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Five-year results of viscocanalostomy

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PURPOSE. *To prospectively study the success rates and complications of viscocanalostomy.*
METHODS. *Prospective nonrandomized case series of 46 eyes (46 patients) with medically uncontrolled primary and secondary open angle glaucoma. All patients in the study underwent viscocanalostomy. Control of intraocular pressure was used to measure success. Pre and postoperative glaucoma medications, visual acuity, complications, and adjunctive procedures were recorded.*
RESULTS. *At 60 months, qualified success (intraocular pressure below 21 mmHg with glaucoma medication) was achieved in 37 (82%) patients and complete success (intraocular pressure below 21 mmHg without medication) in 25 (54%) patients. Nd:YAG laser goniopuncture was performed in 33 (72%) patients with significant post laser reduction of intraocular pressure. No sight threatening complications were observed in this series. Visual acuity remained unchanged in 33 patients (72%).*
CONCLUSIONS. *Viscocanalostomy appears to be a safe and effective intraocular pressure lowering procedure in eyes with primary open angle glaucoma and certain types of secondary open angle glaucoma. (Eur J Ophthalmol 2008; 18: 417-22)*

KEY WORDS. *Nd:YAG laser goniopuncture, Viscocanalostomy*

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INTRODUCTION

Viscocanalostomy is a procedure that aims to facilitate aqueous outflow without penetrating the globe for the surgical treatment of medically uncontrolled open angle glaucoma. The technique involves deroofing the Schlemm canal, preparing the trabeculo-Descemet membrane, and injecting viscoelastic material into the ostia of the Schlemm canal (1-4). The serious and sight-threatening complications that may be associated with trabeculectomy are primarily the result of a penetrating procedure that results in a direct communication between the anterior chamber and the subconjunctival space (5-13).
We report a prospective, nonrandomized case series of 46 eyes that underwent viscocanalostomy and were followed up for 60 months.

METHODS

Forty-six eyes of 46 patients with medically uncontrolled primary open angle glaucoma (POAG), pseudoexfoliation glaucoma (PXG), or pigment dispersion glaucoma (PDG) were enrolled in the study and followed up prospectively. Ethics committee approval was obtained and the study was conducted in adherence to the tenets of the Declaration of Helsinki. All patients selected for the study had uncontrolled glaucoma (POAG, PXG, or PDG) that was defined as progressive glaucomatous visual field loss and glaucomatous optic nerve morphology, on maximum tolerated medical therapy.
Exclusion criteria were previous intraocular surgery, any ocular abnormality preventing reliable applanation tonometry, advanced lens opacities, or that the eye in question was the patient's only seeing eye.
With the above criteria, 61 patients were selected. All patients were informed of the possible risks and benefits of viscocanalostomy and the details of the trial. Fourteen patients were unwilling to participate in the trial, one patient died 1 week prior to surgery, and 46 were included in this study. All surgeries were performed by one surgeon (K.G.K.).
Preoperatively, visual acuity was assessed with the Snellen chart and intraocular pressure (IOP) was recorded using a slit lamp mounted applanation tono-

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meter. All patients also underwent slit lamp biomicroscopy, gonioscopy, visual field assessment (Humphrey 24-2 computerized perimetry), and dilated fundus biomicroscopy.

Surgical techniques

Viscocanalostomy. A fornix-based conjunctival flap was fashioned. Wet field bipolar cautery was used to achieve hemostasis. A 5 x 5 x 5 mm triangular, one-third thickness scleral flap was created and dissected 0.5 mm into clear cornea. A second triangular flap was dissected 0.5 mm inside the margin of the first that was approximately two third thickness. The deep flap was dissected forwards, Schlemm canal identified and deroofed. The Schwalbe line was depressed with the tip of a cellulose sponge separating the Descemet membrane from the corneal stroma for about 1 mm anteriorly. The inner scleral flap was then excised. The juxtacanalicular meshwork was scraped off the bed of the Schlemm canal. Sodium hyaluronate (14 mg/mL) was injected into the cut ends of the Schlemm canal by multiple injections without withdrawing the cannula. The superficial flap was sutured tightly with three 10-0 nylon sutures. Sodium hyaluronate (14 mg/mL) was injected under the flap and conjunctiva was closed with 10-0 Vicryl sutures.

Postoperative management

Immediately postoperatively a subconjunctival injection of betamethasone and cefuroxime was given. Postoperatively, patients were treated with prednisolone acetate 1% eight times a day for 2 weeks; this was then reduced over the next 3 months. After surgery, all the previously mentioned examinations, except for visual field assessment, were conducted on days 1, 7, and 14 as well as at 1, 2, 3, 6, 9, 12, 18, 24, 30, 36, 48, 54, and 60 months. Visual field examination was repeated every 6 months.

Complete success was defined as IOP lower than 21 mmHg without glaucoma medication. Qualified success was defined as IOP below 21 mmHg with and without glaucoma medication.

Statistical analysis

The SPSS program (v 15.0) for Windows was used for statistical analysis.

RESULTS

The patients' demographic data are given in Table I. Preoperative data and diagnosis are mentioned in Table II.

Operative and postoperative data

The average time from first incision to closure was 34.2 min (range 21–43 min). In no eye that underwent viscocanalostomy were the Descemet membrane ruptures visible.

Goniopuncture with Nd:YAG laser was performed on 33 patients (72%) when filtration through the Descemet window was suspected to be insufficient. The mean time between viscocanalostomy and goniopuncture was 9.1 (SD 8) months. There was a statistically significant difference ($p<0.001$) between the mean IOP prior to goniopuncture, 21.6 (SD 5) mmHg, and the mean IOP following goniopuncture, 16.4 (SD 5) mmHg.

Visual acuity

Visual acuity remained unchanged in 33 patients (72%) during the follow-up period. Visual acuity was reduced in

TABLE I - PATIENT DEMOGRAPHICS

Characteristics	Values
Age, yr (SD)	66 (9.3)
Male/female	21/25
Race	Asian (Indian)

SD = Standard deviation

TABLE II - PREOPERATIVE DATA

Characteristics	Values
Preoperative IOP, mmHg (SD)	31.8 (4)
Preoperative glaucoma medication (SD)	2.5 (0.65)
Mean follow-up, mo (SD)	37.2 (10)
POAG	30
PXG	14
PDG	2

IOP = Intraocular pressure; SD = Standard deviation; POAG = Primary open angle glaucoma; PXG = Pseudoexfoliation glaucoma; PDG = Pigment dispersion glaucoma

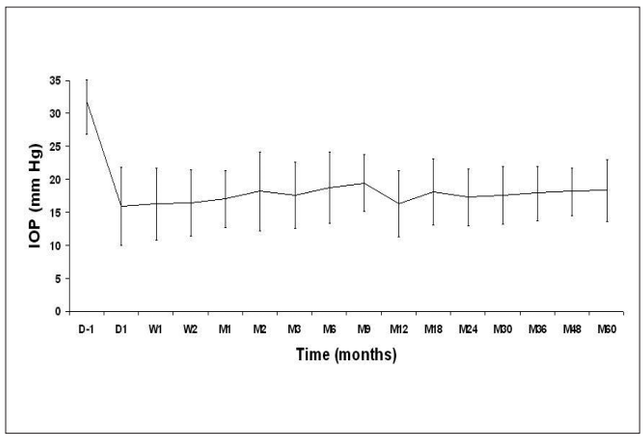

Fig. 1 - *Mean intraocular pressure before and after viscocanalostomy. Vertical error bars represent ± 1 standard deviation. N = 46 (9 M), 45 (12 M), 42 (24 M), 42 (30 M), 41 (36 M), 37 (48 M), 33 (60 M).*

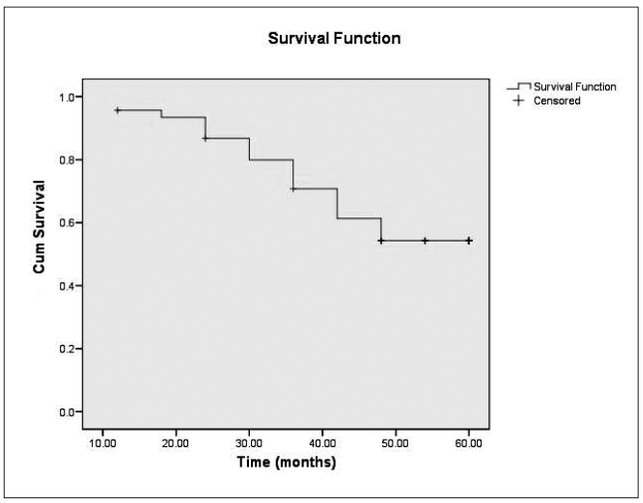

Fig. 2 - *Kaplan-Meier cumulative survival curves for complete success (intraocular pressure below 21 mmHg without medication).*

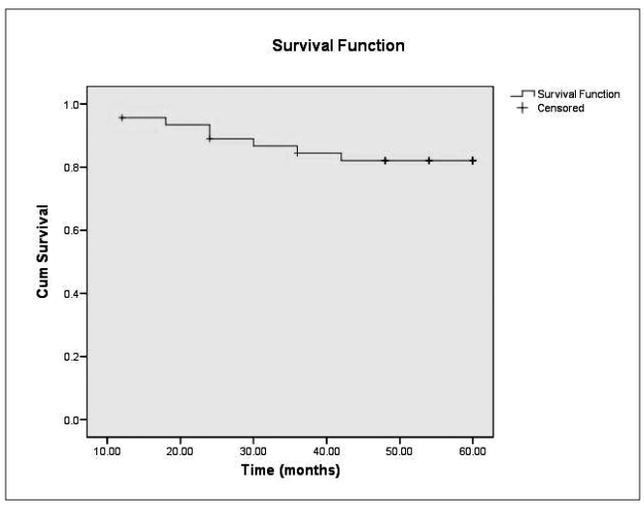

Fig. 3 - *Kaplan-Meier cumulative survival curves for qualified success (intraocular pressure below 21 mmHg with or without medication).*

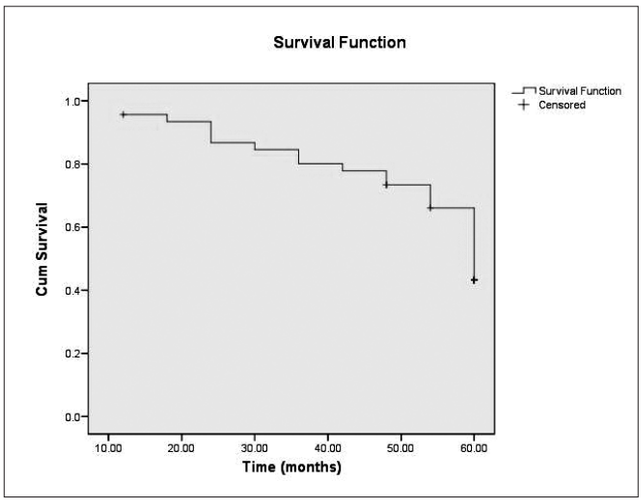

Fig. 4 - *Kaplan-Meier cumulative survival curves for an intraocular pressure of 16 mmHg or less with or without medication.*

13 patients, of whom surgery-related cataract (defined below) was noted in 3 patients (6%), age-related macular degeneration reduced vision in 3 patients (6%), senile nuclear sclerosis was noted in 6 patients (13%), and 1 (2%) had central retinal vein occlusion.

Surgical success and failure

The mean preoperative IOP was 31.8 (SD 4) mmHg. The mean IOP on the first postoperative day was 15.9 (SD 6) mmHg. The mean IOP during further follow-up is shown in Figure 1.

Complete success (IOP lower than 21 mmHg without medication) was achieved in 54.3% (Kaplan-Meier survival analysis; Fig. 2) of patients at 5 years. Qualified success (IOP lower than 21 mmHg with medication) was achieved in 82.1% (Kaplan-Meier survival analysis; Fig. 3) of patients at 5 years. An IOP of 16 mmHg or lower was achieved in 43.2% (Kaplan-Meier survival analysis; Fig. 4) at 5 years. The mean number of medications per eye was reduced from 2.5 (SD 0.65) to 0.75 (SD 0.81) at 48 months postoperatively.

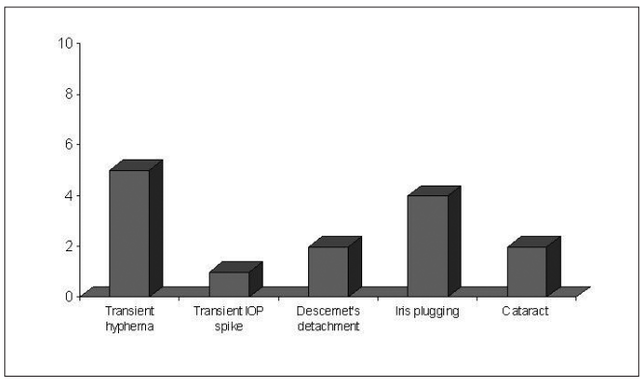

Fig. 5 - *Postoperative complications.*

IOP reduction achieved was 40.8% (SD 3) at 6 months, 48.7% (SD 4) at 12 months, 43.3% (SD 4) at 36 months, and 42.1% (SD 3) at 60 months. In the qualified success group (37 eyes) 22 patients had an IOP between 16 and 21 mmHg and 15 had an IOP of 15 mmHg or less.

Bleb formation was noted in 6 (13%) eyes. At 48 months, five of these eyes were complete successes and one was a qualified success. The mean IOP was 14.8 mmHg, while the mean IOP in the others was 17.5 mmHg. The difference in the mean IOP was not significant (p=0.188).

Of the 46 patients who underwent viscocanalostomy, 9 did not achieve complete or qualified success criteria. One patient developed neovascular glaucoma following a central retinal vein occlusion and needed transscleral diode laser cyclophotocoagulation for IOP control. Five patients had primary open angle glaucoma and three had pseudoexfoliative glaucoma. In these eight patients the mean time to failure was 27.75 (SD 12.8) months. All these patients underwent trabeculectomy with adjunctive mitomycin C.

Complications

Postoperative complications are detailed in Figure 5. Blood was considered present in the anterior chamber when erythrocytes were observed. Transient IOP spike was defined as IOP above 21 mmHg, in the initial 2 weeks following surgery. Non-hemorrhagic Descemet detachment was seen in two patients in whom the detachment was limited to the superior 2 mm of the cornea. In both these patients there was spontaneous resolution of the detached Descemet membrane. Iris tissue was seen to plug the Descemet window in four eyes; one was noticed 2 weeks following viscocanalostomy while the others followed laser goniopuncture. In all these patients a 4- to 6-week course of topical pilocarpine 2% eyedrops pulled the iris away from the peripheral cornea. Two (4%) patients had surgery-related cataract progression that was defined as reduction of visual acuity (over 1 month) and development of cortical lens opacities. Age-related nuclear sclerosis was not included in this group. In neither of these was cataract surgery needed during the study period.

DISCUSSION

Recent studies have provided valuable clues to the mechanism of viscocanalostomy. Roters et al (14) found that the size of the intrascleral lake did not correlate with later IOP and that a 0.10 mm to 0.15 mm thick residual trabeculocorneal membrane was associated with better IOP control. Smit and Johnstone (15) have shown that cannulation and injection of viscoelastic material into the Schlemm canal results in marked dilation of the Schlemm canal and the collector channels. Tamm et al (16) performed histopathologic studies on monkey eyes that had undergone viscocanalostomy and showed focal disruptions of the inner wall endothelium of Schlemm canal and disorganization of the juxtacanalicular zone, resulting in direct communication of juxtacanalicular zone extracellular spaces with the lumen of Schlemm canal. The continuous presence of sodium hyaluronate might prevent repair of these defects by interfering with thrombocyte function. These findings suggest that preparing an adequately thin trabeculo-Descemet window was vital in this procedure and that there exists a direct communication between the intrascleral lake and the Schlemm canal that enhanced conventional aqueous outflow.

While this evidence leads us to believe that surgical technique is critical to the success of viscocanalostomy and intraoperative complications such as Descemet membrane detachment and non identification of the Schlemm canal can be minimized by improved surgical skill, Dietlein et al (17) have noted that sclera is usually thicker and the trabecular meshwork darker in black patients than in white patients and consequently surgical dissection of the deep scleral flap in white patients seems to be even more demanding, because in these patients an important intraoperative topographic landmark is missing.

The results of our study compare favorably with many recent studies reported in the literature. Qualified success was

achieved in 82% of patients at 5 years. Shaarawy et al (18) have reported a qualified success rate of 90% in a similar group of patients with glaucoma. Their technique differed in that they aimed to produce a draining bleb. Though we did not endeavor to create a bleb, a filtering bleb was noted in six patients. Of these, five were complete successes and one was a qualified success at 48 months. None of the six eyes that developed a bleb in this study suffered related complications but they retain the potential for these complications. Bleb formation was probably due to invisible microperforations of the trabeculo-Descemet membrane or loosening of the flap sutures or both. We also noted that the mean IOP in these eyes was lower than the mean IOP of eyes in the qualified success group ($p>0.05$) at all times during follow-up (18, 19). While it is possible that the primary route of aqueous drainage is across the Descemet window through the intrascleral lake and into the Schlemm canal, ultrasound biomicroscopic studies by Kazakova et al (20) in eyes that have undergone nonpenetrating glaucoma surgery show that aqueous outflow also occurs through the subconjunctival space, intrascleral blebs, and through the suprachoroidal space.

It appears that intentional or inadvertent loosening of flap sutures may lead to the formation of a draining bleb and possibly lower IOPs. Therefore in eyes where lower target IOPs are required loose flap sutures with the intention of obtaining a draining bleb can be used, while where target IOPs in the high teens suffice watertight flap sutures can be used. This method allows the surgeon to adjust the aqueous outflow and an intact trabeculo-Descemet membrane may prevent excess aqueous drainage that may possibly cause hypotony and related complications. Successful drainage in eyes that have undergone viscocanalostomy and resulted in blebs suggests a possible role for antimetabolites in maintaining long-term drainage.

IOP lowering following goniopuncture indicates that late rise of IOP following viscocanalostomy is possibly due thickening of the trabeculo-Descemet membrane (presumably due to fibroblast proliferation). Nd:YAG laser goniopuncture transforms a nonpenetrating procedure into a penetrating one, but it does not lead to sudden decompression of the globe that may occur with an intraoperative penetration into the eyeball. The mean time between viscocanalostomy and laser goniopuncture in our study was 9.1 months, the earliest was performed at 3 weeks postoperatively, presumably due to inadequate dissection and preparation of the trabeculo-Descemet window. Iris incarceration at the goniopuncture site was seen in three eyes. Though in our patients a short course of topical pilocarpine drops pulled the iris away from the peripheral cornea, argon laser iridoplasty can be performed as an alternative. This procedure did not lower the safety profile of viscocanalostomy, in that none of our patients had hypotony or any long-term complications. Thus Nd:YAG laser goniopuncture appears to be a safe and efficient adjunct to viscocanalostomy where filtration through the trabeculo-Descemet membrane is considered to be insufficient.

In our study, early postoperative complications included a low incidence of transient hyphema, limited Descemet membrane detachment, peripheral iris plugging the trabeculo-Descemet window, and transient IOP spike. None of these complications affected patients' visual acuity in the long term. While it is difficult to compare studies and their results because success rates are not uniform, there are significant differences in types of glaucoma, their natural history, and morphologic variability of the anterior chamber angle between different racial groups that make a simple comparison of success and failure rates difficult (17).

To our knowledge, this trial is the first to examine intermediate and long-term results of viscocanalostomy in an Asian population. Viscocanalostomy appears to be a safe and effective IOP lowering procedure for Asians in primary open angle, pseudoexfoliation, and pigmentary glaucoma.

The authors have no proprietary interest in this study or in products used as part of the study.

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