


Surgical Treatment Outcome in Malignant Glaucoma: Hospital-Based Single-Center Retrospective Study

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Objective: To determine the results of surgical treatment for malignant glaucoma among inpatients at the Department of Ophthalmology of the First Central Hospital and to evaluate the post-operative visual acuity, intraocular pressure, and the usage of intraocular antiglaucoma drops. **Methods:** A hospital-based, single-center, retrospective study of 19 patients treated for malignant glaucoma during the period from January 2019 to April 2023 at FCHM was conducted. Demographic and clinical data of cases were collected from medical records. **Results:** The average age was 74.5 ± 9.8 years. Female gender predominated, with 14 (82.3%) females and 16 (88.8%) eyes being pseudophakic. Of these, Pars plana vitrectomy (PPV) was performed in 9 (52.9%) cases, and transpupillary anterior vitrectomy (AV) was performed in 8 (47.1%) cases. Surgical capsulotomy and iridozonulotomy were done in all cases. The mean follow-up period was 11.44 ± 13.4 months (range, 2-38 months). The mean intraocular pressure decreased significantly from 39.4 ± 10.3 mmHg to 11.2 ± 3.2 mmHg (p value < 0.01), and the number of antiglaucoma drops decreased significantly (p value < 0.01). In the anterior vitrectomy group, IOL removal surgery was performed in 2 cases due to recurrence detection. **Conclusion:** Pars plana vitrectomy surgery has been shown to improve visual acuity and effectively reduce intraocular pressure in patients with malignant glaucoma that is ineffective in laser and medical therapy. Transpupillary anterior vitrectomy, capsulotomy, and iridozonulotomy surgery are effective methods for reducing intraocular pressure and decreasing the need for antiglaucoma drops.

Key words: Glaucoma, Vitrectomy, Aqueous humor, Visual acuity, Intraocular pressure.

Introduction

Malignant glaucoma is a rare form of secondary angle-closure glaucoma. It is characterized by a shallow anterior chamber (AC) both centrally and peripherally, along with increased intraocular pressure (IOP), which can cause irreversible vision loss in a short period.¹ This condition can happen independently of iridectomy. Malignant glaucoma was first described

by Von Graefe in 1869 as a shallow or flat anterior chamber (AC) elevated during the course of the disease, even when a peripheral iridectomy (PI) was patent.² It occurs in about 0.06% to 4% of cases after surgery for either open-angle or angle-closure glaucoma.³⁻⁵ Specifically, it happens in around 2% to 4% of cases after surgery for primary angle-closure glaucoma.⁶ Lin, et al. reported that malignant glaucoma occurred in 0.75% of the 5044 cases treated surgically for primary angle-closure glaucoma.⁷ Although the exact cause is not fully understood, several theories try to explain its development. A main idea is that cilio-lenticular block (irido-cilio-lenticular in pseudophakia and aphakia) interferes with normal intraocular fluid flow. This can result in fluid build-up, pushing the ciliary body and vitreous forward, which leads to a closed angle.⁸

The duration of malignant glaucoma formation after surgery can vary. Malignant glaucoma typically affects individuals previously diagnosed with angle-closure glaucoma and usually involves one eye with a short axial length. This condition can also occur after ophthalmic surgeries and outpatient procedures, such as peripheral laser iridotomy and cyclophotocoagulation, regardless of whether the patient is pseudophakic or phakic. Although malignant glaucoma occurs predominantly in females, there is insufficient evidence to suggest that sex is a significant risk factor for the condition.^{7,9}

This condition is diagnosed by excluding other potential diagnoses (differential diagnoses). In malignant glaucoma, treatment aims to restore normal aqueous flow. Medical treatments are used to reposition the lens-iris diaphragm and reduce the fluid accumulation. Pharmacotherapy, which is IOP-lowering topical or systemic treatment, is effective in up to 50% of cases.¹⁰ Argon laser ablation of the anterior vitreous and posterior capsule in eyes /pseudophakia and aphakia/, refractory to medical therapy, has a 75% short-term success rate.¹¹⁻¹³ Recent studies suggest that pars plana vitrectomy (PPV), capsulotomy, and zonulo-iridectomy surgery are considered effective methods of surgical treatment when drug and laser treatments are ineffective.¹⁴⁻¹⁶ Pars plana vitrectomy boasts a success rate ranging from 96% to 100% when medical and laser treatments are unsuccessful.¹¹ Additionally, the efficacy of anterior vitrectomy (AV), which is cost-effective and less invasive, for malignant glaucoma has been noted in small studies and case series.¹⁶⁻¹⁹

In this study, we aimed to evaluate the outcomes of pars

plana vitrectomy (PPV) and anterior vitrectomy (AV) surgeries in patients diagnosed with malignant glaucoma at the Department of Ophthalmology of the First Central Hospital of Mongolia.

Material and Methods

This retrospective study reviewed the outcomes of pars plana vitrectomy (PPV) and anterior vitrectomy (AV) surgeries in patients diagnosed with aqueous misdirection at a single tertiary hospital in Mongolia from January 2019 to April 2023. Patient records were collected from the electronic medical record system (E-health) of the First Central Hospital of Mongolia.

This study was reviewed and approved by the Branch Committee of Ethics Oversight of the Mongolian National University of Medical Sciences (MNUMS) during meeting No. 2020(3-08), held on February 23, 2021.

Malignant glaucoma was defined as uniform (central and peripheral) shallowing and/or flattening of the anterior chamber (AC) in the presence of a patent peripheral iridectomy (PI), intraocular pressure (IOP) > 22mmHg. Any other pathologies that produce shallow or flat AC (eg, pupillary block, choroidal effusion, suprachoroidal hemorrhage, secondary surgery for MG) were excluded.

Patient demographic and clinic information that includes age, sex, preexisting glaucoma type, previous surgery type, and preoperative and postoperative information, including onset to surgery interval (months), axial length (AL), number of glaucoma medications used, follow-up duration (months), and complications, were extracted from the medical records. The best corrected visual acuity (BCVA) was measured using a Snellen chart. Intraocular pressure (IOP) was measured using Goldmann applanation tonometry. Cornea, anterior chamber depth, pupil, pupillary block, peripheral iridectomy, lens status, and cup-to-disc ratio were measured. Each follow-up examination included best-corrected visual acuity (BCVA), intraocular pressure (IOP), the number of glaucoma medications, anterior chamber depth, complications, and recurrence.

All patients received IOP-lowering medications and cycloplegic topical medical treatment before the surgery. Mannitol 10%-IV infusion was used in some cases, depending on IOP. In all cases, retrobulbar anesthesia was used. The standard three-port technique performed PPV. During PPV, hyaloido-zonulo-iridectomy and posterior capsulotomy were performed using

the vitreous cutter from a posterior approach. AV surgery was performed by clear-corneal paracentesis through a transpupillary approach. The anterior chamber was deepened after suprachoroidal fluid was drained through the pars plana space in every case of AV needed for an anterior chamber maintainer. As soon as the anterior chamber became deeper, the vitrector tip was penetrated through the corneal incision, performing peripheral iridectomy, zonullectomy. A vitreous cutter was placed under the IOL (after phacoemulsification in case of phakic eye), and posterior capsulotomy was performed, cutting the anterior vitreous until the anterior chamber was sufficiently deep.

In some cases, a cyclodialysis spatula was used to free iridocapsular adhesion or any element of peripheral anterior synechiae. Subconjunctival injections of an antibiotic and a steroid were given at the end of the surgery. Postoperatively, topical medication was prescribed as follows: an antibiotic drop every 2 hours and a topical steroid drop every 2 hours for the first week, then tapered over 4–6 weeks.

The post-surgical BCVA, IOP, anterior chamber depth, and the number of glaucoma medications are measures of surgical success.

Statistical analysis was performed using Stata 16 software. An ANOVA test was applied to determine the statistical significance between VA and IOP before the surgery and final examination. Spearman's correlation coefficient was used to determine the relation between axial length and IOP. Qualitative data of patients who underwent AV surgery were compared using the Kaplan-Meier survival analysis. A value of p value ≤ 0.05 was considered to be statistically significant.

Results

17 eyes of 17 patients (female 14 and male 3) with an average age of 74.5 ± 9.8 (range 55–96) years were included in this study. At the initial assessment, the mean IOP was 39.4 ± 10.3 mmHg (range: 25–61) and the mean logMAR VA was 1.47 ± 0.79 (median: 1.4, range: 0.3–2.7). The majority of the eyes ($n=14$, 82.3%) had a previous glaucoma diagnosis, of which 8 (47%) cases had primary angle-closure glaucoma. 16 (94.1%) eyes had undergone cataract surgery. One patient had undergone surgical iridectomy and combined surgery, cataract surgery with trabeculectomy, was done in 4 (23.5%) cases. The time interval between associated ocular surgery and formation of

malignant glaucoma had a tremendous gap (between 4 days to 2.6 years). The mean follow-up time was 11.44 ± 13.4 (median: 7.1, range: 2–38 months). PPV–capsulotomy–iridozonullectomy in 9 eyes and AV–capsulotomy–iridozonullectomy in 8 eyes were done, respectively. The average axial length was 22.98 ± 0.53 mm. The study participants' demographic data is shown in Table 1.

In this study, 9 eyes from 9 patients who underwent PPV with an average age of 75.2 ± 11.8 (range: 55–96) years were included. Eye laterality was 44.4% right eye. At the time of diagnosis of malignant glaucoma, the mean IOP was 38.0 ± 10.4 (range: 25–55) mmHg. After surgery, the mean IOP was significantly reduced to 12.0 ± 3.4 (range: 9–22) mmHg on the last visit (p value = 0.002). The mean IOP-lowering medication usage was reduced (p value = 0.003). Mean BCVA was 1.46 ± 0.5 logMar (median: 1.5, range: 0.3–2.4) at the baseline, and improved to 1.04 ± 0.3 logMar (median: 0.7, range: 0.2–2.4) at the last visit. A statistically significant correlation was observed between AXL and IOP ($r = 0.319$).

8 eyes underwent AV by transpupillary approach. Mean age was 74 ± 8 (range 65–90) years. On the post-operative first day, the mean IOP decreased from 41.0 ± 10 mmHg (median: 39, range: 30–61) at baseline to 10.4 ± 1.4 mmHg (range: 9–12). Significant pre- and postoperative differences were detected in IOP (p value = 0.001) and in the number of glaucoma medications (p value = 0.013). Regarding the BCVA, preoperative BCVA 1.49 ± 0.5 logMar (median: 1.2, range: 0.3–2.7) was enhanced to 1.04 ± 0.4 logMar (median: 1.7, range: 0.3–2.7). The overall rate of being without recurrence and complication at 3 years was 75%. Statistically significant correlation was observed between AXL and IOP ($r=0.60$).

The mean age of the patients involved in the study and the affected eye laterality showed no statistically significant difference between the two groups undergoing surgical treatment ($p = 0.631$, 0.602). However, the average time from the previous surgery to the subsequent surgery differed. The changes in intraocular pressure, other features were compared using surgical methods, as shown in Table 2. In both treatment groups, intraocular pressure effectively decreased after the same surgical intervention, with no significant difference in the reduction of intraocular pressure between the two groups ($p = 0.384$). Figure 1 and Figure 2 are provided differences of IOP and VA between study groups.

Table 1. Demographic data of 17 eyes with malignant glaucoma.

Number	Patient Sex/ Age/Eye	Previous Diagnosis	Previous Surgery	IOP,mm Hg at time of Malignant glaucoma	Initial VA (logMar)	Event Proceeding Malignant Glaucoma	Time to Malignant Glaucoma /Day/	Postopera- tive Adverse Events
1	F/68/R	PACG	CS, Trab	34	2.4	PPV	133	None
2	M/77/R	Cataract	CS	55	1	PPV	16	None
3	F/76/L	Cataract	CS	42	1.5	PPV	55	None
4	F/77/L	PACG	CS	39	1	PPV	959	None
5	M/67/L	IMSC with PXFS	CS, Trab	25	0.4	PPV	21	None
6	F/87/L	Cataract	CS	32	0.5	PPV	832	None
7	F/74/L	Cataract with PACG	CS	24	2.4	PPV	366	None
8	F/55/R	Cataract	CS	49	2.4	PPV	21	None
9	F/96/R	PACG with cataract	CS	42	1.5	PPV	106	None
10	F/73/ R	Phaco- morphic glaucoma	CS	30	2.7	AV	44	None
11	F/65/ R	PACG with Cataract	CS	40	1.4	AV	82	Recurrence
12	F/83/L	Cataract with PXFG	CS	61	0.7	AV	170	None
13	M/90/ L	Cataract	CS	44	2.4	AV	8	None
14	F/77/ R	-0.424	CS	51	0.3	AV	44	None
15	F/71/L	Cataract with PACG	CS, Trab	38	1	AV, Trab	5	None
16	F/67/L	Cataract with PACG	Iridectomy	32	2.4	AV, CS	4	None
17	F/67/ R	Cataract with PACG	CS, Trab	32	1	AV	149	Recurrence
Mean	-	-	-	39.4	1.47	0.13	177.3	

IOP – intraocular pressure, VA – visual acuity, PACG – primary angle-closure glaucoma, PXFS – pseudo-exfoliation syndrome, PXFG – pseudo-exfoliation glaucoma, PPV – pars plana vitrectomy, AV – anterior vitrectomy, Trab – trabeculectomy, CS - cataract surgery

Table 2. Clinical characteristics in both groups

Variables	Type of Sx (PPV/ ant.vit/ Laser)				p value
	PPV		AV		
	n	%	n	%	
Sex					
Male	2	22.20%	1	12.50%	0.402 ^a
Female	7	77.80%	7	87.50%	
Eye laterality					
OD	4	44.40%	4	50.00%	0.602 ^a
OS	5	55.60%	4	50.00%	
Previous procedure					
No	2	22.20%	1	12.50%	0.701 ^b
Hyalodotomy (laser)	0	0.00%	2	25.00%	
LPI, hyalodotomy	4	44.40%	0	0.00%	
SPI	1	11.10%	1	12.50%	
SPI, hyalodotomy (laser)	2	22.20%	3	37.50%	
Previous surgery					
Cataract surgery	6	66.70%	5	62.50%	0.701 ^a
Trabeculectomy	1	11.10%	1	12.50%	
Combined	2	22.20%	2	25.00%	
Pre-op glaucoma medications					
1	1	11.10%	0	0.00%	0.802 ^a
2	1	11.10%	4	50.00%	
3	3	33.30%	1	12.50%	
4	4	44.40%	3	37.50%	
Sum	9	52.90%	8	47.10%	
	Median	Range	Median	Range	
Mean Age	76	55 - 96	72	67 - 90	0.631 ^b
Duration since diagnosis (day)	106	16 - 959	44	4 - 170	0.702 ^b
Pre-op IOP	39	25 - 55	39	30 – 61	0.711 ^b
Post-op IOP	11	9 - 22	10	9 - 12	0.801 ^b
Follow-up time (month)	13.4	1 - 46	7.5	1.9 – 38.6	0.021 ^{*b}

^a – Fisher's test, ^b – Mann-Whitney test, * - p value less than 0.05

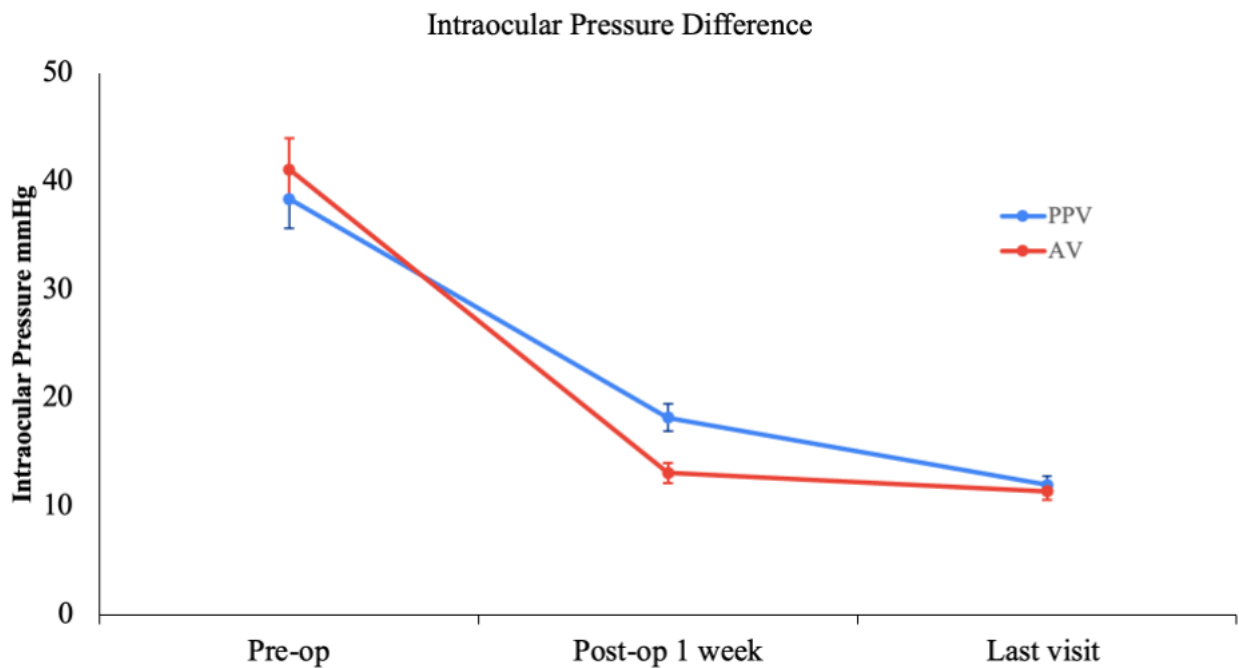


Figure 1. Intraocular pressure differences in both groups

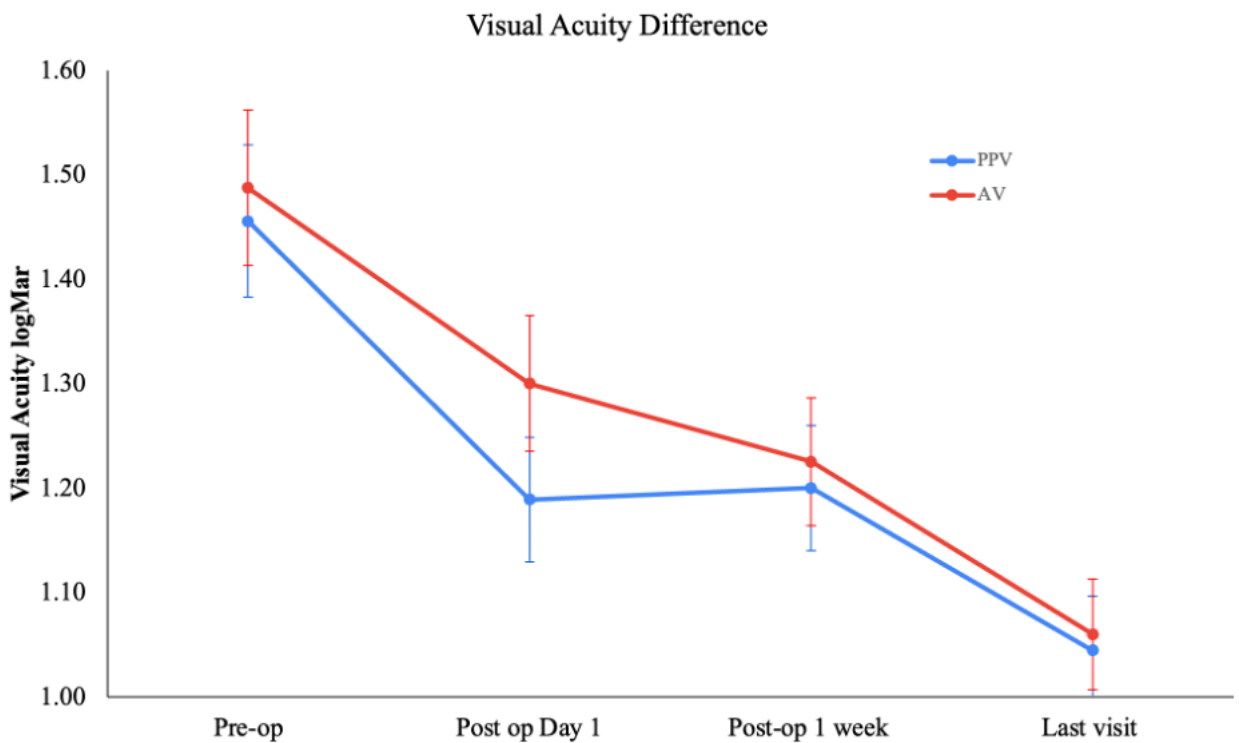


Figure 2. Changes in the mean best corrected visual acuity in logMAR in both groups

Discussion

This single tertiary hospital-based retrospective study investigated cases of malignant glaucoma in patients admitted to the ophthalmology department of a referral hospital and analyzed the outcomes of surgical treatment.

The duration between primary surgery and the development of malignant glaucoma varied from 4 days to 3.8 years. A shorter axial length of the eye was correlated with higher intraocular pressure, a finding similar to that of Zhou, et al. in China. Other studies have shown that hyperopic eyes with an axial length of less than 22 mm are the most frequent precipitating factor.^{7,9,20} In Zhou, et al.'s study, the axial length was 21.56 ± 1.60 mm, and in Rekas et al.'s study, it was 21.8 ± 0.8 mm.²¹ In contrast, in our study, it was 22.98 ± 0.53 mm, indicating that even with a relatively normal eye length, there is still a possibility of developing malignant glaucoma.

The efficacy of medical therapy and laser procedures in treating malignant glaucoma has been limited, with a high recurrence and up to a 50% success rate.^{10,11} Surgical methods to control aqueous misdirection in malignant glaucoma have been developed. The primary goal of surgical treatment is to increase the aqueous flow into the anterior chamber. Conventional pars plana vitrectomy surgery has a recurrence rate of 33% (with pseudophakic eyes) and 75% (with phakic eye). Sharma, et al.'s vitrectomy-phacoemulsification-vitrectomy method showed no recurrence in phakic eyes and effectively reduced intraocular pressure.²² In our study, although there were no complications or recurrences during surgery in 9 cases, all cases underwent cataract surgery before the following surgery, so it is impossible to evaluate the risk of complications and recurrence in phakic cases.

Although pars plana vitrectomy is highly effective, it is costly and requires specific techniques and equipment.²³⁻²⁵ Partial pars plana vitrectomy achieved a higher success rate (85.2%) in controlling IOP, but 11 out of 20 cases (55%) experienced recurrence.^{19,24} In a study by Zarnovski, et al. there were no recurrences up to 18 months of follow-up after anterior vitrectomy through a tunnel within the iridotomy.¹⁸ Liu, et al. reported no recurrences in 25 phakic eyes that underwent phacoemulsification and posterior capsulotomy with anterior vitrectomy, although 5 eyes continued using glaucoma drops.²⁶ In our study, anterior vitrectomy through a transpupillary approach, with posterior capsulotomy and hyaloidotomy, was performed in 8 eyes: 1 aphakic eye, 1 phakic eye (with phacoemulsification), and 6 pseudophakic eyes,

resulting in a significant reduction in intraocular pressure and a favorable visual prognosis without relapse.

There was no statistically significant difference in the reduction of intraocular pressure and improvement in visual acuity between the two surgical groups. The use of glaucoma medications also decreased similarly in both groups, with no intraoperative complications. In 2 out of 8 cases in the anterior vitrectomy group, recurrence of malignant glaucoma occurred, and intraocular lens removal surgery was performed in these cases.

Conclusion

Pars plana vitrectomy, a conventional treatment that requires expensive instruments, has been demonstrated to be an effective treatment for malignant glaucoma. Anterior vitrectomy, performed using inexpensive and simple equipment, yields a similar reduction in intraocular pressure; thus, this surgical approach may be a viable choice. However, given the rarity of malignant glaucoma, our study was conducted in a small sample, and most patients were pseudophakic at one center. Therefore, future research should focus on determining outcomes specifically for phakic patients, and multicenter studies are essential to ascertain long-term treatment results and complications.

Conflict of Interest

The authors state no conflict of interest.

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methodology, software, writing—original draft preparation, visualization

Enkhtuya Erdene: data curation, formal analysis, writing—original draft preparation, visualization

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All authors have read and agreed to the published version of the manuscript.

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