REVIEW ARTICLE

# The use of intravitreal gases in non-vitrectomised eyes

ALEX ASSI, ZDENEK GREGOR

The first reported intravitreal gas injection for retinal detachment was performed by Ohm, who used air in 1909.[1] Combined air injection and retinopexy was described in 1931 by Anderson.[2] Rosengren used air to specifically tamponade retinal breaks in 1936,[3] but recognised its significant disadvantage of quick reabsorption from the vitreous cavity.[4] The sole use of intravitreal air became less popular as scleral buckles were introduced to relieve vitreoretinal traction, but its combination with scleral buckling procedures was publicised by Chawla and Birchall in 1973.[5]

Oxygen and nitrogen rather than air were first used by Nemetz to prolong the duration of the intraocular bubble in 1957.[6] Subsequently, the use of expanding gases such as sulphur hexafluoride and perfluorocarbon gases in conjunction with pars plana vitrectomy in the 1970s has regenerated interest in such gases as a sole treatment of retinal detachments.[7–11] Pneumatic retinopexy is a term introduced to the English literature by Hilton and Grizzard in 1985[12] as a simplified technique for the treatment of selected cases of rhegmatogenous retinal detachment. The application of intraocular gas in non-vitrectomised eyes has also been reported in the treatment of other conditions such as: (1) submacular haemorrhage (2) optic nerve pit maculopathy, and (3) premacular (subhyaloid) haemorrhage.

## Basic properties of gases and the gas–fluid interface

The most commonly used gases for intravitreal injections are the longer-acting gases such as sulphur hexafluoride ($SF_6$) and perfluoropropane ($C_3F_8$). The therapeutic effects (and potential complications) of intravitreal gases are attributed to their physical rather than chemical properties.

### *Surface tension*

Gas injected in the vitreous cavity forms a curved gas–fluid interface with a particularly high surface tension.[13] The surface tension at the gas–aqueous interface is more than twice that of a silicone oil–aqueous interface due to the stronger hydrogen bonding forces that encourage bipolar water molecules to clump together.[14,15] The gas–aqueous interface can span and plug retinal breaks and prevent the passage of gas or fluid into the subretinal space. This interface is also responsible for optical refraction and reflection induced by a gas bubble and for the total reflection of ultrasound,[16] making the gas-filled portion of an eye difficult to examine.

### *Buoyancy*

The buoyant force of an intraocular bubble is important and can be used to unfold retina,[17,18] close retinal tears, displace subretinal fluid (SRF)[19,20] or blood[21] and push detached retina back towards the retinal pigment epithelium (RPE). Buoyancy is also used to advantage by head positioning which allows the gas bubble to remain in contact with retinal breaks in the most superior part of the eye. On the other hand this force can produce harmful effects by inducing retinal tears,[22–25] forcing SRF into a previously attached macula or creating folds of redundant retina.[26–28]

### *Expansion and longevity*

The expansibility, slower absorption and longer intraocular longevity of $C_3F_8$ and $SF_6$ gases compared with air are governed by the law of partial pressures and are related to their composition, higher molecular weight, low diffusion coefficient and low water solubility.[29–31]

The rate of disappearance of an intravitreal gas bubble is determined by the rate at which the gas can diffuse into the blood stream and the rate of diffusion of other gases, mainly nitrogen from the blood stream into the bubble. When the diffusion rate of gases from the blood stream into the intravitreal bubble exceeds that of gases out of the bubble, the bubble expands until the diffusion rates reach equilibrium. Thereafter, diffusion of gas out of the bubble is greater and the bubble decreases in size and ultimately disappears. When injected in the vitreous cavity, a 100% $SF_6$ gas bubble will double in volume after 36 hours and last 10–12 days. $C_3F_8$ will quadruple in volume in 72 hours and last approximately 6 weeks.

A. Assi
Z. Gregor
Moorfields Eye Hospital
London, UK

Mr A. Assi, BSc, FRCOphth ✉
Moorfields Eye Hospital
City Road
London EC1V 2PD, UK

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Perfluoroethane ($C_2F_6$) has intermediate characteristics.[32,33] There is debate as to the exact volume of gas required to tamponade a certain retinal area but it is generally agreed that for an average size eye, a 0.3 ml bubble will cover about 90° of arc of retina (or about 3 clock-hours).[34] Larger eyes may require disproportionately larger volumes of gas.

### *Chemical effects*

$SF_6$, $C_3F_8$ or $C_2F_6$ have not been shown to have any significant chemical toxicity to ocular tissues when injected into the vitreous cavity.[7] However, some studies have demonstrated a reduction in the vitreous concentration of hyaluronic acid, tearing and distortion of the cortical vitreous lamellae and the breakdown of the blood–ocular barrier.[35–38] These changes are thought to be responsible for preretinal membrane formation.

## Indications for the use of intravitreal gas

### 1. Pneumatic retinopexy

#### *Principles and choice of gas*

An injection of a gas bubble into the vitreous cavity of an eye with a rhegmatogenous retinal detachment allows for tamponade of retinal breaks and for adjunctive retinopexy (laser photocoagulation or cryotherapy) which forms a permanent adhesion between the retina and the RPE. The high surface tension of the gas–fluid interface seals the retinal break permitting the RPE to absorb the subretinal fluid, while the buoyancy of the gas provides an additional force which pushes the retina back against the RPE.

The type of gas used is determined by the size, number and location of retinal breaks, the characteristics of the detachment and the size of the eye. Air may be used for pneumatic retinopexy[39–42] but it has the disadvantage of shorter intraocular duration than expansile gases. In order to achieve a bigger intravitreal bubble, some investigators have combined gas injection with repeated anterior chamber paracentesis[43] and/or drainage of subretinal[39,44,45] or retrohyaloid fluid.[46]

#### *Indications/contraindications*

Pneumatic retinopexy is indicated in certain types of retinal detachment as an alternative to scleral buckling. It may be the preferred procedure in eyes with conjunctival shortage (scarring, filtering bleb), thin sclera, a posterior break under the superior rectus muscle or in patients in whom a general or prolonged local anaesthetic is undesirable. It has been shown that appropriate case selection is of paramount importance. Superior retinal breaks are particularly amenable to this treatment because of the ease of post-operative posturing. Best results are obtained in localised retinal detachments caused by a single and small break with no associated vitreous traction.[47,48] Retinoschisis-related detachments[49,50] and detachments caused by dialysis,[47,51] multiple breaks in several quadrants,[52–54] inferior breaks,[55] giant tears[43,54,56] and macular holes[41,57–59] have all been treated by this method but with less predictable results. Multiple breaks, larger detachments and poor pre-operative visual acuity have been shown to carry a poorer prognosis in terms of reattachment with a single operation and eventual visual function.[48,60,61]

The main contraindication for pneumatic retinopexy is a patient's inability to posture post-operatively in the correct position in order to tamponade the retinal break. Before embarking on the procedure, it is essential to recognise any physical (e.g. musculoskeletal disorders) or mental (e.g. alcohol abuse) condition likely to affect compliance. Inferior vitreoretinal pathology such as extensive lattice degeneration is often regarded as a contraindication because of the increased risk of inducing inferior tractional retinal breaks.[23,62,63] However, in one large retrospective study lattice degeneration did not negatively influence the outcome.[48]

Aphakic and pseudophakic detachments have been shown to have a lower success rate with pneumatic retinopexy.[47,48,52,60,61,64–69] This is probably related to the nature and visibility of the breaks[70] and the altered chemical composition and physical properties of the vitreous in such cases.[25,65,71] An opened posterior capsule was associated with a worse outcome in some studies[25,64,72,73] but not in others.[40,48]

Early stages of proliferative vitreoretinopathy (PVR) is a relative contraindication.[48,61,63] Although some eyes with grade C PVR have been successfully treated,[52] pneumatic retinopexy is not the procedure of choice for a retinal break adjacent to a star fold. Male gender was reported by some investigators to be associated with a lower success rate[61] but this report was not substantiated by another large study.[48] Other relative contraindications to pneumatic retinopexy include cloudy media (such as posterior capsule opacification and vitreous haemorrhage) and glaucoma.

#### *Technique*

##### *Anaesthetic*

Pneumatic retinopexy can be done under topical, subconjunctival, retrobulbar or peribulbar anaesthesia depending on the surgeon's preference and the patient's threshold for pain.

##### *Preparation*

Dilute povidine iodine (Betadine) is instilled in the patient's conjunctival sac and used to clean the periocular skin. A small clear surgical drape is applied to the eye and a sterile speculum placed.

A thorough retinal examination with firm scleral indentation is repeated immediately before gas injection in order to confirm the site of the offending break and to rule out the presence of other pathology. The indentation also softens the eye before gas injection, although an anterior chamber paracentesis is often required.

*Retinopexy*

Cryotherapy is usually applied to the retinal breaks prior to gas injection. If the retina is very bullous or if the break is very posterior, argon laser retinopexy can be applied around the break after retinal flattening.[55] If laser retinopexy is planned, the surgeon should feel confident that the retinal breaks have been clearly identified in relation to visible landmarks such as retinal vessels or pigment. This is particularly important as the breaks may be difficult to locate (once the retina has flattened) and difficult to treat in the presence of an intravitreal bubble. In one study cryopexy was found to be significantly associated with failure compared with laser[69] and some authors advocate 360° of peripheral laser retinopexy to improve surgical results.[48]

*Gas injection*

Gas (0.3 ml 100% $C_3F_8$ or 0.6 ml 100% $SF_6$) is usually drawn in a 1 or 2 ml syringe on a 27 or 30 gauge needle. The injection site is chosen away from large open breaks or highly detached retina and made uppermost by lying the patient in the supine position with the head turned 45° to one side. Under indirect ophthalmoscopy, the needle is introduced with a slight thrust into the mid-vitreous cavity and then partially withdrawn until its tip only remains visible inside the eye. When the needle is in the correct position the gas is briskly injected in order to form a single intravitreal bubble. With the plunger held down, the needle is completely withdrawn and the injection site is plugged with a cotton bud. The patient's head is then turned to the opposite direction to move the bubble away from the injection site and prevent any external gas leak. The eye is examined after the gas injection to exclude central retinal artery occlusion and to ascertain the mobility of the gas bubble in the vitreous cavity. The presence of multiple small bubbles (fish eggs) is undesirable as they reduce the efficacy of the bubble to tamponade the break and increase the risk of gas entering the subretinal space through retinal breaks.

*Post-operative management*

A broad-spectrum antibiotic is instilled in the conjunctival space and used for 2 days post-operatively. The meridian of the retinal break is marked as an arrow on the eye patch to indicate the head position that needs to be maintained. The patient is advised to posture during waking hours (16 hours a day) for 5 days and instructed to avoid sleeping face-up. He or she is also cautioned against travel by air or in mountainous areas and is followed up at regular and frequent intervals after discharge. Pre-operative patient education is important in maximising positioning compliance.

***Anatomical results***

Pneumatic retinopexy has been the subject of one randomised controlled trial and many uncontrolled studies, with primary reattachment rates ranging from 53% to 94%.[12,19,40,47,48,60,61,65,66,67,74–76] However, definitions for terms such as single operation success rate vary amongst investigators and the comparison of reported results is difficult because of different pre-operative characteristics such as phakic status, extent of detachment and number of breaks.

In a meta-analysis of 26 series (1274 eyes treated by pneumatic retinopexy) Hilton and Tornambe[77] calculated a primary reattachment rate of 80% with a single procedure and an overall success rate of 98% after reoperations.

The results of the multicentre randomised controlled trial comparing pneumatic retinopexy with scleral buckling in 198 patients showed that single-operation success rate was higher in the scleral buckling group than in the pneumatic retinopexy group (82% versus 73%; statistically not significant).[64] With further operations there was no difference in final reattachment rate (98% versus 99%) even at 2 years.[78] A retrospective comparative series of similar uncomplicated retinal detachment operations showed that pneumatic retinopexy has a success rate higher (71%) than Lincoff balloon buckling (64%) but lower than that of encircling scleral buckles (96%).[72] This significantly higher primary reattachment rate with scleral buckling was corroborated in another more recent retrospective study.[67]

Because most unsuccessful pneumatic retinopexy fail within the first few post-operative weeks[48,60,61] and redetachment after the first 6 months is unusual,[48,60,78] patients should be followed closely post-operatively. The literature suggests that a failed attempt at pneumatic retinopexy does not disadvantage the eye's anatomical or visual outcome after subsequent surgery.[25,48,52,60,64,67,69,78,79]

***Visual results***

It has been noted in some series that pneumatic retinopexy is better and quicker at restoring vision with a lower morbidity than scleral buckling combined with drainage of SRF,[19,60,64,78] but no studies to date have compared it with non-drainage segmental scleral buckling. The randomised controlled trial demonstrated quicker and better visual recovery in the pneumatic retinopexy group if the macula was detached for less than 2 weeks, with no significant difference in the visual outcome of macula-on detachments.[64] The reason for this difference is not entirely clear but might be related to the longer duration of macular detachment in the scleral buckling group[80] and to the adverse effect of SRF drainage or scleral buckling (particularly encirclements) on macular function or choroidal perfusion.[81]

In one retrospective study, visual rehabilitation (lack of diplopia, change in refraction) was faster in eyes treated by pneumatic retinopexy than by scleral buckling or by Lincoff balloon. However, there was no significant difference in the visual acuities of eyes after successful treatment.[72]

### *Peroperative complications*

#### *Anterior hyaloid injection*

Gas entrapment in front of the anterior hyaloid face (space of Petit) was the commonest intraoperative complication reported in a large retrospective series.[48,77] This is usually recognised by the loculated appearance of a poorly mobile bubble ('sausage sign') and initially treated by face-down positioning to allow the gas to move further back into the vitreous cavity.[68,82] Alternatively, the bubble can be removed by venting it to the atmosphere.[82]

#### *Increased intraocular pressure*

Intraocular pressure can rise significantly after gas injection, particularly if more than 0.3 ml of gas is injected.[13] This immediate but brief elevation in intraocular pressure is commonly observed, but pressure usually returns to normal within 90 min.[12,62] In the immediate post-operative period the central retinal artery should be observed for perfusion and a paracentesis performed if necessary. The intraocular pressure must subsequently be monitored by applanation tonometry and appropriate hypotensive treatment instituted as required. Particular attention should be given to eyes with pre-existing glaucoma and impaired flow facility.

#### *Subretinal gas*

Subretinal gas is an infrequent complication.[48,64,69] If the needle has not fully penetrated inside the eye, gas can detach the non-pigmented epithelium of the pars plana and enter the subretinal space.[48,64,69] Passage of gas into the subretinal space can occur through a large retinal break in the presence of multiple small bubbles (fish eggs) and excessive vitreoretinal traction.[12] Patient repositioning can allow the gas bubble back into the vitreous cavity through the same retinal break. Alteratively, needle aspiration of the gas, scleral buckling or vitrectomy may be required.[83]

### *Post-operative complications*

#### *Persistent subretinal fluid*

If substantial subretinal fluid is still present at 72 hours after pneumatic retinopexy a thorough investigation of the possible causes should be undertaken. The incidence of the initial break remaining open and subretinal fluid failing to absorb has been reported to be between 1% and 14%.[19,61,64,65,72,75] The causes of initial failure have been directly related to inappropriate case selection (e.g. inferior breaks), poor compliance in posturing, inadequate gas volume or retinopexy or excessive vitreoretinal traction on the break.[61,64,69,77] Since the fundamental problem of vitreoretinal traction not only persists after the gas bubble is injected but can even sometimes be exacerbated,[68,72] investigators have attempted to combine Nd:YAG laser vitreoretinal disruption at the retinal operculum with the pneumatic retinopexy procedure.[84] Reopening of the break seems more common in younger patients in whom the vitreous is more solid and thus more likely to persist in tugging on the retina.[13]

The so-called delayed absorption of subretinal fluid is reported to occur in up to 20% of cases.[69,85] Small inferior or posterior pockets (involving the macula) of loculated subretional fluid which do not communicate with a break are often associated with heavy cryopexy and subretinal pigment epithelial precipitates can occur and persist for several weeks or months.[85,86] These pockets, occurring in up to 15% of cases, should be managed conservatively.[86,87]

#### *New breaks*

New breaks are the commonest post-operative complication and are a major cause of failure of pneumatic retinopexy. The average incidence of these breaks described in larger series is 13%[77] with incidences of 20% or more reported in the randomised trial and other studies.[64,65,72,88] New breaks are more common in aphakic and pseudophakic eyes[64,68,72] and they tend to develop away from the original break, usually inferiorly[22,23] or posteriorly.[24] Most of these breaks are noted within the first month after gas injection[64,69] but some were noted 33 months after the original procedure at 180° from the original offending break.[89]

Such new breaks tend to occur in eyes with incomplete posterior vitreous separation and are thought to be caused by expansion and upward movement of the gas bubble.[22–25,72] Progressive vitreoretinal traction may also be exacerbated by a breakdown of the blood ocular barrier and this can persist long after the gas has resorbed.[25,37] Although no association has been established between new break formation and gas-bubble size or duration,[48] these breaks seem less common when intravitreal air is used.[39,40,64,90,91] Peripheral encircling retinopexy was suggested by Tornambe[48] in an attempt to prevent such breaks.

#### *PVR*

PVR is a small but significant risk factor for failure of pneumatic retinopexy and it is estimated to occur in about 4–10% of cases overall.[47,65,67,69,75,77] In theory, pneumatic retinopexy may encourage the dispersal of viable retinal pigment epithelium cells onto the surface of the retina and into the vitreous.[92] Indeed, vitreous flare and pigment cells have been observed as a result of subretinal fluid being squeezed through the open break by the gas bubble.[93] However, the results of clinical studies do not suggest that PVR occurs more frequently after pneumatic retinopexy than it does after scleral buckling procedures.[64,67,72] In one large retrospective series, neither the size nor the duration of the injected gas bubble nor the type of retinopexy used seemed to influence the incidence of PVR.[48]

*Epiretinal membranes*

Several cases of macular pucker have been reported in the literature and the incidence of symptomatic epimacular membrane varies between 2% and 3%.[47,48,65,69]

*Cataract*

In a prospective study on 33 eyes undergoing pneumatic retinopexy using 0.2–0.9 ml $SF_6$, there was no objective nor subjective change in lens transparency after 2 years compared with the fellow eyes.[94] The absence or very low incidence of cataract formation in pneumatic retinopexy is also confirmed by other studies.[19,48,69,78]

*Endophthalmitis*

Endophthalmitis after pneumatic retinopexy is rare. Two cases due to *Staphylococcus epidermidis* have been reported in the literature.[64,95]

*Other*

Other rare complications of pneumatic retinopexy include detachment of previously attached macula,[65,72,96] choroidal detachment,[48,64,69] cystoid macular oedema,[48,49] macular hole formation[48,64,69,97–99] and clear corneal cataract wound dehiscence.[100]

***Practical considerations***

One study estimated the cost of repairing retinal detachments with pneumatic retinopexy including reoperations to be approximately half the cost of repairing a similar group with scleral buckling.[48] However, the increasing use of local anaesthetic and day case surgery[101] is likely to reduce the overall expense of caring for patients with retinal detachment.

A survey we conducted in 1999 revealed that the wide acceptance of pneumatic retinopexy in the United Kingdom has been tempered by the perceived higher rate of complications and redetachment in the early post-operative period compared with conventional scleral buckling surgery.[102] On the other hand, two American surveys disclosed an increase in the popularity of pneumatic retinopexy amongst younger vitreoretinal surgeons and those practising in California and Florida, particularly as it is quick and can be carried out as an office procedure.[103,104]

Further studies are required to determine the effect of the patient's systemic condition on the success of pneumatic retinopexy and the most cost-effective technique that offers the best functional outcome.

**2. The use of intravitreal gas in conjunction with scleral buckling**

Air or long-acting gases (usually $SF_6$ or $C_3F_8$) may be injected into the vitreous cavity as an adjunct to scleral buckling for a number of indications either intra- or post-operatively.

***Restoration of intraocular volume***

Drainage of large amounts of subetinal fluid in bullous retinal detachment can produce severe intraoperative hypotony. Injection of filtered air into the vitreous cavity can restore intraocular pressure either after[5,105] or before cryopexy as part of the drain, air, cryopexy, and explant (DACE) sequence.[90,91,106,107]

***Fish mouthing***

Retinal redundancy can develop at the break in scleral buckling and allows fluid to continue leaking from the vitreous cavity into the subretinal space. This phenomenon is exaggerated with large tears and high buckles and can be treated with injecting a small amount of air into the vitreous cavity that will iron out the fish mouth.[7,108,109] There is no need for a long-acting tamponade if the buckle is correctly positioned and of adequate size to support the break.[110]

***Persistent retinal detachment***

Failure of reabsorption of subretinal fluid or reaccumulation of fluid that had been drained intraoperatively may be treated with pneumatic retinopexy and subsequent lasering.[110–114] This alternative to surgical revision of scleral buckling has a variable success rate and should not be used in cases with persistent vitreous traction or if the breaks are in the inferior periphery.[55,112,115,116]

**3. Pneumatic displacement of submacular haemorrhage**

Submacular haemorrhage may arise from the retinal or choroidal circulations and causes a profound loss in visual acuity. It commonly originates from retinal arterial macroaneurysms or choroidal neovascular membranes (CNV) associated with age-related macular degeneration (AMD). Mechanical disruption, chemical toxicity and impaired diffusion through RPE contribute to photoreceptor damage and poor visual outcome.[117,118] The prognostic factors that determine visual outcome include the underlying cause,[117,119–121] the thickness,[117] the surface area[118] and the duration[122–125] of the haemorrhage.

*Surgical treatment*

Various surgical techniques, mostly in combination with vitrectomy, have tried to evacuate or displace submacular haemorrhage in an attempt to improve visual acuity.[98,126,127] However, pneumatic displacement of the submacular haemorrhage without prior vitrectomy was first reported in 1996[128] and it has the main advantage of greater simplicity and reduced surgical trauma to sensory retina and RPE. The principle is that face-down positioning following intravitreal gas injection allows the gas bubble to mechnically displace the submacular blood away from the fovea. When used with a prior intravitreal injection of a fibrinolytic agent (TPA), 19 of 20 patients had successful extrafoveal displacement of the submacular haemorrhage but only 4 patients (20%) obtained post-operative visual acuities better than 6/60.[21] Subsequent studies reported good anatomical success rates and visual acuities of 6/24 or better in 40% of cases with AMD associated with large and thick haemorrhages.[129,130] Other series showed variable improvement in anatomical appearance and post-operative visual acuity.[131–134]

Fresh and larger haemorrhages seem more amenable to displacement by the gas bubble,[129] and in one small retrospective study post-operative visual acuity was unrelated to the haemorrhage duration, size or dose or TPA injected.[130] The final visual outcome is often limited by the progression of the underlying pathology, although significant and stable recovery is possible in some eyes.[130] Reported complications arising from intravitreal gas injection for the treatment of subretinal haemorrhage include posterior vitreous detachment,[131] vitreous haemorrhage,[129,130] retinal detachment[21,129] and endophthalmitis.[130,134]

### 4. Pneumatic displacement of submacular fluid in optic nerve pit maculopathy (ONPM)

*Pathophysiology*

Optic nerve pits are uncommon congenital anomalies and about half of patients develop serous macular detachment leading to significant reduction in visual acuity.[135–138] The pathophysiology of ONPM is not clear but optical coherence tomography recently confirmed the previously observed bilaminar structure of the elevated macula and suggested that the apparent serous detachment that connects to the pit is a schisis-like separation of the inner retinal layers. There is also a secondary, outer layer detachment centred on the macula and not connected to the pit.[20,139–142] The mechanism of detachment remains speculative and theories regarding the source of subretinal fluid include communication with the subarachnoid space[135,141] and leakage from either choroidal vessels[143] or vessels within the pit.[137,144] Other observations support the rhegmatogenous theory of liquefied vitreous entering through a small hole in the membrane overlying the pit with associated traction from surrounding attached vitreous.[136,138,143,145,146]

*Surgical treatment*

Although spontaneous macular reattachment has been reported in up to 25% of cases,[138,147–150] most eyes with ONPM have a relatively poor visual prognosis if left untreated.[135–137,147,151,152] Surgical treatment for this condition remains controversial and includes laser photocoagulation only,[135,137,138,145,147,152–154] posterior scleral buckling,[155,156] vitrectomy combined with laser and/or gas injection[152,153,157–161] and pneumatic retinopexy with or without juxtapapillary laser.[20,138,157,162]

Due to the disappointing results of laser photocoagulation alone, investigators have used pneumatic retinopexy to relieve vitreous traction around the break overlying the optic nerve pit[138,145] or displace SRF inferiorly from the macula and enhance the effect of subsequent laser applications.[153,157,162] Clinical examination supported by optical coherence tomography provided evidence that an improvement in central vision coincides with a flattening of the outer layer detachment at the macula.[20,142,157] Early treatment after the onset of the macular detachment is more likely to prevent irreversible changes in the retinal pigment epithelium and sensory retina and improve the prognosis for visual recovery.[151,152,157]

## Conclusion

Pneumatic retinopexy is a relatively simple procedure which can be used for several retinal disorders. It should be performed in carefully selected cases with specific indications in mind and both patient and surgeon alike should be aware of the potential pitfalls and complications arising from it.

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