

Mini-vitrectomy; a Simple Solution to a Serious Condition

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Abstract

Purpose: To evaluate the safety and efficacy of clear corneal approach irido-zonulo-hyaloido-vitrectomy, which we named “mini-vitrectomy,” in the management of pseudophakic aqueous misdirection.

Methods: In this retrospective, non-comparative interventional case series, 24 eyes with diagnosis of pseudophakic aqueous misdirection were enrolled. Medical therapy with cycloplegics and laser therapy, including posterior capsulotomy and hyaloidotomy, was not effective in the management of the condition. The eyes underwent mini-vitrectomy, a simple technique in which iridotomy, zonulectomy, hyaloidectomy, and limited anterior vitrectomy were performed via a clear cornea incision. The main outcome measure was reformation of the anterior chamber, which was evaluated at day 1 and months 1, 3, 6, and 12.

Results: The mean age of patients was 75.3 ± 11.3 years (range, 47 to 90), and 13 (54.2%) patients were women. Anterior chamber was deep in 22 patients (91.7%) at the last follow-up visit. The mean intraocular pressure (IOP) was 30.31 ± 1.9 mm Hg at presentation on 2.67 ± 1.09 glaucoma medications. IOP decreased significantly to 14.5 ± 4.6 mm Hg at 12-month follow-up. ($P = 0.001$). The number of glaucoma medications at final visit was 2.2 ± 0.9 ($P = 0.21$).

Conclusion: Mini-vitrectomy is a simple, safe, and effective procedure in the management of pseudophakic aqueous misdirection, and it can be adopted by all ophthalmologists who are involved in glaucoma management and are not comfortable with the pars plana vitrectomy approach.

Keywords: Aqueous Misdirection; Malignant Glaucoma; Mini-vitrectomy

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INTRODUCTION

Von Graefe conceived the term “malignant glaucoma” in the 19th century to refer to a rare form of aggressive postoperative glaucoma that is not responsive to treatments and leads to blindness.^[1]

This terminology has been largely replaced by other names based on the possible mechanism of the condition,

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such as aqueous misdirection, ciliary block glaucoma, direct lens block syndrome, vitreous displacement syndrome, and vitreous block glaucoma.^[2-4]

Aqueous misdirection is the most common term used in the literature, and we also use this name.

It is estimated that aqueous misdirection occurs in 0.4 to 6% of patients who undergo incisional surgery for angle-closure glaucoma.^[5] The condition mostly develops unilaterally, which underlines the fact that it is a post-operative complication.^[5] Nevertheless, occurrence of aqueous misdirection in one eye significantly increases the risk of its development in the contralateral eye in the context of ocular surgery.^[5]

There are isolated case reports of spontaneous aqueous misdirection in the literature as well.^[6,7]

The exact mechanism of this condition is yet to be determined, but acute vitreous or uveal congestion,^[8] posterior diversion of aqueous and its accumulation within vitreous gel with anterior displacement of ciliary processes,^[2,9,10] and choroidal expansion^[11] are among the proposed mechanisms of this condition.

Treatment of aqueous misdirection follows a stepwise approach, starting with medical management, which includes mydriatic/cycloplegics, aqueous suppressants, and hyperosmotic agents. Medical therapy is plagued by lack of immediate response, low rate of success (50% response in 5 days), and almost 100% relapse rate after discontinuation of medications.^[12]

Laser therapy, which includes laser peripheral iridotomy combined with posterior capsulotomy and anterior hyaloidotomy, is successful in only 50% of the patients and is also associated with high rate of recurrences.^[13] Combination of pars plana core vitrectomy with iridectomy and zonulectomy has been demonstrated to have rewarding outcomes in pseudophakic patients,^[14] but this approach needs vitreoretinal surgical skills, and not all anterior segment surgeons are familiar with this technique.

Small study series of anterior approach consisting of an iridectomy, zonulohyaloidectomy, and anterior vitrectomy have demonstrated high success and low relapse rate in pseudophakic patients with aqueous misdirection.^[15,16] This alternative technique can be performed instead of pars plana core vitrectomy.

The purpose of this report is to describe our experience with a simple procedure that consists of clear corneal incision, iridotomy, zonulohyaloidectomy, and anterior vitrectomy in a series of pseudophakic patients with aqueous misdirection.

METHODS

In this case series, pseudophakic patients with diagnosis of postoperative aqueous misdirection referred to the glaucoma clinic of Labbafinejad Medical Center from September 2013 to May 2015 were included as

participants. This study was conducted in accordance with the guidelines set forth by the Ethics Committee of the Ophthalmic Research Center of the Shahid Beheshti University of Medical Sciences and followed the tenets of the Declaration of Helsinki. Outcomes and side effects of different therapeutic interventions were thoroughly discussed with each patient, and written informed consent was given by those willing to participate in the study.

Twenty-four pseudophakic eyes of 24 patients were included. The criteria for diagnosis included central and peripheral shallowing of the anterior chamber, "higher than expected" intraocular pressure, patent peripheral iridectomy, no response to laser peripheral iridotomy or posterior capsulotomy and hyaloidotomy, and absence of choroidal hemorrhage. In all cases, medical and laser management – including the use of mydriatic/cycloplegics, aqueous suppressants, hyperosmotic agents, capsulotomy and hyaloidotomy were ineffective in the management of the condition.

Surgical Technique

All procedures were performed in the same center using the same technique by one of two glaucoma specialists (MP and SY) or by a glaucoma fellow under the two specialists' direct supervision. The procedures were performed under topical anesthesia and intravenous sedation. The surgical field was prepared and draped in the usual sterile fashion. A perpendicular clear cornea incision was made using a super sharp 15-degree blade (Straight 15 MK, MANI, Utsunomiya, Tochigi, Japan). Then, the iris, zonules, and vitreous cavity were penetrated using the same knife [Figure 1]. Next, 2 mg

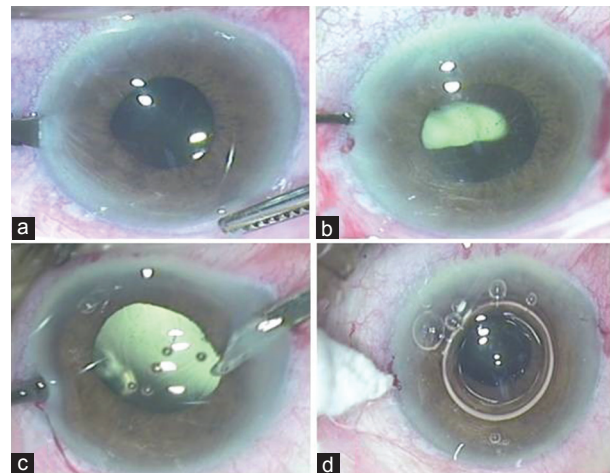


Figure 1. (a) An incision is made through clear cornea, iris, and zonule into vitreous cavity. (b) Triamcinolone is injected behind the IOL into the vitreous cavity. (c) Vitrectomy probe is introduced into the vitreous cavity while maintaining the anterior chamber with inflow. (d) Wound is checked for possible vitreous presence. The anterior chamber is deepened using air bubbles.

of diluted triamcinolone (CORTIRAN, Iran Hormone, Tehran, Iran) was injected into the vitreous cavity using a blunt 27-gauge needle via the corneal incision to enhance vitreous visualization during vitrectomy. Twenty-three-gauge vitreous cutter (Alcon, Fort Worth, TX, USA) was advanced into the vitreous cavity from the created incision until the probe was clearly visualized behind the intraocular lens. After performing a small initial vitrectomy and once the anterior chamber had deepened, an irrigation cannula connected to the BSS solution was introduced into the anterior chamber through another paracentesis. After performing sufficient vitrectomy, clearance of all triamcinolone stained vitreous, and deepening of the anterior chamber, the probe was slowly retracted while still cutting to make sure that a small part of the zonula and also the anterior hyaloid face were removed. If there was peripheral synechiae, viscogoniosynechialysis was also performed at the end of the operation. The anterior chamber was filled with air, and wounds were closed using 10-0 nylon sutures. Subconjunctival betamethasone (Iran Daru, Tehran, Iran) (2 mg) and cephazoline (Iran Daru, Tehran, Iran) (50 mg) were injected, and one drop of 1% atropine (Atrin, Sina Daru, Tehran, Iran) was instilled before patching the eye.

Ophthalmic examinations, including assessment of best-corrected visual acuity (BCVA), slit lamp examination, tonometry, and detailed funduscopy were performed at the time of presentation and were repeated 1, 3, 6, and 12 months after surgery.

Anterior chamber depth was graded as follows: grade 0 meant formed anterior chamber; grade 1 meant there was peripheral iridocorneal touch; grade 2 meant the presence of total iridocorneal touch; and grade 3 meant there was corneal-lenticular touch.^[17]

To present data, we have used means, standard deviations, medians and ranges, frequencies and percentages. To evaluate the BCVA changes, we used the Wilcoxon-singed rank test. Change in the anterior chamber depth from day 1 to month 12 was evaluated using the MacNemar test. A linear mixed model was used to test the changes in IOP during the follow-up period. In this evaluation, the Bonferroni method was used in multiple comparisons. All statistical analyses were performed using SPSS (IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp).

RESULTS

Twenty-four eyes of 24 patients with a mean age of 75.3 ± 11.3 years (range, 47 to 90) were included in this study, and 13 (54.2%) of them were women. The aqueous misdirection had occurred after either glaucoma surgery ($n = 15$, 62.5%) or cataract extraction with posterior chamber intraocular lens implantation ($n = 9$, 37.5%). Of those patients who had undergone glaucoma

Table 1. Summary of patients' data

Parameter	Value
Age (years)	
Mean \pm SD	75.3 \pm 11.3
Sex	
Male	11 (45.8%)
Female	13 (54.2%)
BCVA (logMAR)	
Mean \pm SD	1.78 \pm 0.82
Baseline number of drops	
Mean \pm SD	2.67 \pm 1.09
Type of previous surgery	
Cataract extraction	9 (37.5%)
Glaucoma valve device	6 (25.0%)
Trabeculectomy/with or without cataract extraction	9 (37.5%)
Diabetes mellitus	
Yes	4 (19.0%)
No	17 (81.0%)
Cardiovascular disease	
Yes	7 (33.3%)
No	14 (66.7%)

BCVA, best corrected visual acuity; logMAR, logarithm of the minimum angle of resolution; SD, standard deviation.

surgery, 5 had open angle configuration not necessarily glaucoma before the operation [Table 1].

In 22 eyes (91.7%), the anterior chamber was formed at the end of study without further surgical intervention. Two eyes had recurrence of aqueous misdirection that did not respond to another mini-vitrectomy procedure and were referred to retina service for core vitrectomy.

The mean intraocular pressure (IOP) was 30.3 ± 11.9 mm Hg at presentation on 2.67 ± 1.09 anti-glaucoma medications. The IOP decreased significantly to 16.3 ± 6.7 , 14.6 ± 7.4 , 16 ± 6.3 , 17 ± 8.3 , and 14.5 ± 4.6 mm Hg at day 1, month 1, 3, 6, and 12, respectively (all P values in comparison to baseline = 0.001).

The number of anti-glaucoma medications was 1.3 ± 0.1 at month 1, 1.6 ± 1.1 at month 3, 2.1 ± 1.1 at month 6, and 2.2 ± 0.9 at the final follow-up visit (respective P values compared to baseline: 0.025, 0.032, 0.053, and 0.21).

The mean BCVA changed from 1.78 ± 0.82 logMAR at baseline to 1.52 ± 0.93 at 12 months; this change was not statistically significant (mean change: 0.06 ± 0.64 , 95% CI: -0.32 to 0.45, $P = 0.733$).

Postoperatively, seven eyes (29%) developed hyphema, which was managed conservatively in all cases and resolved within 2 weeks.

No other complication was observed either intra-operatively or post-operatively during the course of follow up.

DISCUSSION

Aqueous misdirection is a type of secondary angle-closure glaucoma whose exact mechanism is still undetermined. Acute vitreous or uveal congestion,^[8] posterior diversion of aqueous and its accumulation within the vitreous gel and subsequent forward pushing of the lens-iris diaphragm,^[2,9] and anterior rotation and displacement of ciliary processes^[5,10] are among the proposed mechanisms for this condition. There is agreement in literature regarding the possible existence of an abnormal anatomic relationship between ciliary processes, crystalline lens or IOL, and hyaloid face, which in concert with impermeable hyaloid face leads to impeded anterior flow of fluid into the posterior chamber.^[5]

Management of this disorder has been challenging and associated with high failure rate. With improvement in surgical techniques, visual outcomes of this potentially devastating condition have also improved.

Timely diagnosis of this condition and exclusion of differential diagnoses, such as pupillary block, suprachoroidal hemorrhage, and choroidal effusion, is of paramount importance. Once the diagnosis is made, management of aqueous misdirection follows a stepwise paradigm, which starts with cycloplegics and intense systemic and topical antiglaucoma medications, including hyperosmotic agents.^[12]

Medical therapy in this condition is, at its best, successful in half the cases and is associated with unacceptably high rate of recurrence.^[18] These medications should be withdrawn very slowly with cycloplegics being the last to withhold; in some patients, indefinite use of cycloplegics may be required.^[12]

Intact hyaloid face is considered to play an important role in the pathophysiology of aqueous misdirection.^[19] Therefore, possible restoration of normal aqueous flow with disruption of the hyaloid face by means of laser capsulotomy and hyaloidotomy or surgical intervention has been practiced with variable success rates.^[19] The reported success rate of laser treatment varies in literature between 50 to 100%, but these are mostly small case series with short follow-up periods.^[12,20] In addition, laser treatment is associated with high rate of relapse; one study reported 75% recurrence rate within 80 days.^[12]

In cases resistant to medical and laser treatment, surgical intervention is needed to ease the flow of aqueous into the anterior chamber. Pars plana core vitrectomy alone resolves the condition in only 25 to 50% of cases.^[21] In order to restore normal aqueous flow, the posterior capsule should be breached, the anterior hyaloid face opened and the anterior vitreous cleared; this is because such a procedure breaks down the pathologic relationship between vitreous body and ciliary body.^[22] In phakic patients, core vitrectomy should be combined with cataract extraction and zonulohyaloidectomy and iridotomy.^[21] A large study involving 50 patients who

underwent core vitrectomy showed a recurrence rate of only 6%.^[23] The main disadvantage of pars plana vitrectomy is that most ophthalmologists are not quite familiar and comfortable with this technique and need to refer the patients to vitreoretinal surgeons, which can delay the treatment. Another limitation of this approach is that it is difficult to remove a part of anterior vitreous; therefore, it may be left intact.

Recently the need to perform pars plana vitrectomy has been debated, and instead of it, anterior limited vitrectomy combined with zonulohyaloidectomy and iridotomy has been advocated as an effective procedure. In this way, one could make a unicameral eye with a less aggressive procedure.^[15,16,22,24] In this study, we performed triamcinolone-assisted anterior vitrectomy through a clear corneal incision and performance of iridectomy and zonulohyaloidectomy. Lois and colleagues first described zonulo-hyaloido-vitreotomy through an existing peripheral iridotomy.^[22] However, because this technique is based on the location of the previous peripheral iridotomy, intraocular maneuvering can be a challenge. We believe our technique in which there is creation of a new stab incision and opening of the iris, zonula and the vitreous cavity provides the surgeon with more space, which makes the procedure easier to perform and less damaging. Lois and colleagues reported 100% success rate with no recurrences over a median of 5.5 months in 5 cases, which is similar to our findings and emphasizes the effectiveness of this procedure. Since then, there have been 2 other small case series, which also showed high success rate of this procedure.^[24,25] Because this procedure involves performance of a quick and limited vitrectomy with easy access from the anterior chamber, we have named it "mini-vitreotomy." Based on our results and previous reports, we assert that mini-vitreotomy is a simple, quick, safe, and effective procedure in the management of pseudophakic aqueous misdirection. This procedure can easily be performed by any ophthalmologist who is not familiar with the posterior approach. In addition, in case of intraoperative happening of aqueous misdirection the same surgeon can form the anterior chamber using this technique.

Epstein has summarized all possible mechanisms involved in aqueous misdirection together into what he called the "unifying concepts in malignant glaucoma."^[26] He emphasized the presence of retrolenticular block that involves the anterior hyaloid face. We assert that "mini-vitreotomy" addresses mentioned elements of retrolenticular block, a fact that explains the high success rate of this procedure.

Some may challenge this technique because of a concern about IOL stability after zonulectomy; however, no patients in this series or previous reports have developed IOL subluxation. Only few zonules should be removed in this procedure in order to avoid IOL instability. Another concern is the possible damage to

the retina during use of the vitrector behind the iris with poor visualization. It is strongly recommended to redirect the probe to the center of vitreous cavity after peripheral iridectomy.

CONCLUSION

In conclusion, mini-vitreotomy is a fast, simple, safe, and effective procedure in the management of intraoperative and postoperative aqueous misdirection, and it can be added to the armamentarium of skills of ophthalmologists who are not comfortable with the posterior approach.

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Conflicts of Interest

There are no conflicts of interest.

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