Pneumatic Retinopexy

By,
Mohamed Hosny El-Bradey, MD,
Professor of Ophthalmology,
Faculty of Medicine, Tanta University.

Ideal intraocular gas

<table>
<thead>
<tr>
<th>Box 104.1 Properties of an ideal intraocular gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Availability</td>
</tr>
<tr>
<td>Readily available</td>
</tr>
<tr>
<td>Cheap/not expensive</td>
</tr>
<tr>
<td>Biocompatibility and safety</td>
</tr>
<tr>
<td>Nontoxic</td>
</tr>
<tr>
<td>Odorless</td>
</tr>
<tr>
<td>Colorless</td>
</tr>
<tr>
<td>Inflammable</td>
</tr>
<tr>
<td>Not cause lens opacity</td>
</tr>
<tr>
<td>Variability in terms of longevity and expansible property</td>
</tr>
<tr>
<td>Water soluble</td>
</tr>
<tr>
<td>Stable when mixed with air</td>
</tr>
</tbody>
</table>
Expansile gas could be used either in pure form or mixed with air and the expansile properties of the gas could be adjusted by mixing the gas with air in different conc.

<table>
<thead>
<tr>
<th>Nonexpansile</th>
<th>Expansile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>Sulphur hexafluoride (SF₆)</td>
</tr>
<tr>
<td>Xenon (Xe)</td>
<td>Perfluorocarbons (C₃F₇)</td>
</tr>
<tr>
<td>Nitrogen (N₂)</td>
<td>Perfluoroethane (C₃F₃)</td>
</tr>
<tr>
<td>Helium (He)</td>
<td>Perfluoropropane (C₃F₆)</td>
</tr>
<tr>
<td>Oxygen (O₂)</td>
<td>Perfluorobutane (C₄F₉)</td>
</tr>
<tr>
<td>Argon (Ar)</td>
<td>Perfluoropentane (C₅F₁₄)</td>
</tr>
<tr>
<td>Krypton (Kr)</td>
<td>Octafluorocyclobutane (C₈F₈)</td>
</tr>
<tr>
<td>Carbon dioxide (CO₂)</td>
<td></td>
</tr>
</tbody>
</table>

Dynamics of expansile gas bubble inside the eye
What we must know about the gas?

- The longevity of the gas inside the eye.
- Expansion ratio in its pure form.
- The nonexpansible concentration.

### Table: Physical properties of common eye gas substitutes

<table>
<thead>
<tr>
<th>Chemical formula</th>
<th>Molecular weight (g/mol)</th>
<th>Reacts</th>
<th>Reacts</th>
<th>Inflammable</th>
<th>Invades</th>
<th>Expansion (times original area)</th>
<th>Time to reach maximum expansion (hours)</th>
<th>Nonexpanding concentration (%)</th>
<th>Retention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ar</td>
<td>--</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>0-1 day</td>
</tr>
<tr>
<td>Oxygen</td>
<td>32</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>1-2 days</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>28</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>3.0</td>
<td>10-12 hours</td>
<td>15</td>
<td>6-8 weeks</td>
</tr>
<tr>
<td>Perfluorocarbon</td>
<td>C,F,</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>3.3</td>
<td>15-30</td>
<td>15-30</td>
<td>6-8 weeks</td>
</tr>
<tr>
<td>Perfluorocarbon</td>
<td>C,F,</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>4.0</td>
<td>15-60</td>
<td>14</td>
<td>6-8 weeks</td>
</tr>
</tbody>
</table>
Other factors determining the longevity of gas

- Lens status.
- Aqueous turnover.
- Presence of vitreous.
- Ocular blood flow.
- Ocular elasticity.

- The life span of SF6 or C3F8 might be more than twice as long in phakic nonvitrectomized eyes than in aphakic vitrectomized eyes.

Intraocular bubble geometry

0.5 to 0.6 of SF6 gives 1.2 cc which supports 3 o'clock hour
This is equal in effect to 0.3 cc of C3F8
Rational for gas choice?

- Air could be used in scleral buckling at end of the surgery, DACE, or to treat fishmouthing. At the end of vitrectomy in selected cases.

- Pure gas (SF6) is used in PR.

- SF6 (20%, 14 days) for cases of RD without PVR.

- C3F8 (14%) in cases with multiple breaks and PVR.

- Slightly expandable gas (25%-30% SF6) in sutureless vitrectomy.
What is PR?

- **Buoyancy:** it pushes the retina against the RPE.

- **Surface tension:** it closes the retinal breaks, preventing liquefied vitreous access to subretinal space. RPE, then, will pump & remove the SRF leading to retinal attachment.

- **Interruption if intraocular currents.**

---

Why PR?

![One Dollar Bill](image)
Basic Indications of PR

- The break (or cluster of breaks) is not larger than one o'clock hour.
- The break is located superiorly between 8 and 4 o'clock.
- There is no PVR greater than grade C1.

PR could manage 40% of primary cases of RD

PR might be good choice as the primary management in the following cases:

- Macular breaks & other posterior retinal breaks.
- Re-detachment after scleral buckling.
- Isolated tear under superior rectus.
- Filtering blebs: If functional bleb is present or if a filtering procedure may be necessary in the future.
- Very thin sclera or very scarred conjunctiva.
Technique of Pneumatic Retinopexy

Cryo versus laser in PR
Indications for cryopexy (one session procedure)

- Media opacities precluding laser.
- Pigment atrophy preventing laser takes.
- Far peripheral tears with no available laser indirect ophthalmoscope.
- Persistent subretinal fluid precluding laser.

Indications for laser (two session procedure)

Excellent drawing is must

- Tear overlying a scleral buckle.
- Recently operated eye (to avoid high pressure from the cryoprobe)
- Very posterior breaks.
- Extensive or large breaks (to minimize retinal pigment epithelial dispersion & morbidity from extensive cryopexy).
- Very high or bullous retina.
Indirect laser Ophthalmoscope

- Photocoagulation could be difficult in partially gas filled eyes as visibility is limited.

- Care should be taken not to over-treat the retina with laser in areas in contact with gas. Without the insulating effect of the liquid vitreous, thermal burn could be excessive, resulting in retinal necrosis and hole formation.

Trans-scleral diode laser Photocoagulation

- Strong, fast chorioretinal adhesion that could be seen clearly with indirect ophthalmoscope.

- It allows treatment of detached retina.

- Treatment could be applied even through a pre-existing buckle.
Multi-center Randomized Controlled Clinical Trial of Scleral Buckling versus Pneumatic Retinopexy

<table>
<thead>
<tr>
<th>Factor</th>
<th>Scleral Buckling</th>
<th>Pneumatic Retinopexy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post operative morbidity</td>
<td>More</td>
<td>Less</td>
</tr>
<tr>
<td>Post op VA in eyes with detached macula &lt; 2 weeks.</td>
<td>56% had VA of 20/50</td>
<td>80% had VA of 20/50 ($P = 0.05$)</td>
</tr>
<tr>
<td>One operation success rate</td>
<td>84%</td>
<td>81% (Non significant)</td>
</tr>
<tr>
<td>Re-operations success rate</td>
<td>98%</td>
<td>99%</td>
</tr>
</tbody>
</table>
### Table: Comparison of Scleral Buckling and Pneumatic Retinopexy

<table>
<thead>
<tr>
<th>Factor</th>
<th>Scleral Buckling</th>
<th>Pneumatic Retinopexy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complications</td>
<td>Same</td>
<td>Same</td>
</tr>
<tr>
<td>Complicated Cataract</td>
<td>4 times more</td>
<td>¼ of that after SB</td>
</tr>
<tr>
<td>New or missed breaks</td>
<td>Less</td>
<td>More</td>
</tr>
<tr>
<td>An open or absent posterior capsule</td>
<td>Low one operation success rate</td>
<td>Same</td>
</tr>
<tr>
<td>PVR</td>
<td>5%</td>
<td>3%</td>
</tr>
</tbody>
</table>

### Case exclusion criteria according to multi-center clinical trial

**Exclusion factors**

- **Ocular**
- **Physician**
- **Patient**
Ocular factors

- Breaks larger than one clock hour or multiple breaks extending more than one clock hour.
- Breaks in the inferior four clock hours of the retina.
- Presence of PVR >C1 or D or tears adjacent to star fold.
- Severe controlled glaucoma.
- Fresh wounds or unstable IOLs.
- Cloudy media.
- Inability to find the retinal break.

Physician factors

- Limited experience with indirect ophthalmoscope.
- Inability of the surgeon to manage potential retinal complications.
Patient factors

- Necessity for the patients to fly or visit an area with a rise in attitude above 4000 feet while gas bubble is present.
- Physical or mental problems preventing adequate positioning (severe arteritis patients, patients with CHF & COPD might not be able to assume position needed to close 3 & 9 breaks).

Factors decreasing the high success rate of PR

- Pseudophakia.
- Multiple retinal breaks.
- Detachment more than 20 o’clock hours.
- Extensive lattice degeneration.
Pneumatic Retinopexy complications

Anterior hyaloid gas

(Sausage sign, donut sign)

Small: Nothing is done.
Large: 24 h face down.
Jeopardized macula: Aspiration & reinjection.
Subretinal gas

1- if small: leave it.
2- if large: use scleral depressor, trans-scleral syringe, or TPPV.

Other complications

Gas in the anterior chamber: usually in aphakic eyes & might cause pupillary block:
- Dilate the pupil.
- Face down.
- Constrict the pupil.
Post-operative complications

- New breaks.
- Endophthalmitis: not reported after iodine use.
- CRAO.
- PVR in 3%.
- Cataract (feathery cataract).

Post-operative care
Post-operative positioning

- After the procedure, the patient is instructed to position the head so that the retinal break is uppermost for at least 16 hours a day for 5 days. (This must be shown to the patient relatives by the physician).

- Never to lie on the back with face toward the ceiling.
The steamroller technique (prevents macular detachment & macular fold). Indications: RD reaching the arcades especially in bullous RD or inf break in attached retina. (N.B: Some don’t recommend cryo with this technique).

Post-operative medication

- Topical antibiotics & prednisolone acetate 4 times daily for 10 days.
- Full activity could be resumed after 2 weeks.
- No air travel or high attitude climbing more than 4000 feet until gas is absorbed.
- No nitrous oxide use if the patient will have GA.
Antiglaucoma medication

Late rise of IOP due to gas expansion has not been reported. This is because the gas bubble acts as internal tonography and eyes with normal outflow facility compensate well.

Eyes with compromised outflow facility, are treated with carbonic anhydrase inhibitors for few days following the procedure.

Post-operative examination schedule

- **Daily examination:** until the macula is attached.
- **Weekly** for 2 weeks.
- **Monthly** for 3 months.

When the retina is completely attached, I apply light laser burn from the posterior margin of the vitreous base to the ora serrata in the area previously detached and not previously treated by cryopexy. (This raises the success rate to 97% in phakic group and to 87% in pseudophakic group)
NB

- Sometimes thick turbid SRF persists inferiorly and may take several weeks to resorb. As long as the macula is attached, these are managed conservatively.

- In some cases isolated pockets of SRF in the midperiphery linger for weeks. These eyes should also be managed conservatively; the fluid eventually resorbs.

Failed PR (Re-detachment)

- RD while gas is still inside the eye: try to new break in the upper 2/3 of the fundus: patient is repositioned to close the new break.

- If the bubble has absorbed or not large enough: PR is repeated.

- If the breaks occur inferiorly: Scleral buckling or vitrectomy is performed.
Why PR should be the 1st choice?

- Least morbidity.
- Best VA.
- PR doesn’t change the shape of the eye.
- PR doesn’t interfere with EOM.
- Sight also returns more quickly allowing patient to return work rapidly.
- Office procedure.
- Less costly.
- If failed, nothing is lost.

Selective types of PR
Multiple sessions PR to treat multiple breaks. Here, we support superior breaks first and continue downwards.
Inverted PR for lower tears

Is it possible in Egypt ????
Why PR is not popular?

- Surgeon’s inexperience.
- Surgeon’s bad experience.
- Poor case selection or poor surgical technique.
- Unwillingness to change if another procedure works.
- It requires more pre and post operative time.
- It requires more patient cooperation.
- It requires close follow up.
Conclusion

**Pneumatic retinopexy** is a very reasonable procedure. It is worthy to try it as a primary management of RD when indicated.

Thanks to these people

- Ohm, 1911: IV air.
- Rosengreen, 1938: IV air & SRF drainage.
- Norton, 1973: SF6 with buckling & TPPV.
- Dominiguez, Hilton, & Grizzard, 1985: PR in AAO.