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Original Research Article

A Retrospective Assessment of the Effectiveness of Surgical Management of Malignant Glaucoma in Phakic Eyes

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Abstract

Aim: Effectiveness of surgical management of malignant glaucoma in phakic eyes

Methods: The retrospective study was conducted in the Department of Opthalmology, Darbhanga Medical College and Hospital, Laheriasarai, Darbhanga, Bihar, India for 15 months, patients who underwent core vitrectomy-phacoemulsification-intraocular lens (IOL) implantation-capsulo-hyaloidotomy at least 1mo after the onset of malignant glaucoma. Malignant glaucoma was defined as uniform shallowing to flattening of the central and peripheral anterior chambers, and with intraocular pressure (IOP) over 22 mm Hg. Patients were excluded if they had: 1) a suprachoroidal effusion or hemorrhage, 2) pupillary block, or 3) lens subluxation.

Results: This retrospective study reviewed 10 consecutive malignant glaucoma patients who underwent core vitrectomy, phacoemulsification, IOL implantation, and capsulo-hyaloidotomy. All eyes had been diagnosed with primary angle-closure glaucoma (PACG); 9 eyes (90%) developed the condition after trabeculectomy. The mean onset to surgery interval was 7.1 month. Significant preoperative and postoperative differences were detected in the IOP (P=0.048), number of IOP- lowering medications used (P=0.003), and ACD (P=0.005). Complete success, qualified success, and anatomical success was achieved in 40%, 80%, and 100% of the eyes, respectively.

Conclusion: The present study indicated that core vitrectomy- phacoemulsification-IOL implantation-capsulo-hyaloidotomy is safe and effective treatment for malignant glaucoma patients with long time intervals between malignant glaucoma onset and surgery, achieved a high rate of anatomical success and low rate of postoperative complications.

Keywords: Malignant Glaucoma, vitrectomy, phacoemulsification, capsulohyaloidotomy.

Introduction

Aqueous misdirection syndrome, more commonly referred to as malignant glaucoma, is a term used to describe a spectrum of disorders with several common features which typically include a shallow or flat anterior chamber with elevated, normal, or occasionally low intraocular pressure at some point during the course of the disease in the presence of a patent peripheral iridectomy with no retinal pathology such as suprachoroidal hemorrhage or choroidal effusion. [1-3] Eyes with primary angle closure disease appear to be particularly susceptible to

develop this condition. [4,5] The phenomenon commonly follows an intraocular surgery, most commonly glaucoma filtering surgery, or laser procedures such as laser iridotomy, laser cyclophotocoagulation, laser posterior capsulotomy and laser suture lysis, and in rare instances has been reported to occur spontaneously as well. [6-12] Several mechanisms have been described to explain the pathogenesis of this phenomenon. [1,13] The key element appears to be a barrier in the forward movement of aqueous due to cilio-lenticular block in phakic eyes, or iridocilio-vitreal block in aphakic or pseudophakic eyes. Disproporortionately large crystalline lenses in small eyes leading to increased cilio-lenticular apposition may predispose these eyes to the development of malignant glaucoma. The mechanism in aphakic and psedophakic eyes is thought to be an increased flow resistance through the vitreous gel resulting in compression of the anterior hyaloid and high resistance to aqueous flow, thereby creating a vicious cycle. Moreover, bchoroidal expansion has been hypothesiszed to initiate the condition by reducing the movement of aqueous across the condensed vitreous gel. [14] The initial treatment of malignant glaucoma is the use of cycloplegia to move the lens-iris diaphragm backwards and widen the middle segment of the eye, aqueous suppressants to reduce the flow of aqueous into the vitreous cavity and hyper osmotic agents to reduce vitreous volume. [1,2] Topical steroids are used to reduce inflammation. Laser treatment in the form of laser capsulotomy with anterior hyaloidotomy to incise the thickened anterior hyaloid or cyclophotocoagulation to shrink the ciliary processes and thereby to break the ciliary block are attempted if medical treatment remains ineffective in pseudophakic or aphakic eyes. [15,16] Surgical modalities are resorted to, if the first two steps fail. The primary goal of surgical treatment is to re- establish a communication between the posterior and anterior segments of the eye. The various approaches reported in the literature include vitreous incision and aspiration of the trapped aqueous, pars plana vitrectomy, vitrectomy-phacoemuslification-vitrectomy in phakic eyes, vitrectomy with hyaloido-zonulectomy and peripheral iridectomy, and vitrectomy with insertion of a glaucoma drainage device. [17]

Material and Methods

The retrospective study was conducted in the Department of Opthalmology, Darbhanga Medical College and Hospital, Laheriasarai, Darbhanga, Bihar, India for 15 months.

Methodology

Patients who underwent core vitrectomy-phacoemulsification-intraocular lens (IOL) implantation-capsulo-hyaloidotomy at least 1mo after the onset of malignant glaucoma. Malignant glaucoma was defined as uniform shallowing to flattening of the central and peripheral anterior chambers, and with intraocular pressure (IOP) over 22 mm Hg. Patients were excluded if they had: 1) a suprachoroidal effusion or hemorrhage, 2) pupillary block, or 3) lens subluxation.

Age, sex, preexisting glaucoma type, previous surgery type, and preoperative and postoperative information, including onset to surgery interval (months), axial length (AL), corneal endothelium density (/mm2), number of IOP-lowering medications used, best-corrected visual acuity (BCVA), IOP, anterior chamber depth (ACD), follow-up duration (months), and complications were obtained from a review of the medical records. The time interval between onset and surgery is from the diagnosis time of the patients at the other hospitals to their surgeries in our hospital. The IOP was measured by Goldmann applanation tonometry. The BCVA was measured using a Snellen chart and then converted to the logarithm of the

minimum angle of resolution (logMAR) for statistical analyses. The ACD was measured from the central inner corneal surface to the most anteriorly visible part of the lens (preoperative) or IOL (postoperative) by ultrasound biomicroscopy (UBM) as previously described. [18] The corneal endothelium density was counted by specular microscopy according to manufacturer's instruction. [19]

Medical treatment was attempted using 1% atropine sulfate, topical steroid, and topical and systemic IOP-lowing medications. If reformation of the anterior chamber was not achieved in 7d, surgery was performed using the following techniques. A 23-gauge vitrectomy probe was inserted through the pars plana, 3.5 mm posterior to the limbus, using a trocar under peribulbar anesthesia. A limited core vitrectomy was performed (2500- 5000 cuts/min, 0-500 mm Hg vacuum) to debulk the vitreous body and soften the eye under microscope illumination. A temporal, self-sealing, transparent corneal incision was made to avoid the conjunctival bleb. An ophthalmic viscosurgical device was then injected to deepen the anterior chamber. Hydro dissection and hydrodelineation were performed after continuous curvilinear capsulorhexis. The lens was extracted using standard phacoemulsification and irrigation/aspiration. A foldable IOL was then implanted in the capsular bag. Subsequently, posterior capsulotomy and anterior vitrectomy were performed using a 23-gauge vitrectomy probe with irrigation of the corneal incision. The trans conjunctival pars plana entry site was sutured with 7-0 absorbable sutures. Tobramycin and dexamethasone solution (Tobradex; Alcon, Fort Worth, TX, USA) was administered every 2h during week 1, and four times per day during weeks 2-4 after surgery. Tobramycin and dexamethasone ointment (Tobradex; Alcon, Fort Worth, TX, USA) was used every night during the first month. IOP-lowering medications were used if the postoperative IOP was higher than 21 mm Hg.

Anatomical success was the primary outcome measure, which was defined as deepening of the anterior chamber without iridocorneal touch. Complete success was the secondary outcome measure, which was defined as the reformation of the anterior chamber with IOP lower than 21 mm Hg, and BCVA improvement in the absence of any IOP-lowering medication. Improvement of BCVA was defined as an increase of at least two lines after surgery compared to the preoperative BCVA. Qualified success was defined as the reformation of the anterior chamber with IOP lower than 21 mm Hg, and with a reduction in the number of IOP- lowering medications.

Results

This retrospective study reviewed 10 consecutive malignant glaucoma patients who underwent core vitrectomy, phacoemulsification, IOL implantation, and capsulo- hyaloidotomy. All eyes had been diagnosed with primary angle-closure glaucoma (PACG); 9 eyes (90%) developed the condition after trabeculectomy. The mean onset to surgery interval was 7.1 month. Significant preoperative and postoperative differences were detected in the IOP (P=0.048), number of IOP- lowering medications used (P=0.003), and ACD (P=0.005). Complete success, qualified success, and anatomical success was achieved in 40%, 80%, and 100% of the eyes, respectively.

Corneal endothelial decompensation was postoperatively observed in 3 cases. No normal corneal endothelium could be identified in either eye. Diode cyclophotocoagulation was required to control the IOP in another 3 cases, timolol, 1% brinzolamide, and 0.2% brimonidine tartrate twice daily. She had decreased VA in her right eye at two years after surgery.

A diagnosis of malignant glaucoma was made. Topical and systemic medical treatments (intravenous mannitol, 50 mg oral methazolamide twice daily, 1% atropine sulfate twice daily, 1% prednisolone acetate every two hours, 0.5% timolol, 1% brinzolamide, and 0.2% brimonidine tartrate twice daily) were used.

At presentation at our clinic 1mo after the diagnosis of malignant glaucoma, the parameters of the patient's right eye were as follows: logMAR BCVA: 0.6; IOP range: 22-35 mm Hg; cup-to-disc ratio: 0.9; AL: 22.5 mm; and ACD: 1.27 mm. Core vitrectomy-phacoemulsification-IOL implantation-capsulo-hyaloidotomy were performed. At 1y postoperatively, she continued to use 0.5% timolol and 1% brinzolamide twice daily in the right eye, in which the logMAR BCVA was 0.3, the IOP was 16.5 mm Hg, and the ACD was 3.72 mm.

Table 1: Demographic and clinical data (*n*=10eyes)

Profile	Mean±SD
Age	49.7±14.7
Onset to surgery interval, mo	7.1±12.2
AL, mm	20.7±2.6
Corneal endothelium densitya, /mm2	946.2±29.66
Preoperative VA, logMAR	2.2±0.8
Postoperative VA logMAR	1.7±0.7
Preoperative IOPb, mm Hg	32.8±13.1
Postoperative IOPb, mm Hg	21.4±10.6
Preoperative number of IOP-lowering medications used	3.1±1.1
Postoperative number of IOP-lowering medications used	1.1±1.6
Preoperative ACDc, mm	0.46±0.48
Postoperative ACDd, mm	2.78±0.65
Follow-up, mo	15.3±8.2
Sex (male)	4
Eye (OD:OS)	6:4
Diagnosis	PACG
Previous treatment, %	
Trabeculectomy	80
Diode laser cyclodestruction	10
Pilocarpine	10
Rate, %	
Anatomical success	100%
Complete success	40%
Qualified success	80%
Recurrence	0
Complication, *n*	
Corneal endothelial decompensation	3

AL: Axial length; VA: Visual acuity; IOP: Intraocular pressure; ACD: Anterior chamber depth. a Corneal endothelium density was not measured in one eye;b.The IOP was measured after IOP-lowering medications used if any; cPreoperative

ACD was not measured in one eye of which the anterior chamber was recorded as flat; dPostoperative ACD was not measured in two eyes of which the anterior chamber was recorded as deep.

Discussion

As a rare and intractable disease, large-scale studies and randomized clinical trials of malignant glaucoma are still lacking. [20-23] The present study observed the treatment safety and efficacy of surgery for long onset phakic malignant glaucoma in a case series. Overall, the VA, IOP, number of IOP-lowering medications used, and ACD improved after surgery. Significant preoperative and postoperative differences were detected in the IOP, number of IOP-lowering medications used, and ACD. High success rate and low complication rate were achieved.

Except for two cases with long time intervals because of well-controlled of malignant glaucoma *via* medications in Krėpštė *et al* [24], all eyes in the previously reported studies had short time intervals. In contrast, the present study included patients with long time intervals. The reason for the 7mo between diagnosis and surgical treatment in the present study is poor follow- up compliance. The time of malignant glaucoma diagnosis is from the medical records of the patients diagnosed at the other hospitals. Therefore, the time interval between onset and surgery is from their diagnosis time at the other hospitals to their surgeries in our hospital. In contrast to the long-time interval of follow-ups, all the 13 cases included in the present study were treated with medical treatment including 1% atropine sulfate, topical steroid, and topical and systemic IOP- lowing medications once they were diagnosed at our hospital. If reformation of the anterior chamber was not achieved in 7d, surgery was performed. Patients with the above characteristics are commonly considered to have a very poor prognosis with minimal benefit expected from surgery because that the degree of optic disc damage caused by high IOP and corneal endothelial dysfunction caused by physical lens-cornea touch might be different according to disease duration. However, in our case series, the improvements in VA, IOP, number of IOP-lowering medications used, and ACD were not inferior to those of previous reports which included patients with short time intervals. A possible explanation for the good surgical outcome of the present study is the surgical technique used. Previous studies reported that oxidative stress in eyes with glaucoma eyes might promote vitreous liquefaction25, starting from the central vitreous and progressing to the cortex of the vitreous body.26 Therefore, effective technique might involve creating a channel connecting the vitreous cavity and the anterior chamber, thus breaking the vicious circle of aqueous misdirection. Compared with most of the previous studies. [27-29] which performed zonulo-capsulo-hyaloidotomy creating the channel through the peripheral iris, we applied capsulo-hyaloidotomy creating the channel through the pupil and the central posterior capsule. Another possible reason for the difference in prognoses between the present and previous study is that the area of vitrectomy might have been larger in out study due to the better visualization afforded by central capsulo-hyaloidotomy. Further methodologically sound examinations and sufficiently sized clinical trials are needed to validate the mechanism.

Longstanding iridocorneal touch resulted in a decrease in corneal endothelium density, with a mean of 947.2/mm2; 50% of the eyes had a corneal endothelium density of 0. Only two of the six patients with a corneal endothelium density of 0 (counted by endothelioscopy) eventually developed postoperative corneal endothelial decompensation. Their VAs were restored to different degrees after Descemet membrane endothelial

keratoplasty (DMEK) surgeries (all clinical data of these two eyes were obtained from the period before DMEK was performed). The above observation suggests that the postoperative corneal endothelial decompensation might not be occurred even though the preoperative endothelioscopy test result is poor. A possible explanation is that endothelioscopy might underestimate the corneal endothelium density in the eyes without anterior chamber. For these eyes, the corneal edema might recover with a certain period of time after operation.

There was one case developed anterior chamber flattening, IOP elevation after merely used pilocarpine. Since there was severe ACD disparity in both eyes, the PACG was excluded. Additionally, the patient did not have ocular trauma history, and we did not observe intumescent cataract, iridodonesis, zonules laxity or rupture, and other signs related to secondary glaucoma during surgery. Therefore, secondary glaucoma was also excluded. The patient was diagnosed as aqueous misdirection. The possible mechanism of pilocarpine induced aqueous misdirection is that pilocarpine induces ciliary muscle contraction causing narrowing of ciliary body ring diameter, laxity of lens zonules, forward movement of the lens-iris diaphragm, ciliolenticular block, and finally leading to aqueous misdirection.

Conclusion

The present study indicated that core vitrectomy- phacoemulsification-IOL implantation-capsulo-hyaloidotomy is safe and effective treatment for malignant glaucoma patients with long time intervals between malignant glaucoma onset and surgery, achieved a high rate of anatomical success and low rate of postoperative complications.

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