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Results of combined phacoemulsification and viscocanalostomy in patients with cataract and pseudoexfoliative glaucoma

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PURPOSE. *Coexisting pseudoexfoliation glaucoma (PEXG) and cataract represents a special challenge. Although phacotrabeculectomy is an effective procedure, it combines the risks of phacoemulsification and trabeculectomy. This study evaluates phacoviscocanalostomy to manage eyes with PEXG and cataract.*

METHODS. *We conducted a prospective noncomparative study that included 30 consecutive eyes of 22 patients with uncontrolled PEXG and cataract. Phacoviscocanalostomy was performed in all. Success rate based on postoperative intraocular pressure (IOP) reduction and requirement for topical antiglaucoma medication was evaluated as the main outcome measure. Visual acuity and complication rates were secondary outcomes.*

RESULTS. *The mean follow-up was 18.6 months ± 6.2 (SD) (range 12 to 36 months). There was statistically significant decrease in mean IOP from 25.3 ± 5.2 mmHg preoperatively to 13.5 ± 6.0 mmHg 1 day after surgery ($p < .05$), 12.3 ± 3.1 mmHg at the final follow-up ($p < .05$), and at all evaluations to the last postoperative visit. Only three eyes (10%) required a single antiglaucoma medication to achieve the target IOP. A complete surgical success (IOP < 21 mmHg without medication) was achieved in 90%, while a qualified success (IOP < 21 mmHg with or without glaucoma medication) was achieved in 100% of cases. Complications included Descemet membrane microperforations (13.3%), macroperforation (3.3%), zonular dehiscence (6.6%), and transient postoperative IOP spike (3.3%).*

CONCLUSIONS. *Phacoviscocanalostomy achieved excellent IOP control and visual acuity improvement in pseudoexfoliation patients with coexisting cataract and glaucoma. Complication rate was low and did not affect the surgical outcome. (Eur J Ophthalmol 2007; 17: 212-9)*

KEY WORDS. *Pseudoexfoliation, Phacoviscocanalostomy, Glaucoma, Cataract*

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INTRODUCTION

Pseudoexfoliation (PEX) syndrome, first characterized by Lindberg in 1917 (1), features abnormal production and progressive deposition of a fibrillar and extracellular matrix material in intraocular and systemic tissues (2). PEX is the most common identifiable condition leading to the development of open-angle glaucoma (3). Pseudoexfoliation glaucoma (PEXG) tends to run a more aggressive clinical course than does primary open angle glaucoma (POAG), to display higher intraocular pressure (IOP), to respond less well to medical therapy, and to have more progressive visual field and optic nerve damage (4-6). This explains why patients with PEXG require glaucoma filtering surgery more frequently, and at an earlier stage, than those with POAG (7, 8). In addi-

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tion to being a risk factor for glaucoma, there has been increasing evidence for an etiologic association of PEX with cataract formation (9, 10).

Managing coincident visually significant cataract and uncontrolled glaucoma in patients with PEX represents a special surgical challenge. The evolution and refinement of small incision cataract surgery has made phacoemulsification coupled with trabeculectomy a common practice in such patients because of its efficacy and relative safety (11). However, phacoemulsification in patients with PEX carries a higher incidence of intraoperative complications, most commonly zonular dialysis, vitreous loss, and dislocation of the lens (12-14).

Although trabeculectomy, with or without antifibrotic agents, has been the preferred procedure in combined surgery, it may have several potentially severe complications: intraoperative or postoperative bleeding, inflammatory reaction, flat anterior chamber caused by excessive filtration or bleb leaks, hypotony, choroidal detachment, and endophthalmitis.

The development of new methods that combine nonpenetrating ab externo glaucoma surgery with phacoemulsification offers interesting surgical alternatives to classic phacotrabeculectomy in patients with PEX. The common denominator of all these surgical procedures is the creation of new facilitated outflow pathways without perforation into the anterior chamber, thus significantly reducing surgical complications well known to be associated with standard phacotrabeculectomy. Trabecular aspiration (15, 16), trabeculotomy (17, 18), and deep sclerectomy (19-21) are among the nonpenetrating surgical techniques that have been described and studied recently.

Viscocanalostomy, described by Stegmann et al (22), is a nonpenetrating glaucoma surgery that consists of deroofing Schlemm canal to expose the trabecular meshwork, creating a Descemet "window" through which aqueous percolates, and injecting a high-molecular-weight viscoelastic material into the ostia of Schlemm canal.

Although several studies have reported good short- to long-term surgical outcomes of combined phacoemulsification and viscocanalostomy in eyes with medically uncontrolled POAG (23-26), the results of this procedure have not been studied in PEXG cases in isolation. The purpose of this study was to investigate the efficacy and safety of phacoviscocanalostomy in PEX eyes with coexisting cataract and medically uncontrolled PEXG.

PATIENTS AND METHODS

Study population

In this prospective series, 30 consecutive eyes of 22 patients with PEX syndrome were included. Ethical approval for the study was obtained by the Research Ethics Committee, and the tenets of the World Medical Association Declaration of Helsinki were followed. An informed consent was obtained from all participants. Inclusion criteria were PEX with visually disabling cataract in combination with medically uncontrolled glaucoma indicated for surgery for one or more of the following reasons: IOP > 21 mmHg despite maximally tolerated medical therapy or IOP ≤ 21 mmHg under medical therapy with poor patient compliance, medication intolerance, or inability to achieve target IOP, i.e., pressure levels which limit or halt visual field progression. Exclusion criteria were other types of glaucoma, any other form of ocular disease, or previous ocular surgery. Patients with PEX with angle-closure glaucoma, occludable angles, peripheral iridectomies, or previous laser trabeculoplasty were also excluded. Eyes with mature cataracts were excluded from the study to avoid bias of technical difficulty in performing phaco in mature cataract.

After obtaining a full ocular and medical history from each patient, a complete preoperative ophthalmologic examination was performed. This included uncorrected visual acuity (UCVA) and best-corrected visual acuity (BCVA), IOP measurement by Goldmann applanation tonometry, gonioscopy, anterior and posterior segment slitlamp biomicroscopy, and indirect ophthalmoscopy of the optic nerve. All participants had a recent automated visual field (VF) assessment dated at least 3 months before surgery using the Humphrey visual field analyzer 24-2 program. If possible, VF assessment was done in the immediate preoperative period as well.

After surgery the same examinations, except for visual fields and gonioscopy, were performed at 1 day, 1 week, 4 weeks, 3 and 6 months, and 1 year. Thereafter, examinations were at 3-month intervals. Visual field examination and gonioscopy was repeated every 3 months. IOP measurement was performed by a separate ophthalmologist to reduce the risk of bias in IOP recording. If a patient had multiple visual acuities or IOP measurements during any follow-up, the mean was used as a data point. Visual acuity was converted to decimal values before statistical analysis.

Surgical technique

All included patients underwent phacoviscocanalostomy, under peribulbar anesthesia, by the same surgeon (K.H.). In all cases, no antifibrotic agents were used.

Standard phacoemulsification with foldable acrylic intraocular lens (IOL) implantation was completed prior to the viscocanalostomy procedure. Phacoemulsification was done through a temporal 3 mm clear corneal incision. Cases with unstable capsular bag were managed either by inserting a capsular tension ring prior to IOL implantation in the bag or by sulcus implantation of the IOL. After conclusion of the phacoemulsification step, the surgeon shifted his position from temporal to superior in preparation for the viscocanalostomy step. The latter procedure was done using a method similar to that described by Stegmann and coauthors (22). A triangular superficial scleral flap, of 4 mm width and 5 mm length, was dissected up to 2 mm into clear cornea. A second deeper scleral flap was fashioned 0.5 mm inside the margins of the superficial flap just above the level of the choroid. With forward dissection of this flap, Schlemm canal could be identified approximately 1.0 mm posterior to the limbus and deroofed, where the glistening floor and the mild blood ooze from its ostia marked it. Using a dry cellulose sponge, Descemet membrane was detached from the overlying corneal stroma by applying gentle pressure on Schwalbe line to create an intact Descemet "window," at least 1.00 mm in width and 3.00 mm long, through which aqueous percolated. The deep flap was then excised by a Vannas scissors. Sodium hyaluronate 1% (Provisc, Alcon) was injected into the open ostia of Schlemm canal. The superficial scleral flap was reflected back and tightly sutured in place using three interrupted 10/0 nylon sutures The resulting intrascleral "lake" was filled with sodium hyaluronate 1% to avoid fibrinous activity and scarring in the early postoperative period. The conjunctiva was approximated by 8/0 Vicryl sutures.

Postoperative management included tapered schedule of steroid (prednisolone acetate 1%) and antibiotic (ofloxacin 0.3%). Preoperative glaucoma medications were stopped after surgery. During follow-up, if target IOP was not achieved by the surgical procedure, glaucoma medication was restarted.

The postoperative IOP was the primary outcome measure. Surgery was considered a complete success with an IOP < 21 mmHg without additional glaucoma medication or surgery. A qualified success was defined as an IOP < 21 mmHg with additional glaucoma medication. In some glaucoma patients with relatively advanced visual filed, adding glaucoma medication was judged necessary if the level of surgically achieved IOP, though < 21 mmHg, was considered inadequate to halt visual field progression. Failure was defined as IOP ≥ 21 mmHg with or without medication or when an eye required further glaucoma drainage surgery. Recorded secondary outcomes included BCVA and postoperative complication rates.

Statistical analysis

For comparison of the means, the paired Student *t* test was used. A difference with a p value less than 0.05 was considered statistically significant. Kaplan-Meier survival curves were constructed to analyze the long-term success rate. Analyses were performed using the SPSS/10.1 program for Windows.

RESULTS

Characteristics of the study eyes

Thirty consecutive eyes of 22 patients with PEX having undergone phaco-VSC were enrolled and analyzed in the study. All patients completed at least 1 year of follow-up. The mean follow-up was 18.6 months ± 6.2 standard deviation (SD) (range 12 to 36 months). The mean preoperative IOP was 25.3±5.2 mmHg on a mean 2.1 medications. Table I shows the demographic data for the study population.

Intraocular pressure control

The mean IOP at different postoperative follow-up periods are shown in Figure 1. There was a statistically significant decrease in IOP from 25.3±5.2 mmHg preoperatively to 13.5±6.0 mmHg 1 day after surgery ($p<0.005$), and at all time points to the last follow-up. The overall mean IOP reduction was 12.4 mmHg (49.1%), and the mean IOP reduction at the final follow-up was 13.0 mmHg (51.3%).

Medications

The mean number of antiglaucoma medications was reduced from 2.1 preoperatively to 0.1 at the last postoperative visit ($p<0.000$). Three eyes (10%) required a single topical antiglaucoma medication to be added postoperatively.

Surgical success

Considering the IOP at the last visit for each patient, a complete surgical success was achieved in 27 eyes (90%), while a qualified success was achieved in all eyes (100%).

TABLE I - DEMOGRAPHIC DATA AND CHARACTERISTICS OF THE STUDY EYES

Characteristic	Value
Eyes	30
Patients	22
Mean age, y, ± SD	69.3±7.9
Sex	
Male	14
Female	8
Race	
White	22
Other	0
Cataract type	
Nuclear	18
Cortical	2
PSC	3
Mixed	7
PEX glaucoma, n (%)	30 (100)
Eyes on glaucoma medication preoperatively, n (%)	30 (100)
Antiglaucoma medication	
Single topical	1
Double topical	25
Triple topical	3
>3	1
Oral CAI	0

Mean preoperative glaucoma medications/eye ± SD (range) 2.1±0.5 (1–4) Mean IOP before surgery (mmHg) ± SD (range) 25.3±5.2 (17–38) Mean follow-up (mo) ± SD (range) 18.6±6.2 (12–36) Mean cup-to-disc ratio 0.69 PSC = Posterior subcapsular cataract; PEX = Pseudoexfoliation; CAI = Carbonic anhydrase inhibitor; IOP = Intraocular pressure

TABLE II - COMPLICATIONS ENCOUNTERED IN THE STUDY GROUP

Type of complication	No. of eyes (%)
Intraoperative	
Zonular dehiscence/no vitreous loss	1 (3.3)
Zonular dehiscence/vitreous loss	1 (3.3)
Microperforation of Descemet	4 (13.3)
Macroperforation without late iris plugging	1 (3.3)
Postoperative	
Transient IOP spike (IOP >25 mmHg)	1 (3.3)

IOP = Iintraocular pressure

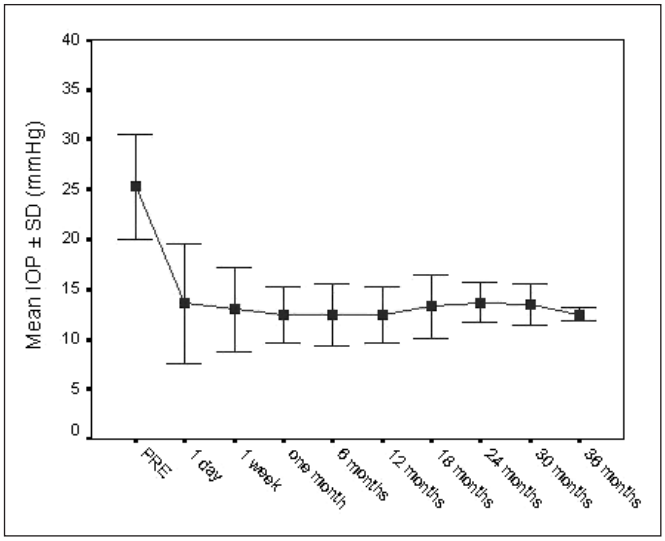

Fig. 1 - *Mean intraocular pressure over time.*

Twenty-four eyes (80%) had an IOP ≤ 15 mmg without antiglaucoma medication, and 26 eyes (86.7%) had an IOP ≤ 15 mmHg with or without antiglaucoma medication at the last follow-up.

Figure 2 shows the cumulative probability, Kaplan-Meier survival curve, of complete success (IOP < 21 mmHg without medication), and Figure 3 shows the probability of success defined as an IOP below or equal to 15 mmHg with or without treatment. A stable high level of surgical success was maintained during different follow-up periods. No eye required goniopuncture or further glaucoma surgery.

Visual acuity

All patients had significant postoperative improvement of visual acuity. The mean preoperative BCVA was 0.25, while the mean postoperative UCVA and BCVA were 0.5 and 0.7, respectively. The change in both postoperative UCVA and BCVA was statistically significant at all follow-up intervals ($p<0.005$).

Complications

Table II summarizes the intraoperative and postoperative complications encountered in the study.

In the eye that sustained macroperforation of the trabeculo-Descemet window (TDW), the iris could be repositioned with the aid of viscoelastic material through the perfora-

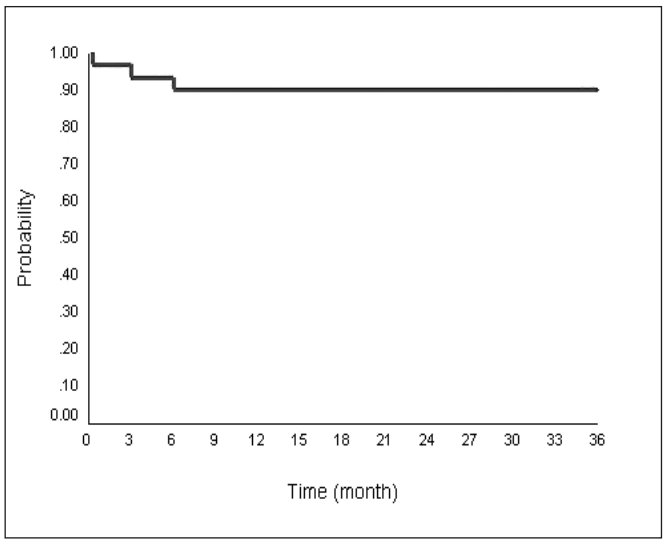

Fig. 2 - *Cumulative probability of success, defined as an intraocular pressure less than 21 mmHg without medical treatment (complete success).*

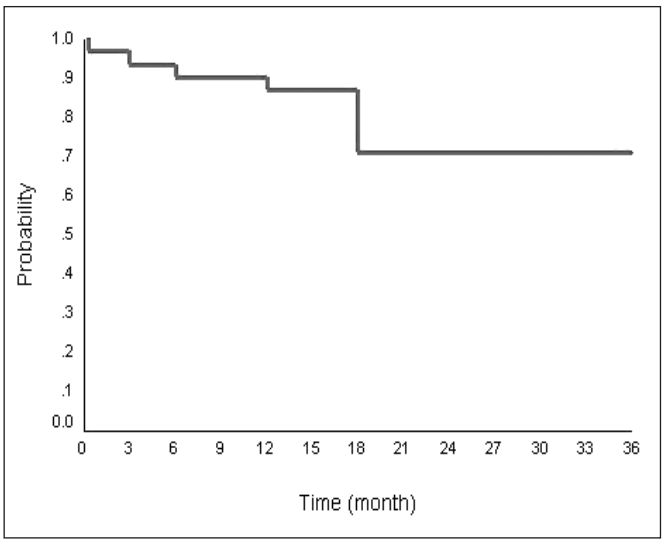

Fig. 3 - *Cumulative probability of success, defined as an intraocular pressure less than or equal to 15 mmHg without medical treatment.*

tion site and then procedure was continued as usual. No late iris plugging or prolapse through the perforation was encountered in this case. In the same eye that developed inadvertent macroperforation of TDW, transient IOP spike developed postoperatively. This was due to retained viscoelastic material used to keep the iris away and avoid its plugging or prolapse through the defect.

No cases required conversion to either extracapsular cataract extraction (ECCE) or trabeculectomy. No eyes required peripheral iridectomy to be added to the viscocanalostomy procedure.

DISCUSSION

Managing concurrent uncontrolled glaucoma and visually significant cataract in patients with PEX represents a common surgical challenge. Although phacotrabeculectomy remains the standard combined procedure, the associated surgical complications are frequent. These complications are multifactorial and directly related to the pathologic changes of PEX on intraocular structures, particularly the lens and iris (27). Markedly elevated preoperative IOP in PEXG eyes may predispose to choroidal hemorrhage or effusion (3). In addition, eyes with PEX are at a particular risk of fibrin exudation and pupillary membrane formation. This is due to impairment of the blood–aqueous barrier with increase in aqueous protein concentration that is attributed to the associated iris vasculopathy (28). Iris microneovascularization is common in PEX secondary to iris vessel narrowing and obliteration with consequent iris hypoperfusion and ischemia (29, 30). Previously undetected iris neovascularization may lead to intraoperative or delayed hyphema from the surgical iridectomy.

Phacoviscocanalostomy has recently gained increasing interest because it has the potential of significantly reducing the surgical complications associated with phacotrabeculectomy (22-26). Reducing iris manipulation and avoiding peripheral iridectomy make phacoviscocanalostomy advantageous in patients with PEX who may be more susceptible to fibrin reaction and hyphema.

In the current study, phacoviscocanalostomy in 30 eyes having PEX syndrome with coexisting glaucoma and cataract, with up to 36 months of follow-up, achieved a complete success rate (IOP < 21 mmHg without medications) of 90%, and a qualified success (IOP < 21 mmHg with or without medications) of 100%. There was a mean IOP reduction of 13.0 mmHg at the final follow-up, which represents 51.3% of the baseline preoperative IOP level.

To our knowledge, there have been no previously published reports of the surgical outcomes of phacoviscocanalostomy in patients with PEX as a separate entity. However, there are studies of other combined procedures

for the management of PEXG and cataract with which to compare our results.

Landa et al (31) reported no significant difference in the success rate (IOP of < 21 mmHg with no treatment) of phacotrabeculectomy with mitomycin C 0.02% between PEX and non-PEX eyes (83.6% vs 83.7%).

Jacobi and Krieglstein (32) have described a technique used in PEXG patients termed trabecular aspiration. It aims at improving outflow facility by removing the intertrabecular and pretrabecular debris of the trabecular meshwork. Trabecular aspiration combined with phacoemulsification was significantly more effective than phacoemulsification alone in controlling IOP and reducing antiglaucoma medication postoperatively, but not as effective as phacotrabeculectomy, especially in the low target pressure range. (15-16) However, trabecular aspiration demonstrated a more favorable risk profile with less postoperative complications than phacotrabeculectomy.

Trabeculotomy is an antiglaucoma procedure that has been presented to relieve the resistance to aqueous outflow by means of mechanical cleavage in the trabecular meshwork and the inner layer of the Schlemm canal. Honjo et al (17) achieved a mean IOP of 14.6 mmHg on a mean of 0.9 glaucoma medications at the final examination after phacotrabeculotomy in 49 eyes with PEXG and cataract.

In the current study, the recorded high success rate of phacoviscocanalostomy in PEX eyes was comparable to other published data of same procedure in POAG (Tab. III). However, the magnitude of IOP reduction in our study was among the highest that has been reported. This could be related to the general tendency of eyes with PEXG to respond more dramatically and attain lower levels of IOP following glaucoma surgery. This is together with the commonly higher baseline IOP in these patients. Several studies have demonstrated this tendency after trabeculectomy (33, 34). The same experience was reported following other antiglaucoma procedures as well. In one study, trabeculotomy, combined with phacoemulsification, has been demonstrated to be more effective in lowering IOP in eyes with PEXG than in eyes with POAG (18). Drolsum (20, 21) has reported that, following deep sclerectomy, complete success (IOP < 19 mmHg) was achieved in 60.7% and 50% of PEXG eyes over a mean follow-up of 19.9 and 45.0 months, respectively, compared with 37.9% and 33.3% in POAG eyes.

The risk of intraoperative phaco complications were reported to be five times greater when PEX was present (13). Zonular weakness results in a greater extent of intraoperative complications than capsule tears in those eyes (38). In the present study, complications reported with the phacoemulsification step were in agreement with those obtained in previous studies of phacoemulsification in PEX eyes (13, 31, 37, 38).

Microperforations were the most frequent complication related to the viscocanalostomy step in our study (13.3%). The incidence of this complication was within the range reported by several previous studies of viscocanalostomy (22-26, 35, 36). Microperforations appear to be unrelated to the surgeon's skill, but may be correlated to the individual anatomic characteristics of the eye (39).

Viscocanalostomy is a procedure that has a steep learning curve and the surgical outcome may reflect the experience of the operating surgeon. Identification of Schlemm canal is a critical step in the procedure. Performing viscocanalostomy after phacoemulsification makes Schlemm canal filled with blood and thus more easily identifiable as a red band under the surgical microscope (26).

The main limitation of this study was that it did not compare the results of phacoviscocanalostomy with those of

TABLE III - REPORTS OF IOP REDUCTION ACHIEVED BY PHACOVISCOCANALOSTOMY AT THE LAST FOLLOW-UP VISIT

Study	Mean follow-up, mo	Mean preop IOP, mmHg	Defined success rate, mmHg	Complete success (no meds)	Qualified success (± meds)	Mean IOP reduction, mmHg (%)
Wishart and Dagres[25]	38.7	24	≤21	85.4	92.7	7.9 (33.2)
Wishart et al[35]	24	23.9	<21	97	100	7.6 (32)
Tanito et al[26]	9.4	20.8	<21	NR	95	5.7 (27.4)
Park et al[36]	28.5	20.2	≤21	58.2	92	5.4 (25.8)
Current study	18.6	25.3	≤21	90	100	13 (51.3)

IOP = Intraocular pressure; NR = Not recorded

phacotrabeculectomy in patients with PEX. We consider our study as a preliminary report of phacoviscocanalostomy in this group of patients. A second randomized study might be necessary to assess differences in the success rate, percentage of IOP reduction, and complications between the two procedures. The other limit of the study is the inclusion of bilateral cases (16 eyes of 8 patients), which from a statistical point of view are not independently related. However, consideration of those eyes from the clinical point of view is based on the noncomparative nature of the study.

The present study concludes that phacoviscocanalostomy is an effective procedure in lowering IOP and improving visual acuity in patients with PEX with PEXG and cataract. The procedure has a high safety profile with only minor adverse events. Phacoviscocanalostomy may represent an attractive alternative procedure in patients with PEX in whom phacotrabeculectomy with antimetabolites might carry a higher risk of vision-threatening complications.

The authors have no financial interest in any aspect of this article and have no proprietary interest in the development or marketing of the products or medical equipment used in this study.

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