Aqueous misdirection: a case series of unexpected surgical complications

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Aqueous misdirection (AM), also known as malignant glaucoma, is a form of secondary glaucoma that typically presents with shallowing of the anterior chamber (AC), raised intraocular pressure (IOP), and reduced visual acuity (VA) in the presence of patent peripheral iridotomies [1]. It typically presents following ocular surgeries such as phacoemulsification or filtrating surgery [2]. Its incidence has been reported to be around 0.4–6% of incisional surgery for primary angle-closure glaucoma [3].

The pathophysiology is described as misdirection of the aqueous humour into the vitreous cavity through an anterior rotation of the ciliary body [4]. It is not fully understood but has been attributed to the abnormal relationship between the ciliary process, lens, and anterior vitreous. The aqueous humour accumulates in the posterior segment and results in anterior displacement of the iris-lens diaphragm, hence the shallowing of the AC and the myopic shift in VA [1].

The aim of treatment is to restore the normal aqueous flow. This is temporarily achieved with medical therapy through topical cycloplegics and antiglaucoma medications. Together, they produce a posterior movement of the lens-iris diaphragm, reduction in aqueous humour, and a decrease in vitreous volume [2].

Surgical intervention is the recommended treatment as highlighted by a recent retrospective study [5]. Over the years various options have developed, such as cyclo-diode laser, vitrectomy, zonulectomy, iridectomy, and phacoemulsification. The aim of surgery is to disrupt the anterior vitreous face and create a tunnel for aqueous flow [2]. To date, no studies have looked at complications of AM.

We present three cases of AM who developed late postoperative cystoid macular oedema (CMO).

Case study 1

We present a 73-year-old Caucasian female with a background of bilateral narrowed angles and previously stable refraction. Her past medical history included type 2 diabetes mellitus, pulmonary embolism, chronic pain, total abdominal hysterectomy, and cholecystectomy. She first presented to the ophthalmology department with a right cataract and underwent an uneventful right phacoemulsification.

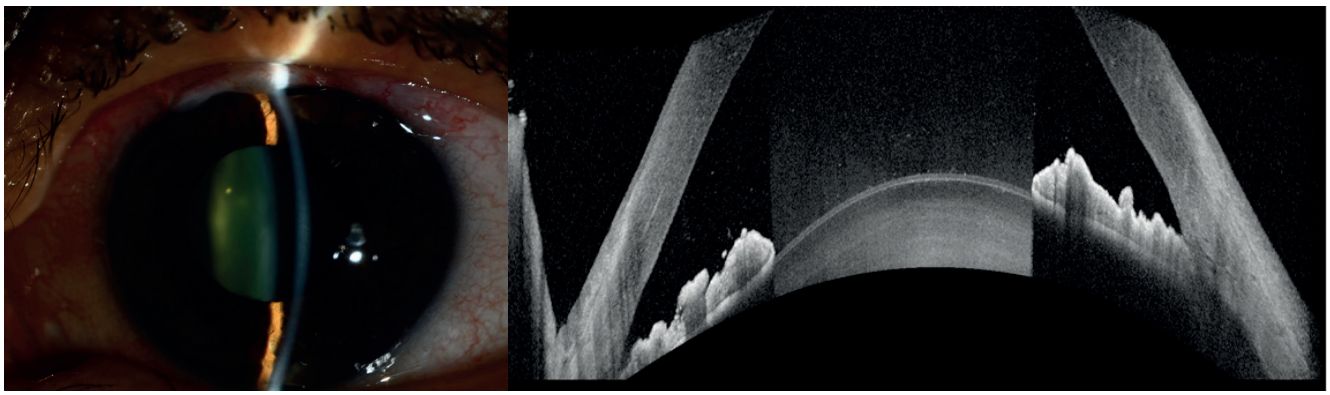
She presented one month later with counting fingers in the right eye – pinhole correcting to 6/18. She had a clear right cornea and AC, however the AC was shallower compared to previous examinations. Intraocular pressures were normal bilaterally.

Medication-wise, she was on prednisolone 1% eye drops four times daily and atropine eye drops once daily. Both eye drops were stopped as she was not responding to them. Two days later her right eye vision had worsened to counting fingers and correction to 6/36-1 with pinhole and had an IOP at 26mmHg. A right anterior zonulo-hyaloidectomy was performed the following week which was complicated by iris root dehiscence of 180 degrees. Postoperatively, there was improvement in the VA at 6/36 unaided and the IOP at 16mmHg. The following month, a left eye YAG peripheral iridotomy at 81mJ was performed for an occludable angle, defined at the time as inability to see the trabecular meshwork for >180 degrees.

One-month post-iridotomy, she re-presented with an IOP at 40mmHg in the left eye and VAs of 6/9 bilaterally with no pinhole improvement. The left AC was shallow on examination. The pressures were brought down pharmacologically and a diagnosis of left eye AM was made. A left phacoemulsification and left anterior zonulo-hyaloidectomy was performed. One month later, she developed right eye CMO which was diagnosed on ocular coherence tomography (OCT).

Three weeks subsequently, a relapse of left eye AM was diagnosed when she presented with left eye VA of 6/24 correcting to 6/12 and left eye IOP of 16mmHg. An enlargement of the opening to her anterior vitreous face through the superior peripheral iridectomy was successfully performed, deepening the AC.

Three months later, she remained responsive to subconjunctival steroid injections and dorzolamide drops three times daily. One year after the left eye relapse, the VAs were 6/9 in the left eye and 6/12 in the right eye with normal IOPs. The right CMO responded to courses of subconjunctival steroids and she was discharged from the department after no recurrence.



Slit-lamp examination on the left demonstrating a shallow anterior chamber. Ocular coherence tomography of the anterior chamber on the right demonstrating narrow iridocorneal angles. Photos are courtesy of Ninewells Hospital, Dundee, ophthalmic photography department.

Case study 2

We present an 80-year-old Caucasian female with a background of chronic angle closure glaucoma (worse on right than left), bilateral laser iridotomy, and allergic conjunctivitis sensitive to many topical medications. Her past medical history included epilepsy managed with phenobarbital, gout, and hypothyroidism. She is under glaucoma specialist follow-up and was on Timolol, Tafluprost, and Pilocarpine eye drops to both eyes. She was listed for a right phacoemulsification, trabeculectomy, and Mitomycin C which proceeded uneventfully. Atropine 1%, dexamethasone 1%, and chloramphenicol were commenced postoperatively.

She presented one week later counting fingers in the right eye correcting to 6/36, raised IOP at 23mmHg, and a very shallow AC. A diagnosis of AM was made.

She did not respond to medical management and underwent a right anterior zonulo-hyaloidectomy. Five days postoperatively she presented with right eye pain, nausea, ciliary injection, and a hypopyon. She received intravenous and topical therapy to lower the IOP from 52mmHg to 32mmHg in the right eye. A diagnosis of postoperative uveitis was made and a topical dexamethasone regimen, dorzolamide, and pilocarpine was started.

At two months follow-up, the VAs were 6/6 and 6/5 in the right and left eyes respectively. During follow-up, she developed an allergy to topical atropine and after stopping it the right AC became shallow and she relapsed into AM. A repeat right anterior zonulo-hyaloidectomy was performed. The following month, she developed a bleb failure and underwent right needling and Mitomycin C.

The IOPs at the next three-month follow-up remained high despite a deep AC and bimatoprost was commenced. The following year, despite control of the IOP, the visual fields were reducing bilaterally, therefore she received a right anterior segment revision with mitomycin C.

A right CMO was developed five years post-diagnosis of AM and responded to subconjunctival steroids and cessation of prostaglandin analogues. At follow-up in 2023 there was resolution of the right CMO. She remains on dual IOP lowering agents bilaterally and continues to remain under ophthalmology follow-up.

Case study 3

We present an 81-year-old Caucasian female with a background of nanophthalmos, high hypermetropia, narrow angle glaucoma, and left amblyopia. Her past ophthalmic history also included right augmented trabeculectomy and bilateral phacoemulsification. She had a past medical history of hypertension, asthma, hypothyroidism, and a back injury.

She presented to the eye department with counting fingers in the right eye, raised IOP at 52mmHg, and AC shallowing. The most recent operation was a right eye phacoemulsification around two weeks prior. She was diagnosed with right eye AM. Intraocular pressure control required IV Acetazolamide and Manitol and when stable, a right eye peripheral iridotomy at 64mJ was performed. Preoperatively the right eye was 6/36 and 6/18+1 in the left eye. The following day, a right vitrectomy, endolaser, and bleb revision was undertaken. During this hospital admission she had received a total of three IV Methylprednisolone doses.

Three months postoperatively she had a right anterior segment revision and 5-Fluorouracil injection. At the next follow up, the right eye VA was 6/36+1 and the left eye was 6/18+2. The right IOP was 9mmHg and 17mmHg in the left. She continued on a single anti-glaucoma agent and the topical dexamethasone which was increased to twice daily.

A few months later, she developed significant CMO in the right eye and was started on systemic steroids. No underlying inflammatory process was identified to explain this. There was difficulty weaning the steroids for the CMO. As a result, she received local steroid injections which she responded to. At two years post-diagnosis, the best corrected VA in the right eye was 6/18 and 6/36 in the left eye. The right CMO resolved years later after increase of the steroid injections. She remains under ophthalmology follow-up to date.

Discussion

We highlight three cases of AM presenting post-phacoemulsification surgery which were successfully managed surgically with an anterior zonulo-hyaloidectomy or vitrectomy with bleb revision. All cases presented with a decrease of visual acuity, shallowing of the AC, and a history of narrow angles. However, one of the cases had a normal IOP at initial presentation.

It is described in previous cases that the IOP may be within normal limits and the condition eludes diagnosis until there is progressive shallowing of the AC or an elevated IOP [6].

Despite the diagnostic uncertainty of AM there are risk factors established in the literature that aid in its recognition. It is a postoperative complication and most commonly arises after glaucoma surgery followed by cataract extraction [2]. This matched our cohort who all had phacoemulsification surgery prior to presentation and with one patient receiving a trabeculectomy in addition. Chronic angle-closure, hypermetropia, and nanophthalmos have also been documented in the literature as key predisposing factors [2,3]. Furthermore, AM is more common in females (female to male, 7:3) owing to the shallower AC and more anterior location of the lens in females compared to males [2]. The phakic status of a patient has also been reported as an important contributor to the success rate of treatment, with Tsai, et al. reporting a vitrectomy success rate of 67% in pseudophakic patients compared to 25% in phakic patients [7]. Another important consideration is the increased risk of incidence of AM in the fellow eye regardless of glaucoma history [4]. This was true for one of our patients (Case 1) who developed AM in the fellow eye one-month post-iridotomy.

Aqueous misdirection in our cohort were initially managed medically. However, definitive treatment for all was surgery. Another case series looking at 10 eyes reported only one eye responding to conservative management [6]. A retrospective study of 21 patients reported recurrence in all patients who received medical management [2]. Surgical management remains the mainstay treatment and various options have been explored in the literature. Sharma, et al. described their surgical management with vitrectomy-phaco-vitrectomy in five cases as recurrence free in their mixed follow-up period [1]. Debrouwere, et al. described a 75% recurrence rate and attributed this to the use of vitrectomy alone not offering a permanent passage for the accumulated aqueous humour in the vitreous to leave [2]. This reasoning was extrapolated to explain the similar short-term effect observed with YAG laser capsulotomy with hyaloidotomy in the literature [6]. In our cohort, only one patient (Case 2) of the three relapsed after stopping the cycloplegia and received a repeat anterior zonulo-hyaloidectomy to correct the AM. It has been previously reported that halting of cycloplegics would result in AM relapse [8]. Interestingly, a history of trabeculectomy was reported as a risk factor associated with treatment failure in two retrospective studies [5]. The same patient (Case 2) also had a history of trabeculectomy and potentially contributed to their relapse.

To the best of our knowledge, CMO has not been reported in the literature as a complication of AM. All patients in our cohort developed CMO in the AM eye postoperatively. Cystoid macular oedema is a recognised complication post cataract and vitreoretinal surgery and although its aetiology is not fully understood it has been proposed that inflammation and prolapsed vitreous may play a role [9]. Cystoid macular oedema in our patient cohort had a relapsing-remitting course and ultimately responded to subconjunctival

Table 1. Characteristics of three aqueous misdirection patients that underwent surgery at Ninewells Hospital, Dundee.

	Age (years)	Aqueous misdirection (eye)	Ocular history	Surgical history	Axial length (mm)		Intervention	IOP (mmHg)		BCVA (Snellen)	
					RE	LE		Pre	Post	Pre	Post
Case 1	73	RE	Bilateral narrowed angles	Right phacoemulsification	20.83	21.08	Anterior zonulo-hyaloidectomy	18	16	6/18	6/12
		LE						40	16	6/9	6/9
Case 2	80	RE	Chronic angle closure, allergic conjunctivitis	Right trabeculectomy + phacoemulsification + Mitomycin C	21.34	21.64	Anterior zonulo-hyaloidectomy	23	15	6/36	6/6
Case 3	81	RE	Nanophthalmos, narrow angle glaucoma, amblyopia	Right phacoemulsification	16.71	16.49	Vitrectomy, endo-laser, bleb revision	52	9	CF	6/36

RE: right eye. LE: left eye
IOP: Intraocular pressure in mmHg
BCVA: best corrected visual acuity
CF: counting fingers for visual acuity

steroids. It is recognised that prostaglandin eye drops post-cataract surgery have the potential to induce CMO and its discontinuation leads to resolution [10]. One of our patients were on prostaglandin eye drops prior to presentation (Case 2), however CMO continued despite its stoppage. It is difficult to speculate the exact cause of CMO but it may be related to the formation of a one-chambered eye in our cohort.

Conclusion

Aqueous misdirection is a rare and serious complication to consider and manage in postoperative patients. Through our case series we have highlighted the risk factors for its development and the limited response to medical therapy alone and its response to surgery. Furthermore, we have highlighted the complication of CMO in all three cases not reported elsewhere. We recommend consideration of CMO when investigating reduced VA in the follow-up of AM patients.

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TAKE HOME MESSAGES

- Aqueous misdirection may present with a normal IOP.
- Important to recognise the risk factors of AM and suspect it in the postoperative patient with a shallow AC.
- Medical management is the first step to treatment of AM.
- Surgical treatment with an anterior zonulo-hyaloidectomy is the mainstay of treatment.
- Complications of AM have not been reported in the literature.
- We recommend consideration of CMO when investigating reduced VA in the follow-up of AM patients.

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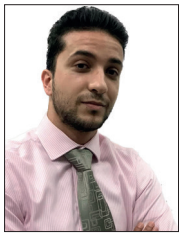

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