Journal of Glaucoma 12:333–339

Comparison between Phacoemulsification and the Blumenthal Technique of Manual Small-Incision Cataract Surgery Combined with Trabeculectomy

*Ravi Thomas, MS, †Rajul Parikh, MS, and ‡Jayprakash Muliyil, PhD

**LV Prasad Eye Institute, Hyderabad; † Department of Ophthalmology, CMCH, Vellore; and ‡Department of Community Medicine, CMCH, Vellore*

Objective: To compare results of filtration combined with either phacoemulsification or the Blumenthal technique of manual small-incision cataract surgery.

Materials and Methods: Records of glaucoma "triple" operations from March 1997 to May 2000 were reviewed. Seventy-eight eyes (70 patients) that underwent phaco-triple were compared with 86 eyes (80 patients) that underwent the Blumenthal technique of manual small-incision cataract surgery combined with filtration (Blumenthal triple). Three minutes of 0.4 mgs/ml Mitomycin was used in all eyes. Posterior chamber IOLs were implanted through 5.5-mm incisions in both groups. Outcome measures were intraocular pressure (IOP) reduction and achievement of target IOP. Fourteen patients who underwent phacoemulsification-triple in one eye and Blumenthal triple in the other eye were also evaluated separately.

Results: The minimum follow-up period was 6 months (range 6–30 months). At last follow-up review, mean reduction in IOP was 17.7 mm Hg (± 9.3 mm Hg) in the phaco group and 17.1 mm Hg (± 10 mm Hg) in the Blumenthal group. At last visit, target IOP was achieved in 75.6% of the phaco group and 73% of the Blumenthal group. There was no significant difference between groups in IOP reduction or achievement of target IOP. In the 14 patients who had undergone phaco-triple in one eye and Blumenthal-triple in the other, there was no inter-eye difference in IOP reduction.

Conclusions: In this small retrospective study we could not demonstrate a difference in IOP outcomes between the two procedures.

Key Words: Blumenthal technique, intraocular pressure, manual small-incision cataract surgery, phacoemulsification, target IOP, trabeculectomy

Trabeculectomy combined with cataract surgery is considered safe and effective in the management of cataract associated with glaucoma. It prevents early intraocular pressure (IOP) spikes responsible for visual field "wipe out" in advanced glaucoma and provides visual rehabilitation with long-term IOP control.[1–3]

The use of phacoemulsification and wound-healing modulators have improved the results of glaucoma triple surgery; reports suggest that IOP control is superior to standard extra capsular cataract surgery combined with filtering surgery.[4–7] Phacoemulsification has several advantages in addition to IOP control. These include less-induced astigmatism, early visual rehabilitation, and a decreased hospital stay.[6] The advantage of phacoemulsification is related to the smaller incision. If a manual small-incision technique were used for the cataract surgery, the small-incision advantage should theoretically still be applicable. We could find only 1 article describing the glaucoma triple operation using a manual

Received August 1, 2002; revised November 6, 2002; accepted April 8, 2003.

Address correspondence and reprint requests to Ravi Thomas, MS, LV Prasad Eye Institute, L.V. Prasad Marg, Banjara Hills, Hyderabad, Andhra Pradesh, India. E-mail: ravithomas@lvpeye.stph.net

small-incision cataract surgery (Blumenthal technique). The study design was non-comparative and the aim was to report the incidence and course of early postoperative IOP elevation and surgical outcome following combined cataract and glaucoma surgery.[8]

We compared the IOP control, need for additional medication, and surgical intervention in glaucoma "triples" performed using either phacoemulsification or the Blumenthal technique of manual small-incision cataract extraction.

MATERIALS AND METHODS

The charts of 150 patients (164 eyes) undergoing a glaucoma triple operation between March 1997 and May 2000 were reviewed. Seventy-eight eyes underwent phaco triple while 86 eyes underwent the Blumenthal technique of manual small-incision cataract surgery combined with a trabeculectomy (Blumenthal triple). Primary, pseudoexfoliation (PEX), and pigmentary glaucomas with IOP greater than 22 mm Hg, operated on by surgeons with at least 3 years of experience following their residency training in our hospital (6 surgeons) were included. Lens-induced, neovascular, normotensive glaucoma, and patients with failed trabeculectomy in same eye were excluded, as were patients with less than 6 months of follow-up review. A small subset of patients (14 patients) who underwent phacoemulsification-triple in 1 eye and Blumenthal triple in the other eye were evaluated separately.

All patients underwent a complete ophthalmic examination. The examination included subjective and objective refraction; best-corrected Snellen visual acuity (BCVA), biomicroscopy, Goldman applanation tonometry, gonioscopy, and a baseline diurnal variation of intraocular IOP. Indirect ophthalmoscopy and stereobiomicroscopic examination of the optic disc with a 60 D lens were attempted in all patients. Visual field examination on the Humphrey Field Analyzer (HFA) was also attempted in all patients. A size V target was used for those with a BCVA of less than 6/24. Target IOP was decided preoperatively based on the individual patient's IOP (including daytime diurnal variation) and optic disc changes with visual field defects (where possible); target IOP was estimated using a published formula and tables.[9,10]

Surgery was performed under local anesthesia with either retrobulbar and facial block, or a peribulbar block. Except for the method used to extract the lens, the surgical technique was similar in both cases. A fornix-based flap and 3 minutes of Mitomycin C (0.4 mg/ml) under the conjunctiva was used in all cases. A 5.5-mm partial-thickness scleral incision with 1.5-mm backward cuts at each end was initiated 1.5-mm posterior to the limbus and used to fashion a corneo-scleral tunnel incision; the incision incorporated the 2 backward cuts. Following injection of methyl cellulose (Viscomet; Milmet, India) into the anterior chamber through a paracentesis, continuous curvilinear capsulorrhexis (CCC) was performed through the paracentesis using a cystitome. An anterior chamber maintainer connected to a bottle of irrigating fluid was inserted into the anterior chamber through an additional paracentesis placed at the inferior limbus. At this stage a super blade was used to make a 1-mm entry into the anterior chamber in clear cornea through the bed of the tunnel under the scleral flap. This incision was later used to perform the trabeculectomy. The anterior chamber was entered (anterior to the above stab incision) with a 2.8-mm Keratome and phacoemulsification performed using the stop-and-chop technique. The internal wound was extended to 6.5 mm prior to insertion of a 6.5-mm diameter IOL.

The Blumenthal technique of cataract surgery was performed as described elsewhere.[11] The CCC was performed and anterior chamber maintainer inserted as detailed previously. A 5.5-mm scleral groove with backward cuts radial to the limbus at each edge of the incision was fashioned as for phacoemulsification. The scleral tunnel was different from that used in phacoemulsification; to express the nucleus, the dissection was more extensive. The tunnel was fashioned with a crescent blade; the incision usually extends approximately 2 to 2.5 mm into the cornea. The dissection was carried out toward the limbus on both sides to create a funnel-shaped "pocket". The blade was then angled to cut backwards so as to incorporate the backward cuts into the pocket. (This dissection of the pocket permits extraction of most nuclei and permits insertion of a 6.5-mm IOL). A super blade was used to make a 1-mm entry into the anterior chamber in clear cornea through the bed of the tunnel under the scleral flap; this incision was later used to perform the trabeculectomy. The anterior chamber was entered using a keratome in the usual manner; the internal incision was about 9 mm. Hydrodissection was performed inferiorly to prolapse the upper pole of the nucleus into the anterior chamber. Alternatively, the Blumenthal canula was introduced through the paracentesis and insinuated just under the anterior capsule to the equator between 10 and 12 o'clock. Hydrodissection was performed and the canula moved in the same plane toward the pupil and then anteriorly thus manipulating the upper pole of the nucleus into the anterior chamber. A Sheet glide was then inserted between the nucleus and the posterior capsule and the nucleus was extracted by hydrodynamic expression:

pressure on the glide applied with forceps within the scleral tunnel caused the nucleus to engage the wound; the nucleus was expressed by the pressure of the ACM (hydrodynamic expression) helped by gentle pressure with a forceps tip applied posterior to the scleral wound. With either technique, cortex extraction was safely performed with a single port-aspirating canal on a syringe, through the paracentesis, in the closed, well-maintained chamber provided by the ACM. A posterior chamber lens (PMMA lens with optic diameter of 6.5 mm) was placed in the bag; if this was not possible, the lens was placed in the sulcus.

For both techniques, the size of the original stab incision into the anterior chamber was then increased to 3 mm. A block of tissue was excised from this wound using a Kelly punch (to cut backward), or a Vanna scissors (to cut forward). The goal was to produce a block with at least 1.0- mm overlap by the scleral flap. Peripheral iridectomy was performed. Filtration was assessed on the table and sutures used to obtain desirable flow; this decision was made by the surgeon on the table. Releasable sutures were used depending on the preference of the surgeon. The conjunctiva was closed with 2 wing sutures and a horizontal mattress, both using 10′0 monofilament nylon.

Post operatively all patients were evaluated on the first postoperative day, first week, at 1 month, 6 months, and every 6 months thereafter. At all visits BCVA, IOP, bleb morphology, anterior segment examination, and fundus examination including stereo- biomicroscopic disc examination was performed. Post operatively, injections of 5-Flurouracil (5 FU) were given subuconjunctivally, 180° away from the bleb area. A glaucoma specialist made the decision on the basis of the IOP and the bleb.

Mean baseline IOP was compared with the IOP on the first day, at 1 week, 1 month, and last visit. The results were analyzed using the following IOP cutoffs:

1) Final IOP (last visit) less than 21 mm Hg
2) Last visit IOP less than 16 mm Hg
3) Achievement of target IOP with or without medication.

The target IOP was calculated using published formulas and tables.[9,10]

The need for additional surgical intervention or medical intervention in the 2 groups was compared.

Difference in IOP reduction between groups and ability to achieve target IOP was assessed at each follow-up review by the paired "t" test.[12] Success of glaucoma surgery in both groups was compared using the Kaplan-Meier survival analysis.

RESULTS

Four hundred and fifty combined cataract and trabeculectomy operations were performed during the study period; 130 cases of standard manual extra-capsular cataract surgery with trabeculectomy were excluded. Of the remaining 227 eyes, 164 had follow-up review of more than 6 months and were included in the study. Eighty-six eyes had undergone the Blumenthal triple and 78 eyes had undergone a phaco triple. Age, sex, and initial IOP were similar in the groups who had more than 6 months follow-up review and those who did not. The demography of the 2 groups was similar (Table 1).

Mean follow-up review was 17 months in the phaco-triple group and 11 months in the Blumenthal group. There were 75 open-angle and 89 angle-closure glaucomas. The phacoemulsification group had 37 eyes with POAG and 41 with PACG; this was 38 and 48 in the Blumenthal group. Mean preoperative medications were similar in both groups: 1.5 (± 0.6) in the Blumenthal group versus 1.6 (± 0.65) in the phacoemulsification group.

Mean baseline and IOP at postoperative follow-up visits are shown in Table 2. There was no difference between the groups at baseline or various postoperative visits.

The mean IOP at last visit was 14.8 (± 4.6) mm Hg in the phaco group and 14.7 (± 5.1 mm Hg) in the Blumenthal group. Mean IOP reduction with phaco-triples was 17.3 mm Hg (± 9.3 mm Hg); this was 17.0 mm Hg (± 10 mm Hg) in the Blumenthal group. At last visit 70 eyes (90%) in the phaco group and 76 eyes (88.6%) in the Blumenthal group had IOP less than 21 mm Hg; 51 eyes (65.4%) in the phaco group and 59 eyes (68.6%) in the Blumenthal group had mean IOP less than 16 mm Hg. Sixty patients in the phaco-triple group and 43 patients in Blumenthal triple group had a follow-up review of more than 12 months and their results were analyzed separately. In these eyes the mean IOP for the phaco triple was 15.0 mm Hg while in the Blumenthal-triple group it was 16.0 mm Hg.

TABLE 1. *Demography of phaco-triple and Blumenthal triple groups*

	Phaco-triple	Blumenthal triple	Statistical significance
Eyes (n)	78	86	
Mean age (y)	54.7 (± 7.2)	55.1 (± 7.5)	$P = 0.72$
Male:Female	41:37	41:45	$P = 0.32$
Open-angle glaucoma	37	38	
Angle-closure glaucoma	41	48	
Mean follow-up-review (mos)	17 (± 7.8)	11 (± 4.8)	$P < 0.001$

TABLE 2. *Mean intraocular pressure at baseline and follow-up visits*

	IOP mm Hg (Phaco-triple)	IOP mm Hg (Blumenthal triple)	Statistical significance
Baseline	32.5 mm Hg (± 8.4) (N = 78)	31.8 mm Hg (± 9.4) (N = 86)	$P < 0.61$
First day	17.5 mm Hg (± 7.4) (N = 78)	15.95 mm Hg (± 7.2) (N = 86)	$P < 0.18$
1 week	13.9 mm Hg (± 6.8) (N = 78)	14.7 mm Hg (± 6.7) (N = 86)	$P < 0.45$
1 month	14.8 mm Hg (± 5.3) (N = 78)	14.8 mm Hg (± 5.7) (N = 86)	$P < 1.00$
Last visit	14.8 mm Hg (± 5.3) (N = 78)	14.7 mm Hg (± 5.1) (N = 86)	$P < 0.90$
12 months	15.0 mm Hg (± 5.7) (N = 60)	16.0 mm Hg (± 5.9) (N = 43)	$P < 0.28$

IOP, intraocular pressure.

The published formula and tables for target IOP provided similar results (Table 3). Achievement of target IOP on a single medication (at the last visit) was 89.5% in the phaco group and 90.7% in the Blumenthal group. Twelve eyes in the phaco group and 11 eyes in the Blumenthal group needed 1 medication to achieve the target IOP; 3 eyes in the phaco group and 1 eye in the Blumenthal group needed 2 medications to achieve this result.

The Kaplan-Meier survival analysis for the 2 groups is shown in Figure 1. Inability to achieve target IOP by the Jampel formula was considered as failure.

The 14 patients who underwent phaco-triple in one eye and Blumenthal triple in the other were also analyzed separately. The mean IOP in these eyes is shown in Table 4; ability to achieve target IOP is shown in Table 5.

Forty-nine cases (62.9%) received postoperative subconjunctival 5 FU injections in the phaco group; 54 cases (62.8%) received such injections in the Blumenthal group. All these eyes received at least one 5-FU injection with a mean of 3.5 injections in phaco group and 3.7 in the Blumenthal group.

Table 6 shows details of the bleb at the last visit in both groups. At the last visit, a bleb was present in 82% of the phaco group and 81% of the Blumenthal group.

Table 7 summarizes intra-operative and postoperative complications for both groups. Three eyes required partial anterior vitrectomy with the phaco versus the 7 eyes with Blumenthal group. One eye in the phaco group and 3 in the Blumenthal group required drainage for choroidal effusion. In the phaco group 1 eye required a scleral patch graft for overfiltration. One eye in Blumenthal group needed bleb resuturing.

Releasable sutures were released in 22 eyes in Blumenthal group and 17 eyes in the phaco group; this was done within the first 3 weeks. Five eyes in each group underwent suture lysis using a frequency doubled YAG laser (Ophthalas 532 Eyelite Laser Photocoagulator, Alcon Surgical). Two patients in the phaco group and 4 in the Blumenthal group underwent suture lysis in addition to removal of releasable suture.

In the Blumenthal group, 88.2% eyes achieved a visual acuity of greater than or equal to 6/12 (20/40) at the last visit and 89.1% in the phaco group achieved a visual acuity of greater than or equal to 6/12 (20/40) at the last visit. One eye had visual acuity of less than 6/60 in the Blumenthal group due to corneal decompensation; 1 eye in the phaco group had a visual acuity of 6/60 preoperatively due to a macular split. The acuity remained poor postoperatively also.

DISCUSSION

The literature suggests that IOP control is better with combined phacoemulsification and trabeculectomy as

TABLE 3. *Success of surgery*

Success criteria	Phaco-triple (%) (n = 78)	Blumenthal-triple (%) (n = 86)
IOP < 21 mm Hg single medication	70 (90%)	76 (88.4%)
IOP < 16 mm Hg single medication	51 (65.4%)	59 (68.6%)
Target IOP (Jample) without medication	59 (75.6%)	63 (73.2%)
Target IOP (Jample) single medication	71 (89.5%)	78 (90.7%)
Target IOP (Hoddap) without medication	58 (74.3%)	66 (76.5%)
Target IOP (Hoddap) single medication	64 (90.0%)	79 (91.8%)

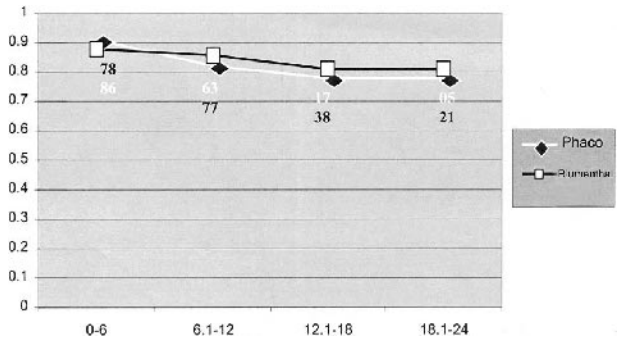

FIGURE 1. Kaplan-Meier survival analysis (achievement of target IOP) for Blumenthal and phacoemulsification triple. X axis shows mean follow-up review (months). Y axis shows success rate.

compared with trabeculectomy combined with standard manual extracapsular surgery.[3–5] It has been suggested that differences might be due to the use of mitomycin rather than incision size.[13] The reported success rates with phaco triples vary from 66 to 93%.[14–21] The IOP reduction is reported to be similar in phaco triples with a 3.2-mm incision (foldable lens) and those with a 5.5-mm incision (PMMA lens).[22–27] There are no reports comparing the results of phacoemulsification combined with trabeculectecomy to manual small-incision cataract surgery combined with trabeculectomy.

Our results show that the mean IOP at all follow-up visits were similar in both groups; 17 mm Hg, a 50% IOP reduction from baseline at last follow-up review. Achievement of target IOP is one way of assessing success.[9] With the use of Mitomycin in all cases, supplemented with 5 FU injections as indicated, we could achieve the target IOP in 75% patients; 90% with one medication. The results are poorer than in western eyes.[19–21] Morris et al[28] reported that African-American race has a higher failure rate after glaucoma surgery and perhaps Indian eyes behave more like African-American eyes. We could not locate reports on combined cataract and trabeculectomy in Indian eyes, but short-term success of 93% has been reported after trabeculectomy with a short follow-up review of 18 weeks and success defined as a postoperative IOP less than 21 mm Hg.[29]

TABLE 4. *Mean intraocular pressure at baseline and follow-up in patients who underwent phaco-triple and Blumenthal-triple*

	IOP (mm Hg) (Phaco-triple) (n = 78)	IOP (mm Hg) (Blumenthal triple) (n = 86)	Statistical significance
Baseline	29.2 mm Hg (± 7.2)	31.9 mm Hg (± 7.2)	$P < 0.9$
First day	10.8 mm Hg (± 3.4)	13.1 mm Hg (± 4.2)	$P < 0.8$
1 week	9.2 mm Hg (± 4.4)	10.1 mm Hg (± 4.6)	$P < 0.9$
1 month	12.1 mm Hg (± 4.5)	12.1 mm Hg (± 4.9)	$P < 1.0$
Last visit	12.8 mm Hg (± 3.2)	13.8 mm Hg (± 3.5)	$P < 0.9$

IOP, intraocular pressure.

TABLE 5. *Success of surgery in patients undergoing phaco-triple and Blumenthal-triple*

Success criteria	Phaco-triple (n = 14)	Blumenthal-triple (n = 14)
IOP < 21 mm Hg single medication	13 (93%)	14 (100%)
IOP < 16 mm Hg single medication	9 (63%)	10 (70%)
Target IOP (Jample) without medication	11 (77%)	11 (77%)
Target IOP (Jample) on single medication	12 (85%)	13 (93%)

When patients with a follow-up review of more than 1 year were analyzed separately; the reduction in the Blumenthal group was 15.8 mm Hg compared with 17.5 mm Hg in the phacoemulsification group. While this difference was not statistically significant, it occurred despite the phaco group having a longer follow-up review and may be clinically significant. The trend may be confirmed with a longer follow-up review.

Postoperative visual acuity was similar in both groups. While the uncorrected visual acuity is usually taken to indicate success, postoperative refractions were not necessarily planned for emmetropia. Accordingly we felt that BCVA would be a better indicator of visual outcome. Induced astigmatism would have been a good secondary outcome measure. However, as this study was retrospective, pre- and postoperative keratometry was not available for all patients. Oshika et al[30] reported a statistically significant difference in surgically induced astigmatism between 3.2 mm and 5.5 mm phacoemulsification, but the magnitude of the difference producing this significance was 0.3 D cylinder. Our unpublished data comparing induced astigmatism between phacoemulsification with a foldable lens (3.2-mm incision) and the Blumenthal technique (5.5-mm incision) also revealed a difference of 0.3 D cylinder. While surgeons may interpret the clinical significance of this difference differently, those in developing countries may not consider this a major advantage. If a foldable lens is used,

TABLE 6. *Complications in patients who underwent phaco-triple and Blumenthal-triple*

Complications	Phaco-triple (%) (n = 78)	Blumenthal-triple (%) (n = 86)
Posterior capsular rupture	2 (2.6%)	5 (5.8%)
Zonular dialysis	1 (1.3%)	2 (2.3%)
Descemet detachment	3 (3.9%)	3 (3.5%)
Nucleus drop	1 (1.3%)	0 (0.0%)
Hyphema	3 (3.9%)	4 (4.7%)

TABLE 7. *Bleb morphology in patients who underwent phaco-triple and Blumenthal-triple*

Bleb morphology	Phaco-triple (n = 78)	Blumenthal-triple (n = 86)
Good	26 (33.4%)	18 (20.9%)
Moderate	18 (23%)	17 (19.8%)
Shallow	20 (25.6%)	33 (38.3%)
Absent	14 (18%)	18 (20.9%)

phacoemulsification does have the advantage of a smaller incision, and perhaps even earlier visual rehabilitation. This increases the cost, but may not improve the success as far as control of IOP is concerned.[22–27]

The 14 patients who underwent phaco triple in one eye and Blumenthal triple in other eye had similar results (IOP and vision) in both eyes. Mean IOP reduction, achievement of target IOP, and visual acuity were similar. Although the number of patients is small we feel that a similar result in the fellow eye of the same patient is evidence in favor or equivalence of techniques.

There was a higher rate of posterior capsular rupture and vitreous loss in the Blumenthal group. We attribute this to 2 reasons. First, in the setting of combined cataract and glaucoma surgery, most surgeons had used phacoemulsification for a longer time compared with the Blumenthal technique. Some of the surgeons were still in the learning curve for the latter technique when combined with a trabeculectomy. Secondly, most cases with advanced cataract (black and brown cataract) preferentially underwent the Blumenthal technique. With such cataracts, all surgeons "felt" safer with and were biased toward the Blumenthal technique.

Our study has several limitations. It is a chart review with all limitations of a retrospective study design. Glaucoma is chronic disease and results with longer follow-up data are desirable. The distribution of cataracts also was unequal, with more advanced cases in the Blumenthal group. The unequal distribution was in keeping with our training and philosophy: in our hands, harder cataracts were more easily done by the Blumenthal technique. The unequal distribution should be discounted because while there were higher complications with the Blumenthal technique, the results were still similar. Several surgeons performed surgery; however this can also be considered strength as far as applicability is concerned. Finally, a differential follow-up period in the 2 groups is also a limitation. The failure to find a difference could be due to low power of the study: with an α error of 0.05 the power to detect a difference of 2 mm Hg was 80%; the power to detect a difference of 1.5 mm Hg was 60%.

Our results have a bearing on surgery in developing countries. The Blumenthal technique (and other manual small incision techniques are less instrument dependent and more cost effective compared with phacoemulsification. We feel this is especially true for the advanced cataracts, and with an annual per capita income of $350/- in India makes the technique is a very attractive alternative. Additionally, we feel that for the average cataract surgeon, it is applicable to a wider range of cataracts. In developing countries where there are a lot of mature, brown and black cataracts, this may be a major advantage.

This small retrospective study could not demonstrate a difference in reduction of IOP between the Blumenthal triple and the phaco triple.

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