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Subretinal air migration after pars plana vitrectomy and air tamponade for rhegmatogenous retinal detachment

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1. Introduction

Subretinal gas has been reported as a complication of pneumatic retinopexy for the treatment of rhegmatogenous retinal detachment (RRD).[1] McDonald et al. (1987) reported seven cases of subretinal gas after pneumatic retinopexy and concluded that the presence of multiple intravitreous gas bubbles is a risk factor for subretinal gas and that once identified, it should be managed by appropriate head positioning to avoid redetachment and reoperation.[1] However, massive subretinal air migration after pars plana vitrectomy (PPV) is a rare complication. We found only one case report in PubMed about subretinal gas or air as a complication after PPV; it was likely due to improper injection of additional gas into the subretinal space when correcting hypotony at the final phase of surgery.[2]

We hereby report three cases with subretinal air after PPV plus air tamponade for RRD. This case report informs clinicians of possible subretinal gas migration, even after an initially successful PPV without post-operative complications. We infer that short-term face-down positioning and involuntary eye movement contributed to subretinal gas migration.

2. Case report

2.1. Case 1

A 47-year-old woman underwent PPV plus air tamponade for RRD due to a horseshoe tear in the upper temporal quadrant of her right eye (Fig. 1A). Posterior vitreous detachment (PVD) was present. She underwent PPV with no intra-operative complications and was instructed to maintain a face-down position for an hour after the operation, but was allowed free positioning after that. Examination performed the next day showed reattachment of the retina, with intravitreous air remaining at approximately 70%. However, on post-operative day 5 (POD5), subretinal air appeared as a glistening, dome-like structure beneath the retina (Fig. 1B). Vitreous air remained at approximately 30%. Three days later, persistent retinal detachment was seen. It was secondary to subretinal air, which presumably held the original tear open to lead subretinal fluid beneath the retina (Fig. 1C). The patient received additional sulfur hexafluoride gas injection that eventually allowed the subretinal air and fluid to exit through the retinal break into the vitreous cavity. On POD10, reattachment was verified and laser photocoagulation was performed. The retina flattened without further complications (Fig. 1D). The patient's visual acuity improved from 0.02 (using decimal chart) at the initial visit to 0.6, six months after surgery.

2.2. Case 2

A 47-year-old woman underwent PPV plus air tamponade for RRD due to multiple retinal holes within a lattice degeneration in the upper nasal quadrant of her right eye (Fig. 2A). Fundoscopic examination revealed the presence of a PVD before surgery. After a night of head-down position after surgery, the patient was allowed free positioning. The next day, reattachment was achieved, with air occupying 70% of the vitreous cavity. Subretinal air was identified on POD2 when half of the air was absorbed (Fig. 2B). Persistent detachment was noted on POD5, which required a second vitrectomy (Fig. 2C), resulting in retinal reattachment (Fig. 2D). Subsequently, the patient developed secondary epiretinal membrane and cataract three months after the initial surgery that required combined PPV plus cataract extraction with intraocular lens implantation. Four months after the combined surgery, the patient's visual acuity was at 1.0.

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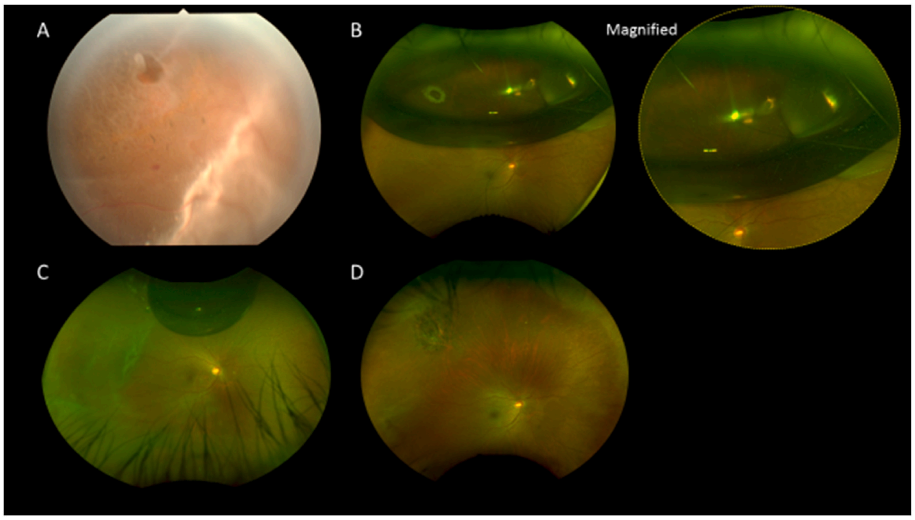

Fig. 1. Case1: A 47-year-old female. A: RRD due to a small horseshoe tear in the upper hemisphere. B: Subretinal air identified on postoperative day 5 in the upper nasal area. Magnified image shown on the right panel. C: Re-detachment on postoperative day8. D: Flat retina 10 months after initial operation.

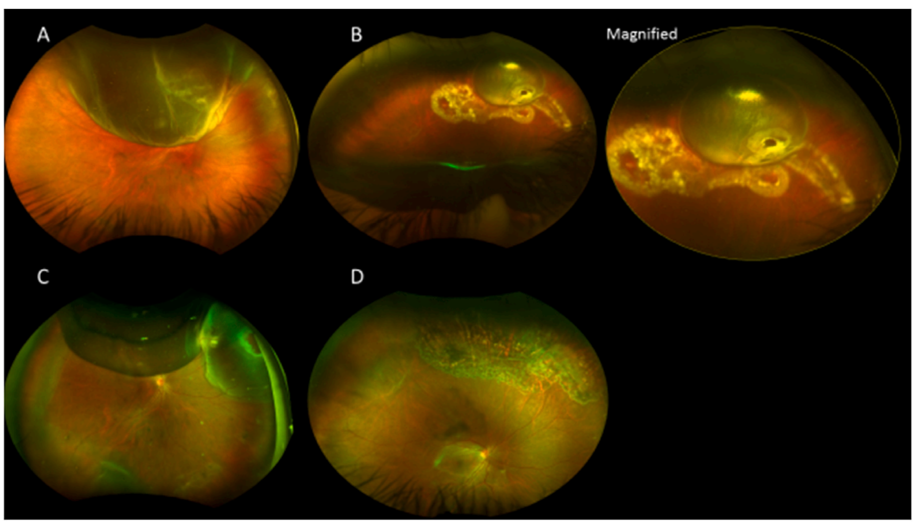

Fig. 2. Case2: 47-year-old female. A: RRD due to a hole within a lattice degeneration in the upper nasal quadrant of her right eye. B: Subretinal air noted on day 3. Magnified image shown on the right panel. C: Redetachment on day 5 when a large percentage of vitreous air was absorbed. D: Flat retina observed 2.5 months after initial operation.

2.3. Case 3

A 73-year-old woman underwent PPV plus air tamponade for RRD due to a horseshoe tear in the upper nasal quadrant of her left eye (Fig. 3A). PVD was present. After an hour of head-down position post-operatively, the patient was allowed free positioning. Successful reattachment of the retina was confirmed on the following day. When she presented to the outpatient clinic for checkup on POD5, air in the vitreous cavity was at 50%, and a small amount of subretinal air was noted (Fig. 3B). As the amount of migrated air was minimal, no further intervention was performed. There was no subretinal fluid or air noted on examination after a week (Fig. 3C). Two months later, her visual acuity was 1.0.

Surgical procedures in all three cases were performed by an experienced surgeon. The surgeon performed 272 cases of PPV for RRD from May 2017 to March 2019, the period where all three cases of subretinal air migration were observed. Patients underwent a standard 25-gauge PPV with drainage of subretinal fluid through the primary break using perfluorocarbon liquid, endolaser photocoagulation, and fluid-air exchange under local anesthesia. The operation times in the three cases were 30, 41, and 38 minutes, respectively. In case 2, several lattice degenerations were present, and a thorough vitrectomy of the area resulted in some iatrogenic breaks, which were sealed successfully. In cases 2 and 3, sutures were placed at the sclerotomy sites for complete closure, and intraocular pressure was adjusted by an additional injection of air through a 30-gauge needle via the pars plana. In case 3, a combined cataract surgery was performed. Cataract was extracted by phacoemulsification before trochar insertion, and the intraocular lens was inserted after vitrectomy before the fluid-air exchange procedure.

3. Discussion

It was assumed that subretinal gas migration after pneumatic retinopexy was related to the presence of multiple gas bubbles in the vitreous and that such complications were unlikely to occur when the retinal break is one clock-hour or less in size.[1] We observed that no bubbles were detected at any post-surgical examination; thus, subretinal gas post-PPV is not a likely result of gas bubbles. As seen in the figures,

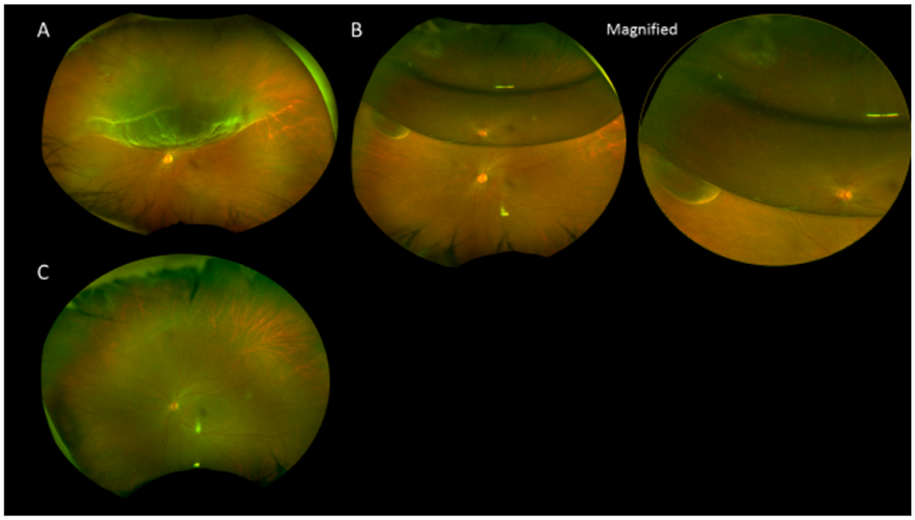

Fig. 3. Case3: 73-year-old female. A: RRD due to a horseshoe tear in the upper nasal quadrant of her left eye. B: Subretinal air noticed on 5. Magnified image shown on the right panel. C: Subretinal air was absorbed on day 12.

retinal break size was not a factor in this case series. A recent report described a case of subretinal gas noted on the day following PPV for RRD.[2] The authors found out that subretinal gas was a result of improper injection of additional gas into the subretinal space when correcting hypotony at the final phase of surgery. However, this could not be the cause in this case series because the flat retina was maintained in the early post-operative period. Air migration was not seen initially but was found several days after surgery. Instead, we think that there are several possible factors related to the current cases, as follows:

These are the possible mechanisms of retinal air migration in the cases presented herein. Assuming vitreoretinal traction had been sufficiently removed during surgery, (thus the confirmed flat retina on post-operative day 1) for any matter to enter the subretinal space, the retinal break must be exposed first to fluid. Adequate adhesion of retinal tears does not develop until a week after photocoagulation; hence, direct contact with fluid opens the break that allows some of the fluid through the break into the subretinal space. It is considered as a subclinical redetachment at this point. When the break slips back into the gas phase again, a portion of air is forced to squeeze its way through the open break into the subretinal space, replacing most of the subretinal fluid. Consequently, the more the breaks, the higher the possibility of its occurrence. The most likely cause of the retinal break plunging into the water phase and back to the air phase is postural change or eye movement. Although it is unlikely for breaks in the peripheral areas in the upper hemisphere of the globe to contact fluid when more than half of the vitreous chamber is occupied with air, it may occur during sleep. Bell's phenomenon may result in the exposure of breaks to intravitreal fluid when in supine position while asleep. In addition, there are discussions concerning the purpose of eyeball movement during rapid eye movement (REM) sleep, one of which is to stir aqueous humor to avoid the risk of corneal anoxia.[3,4] If REM sleep can mix anterior chamber fluid, why not the posterior chamber fluid, i.e. the vitreous fluid?

Notably, the breaks were in the superior region of the sphere in all cases. Subretinal air after PPV is believed to develop only when the break is in the upper hemisphere of the retina, when vitreous air is absorbed to the extent that both fluid and air can touch the break with slight changes in head or eye position, and not in inferior areas where the subretinal fluid does not have a chance to be replaced by air.

In our practice, we instruct the face-down position, but the duration is determined on a case-by-case basis. Several recent studies question the necessity of strict prone positioning after RRD operation, especially in eyes with inferior retinal breaks.[5–8] All three patients in this study were instructed to maintain a minimal face-down position. Prolonged prone positioning or other postures such as lateral or sitting position may have prevented the exposure of breaks to intravitreal fluid, thus lowering the risk of subretinal air migration.

Once this complication is recognized, proper management is required. A minimal amount of subretinal air can be absorbed over time without any intervention, as in case 3. On the other hand, a certain amount of air may exit the subretinal space and join the remaining intravitreal air in accordance with surface tension in the natural course, or if vitreous air is not abundant enough to contact subretinal air through the break, additional air or gas injection can be effective, as in case 1. However, large air migration can directly lead to retinal redetachment, notably when most of the vitreous air has been absorbed and a large portion of the vitreous cavity is in the water phase, and when more than one break is present, as in case 2. In such cases, subretinal air holds the break(s) for the vitreous fluid to enter the subretinal space, and subsequent PPV is recommended.

4. Conclusion

Subretinal air is a rare but critical complication of PPV for RRD. Further discussion on possible mechanisms is required, but a likely theory is presented. Management depends on the volume of air that has migrated under the retina and the amount of vitreous air remaining in the vitreous cavity.

References

1. McDonald HR, Abrams GW, Irvine AR, et al. The management of subretinal gas following attempted pneumatic retinal reattachment. *Ophthalmology*. 1987;94(4): 319–326.
2. Seamone ME, Lewis DR, Almeida D, et al. Massive subretinal gas after vitrectomy surgery: mechanism and management. *Retin Cases Brief Rep*. 2019;13(3):266–268.
3. Maurice DM. The Von Sallmann Lecture 1996: an ophthalmological explanation of REM sleep. *Exp Eye Res*. 1998;66(2):139–145.
4. Modarreszadeh S, Abouali O, Ghaffarieh A, Ahmadi G. Physiology of aqueous humor dynamic in the anterior chamber due to rapid eye movement. *Physiol Behav*. 2014; 135:112–118.
5. Martinez-Castillo V, Boixadera A, Verdugo A, Garcia-Arumi J. Pars plana vitrectomy alone for the management of inferior breaks in pseudophakic retinal detachment without facedown position. *Ophthalmology*. 2005;112(7):1222–1226.
6. Chen X, Yan Y, Hong L, Zhu L. A comparison of strict face-down positioning with adjustable positioning after pars plana vitrectomy and gas tamponade for rhegmatogenous retinal detachment. *Retina*. 2015;35(5):892–898.
7. Shiraki N, Sakimoto S, Sakaguchi H, et al. Vitrectomy without prone positioning for rhegmatogenous retinal detachments in eyes with inferior retinal breaks. *PLoS One*. 2018;13(1), e0191531.
8. Otsuka K, Imai H, Miki A, Nakamura M. Impact of postoperative positioning on the outcome of pars plana vitrectomy with gas tamponade for primary rhegmatogenous

retinal detachment: comparison between supine and prone positioning. *Acta Ophthalmol*. 2018;96(2):e189–e194.