SULPHUR HEXAFLUORIDE IN THE TREATMENT OF FLAT ANTERIOR CHAMBER FOLLOWING TRABECULECTOMY

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SUMMARY

The efficacy and side effects of sulphur hexafluoride (SF_6) in the reformation of the flat anterior chamber (AC) after standard trabeculectomies were studied. Ten patients with lenticulocorneal touch following trabeculectomy were enrolled. All had water-tight conjunctival wounds with overflowing fistulas. In 5, one to four surgical attempts to reform the AC were unsuccessful. Two to seven days after trabeculectomy, the AC was reformed by a single injection of SF_6/air mixture (20–40%). Gas was injected through the limbus at 3 or 9 o'clock. The AC remained deep after absorption of the gas in 2–7 days. All patients had stromal oedema in the first 4 days. This resolved and specular microscopy did not show any abnormality. After a mean follow-up of 2.5 years, all had normal intraocular pressure, 3 with one topical antiglaucoma treatment. Three patients developed cataracts before and 3 after reformation of the AC. The latter 3 were not anterior capsular cataracts as induced by gases. SF_6/air mixture (20–40%) is inert and kind to the cornea and, as it is absorbed in less than 7 days, it exerts minimal damage to the crystalline lens. It is effective in the reformation of flat ACs.

Flat anterior chamber (AC) with hypotony is a serious complication of drainage surgery, with an incidence of 2–4%.[1] This can be reduced further with new surgical precautions such as releasable sutures. Flat AC is due either to a leaking conjunctival wound or to an over-filtering fistula. If untreated, it may cause corneal endothelial and stromal damage, peripheral anterior synaechiae, closure of filtering fistula and cataract.[2] Hypotonic maculopathy and serous retinal detachment are other possible complications.

A leaking conjunctival wound can be dealt with either conservatively, by padding, insertion of a contact lens and scleral shell,[2–4] or by surgical intervention. When flat AC is due to an overflowing fistula, suturing of the scleral flap, autogenous subconjunctival blood patch or injection of air into the AC with drainage of supra-choroidal fluid have been suggested.[5,6] Intraocular injection of perfluoropropane (C_3F_8) without a drainage sclerotomy has also been successfully employed in pseudophakics.[7,8]

Surgeons have been reluctant to utilise gases in the AC because of their potential side-effects.[9] The aim of this study was to examine the efficacy and side-effects of sulphur hexafluoride (SF_6) gas/air mixture 20–40% in reforming the AC.

PATIENTS AND METHOD

Between July 1989 and January 1994, all consecutive patients with flat ACs following 490 standard Cairns-type trabeculectomies[10] were evaluated. Cases with a leaking conjunctival wound and those responding to conservative treatment were excluded.

Ten patients (6 men and 4 women) met the study criteria. Their ages ranged from 59 to 84 years (mean 68 years). They were followed up from 6 months to 5 years (mean 2.5 years). In 9 patients the AC was flat on the first post-operative day. In case 6, the AC was formed on the first day but flat on the second day. All had choroidal detachment and lenticulocorneal touch due to an overflowing fistula. Initial conservative treatment with double padding, pupil dilation and topical steroid was unsuccessful. In 5 patients (cases 2, 3, 6, 7, 9) surgical attempts (one to four) to reform the AC using Balanced Salt solution

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Table I. Ocular findings and surgery before reformation of the anterior chamber (AC)

Patient no.	Age/Sex	Ocular history	Pre-operative VA	First surgery/further attempts	Post-operative VA with flat AC
1	79/M	POAG	6/18	Trabeculectomy	6/24
2	62/M	CACG	6/5	Trabeculectomy/conjunctival resuturing	6/18
3	61/M	POAG	6/12	Trabeculectomy/air injection	6/12
4	67/F	CACG, Cat.+++	CF	Trabeculectomy	CF
5	72/F	AACG, Cat.++	6/60	Trabeculectomy	6/60
6	65/M	PXF (advanced)	HM	Trabeculectomy/Na hyaluronate injection	HM
7	67/F	POAG	6/6	Trabeculectomy/2 resuturing of flap/ 4 reformation attempts by BSS + Na hyaluronate	4/60
8	84/F	PXF	6/18	Trabeculectomy	6/60
9	68/M	PXF, Cat.+	6/6	Trabeculectomy/resuturing of flap/Na hyaluronate injection	5/60
10	59/M	CACG	6/6	Trabeculectomy	6/6

VA, visual acuity; POAG, primary open-angle glaucoma; CACG, chronic angle-closure glaucoma; AACG, acute angle-closure glaucoma; PXF, pseudoexfoliation glaucoma; Cat., cataract.

(BSS), sodium hyaluronate, air and resuturing of the scleral flap were ineffective (Table I).

Two to seven days after trabeculectomy the ACs were reformed by injecting SF_6/air mixture, in 6 cases under topical anaesthesia. Snellen visual acuity, intraocular pressure, crystalline lens and fundus were assessed pre- and post-operatively.

The SF_6 concentration in the mixture was 40% in 4 and 20% in 6 patients. SF_6 was drawn up into a syringe through a 0.2 μm Millipore filter and then diluted with the air drawn through the same filter (ratio: 1 in 5 ml for 20%, 2 in 5 ml for 40%). Gas was injected into the AC, under sterile conditions, in the operating theatre. The injection site was the limbus at 3 or 9 o'clock. A 30-gauge half-inch needle was used. The globe was held firmly with a toothed forceps. To minimise iris and lens damage, the bevel was facing the iris plane at the site of the entry. Special care was taken not to inject anterior to Descemet's membrane.[11] Between 0.15 and 0.2 ml of SF_6 was adequate to create a deep AC in 5 cases. In the other 5 cases some gas escaped into the bleb; they required more gas at the same surgical sitting to maintain a deep AC.

To reduce gas contact with the lens post-operatively, no cycloplegic drop was administered until the gas was completely absorbed. A double pad was applied overnight and the head positioned at 30°. Patients were discharged 1–2 days after the procedure when the gas bubble was fully absorbed or very small. Patients were advised to have minimal activity for 1 week. Topical steroids and antibiotics were prescribed for 2 weeks, after which they were gradually tapered. Three specular microscopies were performed on 6 patients. The first was performed just before injection of the gas, the second after its absorption and the third 3 months later.

RESULTS

In all cases the AC remained deep after absorption of the gas. Gas was absorbed in 2–7 days (mean 4.8 days). Six patients had reduced visual acuity after trabeculectomy, 2 of whom (cases 2, 9) improved after the reformation of the AC (Table I). Six patients had cataracts (cases 1, 4, 5, 7, 8, 9), 3 of which developed before and 3 after the reformation (cases 1, 7, 8). Four of these patients (cases 1, 4, 7, 8) had significant reduction of vision. In this group cases 1, 4 and 7 underwent cataract surgery and achieved unaided visual acuities of 6/9, 6/18 and 6/9 respectively. Case 8 was on the waiting list for cataract surgery. The remaining patients, cases 5 and 9 with mild cataracts, did not have any further surgery (Table II). All cataracts were nuclear sclerotic or

Table II. Ocular findings during and after injection of SF_6 into the anterior chamber

Patient no.	Final reformation by	Days for gas resorption	Folow-up (years)	Latest ocular finding	Final VA	Final IOP
1	SF_6 40%	4	4.5	↑Cat.+++	HM	15[a]
				ECCE+IOL	6/9	
2	SF_6 40%	6	4.5	—	6/12	18
3	SF_6 40%	6	2.0	—	6/18	20
4	SF_6 40%	7	4.5	Cat.+++	CF	17
				ECCE+IOL	6/18	
5	SF_6 20%	4	0.8	Cat.++	6/60	14[a]
6	SF_6 20%	2	0.5	Advanced glaucoma	HM	18
7	SF_6 20% + sclerostomy	4	3.0	↑Cat.+++	6/60	17[a]
				ECCE+IOL	6/9	
8	SF_6 20% + sclerostomy	5	1.0	↑Cat.++++	HM	10
9	SF_6 20%	5	2.0	Cat.+	6/18	18
10	SF_6 20%	5	0.5	—	6/6	18

VA, visual acuity; IOP, intraocular pressure; ↑, progression of cataract; ECCE+IOL, extracapsular cataract extraction + intraocular lens.
[a] With one topical medication.

cortical; there were no anterior capsular opacities such as usually occur after prolonged gas–lens contact.

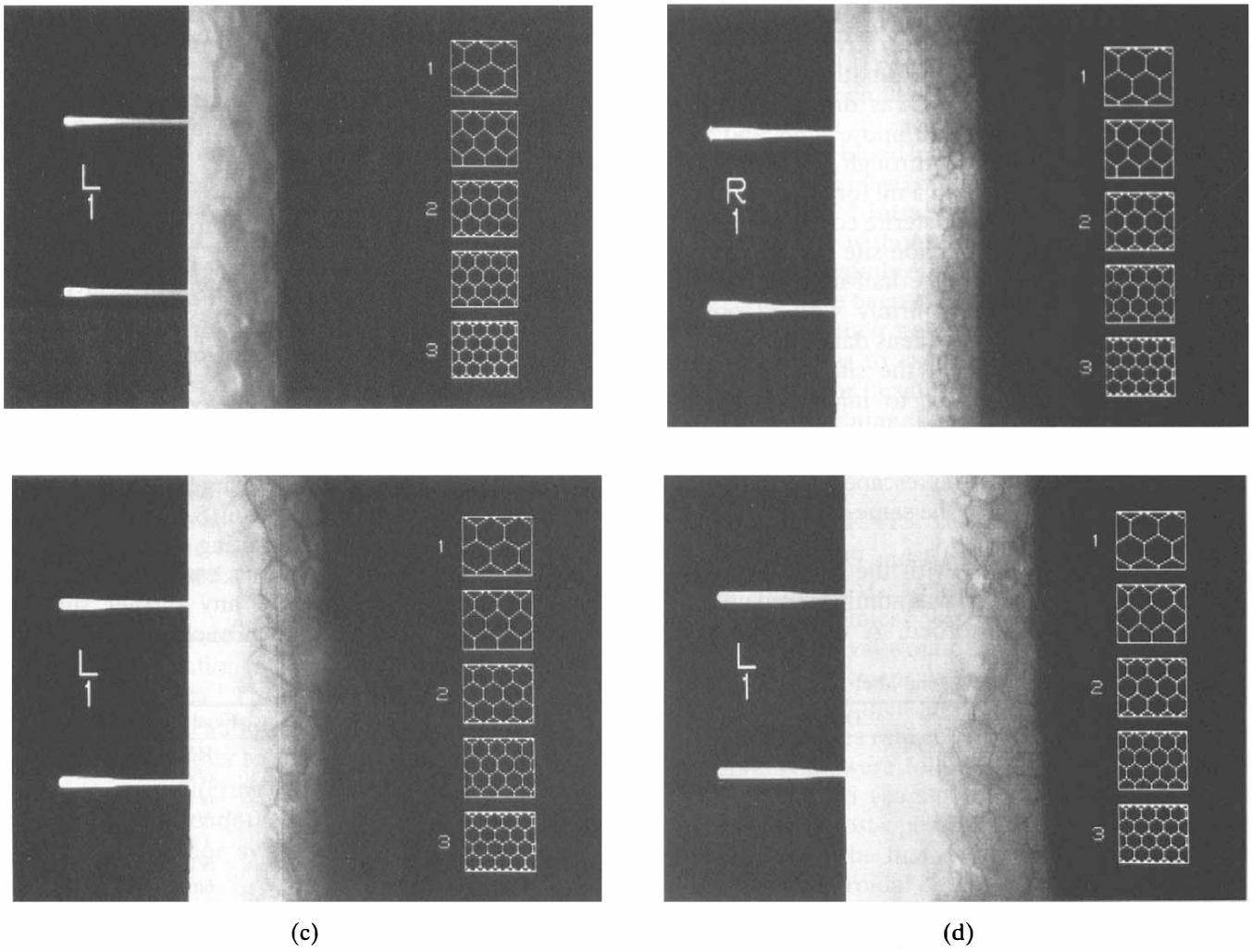
All patients had mild corneal stromal oedema before the injection of SF_6. This persisted for up to 4 days after the injection. In 4 patients the central stromal oedema increased after the reformation (cases 1, 3, 4, 7). Case 4 had a moderate uveitis with keratic precipitates. All the above conditions recovered in 1 week. A small stromal opacity, away from the visual axis, remained in case 7, due to mechanical endothelial damage during one of the surgical interventions to reform the AC.

Specular microscopy of corneal endothelial cells showed polymegatism and reduced cell count before the reformation. No deterioration was recorded after absorption of the gas. Specular microscopy of case 5, with 7 days of flat AC, showed a significant reduction in the corneal endothelial cell count (520 cells/mm^2) before the injection of SF_6. The cell count did not deteriorate after the injection of gas (Fig. 1). Specular microscopy of case 10, with 2 days of lenticulocorneal touch, was not as severely affected. The cell count was 2080 cells/mm^2 in the affected eye and 2880 in the normal eye. Three months later this improved to 2240 cells/mm^2 in the affected eye. A similar pattern was noted in the other four specular microscopies.

After absorption of the gas the intraocular pressure remained controlled in all cases. Cases 1, 5 and 7 required one topical antiglaucoma medication, later in their follow-up.

DISCUSSION

Trabeculectomy, like many other intraocular surgical procedures, can produce hypotony. This is followed by choroidal detachment due to transudation of the fluid into the suprachoroidal space.[12,13] Injection of gases used in the retinal surgery has been advocated for the reformation of the AC, especially in



(c) (d)

Fig. 1. *Specular microscopy of case 5 with left flat anterior chamber. (a) Endothelial cell count before injection of the gas shows polymegatism and 520 cells/mm^2 in the left eye. (b) Normal endothelial cell count of 2560 cells/mm^2 in the right eye. (c) Endothelial cell count of the left eye after absorption of the gas, 5 days later, shows the same reading as before the injection of the gas (600). (d) Endothelial cell count 4 months later shows an increase to 1040 cells/mm^2 in the left eye. The right eye count was almost unchanged at 2360 cells/mm^2.*

pseudophakic patients.[14] SF_6 and C_3F_8 are not water soluble. When their intraocular concentration is 50% or higher, the gas bubble expands as O_2, N_2 and CO_2 from the circulation penetrate the AC. The high surface tension of these gases and their high buoyant force seal the fistula and increase the intraocular pressure. Once the intraocular pressure is restored and maintained, transudated fluid will be redirected into the choroidal circulation and the AC deepens due to the restoration of the vitreous cavity. After a period of equilibrium the bubble is re-absorbed back into the circulation.[15] When pure gas is used, absorption takes 3–7 days for air, 7–14 days for SF_6 and 30-60 days for C_3F_8.[1,16,17]

The aim was to use a certain concentration of gas to seal the fistula long enough to restore the AC, but not too long to induce any side-effects. SF_6 20–40% has more surface tension than air and is absorbed much faster than C_3F_8. It is absorbed faster in the AC (2–7 days) than SF_6 100% in the vitreous cavity (7–14 days).

Patients in this study had over-filtering fistulas which were not controlled with conservative treatment. In 5 of the cases the AC did not reform after one to four surgical interventions (cases 2, 3, 6, 7, 9). In 2 other cases per-operative injection of air or sodium hyaluronate into the AC did not prevent a flat AC.[18] A single injection of SF_6 20–40% reformed the AC in all cases.

Intraocular side-effects of gases have been widely investigated. Recent studies in rabbit eyes have shown corneal stromal oedema and inflammatory cells with a second Descemet's membrane after an injection of air, pure C_3F_8 and pure SF_6.[19,20] But when SF_6 50% and C_3F_8 15% are used only swollen endothelial cells are seen. It is believed that at this concentration neither of the two gases is more toxic than air.[1]

The corneal oedema in cats and rabbits persists as long as SF_6 20–40% remains in the AC, but resolves 1 week after the absorption of SF_6. However, after the absorption of C_3F_8, corneal oedema persists and fibrin deposition on the posterior surface of the endothelial cells forms a membrane. An SF_6/air mixture was therefore considered to be more suitable and was used in this study.[21] Initially SF_6 40% was used, but later in the study it became clear that SF_6 20% was sufficient to maintain the AC, despite its absorption in less than 4 days. A few cases needed higher volume of the gas during the initial injection as some escaped into the bleb. If further injection of the gas does not deepen the AC adequately, suturing of the scleral flap may be required at the same sitting.

Cataract formation is another complication of a flat AC.[22] Gases produce anterior capsular opacities, especially on the upper half of the lens surface, which can resolve spontaneously. This was not seen in our patients. Acute gas cataract can be avoided by reduction of the gas–lens contact time, using diluted SF_6. Cases 1, 7 and later 8 in this study developed cataracts after injection of the gas; however, these were nuclear sclerotic rather than anterior capsular, suggesting that probably gas alone did not contribute to their formation. Three other cases had developed nuclear sclerotic and anterior cortical cataracts immediately after the lenticulocorneal touch.

Gases used in intraocular surgery are not toxic. However, they can create a mechanical barrier between the aqueous humour and corneal endothelial cells and the crystalline lens which can lead to nutritional deprivation of the intraocular tissue. The longer this barrier is in place, the greater the damage. Ironically, a prolonged flat AC damages the cornea and the lens by the same mechanism. In this study a poor endothelial cell count was noted in cases with a longer lens–cornea contact. This did not deteriorate after the injection of SF_6. Early absorption of SF_6 seems to minimise the nutritional deprivation of tissues in the AC. With the absorption of SF_6 20% in 4 days, corneal endothelial cells and the crystalline lens are spared from irreversible damage.[23]

CONCLUSION

A flat AC is a serious complication of drainage surgery with a potentially disastrous outcome. Different techniques have been suggested for its management. A single intraocular injection of SF_6 20–40% was enough to reform the AC of 10 patients in this study, in 5 of whom multiple surgical attempts had been unsuccessful. All patients achieved a reasonable visual acuity and normal intraocular pressure. Twenty per cent SF_6/air mixture is inert and kind to the cornea and, as it is absorbed in less than 4 days, exerts minimal damage to the crystalline lens. A prolonged flat AC is more traumatic.

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Key words: Flat anterior chamber, Choroidal detachment, Lenticulocorneal touch, Sulphur hexafluoride.

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