glaucoma surgeons often allow a grace of 1 to 2 mm Hg over the upper limit of the target IOP range, provided that the patient is able to easily achieve target IOP by the next 1 or 2 follow-up visits.

Furthermore, the large loss to follow-up in the study (~50%) may have caused falsely low observed success rates, as the majority of the lost patients were likely those with adequate glaucoma control who returned to their community ophthalmologist or

Table 4—Mean intraocular pressure before surgery and during 2-year follow-up

Time	TrabMMC, mm Hg	PhacotrabMMC, mm Hg	*p* value
Pre-op	26.12 ± 9.03 (*n* = 85)	20.25 ± 7.00 (*n* = 105)	< 0.0001
Post-op			
3 mo	13.41 ± 5.65 (*n* = 73)	13.60 ± 5.54 (*n* = 86)	0.83
6 mo	15.51 ± 6.83 (*n* = 62)	13.18 ± 4.15 (*n* = 82)	0.01
9 mo	14.23 ± 5.28 (*n* = 44)	13.56 ± 3.58 (*n* = 61)	0.43
12 mo	13.39 ± 6.66 (*n* = 49)	14.34 ± 4.81 (*n* = 73)	0.36
18 mo	13.78 ± 6.41 (*n* = 46)	13.17 ± 3.80 (*n* = 69)	0.52
24 mo	13.56 ± 4.92 (*n* = 39)	13.98 ± 4.74 (*n* = 59)	0.67
Target IOP*	15.5 ± 2.6	15.3 ± 2.1	0.56

*Target IOP represents the upper limit of the target intraocular pressure range.
Note: TrabMMC = trabeculectomy with mitomycin-C; PhacotrabMMC = phacotrabeculectomy with mitomycin-C.

Table 5—Decrease in mean intraocular pressure from preoperative levels

Post-op time	TrabMMC, mm Hg	PhacotrabMMC, mm Hg	*p* value
3 mo	–12.04 ± 9.89 (*n* = 73)	–6.67 ± 9.25 (*n* = 86)	0.001
6 mo	–10.70 ± 10.17 (*n* = 62)	–6.88 ± 8.49 (*n* = 82)	0.02
9 mo	–11.23 ± 9.51 (*n* = 44)	–5.57 ± 7.02 (*n* = 61)	0.001
12 mo	–11.55 ± 9.03 (*n* = 49)	–6.23 ± 8.83 (*n* = 73)	0.002
18 mo	–11.37 ± 10.47 (*n* = 46)	–6.67 ± 7.92 (*n* = 69)	0.007
24 mo	–10.87 ± 8.33 (*n* = 39)	–6.15 ± 7.01 (*n* = 59)	0.003

Note: TrabMMC = trabeculectomy with mitomycin-C; PhacotrabMMC = phacotrabeculectomy with mitomycin-C

optometrist, leaving a difficult-to-treat patient population towards the latter half of the study period. Importantly, it is believed that this discrepancy should not have affected 1 group more than the other, allowing us to compare the 2 groups with reasonable confidence.

Of note, the trabMMC group showed a significantly greater IOP drop from baseline than the phacotrabMMC group at all follow-up times. This is likely a consequence of the higher baseline IOP in the trabMMC group, which naturally predisposed these eyes to a greater IOP drop with surgery. In fact, several studies have demonstrated a linear relationship between preoperative IOP and the reduction in IOP achieved by either of these procedures.[12,18] One perspective, which we favor, is that the difficulty of preoperative IOP control in either group should have minimal bearing upon the ability to lower IOP with surgery, since the basic impediment to adequate filtration (i.e., resistance to aqueous outflow via the trabecular meshwork) is essentially being bypassed with the creation of a fistula. The difference in baseline IOP observed in our groups likely reflects different indications for surgery in the 2 groups, as patients in the trabMMC group would have undergone surgery strictly for uncontrolled IOP, whereas many patients in the phacotrabMMC group may have undergone elective trabeculectomy at the time of cataract surgery, despite reasonable IOP control.

The similarity in mean postoperative IOP and mean number of glaucoma medications in either group throughout the 2 years of follow-up provides further evidence that both procedures are equally effective in IOP control (these are valid comparisons

in this study as the upper limit of target IOP range was similar between the 2 groups and, therefore, there was no propensity to treat either group differently with respect to filtering surgery or postoperative management). The rates of serious postoperative complications, including suprachoroidal hemorrhage, vitreous hemorrhage, hypotonous maculopathy, and endophthalmitis, were also similarly low between the groups. The increased rate of early IOP spike observed in the trabMMC needs to be corroborated in future studies.

Studies conducted to date comparing these 2 procedures have reported various results. Derick et al compared 42 consecutive eyes that underwent phacotrabMMC with an age-matched control group of 42 eyes that underwent trabMMC and found no significant difference in mean postoperative IOP or mean IOP-lowering from baseline (both groups had similar preoperative IOPs) at a final follow-up time of 21.8 ± 6.0 months.[10] Conversely, Kleinmann et al reported a lower mean postoperative IOP and a greater mean IOP drop from baseline in 33 eyes that underwent trabMMC as compared with 102 eyes that underwent phacotrabMMC; however, the mean follow-up time was significantly different between the 2 groups (22.6 ± 13.3 months in the trabMMC group versus 14.2 ± 8.0 months in the phacotrabMMC group).[11]

Of the studies that compare phacotrabeculectomy with trabeculectomy without the use of intraoperative MMC, some report no difference in mean postoperative IOP or mean IOP-lowering from baseline,[13] while others report better IOP-lowering with trabeculectomy alone.[12,14,15] Of note, all these studies observed a significant decrease in IOP from baseline in both procedures and most also reported an overall low rate of complications, with the highest rates generally seen for hyphema and early IOP spikes.

There are a number of limitations to this study. The retrospective nature of the study lends itself to a number of unavoidable random and systematic errors in data interpretation. One manifestation of this is the significant loss to follow-up encountered in the

Table 6—Mean number of glaucoma medications*

Time	TrabMMC	PhacotrabMMC	*p* value
Pre-op	2.86 (*n*=85)	2.80 (*n*=105)	0.76
Post-op			
3 mo	0.51 (*n*=72)	0.60 (*n*=84)	0.60
6 mo	0.77 (*n*=61)	0.62 (*n*=82)	0.41
9 mo	0.72 (*n*=43)	0.84 (*n*=63)	0.56
12 mo	0.85 (*n*=48)	0.84 (*n*=73)	0.93
18 mo	0.88 (*n*=43)	0.99 (*n*=71)	0.64
24 mo	1.16 (*n*=38)	1.05 (*n*=58)	0.65

*Combination drops were counted as 2 medications.
Note: TrabMMC = trabeculectomy with mitomycin-C; PhacotrabMMC = phacotrabeculectomy with mitomycin-C.

Table 7—Surgical complication rates*

Complication	Early postoperative (≤ 8 weeks)		Late postoperative (> 8 weeks)	
	TrabMMC % (no.) (*n* = 85)	PhacotrabMMC % (no.) (*n* = 105)	TrabMMC % (no.) (*n* = 82)	PhacotrabMMC % (no.) (*n* = 104)
Day 1 IOP spike	12 (10)	6 (6)	—	—
Hypotony	45 (38)	39 (41)	12 (10)	9 (9)
Hypotonous maculopathy	1 (1)	0	1 (1)	0
Bleb leak	8 (7)	5 (5)	0	2 (2)
Hyphema	24 (20)	18 (19)	—	—
Corneal edema	1 (1)	6 (6)	4 (3)	1 (1)
Uveitis	1 (1)	3 (3)	0	2 (2)
Suprachoroidal hemorrhage	2 (2)	1 (1)	0	0
Vitreous hemorrhage	1 (1)	0	0	0
Endophthalmitis	1 (1)	0	0	0
Choroidal detachment	1 (1)	2 (2)	0	0

*Please see Methods section for definitions of listed complications.
Note: TrabMMC = trabeculectomy with mitomycin-C; PhacotrabMMC = phacotrabeculectomy with mitomycin-C.

study (approximately 50% of patients were lost by 2 years postoperatively), which may impart an indiscernible bias upon the results. Our interpretation is that most patients lost to follow-up likely returned to their community ophthalmologist because of adequate glaucoma control, thereby leaving an increasingly difficult-to-treat patient population with each postoperative visit, and thus our numbers may underestimate the absolute success rate with both procedures. Moreover, the lack of patient randomization may have caused selection bias due to differences in baseline demographics and indications for surgery. Nevertheless, none of the variables applied to the multivariate analysis were associated with significantly different outcomes between the 2 groups. We have tried to minimize selection bias by adjusting for potential confounders, such as differences in age, race, and target IOP, through a multivariate model. Because follow-up evaluation was consistently performed by the operating physician and the relevant data were consistently recorded at all follow-up visits, variability in data collection would have minimally influenced the results.

Overall, the results of this study suggest that trabeculectomy and single-site phacotrabeculectomy with intraoperative MMC may be equally safe and effective surgical procedures for IOP control over 2 years in a patient population with advanced glaucoma and at increased risk for filtering surgery failure. However, both procedures are associated with a relatively low success rate at 2 years, suggesting a potential need for earlier and more aggressive therapeutic modalities to maintain IOP within the target range over the long term. Future prospective randomized studies are needed to validate the routine use of phacotrabMMC in patients with both glaucoma and cataract.

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Key words: trabeculectomy, phacotrabeculectomy, mitomycin-C, intraocular pressure, target IOP range