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RESPONSE TO LETTER

Comments on: Internal Limiting Membrane Peeling and Gas Tamponade for Full-Thickness Macular Holes of Different Etiology – Is It Still Relevant? [Response to Letter]

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Dear editor

Thank you for your interest in the article and the comments you made regarding our gas tamponade technique. The volume of this article did not allow us to consider in detail the features of gas tamponade and the analysis of postoperative IOP increase, so we will do our best to answer your comments.

Definitely, intraocular gas volume on the first postoperative day is an important indicator of postoperative gas dynamics, because less gas volume would lead to insufficient tamponade to the retina, while excess gas volume may cause optic nerve damage, retinal ischemia, and subsequent visual loss.[1,2] Postsurgical IOP elevation is associated with high gas concentrations, which is determined by the amount, type of injected gas and the vitreous chamber volume (VCV).[3] Therefore, knowledge of the exact volume of the vitreous cavity is extremely important for the prevention of such complications.

The current consensus indeed suggests that the volume of the vitreous ranges about 4 mL, but these figures have been derived from early postmortem studies that determined the VCV in a somewhat biased way due to the use of acidic tissue fixatives and frozen sections. Such measurements of the VCV resulted in the precipitation of glycosaminoglycans and subsequent changes to the vitreous, therefore, imprecise measurement of the eye volume.[4] The modern research convincingly demonstrates that the volume of the vitreous chamber might be greater than previously suspected.

Thus, Zhou et al[5] analyzed the topography of human eyes through volume rendering images by high-resolution 3D-MRI and established a model to estimate the vitreous volume. Logistic regression was used to establish a model to predict this volume. The regression model in the emmetropic group according to the axial length found: Vitreous volume = 458.35 × Axial length - 6331.14 (R2 = 0.360, P = 0.001). According to this formula, the VCV for an eye with axial length 24.4 mm (average value in our series) would be 4852.6 mm^3.

Authors from the Stein Eye Institute (USA) measured the VCV in humans using high-resolution computed tomography (CT) scanning, combined with three-dimensional analysis software.[6] In their sample of 100 eyes, they found the average VCV to be greater than the currently accepted volume of 4 to 4.4 mm3. For eyes with a mean axial length of 24.7 mm, the mean VCV was found to be 4969.0 mm3.

de Santana et al[7] developed an equation for estimating the vitreous chamber volume in 112 pseudophakic patients who underwent vitrectomy surgery for a macular hole or an epiretinal membrane based on the axial length of the eye. This

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model is as close as possible to our study. Their mean (SD; range) axial length was 23.78 mm (0.93; 21.55–25.26), and the mean (SD; range) VCV was 4.96 mL (0.69; 3.60—6.40). The estimated regression equation was, thus, Y = 0.71X − 11.84, where Y was the VCV, X was the axial length of the eye, the linear coefficient for the straight line was −11.83, and the angular coefficient was 0.71 ($p < 0.01$).

Substituting in the formula the data of the mean axial length of 24.4 mm from our study, we obtain the main VCV to be 5.48 mL. This result exactly matches the data of the previous study using MRI, by Xu et al,[8] who found a greater average VC volume of 5.482 ± 0.440 mm3 in their 31 emmetropic adult patients.

Thus, there is a high probability to believe that the average VCV in our group was not 4 mL, but about 5 mL.

In practice, the type and final gas concentration used during vitrectomy for macular hole is at the surgeon's discretion.[9] In our study, we used the modified "sparkling technique", proposed by Didier Ducournau,[10] because it is cost-effective and allows us to achieve a longer effective tamponade (>80% gas volume) of the macular hole. Injection of 1.5 cc pure SF_6 with a 30-gauge needle inserted through the pars plana superiorly was done with the second needle used for venting. The difference from the original method is that we inject gas after a complete fluid-gas exchange.

Simple calculations of the gas dynamics (air and SF_6) show that on the first day postoperatively, the amount of SF_6 will double, while about 2 mL of air will remain, which will come to a total of 5.0 mL. Considering the calculated average VCV in our group was 4.9–5.5 mL, this avoids a significant increase in IOP on the first day postoperatively, despite the resulting SF_6 concentration being 30%.

Of course, in cases with a smaller VCV (short axial length, especially in phakic eyes), an increase in IOP on the first postoperative day will be expected, which we observed in four of our cases 4/38 (10.5%) (2 phakic eyes and 2 pseudophakic ones with an axial length <23.5 mm).

A slightly expansile concentration of 25% SF_6 can be used safely and beneficially in 25-gauge pars plana vitrectomy to increase the amount of gas fill in the vitreous cavity and to prevent postoperative hypotony and its related complications.[11]

Interestingly, Kannan et al[12] conducted a retrospective study of 76 eyes with idiopathic macular holes that underwent 23-gauge pars plana vitrectomy with 2 cc pure SF_6 gas tamponade. A closure rate of 100% was achieved with reoperation in 4 eyes. Surprisingly, a gas bubble size of 73% obtained on the first postoperative day in this study is lower than the 83.8% reported by Kusuhara et al[1] with 25% SF_6. Postoperative elevation in IOP (≥30 mmHg) was documented in only 3 eyes (4%), which is significantly less than in our study (10.5%)[13] and the study by Wong et al (20.4%).[14]

Indeed, we cannot always accurately predict the behavior of the gas in the eye because clinically, the dynamics of the gas tamponade may differ from a theoretical model. Thus, eyes treated with 23/25-gauge transconjunctival vitrectomy tend to have earlier gas disappearance or incomplete gas fill as a result of postoperative gas leakage through unsutured sclerotomis.[15] Also, an indefinite amount of gas can exit through the second needle or cannula when it is injected.

Without a doubt, when using pure SF_6 or another gas, a volume must be chosen so that subsequent expansion of the gas does not result in a dangerous elevation of IOP.[16] Measurement of the axial length could be recommended for the estimation of the vitreous volume during vitrectomy, if gas tamponade is needed.

In conclusion, we would like to once again thank you for the very important questions raised, and we hope our response could answer some of the concerns in question.

Disclosure

The authors report no conflicts of interest in this communication.

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