

Primary Posterior Capsulectomy With Irido-Zonulo-Hyaloido-Vitrectomy via An Anterior Vitrector to Prevent Relapse Of Aqueous Misdirection: A Case Series And Review Of Contemporary literature

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ABSTRACT:

Purpose

To report the outcomes of Primary Posterior Capsulectomy (PPC) when combined with Irido-Zonulo-Hyaloido-Vitrectomy (IZHV) in the surgical management of aqueous misdirection (AM) to prevent recurrence, performed by an anterior segment surgeon with an anterior vitrector via various incisional approaches.

Methods

Retrospective, non-comparative and interventional case series reporting the outcomes of reformed and sustained deep anterior chamber, intraocular pressure (IOP), anti-glaucoma medications (AGM), complications and best corrected visual acuity (BCVA) of AM management subsequent upon intervention (IZHV with PPC). A fellowship trained glaucoma specialist managed all cases with IZHV and PPC with an anterior vitrector via ostial, corneal or pars plana incisions.

Results

Eight eyes of 7 patients with AM were treated with IZHV and PPC. AM occurred in 3 eyes intra-operatively in combined phaco-

filtration surgery in primary angle closure glaucoma (PACG); rest occurred in the post-operative period. Mean follow-up was 25.4 ± 20.8 months (range 3-66). All cases achieved reversal of AM; none developed relapse of AM. Each had deepening of anterior chamber (AC), control of IOP in mmHg (pre-IZHV 37.6 ± 14.7 , 95% CI [25.3, 49.9] vs post 14.5 ± 2.3 , 95% CI [12.5, 16.4], $p=0.003$) and decrease in number of AGM (pre-IZHV 3.25 ± 0.8 , 95% CI [2.6, 3.9] vs post 0.5 ± 0.8 , 95% CI [-0.1, 1.2], $p<0.001$). All except one patient recovered pre IZHV BCVA. None developed retinal break nor detachment.

Conclusions

Primary posterior capsulectomy, when combined with IZHV, is an efficient means of ensuring complete hyaloidectomy, essential for preventing recurrence of AM. It can be successfully utilised by the anterior segment surgeon through multiple incisions with an anterior vitrector, thereby reducing burden on the resources and skills required in a vitreo-retinal procedure.

Key words

Aqueous misdirection; malignant glaucoma; primary posterior capsulectomy; PPC; Irido-Zonulo-Hyaloido-Vitrectomy; IZHV;



Introduction

Aqueous misdirection (AM) or malignant glaucoma or ciliary block glaucoma has been described after a myriad of procedures¹ and even spontaneously, though typically it occurs post incisional surgery in angle closure glaucoma. It has also been reported following needling, laser iridotomy and even in the use of Pilocarpine in angle

closure eyes. Anatomical predisposition thus appears to be a significant risk factor and therefore it is hypothesized to be more common in females due to relatively smaller anterior segment dimensions when compared to males.^{2,3}

If surgical management is indicated, then in recent times, Irido-Zonulo-Hyaloido-Vitrectomy (IZHV) via the anterior route has been favoured over pars plana vitrectomy (PPV), especially in pseudophakic eyes; however, both these procedures are fraught with recurrence.

In this brief report, we present the surgical outcomes of AM management with primary posterior capsulectomy (PPC) when

combined with IZHV in patients who developed misdirection post intervention.

Subjects and Methods

This is a retrospective, non-comparative and interventional case series reporting the outcomes of reformed and sustained deep anterior chamber (AC), intraocular pressure (IOP), anti-glaucoma medications (AGM), complications and best corrected visual acuity (BCVA) of the surgical management (IZHV with PPC) of aqueous misdirection.

Informed consent for surgery was obtained from all the eligible participants.

Ethical clearance was obtained from the Ethics Committee; the study adhered to the principles as laid down by the Declaration of Helsinki.

VA was converted to LogMAR for computing purposes. Previous interventions included trabeculectomy, Ahmed Glaucoma valve (AGV), Nd: YAG laser posterior capsulotomy and also recurrent AM following pars plana vitrectomy (PPV). All of them presented either intra-operatively with non-forming anterior chamber (AC) and hard eye or within the first week of intervention with flat or extremely shallow AC and high

IOP. A fellowship trained glaucoma specialist managed all cases with IZHV and PPC with an anterior vitrector through various incisions (Figure 1) –corneal (Figure 1A), ostial (Figure 1B) or pars plana. (Figure 1C).

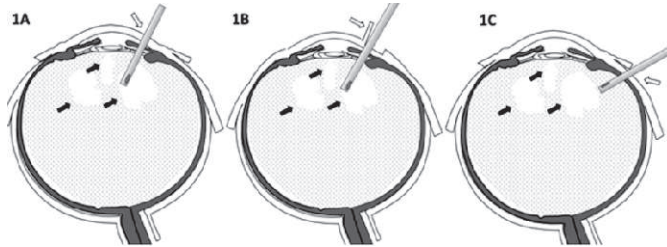


Figure 1 : 3 main routes of IZHV & PPV

Surgical method:

Pre-operatively Mannitol 20% 1-3 mg/kg body weight is injected intra-venously for deturgescence of the vitreous.

IZHV was performed via any one of three incisions – corneal if a pre-existing iridectomy was available; pars plana, if it was not. If IZHV was performed intra-operatively in trabeculectomy, or soon thereafter, then the ostium and iridectomy created as part of filtration surgery was taken advantage of.

Under peribulbar anaesthetic block, and sterile conditions, paracentesis is made at 9 o'clock position with a micro-vitreo-retinal (MVR) blade but entry into AC is usually extremely difficult. Cohesive viscoelastic is then injected, which helps to create a slit-like space of the AC. Two further ports are made - at 7 o'clock (for the right eye; 5 o'clock for the left) for the placement of an AC maintainer and the other at 3 o'clock; a corneal incision is made, with MVR blade, overlying the precedent iridectomy (Figure 2A), which may be enlarged. A 23-gauge anterior vitrector is inserted through the corneal incision almost vertically and via the patent iridectomy (Figure 2B) to perform a zonulectomy first. The vitreous cutter initially faces the surgeon posteriorly (Figure 2 B), and once the zonules are cut adequately, the vitreous cutter is slowly rotated anteriorly, all the while cutting vitreous, until the vitrector is visible behind the posterior capsule in the anterior vitreous. It is at this juncture that the AC starts to deepen, and typically the AC 'flops' down, marking the point of reversal of AM (Figure 2C). Anterior hyaloid face is then debulked and is deemed adequate when a primary posterior capsulectomy (PPC) is performed as the last step of the procedure.

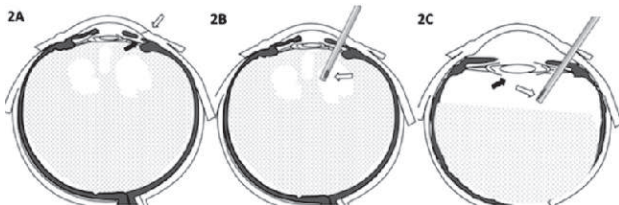


Figure 2 : Various surgical steps of IZHV & PPC (see text for explanation)

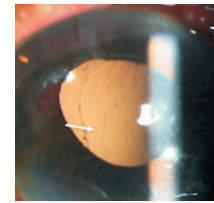


Figure 3. (Primary Posterior Capsulectomy performed intra-operatively and seen post-operatively on the slit lamp via retro-illumination technique, white arrow).

Sustained deepening of AC, without viscoelastic and AC maintainer, served as an end-point and the corneal wound was then sutured with an interrupted 10/0 nylon suture.

In situations where ostium and iridectomy are available, the 23-gauge anterior vitrector is inserted almost vertically through the pre-existing ostium and iridectomy (Figure 1B), and the procedure is completed as described before. Scleral flap is then sutured with two 10/0 nylon sutures and conjunctiva is closed routinely with 10/0 vicryl continuous mattress suture.

When an antecedent iridectomy is not available, then a conjunctival peritomy is done in the supero-temporal quadrant and a stab incision 3.5 mm behind the limbus (Figure 1C) is made at 10 o'clock with MVR blade, along with 2 other ports as described, including one for an AC maintainer. A 23-gauge anterior vitrector is introduced through this pars plana incision and advanced into anterior hyaloid; hyaloidectomy and PPC are then done. The vitrector is then advanced towards the opposite limbus, behind the iris, and zonulectomy along with iridectomy is done at this location via a posterior to anterior approach (Figure 4). The pars plana wound as well as conjunctiva is sutured with 8/0 vicryl suture.

Subconjunctival dexamethasone 2 mg is injected at the end of the procedure in all eyes.



Figure 4 : Posterior approach to zonulectomy with iridectomy

Results

Eight eyes of 7 patients underwent IZHV and PPC via the ostium, cornea or pars plana stab incision using an anterior vitrector. All but one patient, were males and ratio of right to left eye was 1:1. Mean age of patients was 53.7±17.9 years and were followed up for 25.4 months. All eyes that developed AM post-operatively (n=5), except one, were pseudophakic with intraocular lens (IOL) in the bag; the only phakic eye had lens extraction along with IZHV and PPC.

AM occurred in 4 Primary Angle Closure Glaucoma (PACG) eyes; 3 of these occurred intra-operatively in combined phaco-filtration surgery (after IOL was placed in the bag), 2 in the same patient. The third patient had a history of AM post filtration surgery in the post-operative period in the phakic fellow eye and therefore lens extraction was planned to reduce the risk of AM; nonetheless the eye developed intra-operative AM.

Post-operatively, one phakic Plateau Iris Syndrome (PIS) eye developed misdirected aqueous following bleb repair. This phakic eye with AM had lens extraction and IOL placement in bag followed by IZHV with PPC through the ostium.

Aqueous misdirected in one pseudophakic Juvenile Open Angle Glaucoma eye post AGV implantation; this eye also had a history of multiple previous trabeculectomies. One vitrectomised PACG eye presented with recurrence of AM after pars plana posterior vitrectomy (PPV) and Ahmed Glaucoma Valve (AGV) performed when the eye developed AM following phaco-filtration surgery (both surgeries done elsewhere). This eye has been followed-up for a year and has not developed any further recurrence following IZHV and PPC.

All cases achieved reversal of AM with deepening of anterior chamber (AC) per-operatively as well as during the follow-up period. There was significant reduction in mean IOP and requirement for AGM at last follow-up (p=0.003 and <0.001 respectively, paired t test). All except 1 patient recovered pre-IZHV BCVA (Table 1).

Table 1. Intraocular Pressure (IOP), Anti-glaucoma medications (AGM) and best corrected visual acuity (BCVA): Pre and post Irido-zonulo-hyaloido-vitrectomy (IZHV) with primary posterior capsulectomy (PPC)

	Pre-IZHV with PPC	Post-IZHV with PPC	p value
IOP mmHg, Mean±SD, 95% CI	37.6±14.7, 95% CI [25.3, 49.9]	14.5±2.3, 95% CI [10.9, 16.6]	0.003
No of AGM, Mean±SD, 95% CI	3.25±0.8, 95% CI [2.6, 3.9]	0.5±0.8, 95% CI [-0.2, 1.2]	<0.001
BCVA, Mean±SD, 95% CI	1.21±0.8, 95% CI [0.54, 1.88]	0.73±0.74 95% CI [0.11, 1.34]	0.3

None of the eyes developed recurrence in the follow-up period. There were no intra-operative complications; one patient had choroidal exudation post IZHV. None developed a break or retinal detachment; nor was corneal decompensation, subluxation and/or dislocation of IOL seen in the follow-up period.

Summary of all cases are provided in Table 2.

Table 2: Summary of all cases undergoing Irido-zonulo-hyaloido-vitrectomy (IZHV) with Primary posterior capsulectomy (PPC)

Case no.	Gen der	Age	Eye	Aetiology of glaucoma	Phakic status	Procedure inciting AM [#]	Timing of AM	Pre-procedure VA	Pre-procedure IOP mmHg	Follow-up in months	Re-lapse of AM	Last VA	Last IOP mm Hg	Last AG M
1.	M	84	OD	Pseudo-phakic	pseudo-phake	Trab	Post-operative Day 5	20/40 eccentric	31	12	Nil	HM	10	0
2.	M	48	OS	JOAG [*]	pseudo-phake	AGV (previous Trab X 2)	Post-operative Day 5	PL [§]	47	3	Nil	PL	14	0
3.	M	70	OD	PACG ^{**}	pseudo-phake	AGV	Post-operative Day 5	CF ^{\$\$\$}	60	12	Nil	20/80	16	0
4.	M	29	OD	PIS ^{***}	phakic	Bleb repair	Post-operative week 3	CF	30	66	Nil	20/20	13	2
5.	F	56	OS	PACG	pseudo-phake	AGV +PPV (previous Phaco-trab)	Post-operative week 6 (relapse post PPV)	CF	15	20	Nil	20/30	13	0
6.	M	58	OS	PACG	phakic	Phaco-Trab	Intra-operative	20/40	56	21	Nil	20/40	16	2
7.	M	58	OD	PACG	phakic	Phaco-Trab	Intra-operative	20/40	24	15	Nil	20/30	18	0
8.	M	27	OS	PIS	phakic	Phaco-Trab	Intra-operative	20/125	38	54	Nil	20/63	16	0

*JOAG – Juvenile Open Angle Glaucoma §PL – perception of light **PACG – Primary Angle Closure Glaucoma \$\$\$CF – Count fingers

***PIS – Plateau Iris Syndrome # A M - A q u e o u s
 misdirection

Three representative cases, of varying incisional approach for
 IZHV and PPC are described below.

Case 1

An 84-year-old pseudophake presented with pseudophakic secondary angle closure glaucoma 11 years after he was lost to follow-up, with a complaint of deteriorating vision in the left eye. He had undergone extracapsular cataract extraction with implant (ECCE + IOL) in the right eye in 1999 and phacoemulsification with IOL in the left eye in 2003. Visual acuity (VA) was recorded as 20/20 in the right eye and 20/40 on eccentric fixation in the left eye. IOP was uncontrolled on 5 AGM, so was advised immediate Trabeculectomy with mitomycin C (trab+MMC) in the left eye under guarded visual prognosis. However, he appeared for his surgery only 2 months later, after having discontinued all AGM for 4 weeks, with further deterioration of vision in the left eye. A routine trab+MMC was done under peribulbar anaesthetic block. His anterior chamber (AC) was a little shallow pre-operatively; at conclusion of the surgery it was reformed with filtered air and cycloplegic eyedrops were instilled. Postoperative day 1 BCVA was hand movements (HM) and his AC was very shallow, with an IOP of 19 mmHg; bleb was formed and diffuse and surgical PI was patent. He was advised atropine eyedrops along with topical steroids and antibiotics and AGM was re-commenced the fellow right eye. Day 5 post-operatively his AC was flat with an IOP of 31 mmHg and patent surgical iridectomy; funduscopy did not reveal a choroidal detachment. Misdirection process was suspected, and AGM was also commenced. Laser posterior capsulotomy and hyaloidotomy was not possible as he was unable to co-operate at the slit lamp for any length of time. He underwent IZHV and PPC under peribulbar block 48 hours later. Under sterile conditions, IZHV and PPC (as described) was done via the pre-existing ostium and patent iridectomy (which was enlarged) after having reopened the preceding conjunctival wound and scleral flap.

Post-operatively his AC remained deep and well-formed till last follow-up, a year after IZHV with PPC. His bleb was diffuse and well-formed with an IOP of 10 mmHg without AGM. His vision, however, did not recover.

Case 2

A 48-year-old one-eyed pseudophakic male presented with flat AC on fifth post-operative day following routine Ahmed Glaucoma Valve (AGV) surgery of the left eye, model FP7. His past ocular history was significant for very advanced Juvenile Open Angle Glaucoma with failure of two filtration procedures. His first filtration was 20 years ago and the second one was combined with phaco surgery 18 months prior. Just prior to AGV surgery, VA was Perception of light with

inaccurate projection, and an IOP of 22 mm Hg on 2 AGM. More significantly, there was rapid deterioration in vision in the months preceding; last recorded VA was 20/63 eight months ago.

Day 5 post-AGV, VA was unchanged and IOP was 47 mmHg; the AC was flat, and the tube was barely visible in the AC (Figure 5A), having been engulfed by the iris. A large surgical PI was patent. Although he was atropinised immediately along with topical steroids, antibiotics and AGM, there was poor response to medical management. In view of his one-eyed status, IZHV with PPC was done within 2 days, through a corneal incision overlying the surgical iridectomy.

Post-IZHV and PPC on day 1, AC was deep with controlled IOP (14 mmHg) and good visibility of tube in the AC (Figure 5B). At last follow-up, VA was unchanged, IOP was borderline controlled but AC was deep. He was referred to our

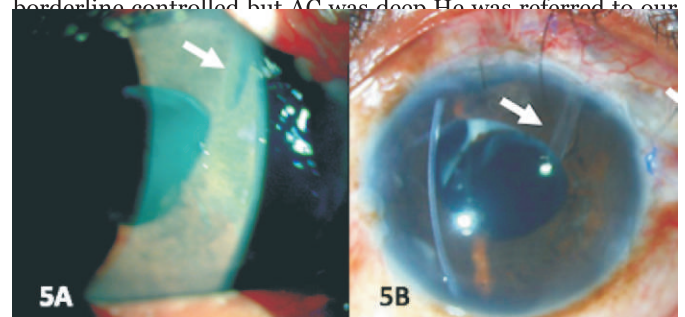


Figure 5A & 5B : Pre & Post IZHV & PPC images in AGV patient

Case 3

A 70-year-old male with PACG and pseudophakia presented with pain, redness and decreased vision in the right eye 5 days after he had undergone routine primary AGV, as superior conjunctiva was immobile. He was a bilateral pseudophake with cataract surgery having been done elsewhere, many years ago.

BCVA in the right eye was hand movements, AC was uniformly flat, cornea was oedematous with patent laser peripheral iridotomy (LPI).

Medical management was initiated but he did not respond, and AC continued to be uniformly flat as before and he continued to be symptomatic. Hence, he underwent IZHV and PPC via a pars plana stab incision, as described above.

Post-operatively day one, he was comfortable and remarked on the ‘magical’ disappearance of pain overnight. At his last follow-up visit, his BCVA was 20/80; AC was deep and IOP was recorded as 8 mmHg.

Discussion

Although pathogenesis of AM is still obscure, it is generally accepted that there exists a deviant relationship in the

interface between the lens, ciliary body and the anterior hyaloid face.

Stepwise management has been the historical approach to the management of AM; medical management being instituted first and foremost in the form of cycloplegics and AGM, followed by laser and then surgery.^{4,5} Recurrences are frequent following cessation of medical management and success with laser hyaloidotomy is also limited (100% and 75% as reported by Debrouwere et al).³ The aim of surgical management is to create a direct and unhindered communication between the aqueous and vitreous cavity, rendering the eye unicameral. This has traditionally been achieved by the use of pars plana posterior vitrectomy (PPV). However, core vitrectomy is more successful in pseudophakic eyes (65–90%) when compared to phakic eyes (25–50%).^{6,7} It is fraught with recurrences – perhaps a reflection of inadequate hyaloidectomy for risk of damaging the lens. Therefore, not only removal of lens (with IOL implantation) but also a primary posterior capsulectomy is highly recommended in phakic eyes.

In view of the relatively high rate of recurrence, skill and cost notwithstanding, the surgical management of AM evolved, and shifted from posterior to anterior management.

At the turn of the millennium, Lois et al from the Vitreo-Retinal department of Royal Liverpool Hospital (UK)⁸ reported the use of anterior vitrectomy in AM and appear to be the pioneers in describing IZHV via the anterior route in a series of five pseudophakes. No recurrence was reported over a relatively short period of follow-up (median 5.5 months).

Almost a decade later, in 2010, Bitrianand Caprioli,⁹ reported the successful application of this surgical procedure, via the anterior route. These glaucoma surgeons preferred a pars plana incision for anterior vitrectomy as opposed to a clear corneal one, relieving AM in their case series of 5 pseudophakic patients, with no recurrence in the follow-up period of 7.6 months

However, Debrouwere et al³ in 2012, did not favour either the anterior approach as they encountered recurrence in 2 out of 3 cases, nor conventional pars plana vitrectomy (recurrence in 3 out of 4 cases). The authors favoured extensive PPV with vitreous base shaving, requiring VR expertise and resources, along with iridectomy and zonulectomy (posterior to anterior) as definitive management. It is only in this latter group that no recurrence was encountered in a series of 15 eyes. However, follow-up period is short (mean 2 months) and almost a third had a follow-up of approximately only a month, or less.

Zarnowski in 2014¹⁰ questioned the need for the extensive surgery that was recommended by Debrouwere et al,⁽³⁾ as success was found in the anterior approach, yet again. The authors favoured a clear corneal incision, in their case series of

10 patients with a mean follow-up of one year. In a deviation from our technique, they used a blade to cut through iris and zonules and into the vitreous, and only then introduced a 20-gauge vitrector to perform IZHV along with peripheral rather than axial capsulectomy.

PPV compromises conjunctiva in this sub-group of glaucoma patients, is fraught with potentially serious complications and is time-and-resource consuming. In a relatively large series of PPV in the management of AM,¹¹ anatomical reversal was obtained in 90% only, and serious complications like retinal detachment and endophthalmitis were reported.

Not only following PPV, IZHV alone too can be replete with recurrences.¹² Madgula et al¹² have stressed on the need for follow-up to exclude relapse even if IZHV has been successful in the short term. They experienced recurrence in 40% cases in a follow-up period of 50.2 ± 27.2 months. However, majority presented with relapse in the first 12 months, two eyes within the first week. Also, the majority of these recurrences (3 out of 4) in their case series of 10 eyes of 9 patients, appears to be due to blockage by vitreous, perhaps a reflection of incomplete hyaloidectomy.

We hypothesize that hyaloidectomy is incomplete unless one is able to perform a central primary posterior capsulectomy, and hence one of the key elements in the ill-understood mechanism of AM is insufficiently negotiated. As such, there is persistent risk of relapse, which may or may not occur. In order to eliminate the risk altogether, we strongly recommend a central primary posterior capsulectomy along with IZHV. We believe that this step is the reason why we did not encounter any relapses in our series. Furthermore, no further recurrence occurred in case 5 (Table 2), who had presented with a relapse after PPV, done elsewhere. Therefore, an extensive posterior approach, as proposed by Debrouwere et al,³ is not mandatory. We found success by adopting our technique through various incisions with an anterior vitrector, avoiding the resources required for a posterior approach and its potential complications.

We encountered intra-operative misdirected aqueous in 3 eyes undergoing combined phaco-trabeculectomy; 2 eyes were of the same patient and the third was the fellow-eye of a patient who developed AM one week after trabeculectomy in the post-operative period. Per-operative AM was recognised by non-formation of AC and hard eye without loss of red reflex, even after lens extraction and failed intense cycloplegia. Prompt recognition per-operatively with performance of ZHV through ostium and iridectomy resulted in reversal and deepening of AC immediately, with no long-term post-operative sequelae.

We did not encounter any intra-operative complications during PPC with IZHV. Post-operatively one eye developed a

fibrinous reaction. Bleb of this eye became encysted and is controlled on AGM. Another eye developed hypotony related choroidal detachment, which settled down. None of the patients suffered recurrence in the mean follow-up period of over two years. Clinical conditions in each of our case was such that we could not delay surgery when response to medical management was poor; Wu et al¹³ suggest that corneal endothelial decompensation is a palpable sequelae, specially of delayed surgery.

In our series, there was no incidence of corneal decompensation, subluxation and/or dislocation of IOL. None developed retinal break or detachment.

In the modern era, IZHV appears to be the procedure of choice for reversal of the AM process in pseudophakic eyes. We believe that it is easily adaptable in phakic eyes too, wherein lens extraction is strongly recommended, as recurrences can only be prevented if there is complete and adequate hyaloidectomy. We have presented evidence that it is versatile enough and adapts itself to multiple approaches -corneal, ostial or pars plana stab incision, all accomplished with an anterior vitrector.

Therefore, for prompt reversal of AM and its sustained long-term resolution we strongly recommend a complete anterior debulking of hyaloid and disruption of the hyaloid face, as ensured with a primary posterior capsulectomy, along with IZHV. PPC has been described (along with pars plana posterior vitrectomy) once before, by He et al¹⁴ but the aim of this step remains unclear in their series of 30 eyes.

To conclude, in this case series of AM, primary posterior capsulectomy coupled with zonulo-hyaloido-vitrectomy, with either enlargement of a pre-existing iridectomy or creation of one, was successfully employed by a glaucoma surgeon for the relief of AM, with no evidence of recurrence in the follow-up period. It also emphasises on the fact that AM can occur in open angles too and that the treating ophthalmologist needs to be vigilant. Finally, it also highlights the fact that PPC with IZHV can be successfully utilised by the anterior segment surgeon through multiple incisions (ostium, clear-corneal or pars plana) with an anterior vitrector, for long-lasting reversal of the process of AM, thereby reducing burden on the resources and skills required in a vitreo-retinal procedure.

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