Comparison of the Ahmed and Baerveldt glaucoma shunts with combined cataract extraction

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ABSTRACT ●

Objective: To compare the surgical outcomes of combined phacoemulsification with either Ahmed glaucoma valve (AGV) or Baerveldt glaucoma implant (BGI).

Design: Retrospective cohort study.

Participants: A total of 104 eyes that underwent combined phacoemulsification with either AGV (PhacoAGV; n = 57) or BGI (PhacoBGI; n = 47) implantation.

Methods: Failure was defined as uncontrolled intraocular pressure (IOP; <5 mm Hg, ≥18 mm Hg, or <20% reduction), additional glaucoma surgery, vision-threatening complications, or progression to no-light-perception vision.

Results: The PhacoAGV group was older ($p = 0.03$), had poorer baseline visual acuity (VA; $p = 0.001$), and had fewer previous glaucoma surgeries ($p = 0.04$). Both groups had similar baseline IOP (PhacoAGV: 26.4 ± 8.3 mm Hg; PhacoBGI: 25.7 ± 7.3; $p = 0.66$) and glaucoma medications (PhacoAGV: 3.8 ± 1.0; PhacoBGI: 3.6 ± 1.5; $p = 0.54$). At 2 years, failure rates were 44% in the PhacoAGV group and 23% in the PhacoBGI group ($p = 0.02$). Both groups had similar mean IOP reduction (PhacoAGV: 45%; PhacoBGI: 47%, $p = 0.67$) and medication use reduction (PhacoAGV: 47%; PhacoBGI: 58%, $p = 0.38$). The PhacoBGI group had higher IOP and medication use up to 1 month ($p < 0.05$). Both groups improved in VA from baseline ($p < 0.05$) and had similar overall complication rates ($p = 0.31$). The PhacoBGI group required more overall interventions ($p < 0.0005$).

Conclusions: This comparative study found no difference in IOP, glaucoma medications, or complication rates between PhacoAGV and PhacoBGI at 2 years, despite BGIs being implanted in patients at higher risk for failure. The PhacoAGV group had higher failure rates at 2 years. Both groups had significant improvements in VA due to removal of their cataracts. The PhacoBGI group required more interventions, but most of these were minor slit-lamp procedures.

Glaucoma drainage devices have an increasing role in the surgical management of glaucoma.[1] Glaucoma drainage devices have been shown to have superior efficacy and similar safety profiles compared to trabeculectomy with antimetabolite in eyes that have previously undergone trabeculectomy and/or cataract surgery.[2] Although trabeculectomy was used more commonly in the past, the procedure has a high rate of complications and 5-year trabeculectomy failure rates of over 50%.[2,3]

Two commonly used devices are the Ahmed glaucoma valve (AGV; New World Medical, Inc, Rancho Cucamonga, Calif.) and the Baerveldt glaucoma implant (BGI; Abbott Medical Optics, Inc, Santa Ana, Calif.). Both of these devices consist of a silicone tube that shunts aqueous humour to a bleb overlying the end plate.[4] The end plate prevents obstruction of the tube by fibrous encapsulation and determines the bleb surface area available for aqueous absorption.[4]

The AGV contains a unidirectional Venturi-based flow restrictor that theoretically limits the flow of aqueous humor when the intraocular pressure (IOP) drops below 8–12 mm Hg.[5] This mechanism is designed to prevent postoperative hypotony, especially in the early postoperative period when encapsulation of the tube has not yet occurred. Despite its benefits, patients with AGVs often require postoperative IOP-lowering medications due to high rates of encapsulation or insufficient IOP reduction.[6]

The BGI is a nonvalved tube shunt that requires temporary tube occlusion to limit early aqueous flow until adequate healing to modulate flow occurs around the end plate.[7,8]

Nonetheless, patients receiving BGIs have been reported to experience early IOP fluctuations, including both ocular hypertension and hypotony-related complications.[7,8] Once patent, the BGI has been associated with greater IOP control, fewer glaucoma medications, and less encapsulation in the long-term.[6,9,10] These benefits may be due to its larger end plate (350 mm^2 Baerveldt vs 184 mm^2 Ahmed), lack of valve-induced resistance, and delayed early aqueous flow.[10–13] Aqueous from glaucomatous eyes has been demonstrated to promote fibrovascular proliferation,[14] and histologic studies have demonstrated that early aqueous flow results in a thickened fibrovascular bleb capsule, whereas delayed aqueous flow results in a thin avascular bleb.[15]

Because cataract and glaucoma commonly occur simultaneously, cataract extraction with combined glaucoma drainage device implantation has become a popular option in these patients.[16] The combined procedure reduces the

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need for a second surgery, which confers advantages such as reduced anaesthesia, shorter overall operative time, and lower surgical cost to the patient and the health care system.[17]

Prior studies have examined the safety and efficacy of combined phacoemulsification with AGV[18] (PhacoAGV) or BGI[19] (PhacoBGI) implantation independently. Our retrospective, single-surgeon study compares the surgical outcomes of AGV and BGI implantation with a simultaneous phacoemulsification procedure.

Materials and Methods

A retrospective chart review was conducted for all consecutive patients having undergone phacoemulsification with an intraocular lens implant and concomitant glaucoma drainage device implantation at a tertiary care centre. Ethics approval for this study was obtained from Institutional Review Board Services (Aurora, Canada).

Only patients who underwent PhacoAGV or PhacoBGI were included in the study. Patients were excluded if a glaucoma drainage device other than the AGV or BGI was implanted or if the recorded follow-up duration was less than 6 months. Demographic and ocular characteristics of patients were collected preoperatively within 1 month of surgery.

Surgery was performed by a single surgeon (I.K.A.) on eyes with cataract and glaucoma refractory to conventional treatment modalities. All intraocular lenses were placed in the capsular bag. The AGVs used were the FP7 model (48/57 eyes), the FP8 model (8/57 eyes), and the M4 model (1/57 eyes). The BGIs used were the 350-mm^2 model (36/47 eyes) and the 250-mm^2 model (11/47 eyes). The BGIs were ligated with a 7-0 Vicryl suture and had 1–3 venting slits created using a sharp needle blade to control the IOP in the early postoperative period. Both tube types were covered with scleral patch grafts.

IOP, glaucoma medication use, and Snellen visual acuity (VA) data were collected at 1 day, 1 week, 1 month, 3 months, 6 months, 1 year, 18 months, and 2 years postoperatively. Complications of the surgery and additional interventions required were recorded at each visit.

Outcome Measures

The primary outcome measure was failure, defined by any of the following criteria: (*i*) IOP ≥18 mm Hg, IOP <5 mm Hg, or IOP not reduced by 20% from baseline on 2 consecutive visits on or after 3 months, (*ii*) additional glaucoma procedures, (*iii*) removal of the implant, (*iv*) progression to no-light-perception vision, or (*v*) vision-threatening complications related to the implant/surgery (e.g., endophthalmitis, choroidal effusions, or suprachoroidal hemorrhages requiring drainage). Eyes that did not meet any of the failure criteria were considered successes. Success was further categorized as qualified or complete, where complete success did not require any glaucoma medications postoperatively on or after 3 months. If multiple failure criteria were met, patients were categorized under the criterion that occurred first.

Alternative IOP cutoff values of 21 and 14 mm Hg were used for secondary survival analyses. All other criteria for failure were the same as in the primary analysis outlined above. Secondary outcome measures included IOP, glaucoma medication use, VA, complications, and interventions.

Statistical Analysis

All statistical analyses were completed using IBM SPSS Statistics, Version 20.0.0 (International Business Machines Corp, Armonk, N.Y.). All statistical tests were 2-sided, with significance defined as $p \leq 0.05$. Quantitative data were compared using the independent t test, paired t test, Mann–Whitney U test, Wilcoxon signed-rank test, and mixed analysis of variance depending on the distribution of the data. Discrete and qualitative data were compared using the Pearson's χ^2 test and Fisher's exact test. Kaplan–Meier survival analysis with the log-rank (Mantel–Cox) test and Cox regression analysis were employed to compare success rates between the 2 groups. Snellen VA was converted to logMAR for all statistical analyses.

Results

A total of 104 eyes of 92 patients were included in the study: 57 (55%) eyes in the PhacoAGV group and 47 (45%) eyes in the PhacoBGI group. A total of 103 (99%) eyes completed their 1-year follow-up and 86 (83%) eyes completed their 2-year follow-up. There were similar retention rates between groups ($p = 0.31$).

Baseline Patient Characteristics

Baseline characteristics of the study group are summarized in Table 1. The PhacoAGV group was older with a mean age of 68 ± 11 years compared to 57 ± 15 years in the PhacoBGI group ($p = 0.03$). There was a greater proportion of black patients in the PhacoBGI group (34% vs 12%) ($p = 0.01$). There was a greater proportion of Asian patients in the PhacoAGV group (35% vs 9%) ($p = 0.002$).

Baseline Ocular Characteristics

Baseline ocular characteristics are summarized in Table 1. There was no significant difference in the mean preoperative IOP or medication use between both groups ($p = 0.66$ and $p = 0.54$, respectively). The median Snellen VA was 20/200 in the PhacoAGV group and 20/60 in the PhacoBGI group ($p = 0.001$). There was no difference between the 2 groups in preoperative visual field indices, including mean deviation ($p = 0.86$) or pattern standard deviation ($p = 0.91$).

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