Combined posterior vitrectomy and Ahmed valve implantation with prior antiangiogenic application for the management of neovascular glaucoma: a case series study

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1. Resumen

Objetivo y antecedentes: Este estudio tiene como objetivo evaluar el protocolo institucional de manejo interdisciplinario para pacientes con glaucoma neovascular, centrándose en un enfoque quirúrgico combinado que incluye vitrectomía posterior e implantación de válvula de Ahmed, con aplicación previa de un agente antiangiogénico.

Materiales y métodos: Se realizó una revisión retrospectiva de 14 pacientes con glaucoma neovascular que fueron sometidos al procedimiento combinado durante 4 años. Se incluyeron pacientes de 18 años o más que hubieran recibido previamente tratamiento antiangiogénico y que no tuvieran otros tipos de glaucoma ni vitrectomía posterior previa. El éxito quirúrgico se evaluó como la reducción de la presión intraocular por debajo de 21 mm Hg, ya sea sin medicación hipotensora (éxito absoluto) o con medicación (éxito calificado) en diferentes puntos de seguimiento. Los desenlaces secundarios incluyeron la presión intraocular (PIO), el número de medicamentos hipotensores, la agudeza visual, la etiología subyacente y las complicaciones postoperatorias.

Resultados: Al inicio, los pacientes tenían una PIO promedio de 50 mm Hg y utilizaban 4,4 medicamentos para el glaucoma. Tras los 12 meses de seguimiento, la PIO media disminuyó significativamente a 16,4 mm Hg, reduciendo la necesidad de medicación hipotensora. La tasa de éxito calificado fue del 100%, mientras que no se alcanzó el éxito absoluto. La agudeza visual y los resultados anatómicos se mantuvieron, sin casos de pérdida anatómica. Las complicaciones postoperatorias, incluyendo hipema, desprendimiento coroideo y hemorragia vítrea, fueron transitorias y se resolvieron espontáneamente.

Conclusión: El protocolo de manejo interdisciplinario propuesto mostró resultados favorables para el tratamiento del glaucoma neovascular. El enfoque quirúrgico combinado condujo a una reducción considerable de la presión intraocular y del uso de medicación para el glaucoma, indicando una alta tasa de éxito en el control de la enfermedad. La agudeza visual y los resultados anatómicos se mantuvieron estables durante el periodo de seguimiento, sin casos de pérdida anatómica.

Significado clínico: Este estudio demuestra que la combinación de vitrectomía posterior e implantación de válvula de Ahmed, precedidas por terapia antiangiogénica, reduce eficazmente la presión intraocular y la necesidad de medicación para el glaucoma.

2. Abstract

Aim and background: This study aims to evaluate the institutional interdisciplinary management protocol for neovascular glaucoma patients, focusing on a combined surgical approach involving posterior vitrectomy and Ahmed valve implantation, with previous antiangiogenic application.

Materials and methods: A retrospective review was conducted for 14 neovascular glaucoma patients who underwent the combined procedure over 4 years. Patients aged 18 years or older with prior antiangiogenic application and without other types of glaucoma or prior posterior vitrectomy were included. Surgical success was assessed as intraocular pressure reduction below 21 mm Hg, either without hypotensive medication (absolute success) or with medication (qualified success) at various time points. Secondary outcomes included intraocular pressure (IOP), number of hypotensive medications, visual acuity, underlying etiology, and postoperative complications.

Results: At baseline, patients had an average IOP of 50 mm Hg and were taking 4.4 glaucoma medications. After the 12-month follow-up, the mean IOP decreased significantly to 16.4 mm Hg, reducing the need for hypotensive medications. The qualified success rate was 100%, while absolute success was not achieved. Visual acuity and anatomical outcomes were maintained, with no cases of anatomical loss. Postoperative complications, including hyphema, choroidal detachment, and vitreous hemorrhage, were transient and self-resolved.

Conclusion: The interdisciplinary management protocol proposed showed favorable results for neovascular glaucoma management. The combined surgical approach led to a considerable reduction in intraocular pressure and glaucoma medication use, indicating a high success rate in controlling the disease. Visual acuity and anatomical outcomes remained stable during the follow-up period, with no cases of anatomical loss.

Clinical significance: This study demonstrates that combining posterior vitrectomy and Ahmed valve implantation, preceded by antiangiogenic therapy, effectively reduces intraocular pressure and glaucoma medication use.

3. Introduction

Neovascular glaucoma (NVG) is a severe secondary ocular pathology distinguished by the presence of rubeosis iridis, iridocorneal angle neovascularization, and elevated intraocular pressure, resulting from a variety of entities associated with new vessel formation and connective tissue growth.1 The prevalence of NVG is projected to be approximately 0.12%, and it constitutes 6% of all glaucoma cases.2

NVG can be caused by various ocular pathologies, occurring as a complication of retinal ischemia.3 The main causes include proliferative diabetic retinopathy, retinal vein occlusions, and sequelae of chronic retinal detachment.4 Retinal hypoxia and ischemia disrupt the balance between pro- and antiangiogenic factors, leading to angiogenesis.3 This imbalance promotes the formation of new vessels and increases vascular permeability, triggering endothelial mitosis and leukocyte adhesion, resulting in trabecular meshwork obstruction and elevated intraocular pressure (IOP).5

Treatment of NVG remains challenging due to the complexity of the pathology and the poor visual and anatomical prognosis it presents.4 Ideally, the underlying cause of ischemia, which drives the clinical manifestation, should be addressed.5,6 Additionally, retinal photocoagulation, cryotherapy, and antiangiogenic therapy can be employed to treat retinal ischemia. Simultaneously, efforts should be made to control IOP through procedures such as trabeculectomy, drainage device implants, or cyclophotocoagulation.1,5 However, the rapid advance of the disease, the absence of standardized protocols for proper management, and the guarded visual prognosis for NVG patients remain significant challenges.

The aim of this work is to describe the interdisciplinary management protocol for patients with NVG, specifically focusing on individuals who were previously evaluated by retina specialists and treated with antiangiogenic therapies. Subsequently, these patients underwent combined surgery involving posterior vitrectomy and Ahmed valve implantation in a single surgical procedure. This protocol aims to provide a comprehensive approach that addresses both the retinal ischemia and the IOP control aspects of NVG management.

4. Materials and Methods

4.1 Design and Subjects

We performed a retrospective chart review of patients with NVG who underwent a multidisciplinary protocol of posterior vitrectomy and Ahmed valve implantation in a single surgical procedure with previous antiangiogenic application over a 4-year period in our institution.

This study was approved by the Institutional Review Board of the Fundación Oftalmológica Nacional, with informed consent waived due to its retrospective design. All study methods complied with the principles of the Declaration of Helsinki.
Subjects aged 18 years or older who underwent a combined procedure with prior antiangiogenic application, had a history of iris or iridocorneal angle neovascularization, and experienced uncontrolled ocular hypertension were included. Exclusion criteria included history of other types of glaucoma, history of incisional ocular surgeries, cyclophotocoagulation, and prior posterior vitrectomy.

The primary outcome was to assess the anatomical and functional results at 12 and 24 months. The operational definition of surgical success was defined as follows: absolute success of surgery, defined as IOP reduction below 21 mm Hg without medication at 3, 6, 12, and 24 months postoperatively; qualified success of surgery, defined as IOP reduction below 21 mm Hg with medication at 3, 6, 12, and 24 months postoperatively; and anatomic success of the surgery, characterized as the persistence of the eyeball without phthisis bulbi. The secondary outcomes assessed were IOP, the number of hypotensive medications used, visual acuity, and any postoperative complications.

For all subjects included in the study, we collected demographic and clinical data, including preoperative and postoperative IOP measurements, the number of glaucoma medications used, and best-corrected visual acuity at 1, 3, 6, 12, 18, and 24 months of follow-up. Additionally, any adverse effects that occurred during the follow-up period were recorded. When determining the baseline number of glaucoma medications, an oral carbonic anhydrase inhibitor was considered equivalent to one topical glaucoma medication and included in the total medication count. Visual acuity measured with Snellen chart was converted to logMAR using the Holladay conversion scale.7

4.2 Surgical Technique

All Ahmed Valve implantations were performed by a glaucoma specialist (SBR), while a vitreoretinal surgeon (FRA) conducted the vitrectomies for all patients. The procedure was performed under general anesthesia. The surgical technique consisted of conjunctival peritomy, plane dissection, and scleral fixation of the valve plate with 8-0 nylon sutures in

the superotemporal quadrant. Anterior chamber reformation and corneoscleral tunneling were performed using a 22G needle for the insertion of the valve tube. A 2–3 mm portion of the tube was inserted into the anterior chamber with the bevel facing upward. A limbal-based scleral flap was fashioned and secured with 6-0 vicryl sutures, followed by suturing of the conjunctiva using 8-0 vicryl sutures.

A 3-port pars plana vitrectomy was then performed with a 23G system, and endolaser photocoagulation was applied as needed. Phacoemulsification, with or without intraocular lens implantation, was performed if indicated. Additionally, patients who developed a hypertensive phase during follow-up underwent 5-fluorouracil needling revision.

4.3 Statistical Analysis

The statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) (v21; IBM Corp., Armonk, NY, USA). Continuous quantitative variables were described as mean and standard deviation based on their distribution, while qualitative variables were presented as absolute frequencies and percentages.

5. Results

The baseline characteristics of the participants are shown in Table 1. At the time of the procedure, the mean age was 63 ± 10 years. Among the 14 reviewed patients, 7 (50%) were female. All the patients were Hispanic. The average follow-up period was 17.5 ± 7.2 months, but only 6 patients completed 24 months of follow-up. Of the 14 patients with coexisting cataract, 8 underwent phacoemulsification with or without intraocular lens implantation during the surgery.

Table 1: Clinical characteristics before and after combined procedure

								Baseline						Last follow-up			
#	Age	Sex	Etiology	PRP	Anti-VEGF doses	Anti-VEGF type	Time from anti-VEGF to surgery (days)	BCVA (logMAR)	IOP	No. of meds	Surgical procedure	Complications	Follow-up (months)	BCVA (logMAR)	IOP	No. of meds
1	74	Female	PDR	Yes	1	Aflibercept	65	1.9	45	4	Ahmed valve + PPV	Hyphema, choroidal detachment	24	1.3	13	2
2	69	Female	RD	Yes	1	Bevacizumab	53	1.9	48	5	Ahmed valve + PPV	Hyphema	24	0.88	16	3
3	57	Male	CRVO	No	1	Ranibizumab	52	2.7	45	4	Ahmed valve + PPV	–	12	2.9	20	2
4	51	Female	PDR	Yes	1	Bevacizumab	28	2.3	43	5	Ahmed valve + PPV + phaco	–	24	2.3	13	3
5	73	Male	OCVR	Yes	1	Ranibizumab	56	2.3	36	5	Ahmed valve + PPV + phaco	–	24	1.9	22	3
6	48	Male	PDR	Yes	3	Ranibizumab	76	1.9	56	5	Ahmed valve + PPV + phaco	–	18	2.9	7	3
7	50	Female	CRVO	No	3	Ranibizumab	46	3.0	60	5	Ahmed valve + PPV	Hyphema, vitreous hemorrhage	24	2.3	22	3
8	59	Male	PDR	Yes	3	Ranibizumab	7	1.18	43	4	Ahmed valve + PPV + phaco + IOL	Choroidal detachment	20	2.9	15	4
9	54	Male	PDR	No	3	Ranibizumab	72	2.3	55	4	Ahmed valve + PPV + phaco + IOL	–	19	3.0	11	3
10	67	Female	CRVO	No	3	Ranibizumab	87	3.0	65	5	Ahmed valve + PPV	–	6	3.0	2	2
11	58	Male	PDR	Yes	4	Aflibercept	27	2.7	60	4	Ahmed valve + PPV + phaco + IOL	Vitreous hemorrhage	12	1.9	14	3
12	75	Female	PDR	Yes	2	Ranibizumab	147	2.0	43	4	Ahmed valve + PPV	Choroidal detachment	8	1.9	14	2
13	78	Female	PDR	Yes	1	Aflibercept	64	1.43	44	3	Ahmed valve + PPV	–	24	3.3	20	2
14	70	Male	PDR	No	3	Aflibercept	60	2.3	45	4	Ahmed valve + PPV	–	24	3.0	13	2

BCVA, best-corrected visual acuity; CRVO, central retinal vein occlusion; IOL, intraocular lens, IOP, intraocular pressure; PDR, proliferative diabetic retinopathy; Phaco, phacoemulsification; PPV, pars plana vitrectomy; PRP, panretinal photocoagulation; RD, retinal detachment; Demographic and clinical characteristics, surgical procedures, complications, and follow-up outcomes for patients undergoing a combined surgical approach for neovascular glaucoma

Regarding the etiology, 9 (64.2%) patients had diabetic retinopathy, 4 (28.5%) had central retinal vein occlusion, and 1 (7.1%) had retinal detachment.

All patients received antiangiogenic therapy before the combined surgery, with a mean dose of 2 ± 1. Among the patients, 4 (28.5%) received aflibercept, 2 (14.2%) received bevacizumab, and 8 (57.4%) received ranibizumab. The mean time from the last anti-VEGF treatment to surgery was 52 ± 32 days.

IOP and the number of glaucoma medications at baseline and each follow-up time point are presented in Table 2 and Figure 1. The decrease in the number of patients observed at each follow-up time point in Table 2 can be attributed to loss of follow-up. In Table 1, a comparison is made between the baseline parameters and the latest recorded visit. Variables of patients who missed a visit within the specified time frame and otherwise consulted at another time point are not included in the analysis.

IOP was significantly reduced compared to pretreatment levels at all time points, with a mean reduction of 33.6 ± 8.5 mm Hg at the 12-month visit. Prior to surgery, the patients had a mean IOP of 50 ± 7.6 mm Hg and were taking 4.4 ± 0.5 glaucoma medications. However, at 12 and 24 months of follow-up, the mean IOP decreased to 16.4 ± 3.8 mm Hg and 17 ± 5.8 mm Hg, respectively. Additionally, the number of medications also decreased to 2.2 ± 0.6 at 12 months and 2.7 ± 0.9 at 24 months.

The qualified success was achieved in all eyes, while none of the eyes achieved absolute success. It is noteworthy that none of the eyes experienced anatomical losses, such as evisceration or phthisis bulbi.

In terms of visual acuity, the patients had a baseline best-corrected visual acuity (BCVA) of 2.3 ± 0.5 logMAR. At 12 months follow-up, the mean BCVA was 2.2 ± 0.8 logMAR, and at 24 months, it was 2.2 ± 0.6 logMAR.

Regarding complications, a small percentage of patients experienced postoperative complications: 3 patients (21%) had hyphema, 3 (21%) had choroidal detachment, and 2 (12%) had vitreous hemorrhage, all of which self-resolved.

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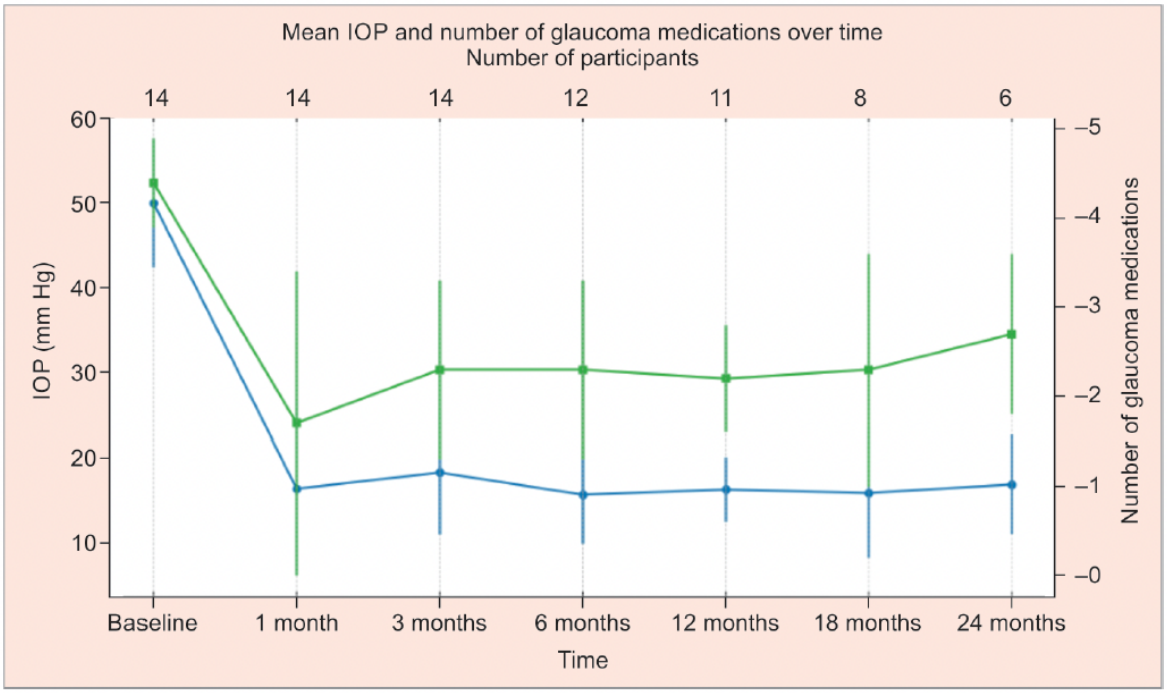

Changes in mean intraocular pressure (IOP) and the number of glaucoma medications over 24 months. The blue line (left Y-axis) represents mean IOP (mm Hg), and the green line (right Y-axis) represents the mean number of glaucoma medications. The X-axis shows the time points: baseline, 1 month, 3 months, 6 months, 12 months, 18 months, and 24 months. The number of participants at each time point is shown above the data points. Error bars indicate the standard deviation

6. Discussion

NVG is a potentially devastating pathology in which treatment remains challenging due to the complexity of the condition and the poor visual and anatomical prognosis. Even if an eye with NVG is effectively managed and IOP is controlled, it may still result in low visual acuity as a consequence of the increased IOP during the initiation of treatment. In this study, we describe an interdisciplinary management protocol for patients with NVG, including an alternative surgical approach involving posterior vitrectomy and Ahmed valve implantation in a single procedure preceded by the application of antiangiogenic therapy. We observed a meaningful reduction in IOP and the need for hypotensive medications, indicating a high success rate for this surgical procedure. Prior to surgery, the patients had a mean IOP of 50 ± 7.6 mm Hg and were taking an average of 4.4 ± 0.5 glaucoma medications. At 12 and 24 months after the combined procedure, the IOP was 16.4 ± 3.8 mm Hg and 17 ± 5.8 mm Hg, respectively. There was an important reduction in the number of hypotensive medications required, with 2.2 ± 0.6 and 2.7 ± 0.9 hypotensive medications at the 12-month and 24-month follow-up visits, respectively.

The reduction of the IOP and number medications remained stable during the follow-up period. However, it is important to note that from the first year on, there was a significant loss of follow-up, with only 6 patients out of the initial 14 completing the 24-month follow-up.

Our study showed a qualified success rate of 100% in all eyes, while absolute success was not observed in any of the cases. This observation can be attributed to the severe damage to

ganglion cells during the NVG crisis, where achieving a very low IOP is necessary to preserve the remaining few ganglion cells. This appears to be similar to previous reports. For instance, Lin et al. reported a reduction in IOP from 48.8 ± 4.3 mm Hg to 17.0 ± 1.5 mm Hg after performing Ahmed glaucoma valve implantation and vitrectomy with and without antiangiogenic therapy. Arcieri et al. reported a reduction of 17.4 mm Hg in IOP after a 12-month follow-up of Ahmed valve implantation with intravitreal bevacizumab. Mahdy et al. reported absolute success in 75% and qualified success in 20% after intravitreal bevacizumab with panretinal photocoagulation followed by Ahmed valve implantation. Noor et al. reported a major decrease in IOP to <21 mm Hg after Ahmed valve implantation with intravitreal bevacizumab and estimated probability of success of 53.6% at 37 months. Cheng et al. and Jeong et al. similarly found significant IOP reduction with combined vitrectomy and Ahmed valve implantation.

Regarding visual acuity, baseline BCVA was 2.3 ± 0.5 logMAR, improving slightly to 2.2 ± 0.8 at 12 months. Although no significant improvement was observed, stability itself is notable considering the severity of the disease and pre-existing damage.
Complications included hyphema (21%), choroidal detachment (21%), and vitreous hemorrhage (12%), all self-resolving. These rates are comparable to prior studies involving similar combined surgical approaches.

Limitations include the retrospective design, small sample size, absence of a control group, and variable timing between onset of symptoms and surgical intervention.

7. Conclusion

The combined technique of posterior vitrectomy and Ahmed valve implantation in a single procedure, preceded by antiangiogenic therapy, seems to be a safe and relatively effective option for the surgical treatment of NVG.

8. Clinical Significance

The findings highlight the potential for improved patient outcomes through a coordinated treatment strategy that addresses both retinal ischemia and intraocular pressure control. The stability in visual acuity and the absence of anatomical loss during follow-up further underscore the effectiveness of this protocol. These results suggest that the proposed combined approach may offer a promising alternative for managing NVG, potentially leading to better preservation of vision and ocular health in affected patients.

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