Long-term intraocular pressure control after clear corneal phacoemulsification in glaucoma patients

Nurit Mathalone, MD, Michael Hyams, MD, Sarit Neiman, MD, Gila Buckman, MD, Yair Hod, MD, Orna Geyer, MD

Purpose: To evaluate long-term IOP control after sutureless clear corneal phacoemulsification in eyes with preoperatively controlled glaucoma.

Setting: Institutional study.

Methods: The charts of 345 patients who had uneventful sutureless clear corneal phacoemulsification with acrylic foldable lens (IOL) implantation were retrospectively reviewed. Included were 58 patients with medically controlled open-angle glaucoma and 287 normal controls. Follow-up was 1 to 2 years. Outcome measures were postoperative IOP and number of glaucoma medications.

Results: Postoperatively, there was an insignificant decrease in IOP in the glaucoma group; the mean decrease was 1.5 mm Hg ± 4.4 (SD) at 12 months and 1.9 ± 4.9 mm Hg at 24 months. The mean number of medications decreased significantly at 12 months (0.53 ± 0.86) and at 24 months (0.38 ± 0.9) ($P = .04$). The control group also had a significant decrease in IOP, with a mean decrease of 0.72 ± 3.7 mm Hg at 12 months ($P = .01$) and 1.33 ± 3.2 mm Hg at 24 months ($P < .0001$). The decrease in IOP was more pronounced in eyes with a higher preoperative IOP in both the glaucoma and control groups.

Conclusions: These findings suggest that sutureless clear corneal phacoemulsification with foldable acrylic IOL implantation is a relatively simple and efficient surgical option in patients with cataract and well-controlled glaucoma. The approach combines long-term IOP control with fewer medications and leads to rapid visual rehabilitation.

J Cataract Refract Surg 2005; 31:479–483 © 2005 ASCRS and ESCRS

Previous studies[1–6] demonstrate that intracapsular and extracapsular cataract extraction improve glaucoma control by reducing intraocular pressure (IOP), the number of required glaucoma medications, or both. Although the relationship between cause and effect has often been observed, the nature by which cataract surgery influences IOP is not fully understood. Possible mechanisms include hyposecretion of aqueous humor, decreased resistance to aqueous humor outflow, and biochemical or blood–aqueous barrier (BAB) alteration.

Today, phacoemulsification represents state-of-the-art cataract surgery. This technique uses small incisions and foldable intraocular lenses (IOLs), which eliminate the need for sutures and greatly reduce operating time. In patients with glaucoma, phacoemulsification can cause less damage to an already compromised outflow facility. Theoretically, the high fluid flow rate generated by phacoemulsification in a relatively closed space may wash out glycosaminoglican deposition in the trabecular meshwork. In addition, it may cause mechanical insult to the trabecular meshwork, inducing cell division and renewed phagocytosis of meshwork debris. Based on

Accepted for publication June 10, 2004.

From the Department of Ophthalmology, Carmel Medical Center, Haifa, Israel.

None of the authors has a financial or proprietary interest in any material or method mentioned.

Reprint requests to Professor Orna Geyer, Head, Department of Ophthalmology, Carmel Medical Center, 7 Michal Street, Haifa, Israel. E-mail: drgo@netvision.net.il.

0886-3350/05/$-see front matter
doi:10.1016/j.jcrs.2004.06.046

these assumptions, IOP would be expected to be lower after phacoemulsification cataract extraction.

Recent studies[7–9] report reduced IOP after phacoemulsification in normal and glaucomatous eyes. Each study, however, used diverse surgical techniques and a different IOL. Modern phacoemulsification uses a sutureless clear corneal incision and a foldable acrylic IOL.

This study evaluated long-term IOP control after sutureless clear corneal phacoemulsification with in-the-bag implantation of foldable acrylic posterior chamber IOLs in eyes with preoperatively controlled glaucoma. The results were compared with those in eyes without glaucoma that had the same procedure. The long-term IOP response to phacoemulsification in eyes with glaucoma and cataract should serve as a guide to clinicians in the management of these patients.

Patients and Methods

The charts of 345 patients who had uneventful sutureless clear corneal phacoemulsification with in-the-bag foldable posterior chamber acrylic IOL implantation were retrospectively reviewed. The Department of Ophthalmology, Carmel Medical Center, serves a large area of northern Israel; thus, the study included only patients who returned to the department for follow-up. All patients had visually significant cataract requiring surgery. Fifty-eight patients had open-angle glaucoma (glaucoma group), and 287 patients had no glaucoma (control group). Glaucoma was diagnosed when the glaucomatous visual field defect matched the optic disc changes irrespective of IOP level.

Excluded were patients with narrow iridocorneal angle, secondary glaucoma, and previous intraocular surgery. All glaucoma patients were receiving glaucoma treatment that adequately controlled IOP.

Surgical Technique

All surgeries were performed by 3 experienced surgeons (O.G., Y.H., M.S. [not an author]) using the same technique. Eyes were prepared for surgery by instilling tropicamide 0.5% and phenylephrine 10% for pupil dilation and benoxinate 0.4% with lidocaine gel for topical anesthesia.

Surgery consisted of a 3.2 mm superior clear corneal tunnel incision, injection of viscoelastic material into the anterior chamber, capsulorhexis, hydrodissection, in-the-bag phacoemulsification using the divide-and-conquer technique, cortex aspiration, additional injection of viscoelastic material, and insertion of a foldable acrylic IOL (Corneal) in the capsular bag. The viscoelastic material was then removed. The corneal incision was closed by hydration.

Postoperatively, all patients were treated with prednisolone acetate 1% and tropicamide 0.5% 3 times daily for 3 weeks, after which the dose was gradually tapered. There was no difference in the postoperative steroid therapy between the glaucoma group and control group. Postoperative antiglaucoma therapy was administered to maintain IOP within levels of acceptable glaucoma control based on 3 consecutive measurements performed at separate clinic tests. Each patient's preoperative glaucoma medications were initially discontinued and then reinitiated as necessary to maintain the IOP within levels of glaucoma control.

Information recorded from preoperative visits included applanation tonometry in both groups and glaucoma medication in the glaucoma group. Patients were examined at the end of the follow-up period (1 or 2 years after surgery), and the same variables were recorded.

Statistical Analysis

The intraindividual differences in the 2 groups in preoperative and postoperative IOPs were analyzed by the Student t test for paired comparisons. The mean changes in IOP after surgery between the glaucoma group and control group were analyzed by the t test. The intraindividual differences between preoperative and postoperative number of glaucoma medications in the glaucoma group were analyzed by the Student t test for paired comparisons. The Pearson correlation test (r) was used to evaluate the effects of the preoperative IOP on the change in IOP and the influence of length of follow-up on the change in IOP after surgery. A P value less than 0.05 was considered significant.

Results

In the glaucoma group, 34 patients (18 men, 16 women) were available at the 12-month follow-up and 24 patients (9 men, 15 women) were available at the 24-month follow-up; the mean age of the patients was 80 years ± 7 (SD) and 77 ± 5 years, respectively. In the control group, 176 patients (72 men, 104 women) were available at the 12-month follow-up and 111 patients (44 men, 67 women) were available at the 24-month follow-up; the mean age was 73 ± 9 years and 73.5 ± 9 years, respectively. Glaucoma patients were significantly older ($P<.004$).

Glaucoma Group

In the glaucoma group, there was no significant difference in the mean preoperative IOP (baseline) between those having 12 months of follow-up and those having 24 months of follow-up (Table 1). After phacoemulsification, the mean postoperative IOP was

Table 1. Intraocular pressure and number of antiglaucoma medications preoperatively and 12 and 24 months postoperatively.

	Mean ± SD			
	Control Group		Glaucoma Group	
Parameter	12 Mo Fu (n = 176)	24 Mo Fu (n = 111)	12 Mo Fu (n = 34)	24 Mo Fu (n = 24)
Preoperative IOP (mm Hg)	13.5 ± 3	13.8 ± 2.7	16.3 ± 4.5	17.0 ± 4.6
Postoperative IOP (mm Hg)	12.8 ± 3	12.5 ± 2.6	14.8 ± 2.5	15.1 ± 3.2
Preoperative medications (n)	—	—	1.1 ± 0.63	1.5 ± 0.9
Postoperative medications (n)	—	—	0.65 ± 0.73	1.1 ± 1.12

Fu = follow-up; IOP = intraocular pressure; n = number

lower than the respective preoperative value at 12 months and 24 months, although the difference was not statistically significant ($P = .057$ and $P = .072$, respectively). The mean decrease in IOP at 12 months was 1.5 ± 4.4 mm Hg (95% confidence interval [CI], −0.05 to 3.05) and at 24 months, 1.9 ± 4.9 mm Hg (95% CI, −0.19 to 4.02). The mean percentage change from baseline was 9.2% at 12 months and 11.7% at 24 months. The difference between 12 months and 24 months was not statistically significant ($P = .71$).

The mean number of preoperative glaucoma medications in patients with a 12-month follow-up was not significantly different from the mean in patients with a 24-month follow-up (Table 1). All patients in the group required medication to control IOP preoperatively. After phacoemulsification, the mean number of medications required to control glaucoma decreased significantly in both follow-up groups. The mean decrease at 12 months was 0.53 ± 0.86 ($P = .04$) and at 24 months, 0.38 ± 0.9 ($P = .04$). After phacoemulsification, 47% of patients in the 12-month group and 38% of patients in the 24-month group required no medication.

Control Group

In the control group, there was no significant difference in the mean preoperative IOP (baseline) between those having 12 months of follow-up and those having 24 months of follow-up (Table 1). After phacoemulsification, the mean postoperative IOP was significantly lower than the respective preoperative value at 12 months and 24 months. The mean decrease in IOP at 12 months was 0.72 ± 3.7 mm Hg ($P = .01$) and at 24 months, 1.33 ± 3.2 mm Hg ($P < .0001$). The mean percentage change from baseline was 5.2% at 12 months and 9.6% at 24 months. The difference between the 12-month and 24-month groups was not statistically significant ($P = .16$).

Both Groups

The baseline IOP was significantly lower in the control group than in the glaucoma group at 12 months ($P < .01$) and 24 months ($P < .03$). The IOP-lowering effect of phacoemulsification at both follow-ups was not statistically different between the 2 groups ($P > .05$).

The decrease in IOP after phacoemulsification was more pronounced in eyes with a higher preoperative IOP in the glaucoma group (at 12 months: $r = 0.84$, $P < .0001$; at 24 months: $r = 0.77$, $P < .001$) and the control group ($r = 0.63$, $P < .0001$ and $r = 0.62$, $P < .0001$, respectively).

Discussion

The data from our study support the possible benefit of sutureless clear corneal phacoemulsification with foldable acrylic IOL implantation in patients with cataract and medically controlled glaucoma. The mean postoperative IOP at 12 months and 24 months was lower than the respective preoperative values, and the mean percentage change from baseline was clinically significant. The change in IOP was not significant, probably because of the small number of patients and the change in medications. We also found a significant decrease in IOP after surgery in patients who did not have glaucoma preoperatively. In our study, the mean postoperative IOP at 12 and 24 months was lower than the respective preoperative values and the mean percentage change from baseline was significant at both follow-ups. The decrease in IOP at 12 and 24 months

was greater in control patients and glaucoma patients who had a higher IOP preoperatively. Although this may reflect a regression toward the mean, it may also suggest that preoperative borderline-controlled IOP may be better controlled after surgery.

In addition, significantly fewer glaucoma medications were required postoperatively (0.53 at 12 months and 0.38 at 24 months) than preoperatively. Medication was eliminated in 47% of eyes at 12 months and 38% at 24 months. Although this may also reflect a regression toward the mean, we believe the decrease in medications postoperatively was real as the antiglaucoma therapy was added based on 3 consecutive IOP measurements performed at separate clinic test sessions. The decrease in the number of medications reduced treatment side effects and increased patient compliance. The clinical importance of this cannot be overemphasized.

Our findings concur with findings in previous studies that document improvement in glaucoma control after phacoemulsification.[9–13] The postoperative IOP course may be influenced by the procedure. Each study, however, used diverse surgical techniques with a different IOL. The nonstandardized surgical technique in these studies may have biased the results. Therefore, these studies are not directly comparable to ours, in which a single phacoemulsification technique (sutureless clear corneal incision and foldable acrylic IOL) was used.

Peräsalo[9] reports a 3.1 mm Hg decline in IOP and fewer required glaucoma drugs in 182 eyes within 1 year of surgery. He used a scleral tunnel technique with implantation of rigid poly(methyl methacrylate) IOLs. Merkur and coauthors[10] found a 2 mm Hg reduction in IOP postoperatively in eyes with pseudoexfoliation syndrome. The decrease was significantly greater than in eyes with primary open-angle glaucoma and in the cataract control group. The mean number of glaucoma medications was reduced. The authors did not describe their surgical technique. Hayashi and coauthors[12] found a decrease in IOP and glaucoma medications after clear corneal phacoemulsification in patients with angle-closure glaucoma and patients with open-angle glaucoma. They did not compare the glaucoma groups to a normal control group.

In a study that may be comparable to ours, Kim and coauthors[11] found a greater than 3 mm Hg drop in IOP with the same medications or a decrease in medications with the same IOP in 28 of 31 eyes with glaucoma 16 months after phacoemulsification. They used temporal clear corneal incisions and inserted a foldable silicone IOL rather than superior clear corneal incisions and foldable acrylic IOLs, as in our study. There were fewer patients (31 eyes) and a shorter follow-up (16 months) in their study than in our study. Furthermore, their study did not include a control group (patients without glaucoma) for comparison. Another study comparable is that by Shingleton et al.,[13] who compared IOP and medication reduction after temporal clear corneal phacoemulsification with foldable silicone IOL insertion in glaucoma patients, glaucoma suspects, and normal controls. They found a significant reduction in IOP in all groups at 6 months and in the control group and glaucoma-suspect group at 12 months. There was also a significant decrease in the number of glaucoma medications, although not in IOP, at 12 months in the glaucoma group. Follow-up was limited to 12 months. The importance of a longer follow-up is demonstrated by the loss of statistical significance in IOP reduction in glaucoma patients from 6 to 12 months in their study, indicating the added power of our study, in which the last follow-up was at 24 months.

We found a decrease in IOP after phacoemulsification in patients without preexisting ocular disease; this has been reported in other studies.[7,8,14–16] We compared the postoperative decrease in IOP in eyes with glaucoma and in eyes without glaucoma. The reduction in IOP in the 2 groups 12 and 24 months after phacoemulsification was not statistically different. This finding may shed light on the mechanism by which phacoemulsification improves IOP control. If the decrease in IOP were caused by an increase in trabecular outflow, a greater IOP decline would be expected in eyes without glaucoma because in eyes with glaucoma, the trabeculum is compromised. Therefore, if the IOP reduction is associated with decreased resistance to aqueous outflow, it may result from increased uveoscleral rather than trabecular outflow. The endogenous prostaglandin F_2 released postoperatively is thought to enhance uveoscleral outflow. Other possible mechanisms are a decrease in secretion of aqueous humor, promoted by increased traction on the ciliary body via the zonular fibers as a result of postoperative shrinkage of the lens capsule or of biomechanical or BAB alterations after surgery.[17,18]

In this study, we assessed long-term IOP control rather than the early postoperative change in IOP after phacoemulsification in glaucoma patients. This is because the clinical decision of surgical management of cataract and glaucoma depends on long-term postoperative IOP control.

Our study included only patients who returned to our department for follow-up. This may have resulted in selection bias. Nevertheless, the number of patients in the study and their selection are comparable with the parameters in other studies of the same subject. The small group of glaucoma patients is a drawback of our study. A larger sample might have showed statistically significant postoperative IOP reduction.

Our findings suggest that sutureless clear corneal phacoemulsification with foldable acrylic IOL implantation is a reasonable surgical option in patients with coexisting cataract and fairly well-controlled glaucoma. This approach has 2 advantages: (1) Long-term IOP control is maintained with fewer medications. (2) The surgery provides rapid visual rehabilitation and fewer complications. Decreasing the number of medications needed for glaucoma control improves the patient's quality of life, encourages compliance, and reduces expenditures, an increasingly important factor in today's cost-conscious health environment. Our study was of eyes with preoperative medically controlled glaucoma. Extrapolation of our results to eyes with preoperative medically uncontrolled glaucoma should not be done.

References

1. Randolph ME, Maumenee AE, Iliff CE. Cataract extraction in glaucomatous eyes. Am J Ophthalmol 1971; 71:328–330
2. Bigger JF, Becker B. Cataracts and primary open-angle glaucoma: the effect of uncomplicated cataract extraction on glaucoma control. Trans Am Ophthalmol Otolaryngol 1971; 75:260–272
3. Onali T, Raitta C. Extracapsular cataract extraction and posterior chamber lens implantation in controlled open-angle glaucoma. Ophthalmic Surg 1991; 22:381–387; erratum, 695
4. Steuhl KP, Marahrens P, Frohn C, Frohn A. Intraocular pressure and anterior chamber depth before and after extracapsular cataract extraction with posterior chamber lens implantation. Ophthalmic Surg 1992; 23:233–237
5. Handa J, Henry JC, Krupin T, Keates E. Extracapsular cataract extraction with posterior chamber lens implantation in patients with glaucoma. Arch Ophthalmol 1987; 105:765–769
6. McMahan LB, Monica ML, Zimmerman TJ. Posterior chamber pseudophakes in glaucoma patients. Ophthalmic Surg 1986; 17:146–150
7. Suzuki R, Tanaka K, Sagara T, Fukiwara N. Reduction of intraocular pressure after phacoemulsification and aspiration with intraocular lens implantation. Ophthalmologica 1994; 208:254–258
8. Suzuki R, Kuroki S, Fujiwara N. Ten-year follow-up of intraocular pressure after phacoemulsification and aspiration with intraocular lens implantation performed by the same surgeon. Ophthalmologica 1997; 211:79–83
9. Peräsalo R. Phaco-emulsification of cataract in eyes with glaucoma. Acta Ophthalmol Scand 1997; 75:299–300
10. Merkur A, Damji KF, Mintsioulis G, Hodge WG. Intraocular pressure decrease after phacoemulsification in patients with pseudoexfoliation syndrome. J Cataract Refract Surg 2001; 27:528–532
11. Kim DD, Doyle JW, Smith MF. Intraocular pressure reduction following phacoemulsification cataract extraction with posterior chamber lens implantation in glaucoma patients. Ophthalmic Surg Lasers 1999; 30:37–40
12. Hayashi K, Hayashi H, Nakao F, Hayashi F. Effect of cataract surgery on intraocular pressure control in glaucoma patients. J Cataract Refract Surg 2001; 27:1779–1786
13. Shingleton BJ, Gamell LS, O'Donoghue MW, et al. Long-term changes in intraocular pressure after clear corneal phacoemulsification: normal patients versus glaucoma suspect and glaucoma patients. J Cataract Refract Surg 1999; 25:885–890
14. Tennen DG, Masker S. Short- and long-term effect of clear corneal incisions on intraocular pressure. J Cataract Refract Surg 1996; 22:568–570
15. Pohjalainen T, Vesti E, Uusitalo RJ, Laatikainen L. Intraocular pressure after phacoemulsification and intraocular lens implantation in nonglaucomatous eyes with and without exfoliation. J Cataract Refract Surg 2001; 27:426–431
16. Schwenn O, Dick HB, Krummenauer F, et al. Intraocular pressure after small incision cataract surgery: temporal sclerocorneal versus clear corneal incision. J Cataract Refract Surg 2001; 27:421–425
17. Meyer MA, Savitt ML, Kopitas E. The effect of phacoemulsification on aqueous outflow facility. Ophthalmology 1997; 104:1221–1227
18. Epstein DL, Hashimoto JM, Grant WM. Serum obstruction of aqueous outflow in enucleated eyes. Am J Ophthalmol 1978; 86:101–105