Phacoviscocanalostomy versus cataract surgery only in patients with coexisting normal-tension glaucoma: Midterm outcomes

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PURPOSE: To compare the midterm efficacy and safety of phacoviscocanalostomy (viscocanalostomy, phacoemulsification, and intraocular lens [IOL] implantation) and cataract surgery (phacoemulsification and IOL implantation) in patients with normal-tension glaucoma (NTG) and cataract.

SETTING: Sensho-kai Eye Institute, Kyoto, Japan.

METHODS: Thirty-one eyes had phacoviscocanalostomy, and 35 eyes had uncomplicated cataract surgery only. The intraocular pressure (IOP), postoperative antiglaucoma medications, and visual outcomes were compared between groups.

RESULTS: The mean follow-up was 34.9 months ± 19.8 (SD) (range 7 to 78 months). At 36 months, the mean preoperative IOP and postoperative IOP were 17.2 ± 1.5 mm Hg and 14.1 ± 1.6 mm Hg, respectively, in the phacoviscocanalostomy group and 16.7 ± 1.4 mm Hg and 15.6 ± 3.4 mm Hg, respectively, in the cataract surgery only group. The differences between groups were significant at all time points ($P<.05$). The success probabilities of the phacoviscocanalostomy group achieving 20% and 30% IOP reductions with (or without) medications were 78.5% (67.4%) and 35.5% (37.4%) at 24 months and 58.0% (44.2%) and 28.0% (26.6%) at 48 months, which were significantly better than the probabilities in the cataract surgery only group, which were 16.0% (9.5%) and 5.7% (2.9%) at 24 months ($P<.001$ for each comparison, Kaplan-Meier life-table analysis with log-rank test). Based on the modified Aulhorn-Greve classification, the visual acuity and visual fields did not deteriorate in the phacoviscocanalostomy group; the visual fields deteriorated in 6 eyes in the cataract surgery only group during the follow-up ($P = .024$).

CONCLUSION: Phacoviscocanalostomy lowered IOP and maintained postoperative visual outcomes; it was safe and effective in elderly patients with coexisting NTG and cataract.

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A recent study[1] reports that the prevalence of primary open-angle glaucoma (POAG) in Japanese patients older than 40 years is 3.9% and that 92% of patients with POAG have an intraocular pressure (IOP) lower than 21 mm Hg. Treatment of elderly patients with coexisting cataract and normal-tension glaucoma (NTG) is an important clinical issue.

Treatment of NTG is controversial because this type of glaucoma develops later in life[2,3] in patients who are often poorly compliant with medication regimens and have a shortened life expectancy. Normal-tension glaucoma generally progresses slowly,[4] and the baseline IOP is low; thus, the need for NTG treatment may be questioned. Although in the Collaborative Normal-Tension Glaucoma Study (CNTGS) Group report,[5] the only previous randomized controlled trial to treat NTG, a 30% reduction in IOP was associated with less progression of visual field damage than in controls. This report showed reducing IOP has a favorable effect on NTG.

Several studies[6–9] except one[10] report that medication alone is insufficient to achieve a 30% IOP reduction and that drugs may not be tolerated in elderly patients who are poorly compliant with topical medication regimens. The effectiveness of calcium channel blockers, which are being evaluated in clinical settings,[11–16] and of argon laser trabeculoplasty is questionable. In addition, these treatments are not widely accepted as beneficial for NTG.[2,17] Conventional filtering surgery remains the mainstay of surgical therapies

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for managing NTG refractory to medication.[6–9,18–21] Trabeculectomy can reduce IOP significantly; however, the surgery may be associated with vision-threatening complications that reduce the quality of vision.[6,8,9] These include bleb leaks, hypotony, a flat anterior chamber, choroidal detachment, and endophthalmitis.[6,9,22] Trabeculectomy slows further progression of visual field damage but does not stop it.[7]

Surgical management of coexisting cataract and POAG is another controversial issue.[2,23,24] Several studies report that corneal incision cataract surgery has a significant IOP-lowering effect[24–27]; however, cataract surgery only may not sufficiently reduce IOP. Moreover, although coexisting NTG and cataract occur frequently, few trials of glaucoma surgery other than trabeculectomy have been reported in combined surgery.[23,28]

Viscocanalostomy, which relies on the free flow of aqueous through a "window" into a "lake," effectively reduces IOP and is safe.[25,28–39] Although studies have shown that viscocanalostomy reduces IOP in patients with high-tension POAG,[28,29,34,39] it is unclear whether it has a positive IOP-lowering effect in patients with NTG. Regarding combined surgery, it is also unclear whether patients are better served by combined viscocanalostomy and cataract surgery or whether cataract surgery only is sufficient to maintain quality of life.

We conducted a retrospective comparative study of phacoviscocanalostomy versus cataract surgery only to determine the efficacy and safety of viscocanalostomy in patients with NTG and cataract over a follow-up period of 4 years postoperatively.

PATIENTS AND METHODS

Between January 2000 and December 2004, consecutive Japanese patients with NTG and cataract who had cataract surgery with or without viscocanalostomy at the Sensho-kai Eye Institute and met the study criteria were included.

The inclusion criteria were age 50 to 90 years, history of IOP not exceeding 21 mm Hg, an open angle, glaucomatous visual field defects measured by the Octopus 301 (Interzeag) full-threshold (G1) program or Goldmann kinetic perimetry, and a visually relevant cataract with a visual acuity of 0.9 or worse on a decimal visual acuity chart. A glaucomatous visual field defect was defined as a cluster of 3 adjacent points depressed by at least 5 dB or 2 independent points depressed by at least 10 dB in the "comparison" visual field. When static perimetry was not applicable, Goldmann kinetic perimetry was used to assess the visual fields. Patients with severe NTG, defined as a mean deviation value in global sensitivities of more than 15 dB with Octopus autoperimetry, were excluded and had primary trabeculectomy or phacotrabeculectomy with mitomycin-C (MMC). Other exclusion criteria were the presence of congenital glaucoma, angle-closure glaucoma, combined-mechanism glaucoma, secondary glaucoma, and vitreoretinal disease or neuro-ophthalmologic disease. Patients with previous surgery who required a conjunctival incision or ocular penetration or who were not followed for at least 6 months were also excluded.

The study was approved by the Institutional Review Board of the Sensho-kai Eye Institute. Written informed consent for surgery was obtained from each patient in accordance with the 1996 tenets of the Declaration of Helsinki.

Surgical Techniques and Postoperative Care

One experienced surgeon (E.C.) performed all surgeries. A clear corneal incision was made in all eyes in which cataract surgery only was performed, and an incision was made at a separate site in eyes in which phacoviscocanalostomy was performed.

Phacoviscocanalostomy has been described as combined viscocanalostomy and cataract surgery.[30,31] Briefly, in the phacoviscocanalostomy group, phacoemulsification, aspiration, and intraocular lens (IOL) implantation were performed before viscocanalostomy through a clear corneal incision. Viscocanalostomy was performed at a different site after IOL implantation. The procedure began with a limbal peritomy and a radial conjunctival incision in the desired quadrant, and a fornix-based conjunctival flap was created. Conjunctival and Tenon's tissue were retracted carefully to expose the sclera. A 5.0 mm × 4.0 mm parabola-shaped scleral incision was created with a razor blade. A one-third thickness limbal-based scleral flap extending 2.0 mm into clear cornea was dissected. Second, a four-fifths thickness, 3.0 mm × 3.0 mm parabola-shaped flap was dissected 1.0 mm into the clear cornea. A blunt knife (Grieshaber Ultrasharp, Alcon) was used to separate Descemet's membrane from the corneoscleral injection. To create the lake, a deeper scleral flap, including the roof of Schlemm's canal, was excised at its base. Sodium hyaluronate 1% (Healon) was injected from the right and left openings of Schlemm's canal and the lake using a 30-gauge cannula. The superficial scleral flap was sutured watertight with 3, 10-0 nylon sutures, and the conjunctival wound was closed with 10-0 BioSorb sutures. At the end of surgery, 0.5 mg of dexamethasone sodium phosphate was injected subconjunctivally. The operated eye was dressed with ofloxacin 0.3% eye ointment and betamethasone ointment.

Outcomes Criteria and Statistical Analysis

The IOP was measured by Goldmann applanation tonometry. The preoperative IOP was the mean of 3 consecutive preoperative measurements. In all patients, postoperative

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IOP was measured at 1, 2, and 4 days and 1 and 2 weeks and then monthly. The postoperative IOP was compared with the preoperative IOP using the paired *t* test, and the number of postoperative antiglaucoma medications used was compared with the preoperative number using the Wilcoxon signed rank test in the phacoviscocanalostomy and cataract surgery only groups independently. The magnitude of the IOP reduction (preoperative IOP minus postoperative IOP) and the reduction in the number of antiglaucoma medications (preoperative medications minus postoperative medications) were compared between the 2 groups using the Mann-Whitney *U* test. Complete surgical success was defined as a mean postoperative IOP of 3 consecutive measurements that was more than 20% or 30% lower than the preoperative IOP without the use of topical antiglaucoma eyedrops. Qualified success was defined as a 20% or 30% reduction in IOP with medication use. The success probabilities of both groups based on these criteria were estimated by Kaplan-Meier life-table analysis and compared using the log-rank test. Visual acuity results were evaluated 3 months postoperatively and then every 12 months using a decimal visual acuity chart. The outcomes were compared between the 2 groups using the Mann-Whitney *U* test.

Visual fields were evaluated once annually after surgery using the Octopus G1 mode or Goldmann kinetic perimetry. The visual field was classified using the modified Aulhorn-Greve classification.[40] When an increase in the glaucoma stage was confirmed by 2 examinations, visual field damage was considered to have deteriorated.

All analyses were performed on a Windows personal computer with StatView software (version 5.0, SAS). A *P* value less than 0.05 was considered significant.

RESULTS

Sixty-six eyes of 66 consecutive patients were studied; 31 eyes in the phacoviscocanalostomy group and 35 eyes in the cataract surgery only group were eligible for inclusion. Table 1 shows the demographic data by group. The characteristics between the groups were similar except for the severity of the preoperative visual fields. The mean follow-up in all eyes was 34.9 months ± 19.8 (SD) (7 to 78 months). No eye required an additional procedure such as neodymium:YAG laser goniopuncture or trabeculectomy during the follow-up period.

Table 1 shows the preoperative and postoperative IOP levels and antiglaucoma medications used in both groups. Significant reductions in IOP and the number of antiglaucoma medications were observed during the entire 36 months in the phacoviscocanalostomy group, while the reductions were significant during the first 6 months only in the cataract surgery only group ($P < .05$) (Table 2). The mean decrease in IOP at 6, 12, 18, 24, 30, and 36 months postoperatively was 4.7, 4.8, 4.5, 3.4, 3.5, and 3.1 mm Hg, respectively, in the phacoviscocanalostomy group and 1.9, 0.7, 0.6, 1.2, 1.1, and 1.0 mm Hg, respectively, in the cataract surgery only group (Table 3). The differences in the decreases in IOP between the 2 groups were significant at all time points ($P < .05$).

The intraoperative and postoperative complications (Table 4) were not vision threatening. Microperforation of Descemet's membrane (7 eyes, 22.6%) was the most common intraoperative complication in the phacoviscocanalostomy group. There were no intraoperative cases of ruptured Descemet's membrane or ruptured lens capsule. Postoperative hyphema lasting longer than 5 days (4 eyes, 12.9%) and postoperative fibrin reaction (5 eyes, 16.1%) were more common in the phacoviscocanalostomy group than the cataract surgery only group. No intraoperative complications developed in the cataract surgery only group, although fibrin reaction and transient postoperative IOP spikes exceeding 25 mm Hg were observed in 1 eye (2.9%). No

Table 1. Patient demographics.

	PV Group	CSO Group	*P* Value
No. patients	31	35	
Age	73.4 ± 7.8	74.9 ± 7.0	0.563*
Range	54–87	57–87	
Men/women	7/24	5/30	0.525†
Preop mean IOP (mmHg)	17.2 ± 1.6	16.7 ± 1.4	0.172‡
Range	14.3–20.0	14.0–19.7	
Medication	1.0 ± 0.9	0.8 ± 0.7	0.125‡
Range	0–3	0–3	
Observation period (months)	33.3 ± 17.2	36.4 ± 20.1	0.533‡
Range	7–69	7–78	
Preop mean visual field grading	2.1 ± 1.1	1.7 ± 1.7	0.017‡

CSO = cataract surgery only; Preop mean IOP = preoperative mean intraocular pressure; Preop mean visual field grading = preoperative mean visual field grading; PV = phacoviscocanalostomy
*Student's *t*-test
†Fisher's exact probability test
‡Mann-Whitney *U* test

Table 2. Preoperative and postoperative IOP levels and number of antiglaucoma medications.

	PV Group					CSO Group				
	No. Eyes	IOP (Mean ± SD)	*P* Value*	Medications (Mean)	*P* Value*	No. Eyes	IOP (Mean ± SD)	*P* Value*	Medications (Mean)	*P* Value*
Preoperative	31	17.2 ± 1.5		1.0		35	16.7 ± 1.4		0.8	
1 mo	31	12.3 ± 2.7	<0.001	0.0	<0.001	35	15.0 ± 2.9	<0.001	0.1	<0.001
2 mo	31	11.8 ± 2.6	<0.001	0.0	<0.001	35	15.2 ± 2.4	<0.001	0.1	<0.001
3 mo	31	12.0 ± 2.4	<0.001	0.1	<0.001	35	14.8 ± 2.7	<0.001	0.2	0.002
6 mo	31	12.6 ± 2.4	<0.001	0.1	<0.001	35	14.7 ± 2.1	<0.001	0.3	0.011
12 mo	28	12.5 ± 2.8	<0.001	0.1	<0.001	32	15.8 ± 2.7	0.138	0.5	0.187
18 mo	24	12.7 ± 2.5	<0.001	0.3	0.002	25	15.9 ± 3.1	0.195	0.5	0.021
24 mo	21	13.7 ± 2.3	<0.001	0.3	0.003	23	15.5 ± 25	0.064	0.7	0.405
30 mo	18	13.7 ± 1.5	<0.001	0.3	0.005	21	15.8 ± 2.1	0.082	0.8	0.366
36 mo	16	14.1 ± 1.6	<0.001	0.4	0.012	20	15.6 ± 3.4	0.145	0.8	0.564

CSO = cataract surgery only; IOP = intraocular pressure; PV = phacoviscocanalostomy
*Wilcoxon signed rank tests compare preoperative and postoperative IOP or number of preoperative and postoperative antiglaucoma medications.

severe complications such as a shallow anterior chamber, bleb leaks, choroidal detachment, hypotensive maculopathy, infections, or detachment of Descemet's membrane occurred in the phacoviscocanalostomy group. In the phacoviscocanalostomy group, the effects of complications, such as microperforations of Descemet's membrane, prolonged hyphema, or a fibrin reaction, on IOP reduction and visual acuity improvement were not statistically significant (data not shown).

Figures 1 and 2 show the Kaplan-Meier life-table analysis of success probabilities in which statistical death was defined as a postoperative decrease in IOP of 20% or less (Figure 1) or 30% or less (Figure 2) than the preoperative IOP. The complete and qualified success rates of a 20% reduction in IOP were 67.4% and 78.5%, respectively, at 24 months and 44.2% and 58.0%, respectively, at 48 months in the phacoviscocanalostomy group and 9.5% and 16.0%, respectively, at 24 months in the cataract surgery only group. The difference was significant ($P < .001$, log-rank test) (Figure 1). The complete and qualified success rates of a 30% reduction in IOP were 37.4% and 35.5%, respectively, at 24 months and 28.0% and 26.6%, respectively, at 48 months in the phacoviscocanalostomy group and 2.9% and 5.7% at 24 months, respectively, in the cataract surgery only group. The differences were significant ($P < .001$, log-rank test) (Figure 2).

Table 5 and Figure 3 compare the preoperative best corrected visual acuity (BCVA) and the postoperative BCVA up to 3 years postoperatively. The mean and standard deviation of the preoperative decimal

Table 3. Postoperative IOP reduction and mean/median reduction rates.

	PV Group			CSO Group			
Time (Mo)	No. Eyes	Magnitude of IOP Reduction (mm Hg) (Mean ± SD)	Mean Reduction Rate (%)	No. Eyes	Magnitude of IOP Reduction (mm Hg) (Mean ± SD)	Mean Reduction Rate (%)	*P* Value*
1	31	4.9 ± 2.7	28.3	35	1.6 ± 3.0	9.3	<0.001
2	31	5.4 ± 2.7	31.2	35	1.5 ± 2.3	8.7	<0.001
3	31	5.3 ± 2.7	30.3	35	1.8 ± 2.7	10.8	<0.001
6	31	4.7 ± 2.5	26.9	35	1.9 ± 2.3	11.2	<0.001
12	28	4.8 ± 3.0	27.5	32	0.7 ± 2.6	4.3	<0.001
18	24	4.5 ± 2.6	26.1	25	0.6 ± 3.2	3.0	<0.001
24	21	3.4 ± 2.0	19.4	23	1.2 ± 2.9	6.6	0.018
30	18	3.5 ± 2.0	19.6	21	1.1 ± 2.6	5.6	0.002
36	16	3.1 ± 1.8	17.6	20	1.0 ± 3.0	5.1	0.047

CSO = cataract surgery only; IOP = intraocular pressure; PV = phacoviscocanalostomy
*Mann-Whitney *U* tests compare magnitude of IOP reduction between the PV group and the CSO group.

Table 4. Intraoperative and postoperative complications.

	PV Group (n = 31) (%)	CSO Group (n = 35) (%)
Intraoperative		
Microperforation of Descemet's membrane	7 (22.6)	NA
Postoperative		
Fibrin reaction	5 (16.1)	1 (2.9)
IOP spike (>25 mmHg)	0 (0)	1 (2.9)
Bleb formation (>14 days)	7 (23.6)	NA
Prolonged hyphema (>5 days)	4 (12.9)	0 (0)

CSO = cataract surgery only; IOP = intraocular pressure; NA = not applicable; PV = phacoviscocanalostomy

BCVA and final postoperative decimal BCVA were 0.43 ± 0.28 and 0.90 ± 0.39, respectively, in the phacoviscocanalostomy group and 0.39 ± 0.27 and 0.73 ± 0.40, respectively, in the cataract surgery only group. In both groups, the visual acuity was significantly improved immediately postoperatively. In the current study, all patients had improved acuity or acuity equal to the preoperative BCVA after phacoviscocanalostomy. There was no significant difference in the preoperative BCVA and postoperative BCVA between the 2 groups at any time.

Table 6 shows the preoperative and postoperative (final) visual field outcomes according to the modified Aulhorn-Greve classification. The postoperative observation period was similar between the groups ($P = .882$). None of the 30 eyes in the phacoviscocanalostomy group had confirmed substantial visual field deterioration using achromatic static automated perimetry or manual kinetic testing over a mean observation period of 27.3 ± 15.3 months; 6 of 31 eyes had significant visual field deterioration in the cataract surgery only group during a mean observation period of 28.1 ± 19.5 months. There was a significant difference between the groups ($P = .024$, Fisher exact probability test).

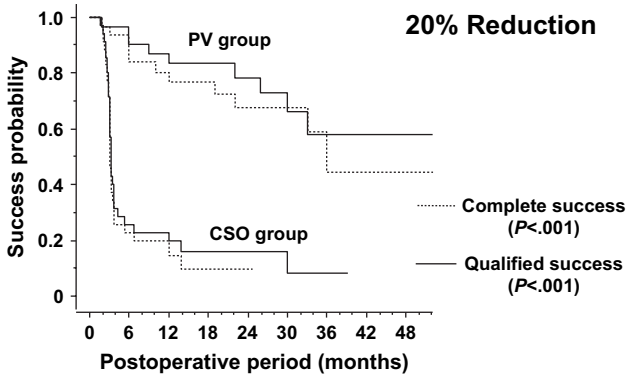

Figure 1. The cumulative survival rate determined by Kaplan-Meier life-table analysis in which the surgical success of IOP control was defined as a postoperative IOP value 20% lower than the preoperative IOP. The dotted lines indicate complete success (without medications) in both groups. The solid lines indicate qualified success (with medications) in both groups. Intergroup analysis was performed using the log-rank test (PV = phacoviscocanalostomy; CSO = cataract surgery only).

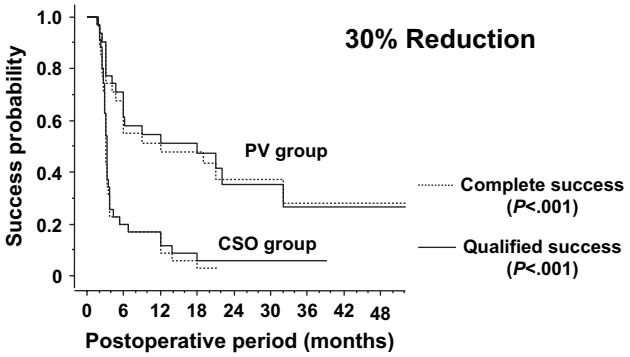

Figure 2. The cumulative survival rate determined by Kaplan-Meier life-table analysis in which the surgical success of IOP control was defined as a postoperative IOP value 30% lower than the preoperative IOP. The dotted lines indicate complete success (without medications) in both groups. The solid lines indicate qualified success (with medications) in both groups. Intergroup analysis was performed using the log-rank test (PV = phacoviscocanalostomy; CSO = cataract surgery only).

DISCUSSION

The current study found that phacoviscocanalostomy maintains lower IOP, lessens the need for glaucoma medication postoperatively, successfully maintains the visual field, and does not negatively affect postoperative visual acuity in patients with combined cataract and NTG compared with cataract surgery only, after which there was also a slight, but significant, reduction in IOP postoperatively.

To our knowledge, this comparative study is the first report of nonpenetrating glaucoma surgery for NTG. The mean reduction in IOP after phacoviscocanalostomy ranged from 3.1 to 5.4 mm Hg (18% to 31% reduction over baseline IOP). The number of topical medications used postoperatively also decreased significantly in the phacoviscocanalostomy group compared with the cataract surgery only group. Most published data suggest that viscocanalostomy is effective in patients with ocular hypertension and POAG; however, the procedure tends to achieve final IOP in the middle or high teens.[28,30,32–34,37,38] In the current study, the magnitude of the IOP reduction was among the lowest that has been reported after viscocanalostomy or phacoviscocanalostomy; studies report reductions ranging from 5.4 mm Hg to

Table 5. Comparison of preoperative and postoperative BCVA.

	PV Group		CSO Group		
	No. Eyes	Decimal VA (Mean ± SD) (with Snellen equivalent)	No. Eyes	Decimal VA (Mean ± SD) (with Snellen equivalent)	*P* Value
Preoperative	31	0.43 ± 0.28 (20/47.6)	35	0.39 ± 0.27 (20/55.6)	0.890*
Postoperative (mo)					
3	31	0.91 ± 0.30 (20/21.3)	35	0.83 ± 0.39 (20/24.0)	0.942*
12	28	0.94 ± 0.30 (20/21.3)	32	0.81 ± 0.36 (20/24.7)	0.535*
24	21	0.92 ± 0.33 (20/21.6)	22	0.67 ± 0.44 (20/29.9)	0.680*
36	16	0.90 ± 0.39 (20/22.2)	20	0.73 ± 0.40 (20/27.4)	0.563*

BCVA = best corrected visual acuity; CSO = cataract surgery only; PV = phacoviscocanalostomy; VA = visual acuity
*Mann-Whitney U tests compare the PV group and the SC group.

30.5 mm Hg.[25,28,30–38] Regarding the difference in surgical outcomes, race, observation periods, preoperative IOP levels, surgical success criteria, preoperative or postoperative medication use, and surgeon experience may have contributed to the wide variations in IOP reduction.

Jongsareejit et al.[6] report that only about 40% of Japanese patients with NTG successfully maintained an IOP level 20% lower than the preoperative IOP after trabeculectomy with MMC. Stark et al.[41] report that they performed phacotrabeculectomy without antimetabolite agents in white glaucoma patients with low IOP (mean 18.7 mm Hg); the final mean reduction was 19.2%. These results are comparable to ours. The mean preoperative IOP in the phacoviscocanalostomy group was 17.2 ± 1.5 mm Hg, and this may be why the postoperative IOP ranged from the low to middle teens.

As reported in the CNTGS,[5] a low IOP is beneficial for maintaining visual fields in patients with NTG.[5] The CNTGS recommended a 30% reduction in IOP; however, in the CNTGS, the benefit of IOP reduction on visual field progression was apparent only after statistically adjusting for patients who developed cataracts after surgery and the 30% may be an arbitrary setting. If patients are elderly and their life expectancy is short, it may be unnecessary to set a 30% lower target IOP; a 20% reduction may be sufficient after glaucoma surgery. In fact, the mean age in our study was more than 10 years older than that of the patients in the CNTGS. Adhering to a goal of a low IOP may result in a higher incidence of disastrous postoperative complications and lower quality of life.[6,18]

Another significant finding is that our patients had good quality of vision after combined cataract and glaucoma surgery. Considering the more important outcomes, such as the quality of vision, quality of activities of daily living, good visual acuity, less deterioration in visual fields, and less need for maintenance (ie, fewer visits to an ophthalmologist and fewer postoperative complications and medications), phacoviscocanalostomy may be a good therapeutic option for elderly patients.

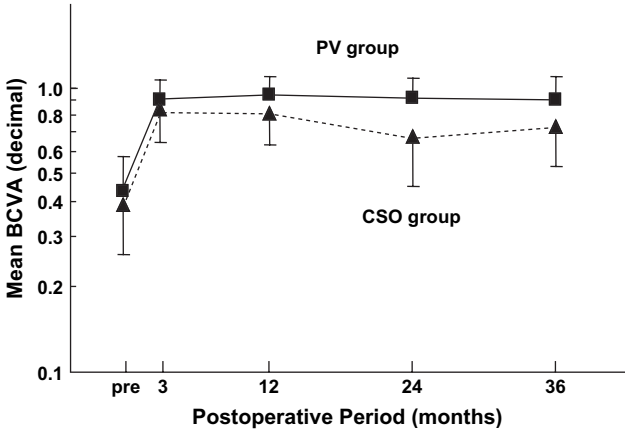

Figure 3. Mean BCVA (decimal) over time.

Table 6. Preoperative and final visual fields.

	PV Group	CSO Group	*P* Value
No. eyes	30	31	
Preop mean visual field	2.1 ± 1.0	1.7 ± 1.3	
Final mean visual field	2.1 ± 1.1	1.9 ± 1.5	
Significant deterioration	0 case	6 cases	0.024*
Observation period (mo)	27.3 ± 15.3	28.1 ± 19.5	0.882†

CSO = cataract surgery only; Preop mean visual field = preoperative mean visual field; PV = phacoviscocanalostomy
Visual field was classified using the modified Aulhorn-Greve classification.
*Fisher's exact probability test
†Mann-Whitney U tests

Regarding complications, published case series agree that viscocanalostomy is associated with fewer complications than trabeculectomy.[25,28,33,34,36] In the current study, no eye in the phacoviscocanalostomy group developed a severe complication. Minor complications were transient and not sight threatening.

This study had limitations. First, the visual fields were evaluated by Goldmann kinetic perimetry in some elderly patients and by automated static perimetry in those with clinically relevant cataracts who had atypical results and low reliability. Careful manual threshold testing by a trained operator is generally acceptable when patients cannot perform automated perimetry reliably[2]; however, our results could not provide a quantified and detailed visual field analysis. Second, the long latency associated with NTG development, along with the 4-year duration of the trial, may have contributed to our results because the changes in the visual fields in patients with NTG typically develop slowly and the deterioration rate varies widely among individuals.[7] Ongoing follow-up will assess the long-term effect of phacoviscocanalostomy. Third, we excluded from our series eyes with severe damage, and this may have affected the results of no progression. Although phacoviscocanalostomy could safely achieve modest IOP reduction, another problem is how we should treat patients with severe disc damage. Finally, this was a retrospective study and may have included differences between the groups even though the preoperative age, IOP, medications, and observation periods were similar. Another randomized study might be necessary to confirm our results.

In conclusion, phacoviscocanalostomy is effective and safe for reducing IOP, maintaining visual fields, and improving visual acuity in patients with cataract and NTG. The results in this study should be helpful when therapeutic options are considered for patients with coexisting NTG and cataract.

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