Malignant glaucoma is a rare secondary glaucoma classically occurring after intraocular surgery in eyes with primary angle closure. Pars plana vitrectomy is reserved for the treatment of malignant glaucoma when medical and laser treatment fail. The primary aim of surgery is the removal of the anterior vitreous to reduce resistance to aqueous flow into the anterior chamber. In phakic eyes, conventional pars plana vitrectomy without lens extraction is frequently unsuccessful because of difficulty visualizing the normally transparent anterior vitreous, combined with the technical challenge of removing the anterior vitreous without damaging the crystalline lens. We describe a technique of intraocular, videoendoscope-guided, fluorescein-assisted pars plana vitrectomy that enables direct visualization and thorough removal of the anterior vitreous without the need for lens extraction in presbyopic patients without cataract.

Malignant (or “ciliary block”) glaucoma is a rare secondary glaucoma classically occurring after intraocular surgery in eyes with primary angle closure.1 It is characterized by axial shallowing of the anterior chamber in the presence of a patent peripheral iridectomy. The intraocular pressure is usually, but not always, elevated.2,3

Although the precise cause is incompletely understood, a key pathophysiologic feature of malignant glaucoma is believed to be reduced aqueous flow at the level of the lens–zonule–ciliary body and anterior hyaloid interface combined with an inherent permeability defect in the anterior vitreous.1 The conventional hypothesis regarding the cause of malignant glaucoma is that of aqueous misdirection, whereby aqueous is thought to be abnormally directed posteriorly into the vitreous cavity instead of anteriorly into the anterior segment. The consequent accumulation of aqueous fluid in the vitreous cavity causes anterior displacement of the lens-iris diaphragm. The resulting shallow anterior chamber is believed to exacerbate the condition because of the decreased access of aqueous to the trabecular meshwork.

Approximately 50% of patients with malignant glaucoma respond to medical therapy with cycloplegic, aqueous suppressant, and osmotic agents.4 These medications either tighten the zonules and pull the lens posteriorly or reduce vitreous volume and relieve the pressure exerted on the lens-iris diaphragm. Topical cycloplegic agents may be required indefinitely to prevent recurrences. Patients unresponsive to medical treatment may respond to laser treatment, including Nd:YAG laser hyaloidotomy, argon laser treatment of ciliary processes visible through a peripheral iridectomy, or transscleral diode laser cyclophotocoagulation.5-7

Pars plana vitrectomy is generally reserved for the treatment of malignant glaucoma when medical and laser treatment fail. The primary aim of surgery is the removal of the anterior vitreous to increase aqueous flow into the anterior chamber. In patients with phakic eyes, the results of vitrectomy without lens extraction have been disappointing primarily because of the difficulty in visualization and removal of the anterior vitreous without damaging the crystalline lens.
during vitrectomy. It is likely that residual anterior vitreous is responsible for the failure of vitrectomy in many cases, and, consequently, primary lens extraction has been advocated to facilitate removal of the anterior hyaloid and avoid the need for a second procedure. However, the loss of accommodation associated with lens extraction is particularly undesirable in young, presbyopic patients without preexisting cataract.

We describe a new technique of videodendoscopic-guided fluorescein-assisted vitrectomy for the treatment of malignant glaucoma; this technique potentially increases the chance of maintaining a transparent lens postoperatively.

**METHODS**

Solution (0.6% sodium fluorescein [NaFl]) is prepared as described by Das and Vedantham by mixing approximately 40 µL of 20% NaFl (Martindale Pharmaceuticals, Essex, England) with 10 mL of balanced salt solution. A standard 3-port vitrectomy with the sclerotomies placed 4 mm from the surgical limbus is then performed using a wide-angle viewing system (BIOM; Ocular Ophthalmic Diagnostics, Wetzlar/Dutenhofen, Germany). Following core vitrectomy, 1.5 mL of the 0.6% NaFl solution is injected into the vitreous cavity through the superotemporal sclerotomy. The infusion is turned off, and the superonasal sclerotomy is kept open. Intravitreal injection of the 0.6% NaFl is continued until the green dye is observed to flow out of the open sclerotomy. The infusion is then restarted and the vitrectomy continued. The central vitreous cavity contains free NaFl, and the rest of the dye is adherent to the uncut peripheral and anterior vitreous gel. The free dye from the central vitreous cavity is removed with the vitreous cutter using standard vitrectomy techniques. Scleral indentation is then used to facilitate removal of peripheral anterior vitreous (Figure 1).

The image from a 19-gauge illuminated ophthalmic videodendoscope (i-Scope; Ophthalmic Technologies Inc, Toronto, Ontario) is then oriented using a test card. The videodendoscope is passed through the superotemporal sclerotomy and directed into the retrolenticular region, taking care to avoid contact with the crystalline lens. The extent and location of any residual green-stained anterior hyaloid gel and its relation to the ciliary body, ciliary processes, and lens are clearly visualized endoscopically, allowing excellent assessment of whether further peripheral anterior vitreous can be removed using indentation. Particular effort is made to ensure complete clearance of vitreous gel from the area immediately posterior to the peripheral iridectomy. The procedure is concluded when the anterior vitreous has been excised and the retrolenticular region is free of endoscopically visible green-stained gel (Figure 2).

**REPORT OF A CASE**

A 30-year-old woman with phakic eyes and chronic angle-closure glaucoma underwent a left-sided trabeculectomy with a fornix-based flap enhanced with mitomycin, 0.2 mg/mL, applied for 2 minutes over the scleral flap. Postoperative topical medications, consisting of 2% homatropine hydrobromide twice daily, chloramphenicol 4 times daily, and 1% prednisolone acetate 4 times daily, were prescribed. The immediate postoperative course was unremarkable, with the anterior chamber remaining deep and the intraocular pressure lower than 15 mm Hg. A diffuse avascular bleb developed, and all eyedrops were discontinued after 4 weeks. Eight weeks postoperatively, the patient developed left-sided ocular pain associated with significant shallowing of the anterior chamber but without lens-corneal contact. The intraocular pressure was 13 mm Hg, the peripheral iridectomy was patent, and there was no evidence of aqueous leakage, choroidal hemorrhage, or effusion. Malignant glaucoma was diagnosed, and treatment with topical 1% homatropine twice daily was initiated. This led to resolution of the ocular pain and deepening of the anterior chamber.

Transscleral diode laser cyclophotocoagulation (Oculight SLx; Iris Medical Instruments, Inc, Mountain View, Calif) was performed (16 laser applications, each of 2 seconds' duration and 2 W power, delivered 1.5 mm posterior to the limbus in the superotemporal quadrant) in an attempt to induce posterior rotation of the ciliary processes and eliminate a potentially abnormal vitreociliary relationship. However, on repeated attempts to discontinue treatment with topical 1% homatropine, the ocular pain and anterior chamber shallowing recurred. Following reinstitution of topical 1% homatropine, the pain subsided and the anterior chamber...
deepened. Because the patient found the unilateral loss of accommodation associated with long-term cycloplegia intolerable, she was offered vitrectomy 6 months following the initial filtering surgery.

With fully informed consent, endoscopy-guided fluorescein-assisted vitrectomy was performed as previously described. On the first postoperative day, the anterior chamber was deep, no intraocular fluorescein dye was visible, and a discrete gap in the anterior vitreous was clearly seen on slitlamp examination of the retrolenticular region. Postoperative eye-drops and cycloplegic agents were discontinued after 2 weeks. Throughout a follow-up of 8 months, the anterior chamber remained deep, with a clear crystalline lens and an intraocular pressure lower than 14 mm Hg without treatment.

The principal aim of vitrectomy for malignant glaucoma is the removal of the anterior vitreous to facilitate aqueous flow into the anterior chamber. The results of modern vitrectomy in the management of malignant glaucoma have been evaluated in several published series, which have confirmed an excellent success rate in the treatment of malignant glaucoma in pseudophakic and aphakic eyes. In phakic eyes, the results of vitrectomy combined with lens extraction (by lensectomy, phacoemulsification, or extracapsular cataract extraction) have generally been good. However, vitrectomy without lens extraction in phakic eyes has been associated with variable and usually much poorer results. Byrnes et al reported success of vitrectomy in 50% of phakic eyes (5/10) compared with 90% of pseudophakic eyes (9/10). Harbour et al reported success with vitrectomy without lens extraction (by lensectomy, phacoemulsification, or extracapsular cataract extraction) in 71% of phakic eyes (5/7) compared with 100% of phakic eyes (7/7) treated with vitrectomy and lensectomy. Tsai et al reported success with vitrectomy alone in only 25% of phakic eyes (1/4) compared with 40% of eyes (4/10) when vitrectomy was combined with cataract extraction.

The relatively poor results of vitrectomy without lens extraction in phakic eyes have been attributed to surgical technique, specifically the difficulty in visualization of the anterior vitreous combined with the technical challenge of removing the anterior vitreous without damaging the crystalline lens during vitrectomy. In pseudophakic and aphakic eyes, excision of anterior vitreous gel is relatively straightforward because inadvertent lens touch is not an issue.

In an attempt to avoid the need for lens removal during vitrectomy for malignant glaucoma in phakic eyes without preexisting cataract, we developed the technique of videendooscopy-guided fluorescein-assisted vitrectomy. The use of 0.6% NaFl to stain the normally transparent vitreous gel enables easy visualization and identification of uncut anterior vitreous. A videendooscopy enables direct visualization of the retrolenticular anatomical features and the green dye-stained anterior vitreous.

Because of the limited illumination field of the videendooscope, and the risk of inadvertent lens touch associated with simultaneous use of the vitreous cutter and the videendoroscope in the retrolenticular region, standard vitrectomy with scleral indentation is used instead of endoscopic vitrectomy alone to achieve removal of the anterior vitreous. The ability to visually assess the completeness of anterior vitreous excision with this technique provides a clearly defined perioperative surgical end point, thus potentially reducing the likelihood of leaving residual anterior vitreous, which is believed to be responsible for the failure of vitrectomy in many cases.

This technique would not be suitable in eyes with marked corneal edema from lens-corneal touch requiring urgent surgery, in eyes with dense cataract, or when the anterior chamber fails to deepen during vitrectomy. The use of 0.6% NaFl to enhance visualization of the vitreous gel during vitrectomy has been effective and had no noticeable adverse effects in a prospective study involving 50 patients undergoing surgery for macular hole. In addition to the standard risks associated with vitrectomy, which include endophthalmitis, retinal detachment, intraocular hemorrhage, and cataract, the procedure described carries the potential for inadvertent lens touch with the intraocular endoscope.

In conclusion, although longer follow-up and more cases are needed, videendooscopy-guided fluorescein-assisted vitrectomy may be an effective therapeutic option for the treatment of selected cases of malignant glaucoma in phakic eyes. It enables direct visualization and thorough removal of the anterior vitreous without the need for lens extraction in presbyopic patients without cataract.

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REFERENCES