Effect of cataract surgery on intraocular pressure control in glaucoma patients

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ABSTRACT

Purpose: To examine the effect of cataract surgery on intraocular pressure (IOP) control in eyes with angle-closure glaucoma (ACG) and open-angle glaucoma (OAG).

Setting: Hayashi Eye Hospital, Fukuoka, Japan.

Methods: This study included 74 eyes with ACG and 68 eyes with OAG having cataract surgery. The IOP was measured and the number of glaucoma medications recorded preoperatively, 1 month postoperatively, and then every 3 months. The IOP control in the 2 groups was compared using survival analysis, with failure criteria being an IOP greater than 21 mm Hg, addition of medications, or the need for additional glaucoma surgery.

Results: The mean IOP and number of medications decreased significantly after surgery in both groups ($P < .0001$). However, the mean decrease in IOP and percentage of IOP reduction in the ACG group were greater than in the OAG group, and fewer medications were required in the ACG group. The cumulative survival probability of IOP control at 24 months was 91.9% in the ACG group and 72.1% in the OAG group. The survival curve in the ACG group was significantly better than in the OAG group ($P = .0012$). The IOP was controlled without medication in 30 eyes (40.5%) in the ACG group and 13 (19.1%) in the OAG group; the difference between groups was significant ($P = .0055$).

Conclusions: Cataract surgery substantially reduced IOP and the number of medications required for IOP control in glaucomatous eyes. Specifically, cataract extraction normalized the IOP in most eyes with ACG. *J Cataract Refract Surg 2001; 27:1779–1786 © 2001 ASCRS and ESCRS*

Surgical management of patients with coexisting visually significant cataract and glaucoma is difficult. The surgeon has 3 options: performing cataract surgery alone, performing glaucoma surgery alone followed by later cataract surgery, or performing combined cataract and glaucoma surgery. In recent years, the intraocular pressure (IOP) lowering effect of glaucoma surgery has been substantially enhanced by the adjunctive use of antimetabolites.[1–4] However, vision-threatening complications, including hypotony, maculopathy, flat anterior chamber, and bleb infection, are not uncommon.[5–8] In particular, an eye with angle-closure glaucoma (ACG) is at risk of developing a flat anterior chamber after filtering surgery.[9]

On the other hand, many studies show that cataract extraction with posterior chamber intraocular lens

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(IOL) implantation also decreases IOP in eyes with or without glaucoma,[10–18] although the effect varies considerably depending on the type and severity of glaucoma.[12,14] In particular, several reports[19–25] assert that cataract extraction can normalize IOP in eyes with ACG. In these studies, the long-term reduction in IOP in eyes with ACG was attributed to significant widening of the anterior chamber angle. The mechanism of primary ACG may be principally related to an imbalance of a large and anteriorly positioned lens and a small anterior segment,[26–30] which leads to relative pupillary block and, subsequently, permanent closure of the anterior chamber angle.[31] Therefore, it seems reasonable that cataract extraction could improve IOP control in eyes with ACG. In contrast, although IOP control in open-angle glaucoma (OAG) has also been reported to improve after cataract surgery,[10–18] the mechanisms of the IOP decrease remain unclear. As the trabecular meshwork is compromised in OAG, the IOP reduction after cataract surgery may be transient.

This study prospectively evaluated long-term IOP control after cataract surgery in eyes with glaucoma. In particular, it sought to determine whether there was a difference in postoperative IOP control between eyes with ACG and those with OAG. To lessen damage to the outflow system and minimize postoperative inflammation, clear corneal phacoemulsification and foldable IOL implantation techniques were used.

Patients and Methods

The study included 74 consecutive eyes of 74 patients with ACG and 68 consecutive eyes of 68 patients with OAG who were scheduled for phacoemulsification and IOL implantation between August 1996 and March 1998. When both eyes had surgery, only the eye operated on first was evaluated. Informed consent was obtained from all patients, and the study was performed after approval by the Institutional Review Board.

The diagnostic criteria of ACG and OAG have been described.[32] Briefly, the diagnosis of ACG was made based on symptoms of IOP elevation, the presence of glaucomatous optic disc excavation, visual field defects on the Humphrey Field Analyzer 30-2 threshold test (Humphrey Instruments Inc.), and gonioscopic findings of synechias or an occludable angle.[33] Indicators of IOP elevation included (1) a history of acute angle-closure glaucoma, (2) intermittent blurred vision, halo, and periocular pain, or (3) IOP greater than 21 mm Hg on 2 consecutive visits approximately 1 month apart. The presence of a shallow anterior chamber measured by a Scheimpflug videophotography system (Nidek) was also used in the diagnosis. The diagnosis of OAG was made based on the presence of optic disc excavation or other nerve fiber layer findings characteristic of glaucoma that were compatible with the visual field defects on the Humphrey 30-2 threshold test. Glaucomatous disc excavation was defined as a cup-to-disc ratio of more than 0.7, disc asymmetry, total or partial thinning of the neural rim, and peripapillary atrophy.

Only patients whose preoperative glaucoma hemifield test results were abnormal were included. Patients with ocular hypertension or secondary glaucoma were excluded.

Of the 74 eyes with ACG, 68 had primary angle-closure glaucoma only. The other 6 also had pseudoexfoliation syndrome, in which an open-angle glaucoma mechanism may contribute to the etiology.[33] Of the 68 eyes with OAG, 48 had primary open-angle glaucoma, while the other 20 had pseudoexfoliation glaucoma. No eye had laser trabeculoplasty before cataract surgery. In the ACG group, 33 eyes had argon laser iridotomy preoperatively.

A single surgeon (K.H.) performed all operations using a previously described technique.[32] Briefly, a 4.1 mm beveled clear corneal incision was made. A continuous curvilinear capsulorhexis measuring approximately 5.5 mm in diameter was created with a 25-gauge bent needle under sodium hyaluronate 1%. After thorough hydrodissection, phacoemulsification of the nucleus and cortex aspiration were performed. The capsular bag was inflated with sodium hyaluronate, and an MA60BM IOL (Alcon Surgical) with a 6.0 mm acrylic optic and poly(methyl methacrylate) loops was implanted.

The IOP was measured using a Goldmann applanation tonometer the day before surgery and 1, 3, 6, 9, 12, 15, 18, 21, 24, 27, and 30 months after surgery. Only patients who were followed for at least 12 months were included in the analyses. Best corrected visual acuity, measured on decimal charts, and the number of glaucoma medications used were also recorded at each visit. The decimal visual acuity was converted to the logarithm of the minimal angle of resolution (logMAR) for statistical analysis. Any kind of glaucoma medication was counted as 1. Gonioscopic examinations and Humphrey 30-2 full-threshold testing were performed the day before surgery and 1 month after surgery. Data on the gonioscopic examinations are not shown as they were subjective and semiquantitative.

Failure was judged using 2 definitions. The first failure criterion included (1) an IOP greater than 21 mm Hg on 2 consecutive visits 1 month apart, (2) more glaucoma medications needed than before surgery, or (3) the need for additional glaucoma surgery. The second criterion included (1) an IOP greater than preoperatively on 2 consecutive visits 1 month apart, (2) more glaucoma medications than before surgery, or (3) the need for additional glaucoma surgery. The first criterion represents poor control of IOP and the second, a worsening of IOP from preoperatively. Transient IOP elevation within the first 3 weeks after cataract surgery was excluded from the determination of success or failure.

Statistical analyses were performed to compare the results between the ACG and OAG groups. The differences in IOP, number of glaucoma medications, logMAR visual acuity, and other continuous variables were compared using the Mann-Whitney *U* test. Temporal changes in IOP and the number of medications were compared using the repeated-measures analysis of variance (ANOVA). Categorical variables were compared using the chi-square or Fisher exact test. Kaplan-Meier survival analysis was used to estimate the probability of continued success of IOP control over time after surgery in each group. Survival curves for the 2 groups were compared with the Mantel-Cox log-rank test. Probability values less than 0.05 were considered statistically significant.

Results

The mean age of the 55 men and 87 women was 73.4 years ± 7.5 (SD) (range 48 to 88 years). The mean length of follow-up after cataract surgery was 25.0 ± 9.2 months. Patient characteristics by group are shown in Table 1. No statistically significant differences were found between the 2 groups in age, ratio of left to right eyes, or mean duration of follow-up. The percentage of women in the ACG group was significantly greater than in the OAG group ($P = .0099$), which is consistent with the results of previous epidemiologic studies.[27,34] All surgeries were completed without major complications.

Table 1. Patient characteristics.

Characteristic	ACG Group	OAG Group	*P* Value
Number of eyes	74	68	—
Mean age ± SD (years)	73.4 ± 7.3	73.5 ± 7.9	.8719*
Men/women	21/53	34/34	.0099†
Mean follow-up (months)	25.7 ± 8.5	24.1 ± 9.8	.3811*

ACG = angle-closure glaucoma; OAG = open-angle glaucoma
*Not statistically significant
†Statistically significant

The mean IOPs and decreases in IOP from preoperative values in the ACG and OAG groups before surgery and 1, 3, 6, 9, 12, 15, 18, 21, and 24 months after surgery are shown in Table 2. The mean percentages of IOP reduction are shown in Figure 1. There was no significant difference in mean preoperative IOP between the 2 groups. After cataract surgery, IOP was significantly less than preoperatively in both groups ($P < .0001$, ANOVA). Although no significant difference was found in the mean postoperative IOPs, the mean decrease and the percentage reduction in IOP in the ACG group were significantly greater than those in the OAG group.

Figure 2 shows the change in the mean number of glaucoma medications required over time. Preoperatively, the number of medications was similar between the 2 groups. After cataract surgery, the number of medications decreased significantly in both groups ($P < .0001$), although the mean number of postoperative medications in the ACG group was significantly less than in the OAG group. The IOP was controlled without medication at 24 months in 30 eyes (40.5%) in the ACG group and 13 eyes (19.1%) in the OAG group; the difference between groups was significant ($P = .0055$).

Figure 3 shows the change in mean logMAR visual acuity over time. The mean acuity improved significantly after surgery in both groups ($P < .0001$). One month after surgery, no eye had impaired visual acuity as a result of cataract surgery. At 24 months, visual acuity was worse than preoperatively in 6 eyes. The visual acuity loss was caused by progression of the glaucomatous field defects in 4 eyes in the OAG group and branch

Table 2. Mean IOP (mm Hg) and mean decrease in IOP (mm Hg) over time.

	Mean IOP ± SD (Decrease)					
Examination	**ACG**		**OAG**		***P* Value**	
Preoperative	21.4 ± 3.9	—	20.7 ± 5.4	—	.1713*	—
Postoperative (months)						
1	15.5 ± 3.2	(5.8 ± 3.7)	15.9 ± 4.2	(4.8 ± 5.0)	.8207*	(.0488†)
3	14.7 ± 2.9	(6.6 ± 3.5)	16.1 ± 5.0	(4.6 ± 4.6)	.1778*	(.0008†)
6	15.3 ± 2.8	(6.1 ± 3.6)	16.1 ± 4.3	(4.5 ± 4.6)	.3098*	(.0120†)
9	15.1 ± 3.2	(6.2 ± 3.9)	16.0 ± 4.1	(4.6 ± 4.7)	.2280*	(.0117†)
12	15.3 ± 3.6	(6.0 ± 3.8)	16.3 ± 4.2	(4.3 ± 4.2)	.1984*	(.0129†)
15	14.6 ± 2.7	(6.8 ± 3.7)	15.1 ± 4.2	(5.1 ± 3.6)	.3939*	(.0148†)
18	14.8 ± 2.8	(6.9 ± 3.7)	15.5 ± 4.0	(4.9 ± 4.1)	.5340*	(.0210†)
21	14.8 ± 2.9	(7.4 ± 3.8)	15.8 ± 4.2	(4.8 ± 4.4)	.3845*	(.0040†)
24	14.5 ± 2.6	(7.2 ± 3.5)	15.2 ± 3.8	(5.3 ± 4.8)	.5781*	(.0200†)
P value	<.0001‡		<.0001‡			

*Not significant difference
†Significant difference between the groups
‡Significant difference between the periods

retinal vein occlusion in 2 eyes in the ACG group. Both the preoperative and postoperative logMAR visual acuities in the ACG group were better than in the OAG group.

Kaplan-Meier survival plots for the 2 groups are shown in Figures 4 and 5. According to the first criterion, failures were recorded in 6 eyes in the ACG group and 19 in the OAG group (Figure 4). Five eyes in the OAG group required trabeculectomy, and no eye in the ACG group had additional glaucoma surgery. The mean time to failure was 15.8 ± 9.3 months in the ACG group and 6.6 ± 5.3 months in the OAG group; the difference between groups was significant ($P = .0146$). The cumulative success probability 24 months after surgery was 91.9% in the ACG group and 72.1% in the OAG group; the success probability curve in the ACG group was significantly higher than in the OAG group ($P = .0012$, Mantel-Cox). In eyes in which surgery was considered a failure, the preoperative IOP was significantly higher than in those in which surgery was considered successful in both the ACG ($P = .0011$) and OAG ($P = .0005$) groups.

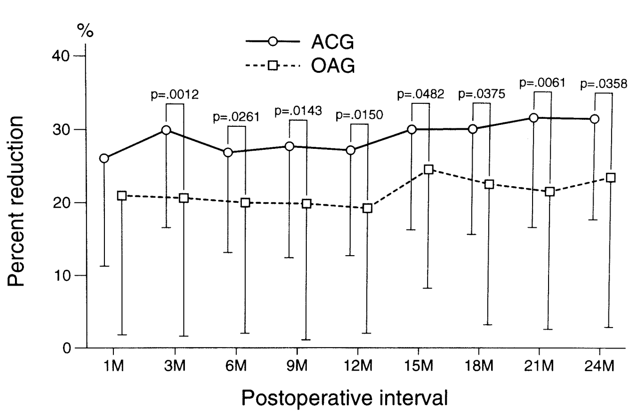

Figure 1. (Hayashi) Comparison of the mean percentage of IOP reduction between the ACG and OAG groups (p = differences between groups at each follow-up, Mann-Whitney *U* test).

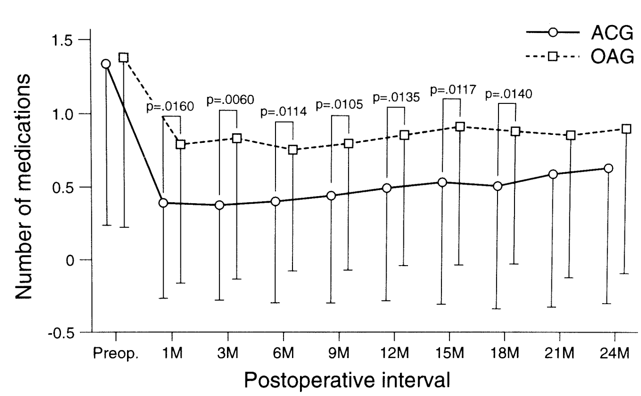

Figure 2. (Hayashi) Change in the mean number of glaucoma medications in the 2 groups (p = differences between groups at each follow-up, Mann-Whitney *U* test).

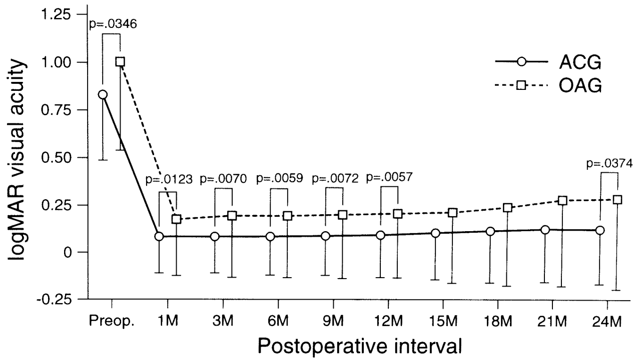

Figure 3. (Hayashi) Change in the mean logMAR visual acuity in the 2 groups.

According to the second criterion, failures were recorded in 2 eyes in the ACG group and 18 in the OAG group (Figure 5). The mean time to failure was 24.0 ± 3.5 months in the ACG group and 8.5 ± 7.4 months in the OAG group; the difference between groups was significant ($P = .0094$). The cumulative success probability at 24 months was 97.3% in the ACG group and 76.5% in the OAG group; the success probability curve in the ACG group was also significantly higher than in the OAG group ($P < .0001$). In eyes in which surgery was considered a failure, the preoperative IOP was significantly higher than in those in which surgery was considered successful in the ACG group ($P = .0244$) but not in the OAG group.

There were no significant differences in the mean IOP, decrease in IOP, percentage reduction in IOP, and the number of medications throughout the follow-up between the 33 eyes in the ACG group that had previous argon laser iridotomy before cataract surgery and eyes without previous iridotomy.

Discussion

There are 3 treatment options for patients with coexisting cataract and glaucoma: cataract surgery alone, glaucoma surgery alone, and cataract surgery later or combined surgery. Although filtering surgery to lower IOP has a high success rate,[2–4] serious complications are not uncommon.[5–8] In addition, deterioration of the central visual field can occur after surgery in eyes with progressive optic nerve damage,[35] and when filtering surgery alone is performed, functioning filtering blebs may become smaller or even vanish after later cataract surgery.[36,37] Thus, glaucoma surgery alone or combined surgery has disadvantages.

It has been reported that cataract surgery alone decreases IOP to some extent.[10–18] The degree of IOP reduction differs depending on the type of glaucoma. Many studies found that cataract extraction can improve IOP control in eyes with ACG.[19–25] Therefore, we performed this study to ascertain whether there are differences in the IOP-lowering effect of cataract surgery between eyes with ACG and those with OAG.

In our study, cataract surgery significantly decreased IOP in eyes with ACG and those with OAG; this decrease continued for up to 2 years. However, the mean decrease and percentage reduction in IOP were greater in the ACG group than in the OAG group. Furthermore, the incidence of transient IOP elevation within a few weeks after surgery was higher in the OAG group than in the ACG group (unpublished data). These re-

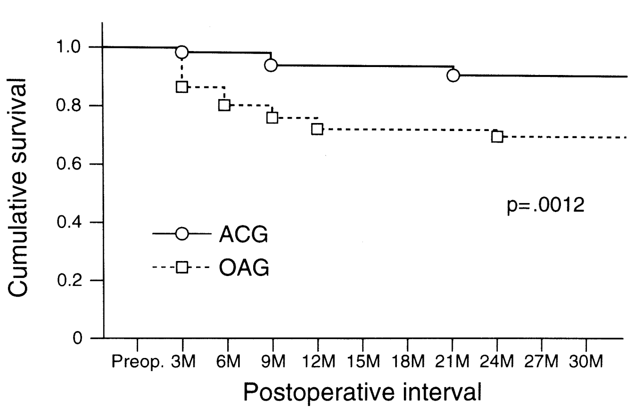

Figure 4. (Hayashi) Kaplan-Meier survival plots of the 2 groups according to the first failure criterion.

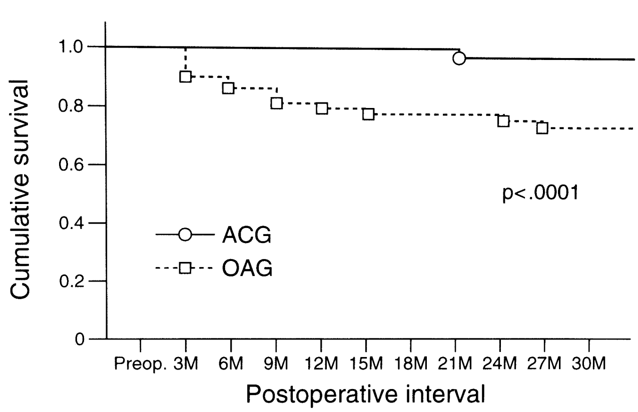

Figure 5. (Hayashi) Kaplan-Meier survival plots of the 2 groups according to the second failure criterion.

sults indicate that the IOP-lowering effect of cataract surgery is more pronounced in eyes with ACG than in those with OAG.

According to the survival analysis, the success rate for maintaining IOP within the normal range was higher in the ACG group than in the OAG group. The duration of a normal IOP level was also longer in the ACG group. In addition, during the follow-up, no eye with ACG required additional glaucoma surgery, while 7.4% of eyes with OAG had trabeculectomy. These results indicate that postoperative IOP control in eyes with ACG is better than in eyes with OAG. The success rate of the criterion representing no worsening of IOP control from preoperatively was 97.3% in the ACG group, which was higher than in the OAG group (76.5%). This indicates that small incision cataract surgery does not worsen IOP control in eyes with ACG.

In this study, the decrease in IOP after cataract surgery was greater than that previously reported.[12,13,17,18] It was more pronounced in the OAG group, whereas previous studies of eyes with ACG demonstrated a substantial reduction,[22,23] which is similar to the results in our study. We cannot explain the reason for this result. However, because other series found almost the same magnitude of IOP decrease,[32,38] we believe it may be related to surgical technique or racial differences among patients and not a measurement error.

The number of glaucoma medications decreased significantly after cataract surgery in both the ACG and OAG groups. However, the number of postoperative medications required in the ACG group was less than that required in the OAG group. More than 40% of eyes with ACG did not require any glaucoma medication postoperatively, while 19% with OAG did. Maintenance of a normal IOP level without medication implies that IOP control can be normalized by cataract surgery in most cases of ACG.

Cataract surgery resulted in significantly better visual acuity. No eye developed serious complications or had impaired visual acuity 1 month after surgery. In contrast, glaucoma-filtering surgery is known to worsen visual acuity in many cases.[5–9] In a study of eyes with ACG, Gunning and Greve[23] report that the final visual acuity was better in eyes having cataract surgery alone than in those having glaucoma surgery first. These results suggest that cataract surgery using a clear corneal incision with foldable IOL implantation is safe, even in eyes with glaucoma.

In a previous study,[32] we showed that cataract extraction widens the anterior chamber angle significantly and deepens the chamber depth in glaucomatous and normal eyes. The angle width and anterior chamber depth after cataract surgery were similar in ACG, OAG, and normal eyes. These results imply that the major pathophysiology of ACG, such as a narrow angle or appositional closure, may be eliminated by cataract extraction. Although laser iridotomy can relieve relative pupillary block, the anterior chamber angle usually remains narrow,[39,40] which can lead to synechial or appositional closure and subsequent elevation in IOP. Thus, cataract extraction is more effective than laser iridotomy in treating ACG.

A major drawback of the current study was that in the ACG group, eyes with various degrees of peripheral anterior synechias were included. In addition, we did not evaluate the gonioscopic examination results. It is difficult to measure the degree of peripheral anterior synechias in the presence of a large lens. It has been also reported that gonioscopy before lens extraction frequently overestimates the degree of synechial closure.[22,41] Thus, gonioscopic examination is subjective and semiquantitative and, therefore, may not be adequate to determine the severity of ACG.

In eyes with ACG and advanced synechial closure, cataract surgery alone is theoretically unable to lower IOP. However, the IOP was normalized in many cases in which peripheral anterior synechias were widely observed before surgery. This suggests that in most cases of ACG, performing cataract extraction first may be more beneficial and safer than performing glaucoma-filtering surgery. The preoperative IOP in eyes with ACG in which surgery was considered a failure was significantly higher than in those in which surgery was considered a success. This indicates that preoperative IOP is a predictor of postoperative IOP control. Therefore, when the preoperative IOP is high enough to be uncontrolled with severe synechial closure, simultaneous goniosynechialysis would likely be more effective.[42–44]

The IOP also decreased significantly after cataract surgery in eyes with OAG. However, the success rate of long-term IOP control in these eyes was significantly lower than in eyes with ACG. In addition, the number of medications required after surgery in the OAG group was greater than in the ACG group. Of the eyes with OAG, 7.4% subsequently required trabeculectomy. Although the exact mechanisms of IOP reduction after cataract surgery in eyes with OAG remain unclear, it has been shown that aqueous outflow facility is accelerated after phacoemulsification in glaucoma-suspect patients.[45] However, this effect may be transient because the trabecular meshwork is compromised in OAG.

In conclusion, phacoemulsification and implantation of a foldable IOL substantially decreased IOP and the number of medications required for IOP control in glaucomatous eyes. Moreover, IOP was normalized in most cases of ACG. Cataract surgery is a safe procedure that rarely causes visual acuity impairment. Even if control of IOP is insufficient after cataract surgery, subsequent glaucoma surgery can be performed safely because of the deepened anterior chamber and intact conjunctiva.[32] Based on these results, we suggest that the first surgical option for treating coexisting cataract and ACG is cataract surgery alone. However, further study is necessary to determine the best surgical option for patients with advanced ACG or OAG.

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