Lesson of the week

Nitrous oxide anaesthesia in the presence of intraocular gas can cause irreversible blindness

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Nitrous oxide inhalation during anaesthesia is contraindicated in patients with intraocular gas

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Retinal detachment arising from a retinal break occurs in about 1 person per 10 000 per year.¹ Spontaneous retinal reattachment is rare, and retinal reattachment surgery is required to prevent irreversible total loss of vision. Modern vitreoretinal techniques often use intraocular gases as tamponading agents. These gases may persist in the eye for up to three months after surgery. During this period further anaesthesia using nitrous oxide will cause the intraocular gas bubble to expand,²⁻⁵ which can result in sight threatening increases in intraocular pressure. We present a case in which this occurred with devastating consequences.

Case report

A 71 year old man presented to his local ophthalmology unit with a two month history of poor vision in the left eye. He was found to have a vitreous haemorrhage in this eye and was followed up with serial ultrasound scans. He subsequently developed a left retinal detachment and was referred to the vitreoretinal unit for surgery. On presentation at the unit his best corrected visual acuity was 6/12 in the right eye and 2/60 in the left. He also had glaucoma and used two topical ocular antihypertensive medications. He underwent a vitrectomy procedure with retinal cryotherapy to create an adhesive chorioretinal scar around the retinal break. A mixture of 86% purified air and 14% perfluoropropane gas was injected into the vitreous cavity as a tamponade. On the first day after operation he fully recovered from the general anaesthetic and could micturate voluntarily. He could see hand movements with his left eye, the retina was attached, and about 80% of his vitreous cavity volume was filled with the gas mixture. Intraocular pressure in the left eye was raised. Topical and systemic ocular antihypertensive agents were prescribed and he was discharged. He was told that he had gas in his left eye and advised to avoid air travel until the intraocular gas had been completely absorbed.

He presented to his local emergency department the next evening with acute urinary retention and was catheterised and admitted to a urological ward. After an unsuccessful trial without a catheter a transurethral resection of his prostate gland was arranged. Before operation he was reviewed at the local ophthalmology unit and found to be able to see hand movements with

the retina attached. The vitreous cavity was about 60% full of gas, and his intraocular pressure was still raised at 40 mm Hg. Another topical ocular antihypertensive drug was added. The history of glaucoma and his recent eye surgery, but not the presence of intraocular gas, were noted in the anaesthetic assessment chart. He underwent surgery under general anaesthesia with oxygen in nitrous oxide. The procedure lasted two hours. The next day he reported that he had had intense pain in his left eye while recovering from the anaesthetic and he had complete loss of vision in his left eye. An urgent ophthalmological opinion was sought. He had no light perception in his left eye; the pupil was mid-dilated and non-reactive; and the intraocular pressure was 31 mm Hg.

The patient was reviewed at the vitreoretinal unit a week after his prostate surgery. The vitreous cavity was 50% full of gas, and the retinal vasculature was attenuated. Three months after the retinal surgery the vision remained at "no light perception" and the optic disc was pale.

Comment

Retinal reattachment surgery involves creating a chorioretinal scar and maintaining the neuroretina in apposition to the retinal pigment epithelium until the scar becomes adherent, sealing the offending retinal break(s). To maintain apposition of the neuroretina to the retinal pigment epithelium, tamponade, whether intraocular or extraocular, is used. Various long acting inert gases, such as sulphur hexafluoride or perfluoropropane, can be used as intraocular tamponading agents.⁶

The kinetics of intraocular gases are similar to those of gases in any enclosed body cavity. When a bubble of tamponading gas is injected into the vitreous cavity nitrogen from the bloodstream will enter the gas bubble, causing it to expand. The solubility of nitrous oxide is 34 times that of nitrogen.² If nitrous oxide is present in the bloodstream it will rapidly enter the bubble, causing expansion and a dramatic increase in intraocular pressure.^{2,3} Nitrous oxide also rapidly leaves the bloodstream and gas bubble once inhalation is terminated,⁴ restoring the intraocular pressure.

In this patient the nitrous oxide used for anaesthesia during his prostate surgery caused the intraocular

gas bubble to expand, resulting in a sudden increase in the intraocular pressure, beyond the perfusion pressure of the central retinal artery (60-70 mm Hg). The lens-iris diaphragm was displaced anteriorly by the expanding bubble causing closure of the trabecular angle, which in turn exacerbated the raised intraocular pressure. At this point blood flow to the retinal and optic nerve head ceased. Experimentally, occlusion of the central retinal artery for more than 105 minutes causes irreparable ischaemic retinal damage.⁷ After the two hour procedure nitrous oxide inhalation was stopped. As the nitrous oxide left the gas bubble and was rapidly expired the intraocular pressure decreased. None of the other anaesthetic agents used were known to cause any significant increase in intraocular pressure. The Valsalva manoeuvre in coughing or straining causes only a small transient increase in intraocular pressure.

Two other reports exist of nitrous oxide anaesthesia being used in patients with intraocular gas in a closed eye.⁵ In both cases raised intraocular pressure was noted and nitrous oxide inhalation was discontinued. In one case the optic nerve was noted to be pale intraoperatively.⁵ Transient occlusion of the central retinal artery and pupillary block have been reported after experimental rapid expansion of an intraocular gas bubble.⁸

In England about 8000 retinal surgical procedures are performed each year.⁹ After such surgery intraocular gas, if used, can persist for up to three months (figure). During the period while the intraocular gas is present, if the patient needs surgery, nitrous oxide must not be used in the anaesthesia. To avoid iatrogenic irreversible blindness, all anaesthetists and surgeons, ophthalmic or otherwise, should be aware of the complications of nitrous oxide inhalation in the presence of intraocular gas or gases in other body cavities. Ophthalmic surgeons should also inform patients that if they need anaesthesia nitrous oxide should not be used. Furthermore, we suggest that such patients should carry cards giving details of possible complications of intraocular gas.

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Appearance on pen torch examination of gas-fluid meniscus in an eye with the vitreous cavity about 50% full of gas

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One hundred years ago

The physiology of the holiday

Now that the holiday time has come, we may do well to consider what is the active principle of a holiday, and the reason of its influence. The ordinary explanations of the holiday cure are very vague. For instance, we attribute our improvement to fresh air, but there is no evidence that the chemical results of country air inside us can withstand an hour's exposure to the air of London. We say that the change has done us good, but we should be hard put to it to define our meaning, or to draw the line between change and the memory of change. We are sure that our holiday has somehow refreshed us, though we may feel just as tired immediately after it as we did before. It is difficult, therefore, to explain the action of holidays; we can only observe that they fail to act on those who do not need them and on those who do not know how to take them, and are content to resume wherever they go the habits and the modes of city life.

Perhaps the closest analogy to the holiday influence is to be found in the restorative power of sleep, for there are many resemblances between the two processes. Concerning sleep, much has been written in vain. It has been described in terms of human physiology, as though vegetables did not also sleep, and wake, and sleep again; and, for all we know to the contrary, there may be a nocturnal state, akin to sleep, through the whole inorganic world. And a holiday, like sleep, is a reversion, a periodical phase or instinct in man; there is a sense of going back to that passive state which is one of the oldest and most constant facts of our nature. It is not the mere absence of work, but the positive satisfaction of existence without work that makes a holiday; it is the exercise of the aboriginal faculty for passive idleness, which has not been exercised for a year; for the faculties of the holiday life are just the difficulties of the working life. (BMJ 1902;ii:471)