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Research Article

Cystoid Macular Oedema Following Macular Hole Repair Surgery Using SF_6 vs. C_3F_8 Gas: A Case Comparison Study

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Received: March 04, 2019; **Published:** July 29, 2019

Abstract

Aim: To compare the outcomes of macular hole surgery using sulfur hexafluoride (SF_6) gas versus octafluoropropane (C_3F_8) for idiopathic macular hole repair.

Methods: A retrospective study of ten eyes of ten patients undergoing macular hole surgery with SF_6 were compared with another consecutive group of 10 eyes (10 patients) in whom C_3F_8 was used.

Optical coherence tomography documentation of anatomical closure and complications of surgery were recorded.

Results: All 20 eyes had successful closure of macular hole. 6 of 20 eyes (30%) developed cystoid macular oedema (CME) postoperatively. Of the eyes with SF_6 tamponade, five (50%) had cystoid macular oedema. In the C_3F_8 group, 1 eye (10%) had cystoid macular edema (Chi-square; p-value = 0.025).

Combined cataract surgery and vitrectomy was performed in 15 cases. There was no statistically significant correlation between cataract surgery and CME (Fisher test; p = 0.14).

Conclusion: In macular hole surgery with SF_6 gas tamponade there is potentially a higher risk of post-operative CME compared to C_3F_8.

Keywords: *Cystoid Macular Edema; Full Thickness Macular Hole; Intraocular Gases; OCT; Gas*

Introduction

Macular hole surgery (MHS) typically involves pars plana vitrectomy, internal limiting membrane (ILM) peeling along with internal gas tamponade [1]. A range of gas types and mixtures and various positioning regimens have been reported with good success. A higher success rate for IMHs with longer lasting mixtures compared with shorter lasting mixtures of perfluoropropane (C_3F_8) has also been reported [2]. The use of the shorter duration gas, sulfur hexafluoride (SF_6) has also been reported with good success [3,4]. Currently, SF_6 is used by approximately one third of surgeons [5]. Longer lasting gas such as C_3F_8 offers more extensive tamponade, but impairs vision for longer, with significant implications for patients' everyday activities for as long as 8 weeks.

Purpose of the Study

The purpose of this study was to evaluate the occurrence of cystoid macular edema following macular hole surgery using SF_6 gas tamponade compared to C_3F_8 gas tamponade.

Methods

A retrospective case comparison study was performed. We studied 20 consecutive eyes (19 patients) that were diagnosed with a stage 2 IMH, between December 2012 and July 2013. Surgery was performed by an expert surgeon RW. Patients with stage II IMHs and no other ocular morbidity were included. We excluded patients who had previous IMH surgery and patients who were diagnosed with diabetes. The study complied with the Declaration of Helsinki. Institutional ethics approval was obtained.

The visual acuity, intraocular pressure, biomicroscopy of the anterior segment and indirect noncontact biomicroscopy of the fundus were conducted preoperatively. The grade and diagnosis of IMHs was confirmed using spectral-domain OCT. Spectral-domain optical coherence tomographic scans were taken using the Topcon 3D OCT 2000 (Topcon, Tokyo, Japan). The 3D macula protocol was used for all scans, which generate 5 to 6 mm of longitudinal resolution and 20 mm of horizontal resolutions at 18,000 axial scans per second in a 6 x 6 mm grid (512 x 128 pixel resolution). Macular hole size was measured as the maximum 'aperture diameter' of the macular holes as previously described [6].

The potential benefits and risks of surgery were explained to the patients and informed consent was obtained from all patients.

All patients underwent standard 23 gauge three-port pars plana vitrectomy. ILM peeling was performed using Brilliant Blue dye (DORC). Exchange of fluid-air was conducted and 30% SF_6 or 16% C_3F_8 gas was injected. Ten eyes were treated with SF_6 injection and ten with C_3F_8 injection.

Patient follow-up was on day 1, 8 weeks, and 32 weeks postoperatively. BCVA, and intraocular pressure were measured and indirect non-contact biomicroscopy examination was conducted. We also assessed the macula using OCT at week 8 and 32 after surgery.

To compare the frequency of cystoid macular oedema in the two different groups we used the Chi-square test. The p-value was considered statistically significant if $p \leq 0.05$. Student t test was used to compare BCVA in the different groups.

Snellen VA was converted to logMAR (Minimum Angle of Resolution) scores using methods previously described by Avery., *et al* [7].

Results

Of the patients who participated in this study ten were female (50%). Mean age was 72.9 (SD ± 7.1) years of age.

The pre-operative, 8 week and 32 week BCVA showed no statistical significance between the SF_6 and C_3F_8 groups (Table 1).

	C3F8*		SF6†		P (t-student)
	Mean BCVA‡	SD**	Mean BCVA	SD	
Preopoperative	0.78	0.14	0.78	0.40	0.98
8 weeks Postopoperative	0.81	0.83	0.51	0.17	0.40
32 weeks Postoperative	0.29	0.25	0.27	0.22	0.85

Table 1: *Best corrected visual acuity (BCVA) before and after macular hole surgery.*
**: Octafluoropropane; †: Sulfur Hexafluoride; ‡: Best Corrected Visual Acuity; **: Standard Deviation.*

There was statistical significance difference between preoperative and 32 weeks postoperative BCVA ($p < 0.0001$).

The mean preoperative macular holes size was 246.0 µm (SD ± 82.26) in both groups, 303,7 (SD ± 56.61) in the C_3F_8 group and 196.1 (SD ± 67.92) respectively.

All 20 eyes had successful closure of macular hole at 8 and 32 weeks post op. However, 6 of 20 eyes (30%) developed cystoid macular oedema (CME) postoperatively. Of the eyes with SF_6 tamponade, five (50%) developed cystoid macular oedema. One eye (10%) had CME 8 weeks postoperatively which resolved with an intravitreal triamcinolone injection. One eye (10%) developed subretinal fluid (SRF) on week 8 which resolved spontaneously at 32 weeks and other the 2 eyes (10%) had persistent SRF 32 weeks postoperatively. Furthermore, one eye (5%) had CME 16 weeks after surgery but resolved at 32 weeks (Table 2).

Age	Sex	Eye	Hole size	Preop VA	PHACO	GAS	CMO*	CMO resolution†
72	F	RE	327	6/24	Yes	C_3F_8	2 months	6 months
81	F	LE	290	6/60	No	C_3F_8		
78	F	LE	179	6/48	No	C_3F_8		
89	F	LE	387	6/38	No	C_3F_8		
82	M	RE	289	6/30	Yes	C_3F_8		
67	F	LE	198	6/30	Yes	C_3F_8		
74	M	LE	327	6/24	Yes	C_3F_8		
68	F	LE	311	6/36	Yes	C_3F_8		
79	M	LE	295	6/36	Yes	C_3F_8		
78	M	RE	319	6/60	Yes	C_3F_8		
72	F	LE	312	6/30	Yes	SF_6	2 months	6 months‡
79	M	RE	295	6/60	Yes	SF_6	2 months	4 months
73	M	LE	100	6/9	No	SF_6		
69	M	LE	205	6/36	Yes	SF_6	2 months	6 months
76	M	RE	235	6/24	Yes	SF_6		
56	F	LE	177	6/48	no	SF_6		
69	M	LE	120	6/18	Yes	SF_6	4 months	No
72	F	LE	200	6/60	Yes	SF_6		
68	F	RE	254	6/24	Yes	SF_6	6 months	No
77	M	RE	201	6/48	Yes	SF_6		

Table 2: *Patients characteristics.*

**: Time of Postsurgical CME Appearance; †: Time of Postsurgical CME Disappearance; ‡: Triamcinolone Intravitreal Injection.*

Combined cataract surgery and vitrectomy was performed in 15 cases. Eight patients in the SF_6 group and 7 patients in the C_3F_8 group had combined surgery. Among these patients, 5 in the SF_6 group and 1 patient in the C_3F_8 group developed CME. There was no statistically significant correlation between cataract surgery and CME (Fisher test; p= 0.14).

In the C_3F_8 group, 1 eye (10%) had cystoid macular oedema 8 weeks postoperatively, which resolved spontaneously by 16 weeks. There was statistically significant difference in the macular oedema incidence between the two groups (Chi-square; p-value = 0.025).

Discussion

Gas tamponade is hypothesised to enhance macular hole closure after removal of tangential force due its surface tension properties which excludes vitreous fluid from the subretinal space [8]. Gas tamponade may also promote inner retinal cell migration [9]. ILM peeling promotes the rate of macular hole closure [10,11] possibly by removing traction and stimulating gliosis [9].

Although the majority of vitreo-retinal surgeons use C_3F_8, approximately a third report using SF_6 [5]. Others have combined shorter duration of gas with little or no face-down positioning [8,12-21]. Advantages of SF_6 include earlier confirmation of closure due to the faster resorption of gas compared to C_3F_8 and C_2F_6.

In the current study, we found a statistically significant difference in the development of macular oedema or subretinal fluid between the SF_6 and C_3F_8 groups ($p = 0.025$).

As in our study, Mulhern., *et al.* found a better anatomical success with C_3F_8 compared with SF_6 in gas tamponade [22]. Brooks had a small subset of SF_6 eyes and found a tendency for reduced closure rate with SF_6 compared with C_3F_8 [23]. There was no reported incidence of CME in either paper.

Kim., *et al.* found no difference between C_3F_8 or SF_6 gas on the macular holes closure rate after primary surgery [24]. Although, in their report, the majority of macular holes treated with C_3F_8 were stage 3 holes whilst those treated with SF_6 were stage 2. Therefore, the cases are difficult to compare and the true efficacy of the type of gas tamponade difficult to elucidate.

The presence of fluid within or under the retina following macular hole repair may be due to the incomplete closure of the hole where the RPE has not fully reabsorbed the fluid. Over time, some residual swelling resolves spontaneously.

Another theory for the presence of CME is inflammation. Cystoid macular oedema secondary to inflammation following cataract surgery is a well-known phenomenon [25]. In our study, 15 patients had combined cataract and vitreous surgery potentially increasing the risk of postoperative inflammatory induced CME. However, we did not detect any inflammation on biomicroscopy at 8 or 32 weeks associated with patients who developed CME. There was also no statistically significant correlation between combined cataract and vitrectomy surgery and CME ($p = 0.14$).

Closure of the macular hole requires the formation of a stable chorio-retinal adhesion between the edges of the neurosensory retina and retinal pigment epithelium. The adhesion must include all edges of the macular hole or the cuff of subretinal fluid may reaccumulate around the macular hole after the gas bubble has reabsorbed. Variability in the rate, completeness, and strength of chorioretinal adhesion may explain why some eyes require the longer duration gas tamponade with C_3F_8.

Thompson., *et al.* suggests three possible ways the long-acting gas bubble may work to enhance the success rate of macular hole repair [2]. He states that a stable adhesion between the retina and retinal pigment epithelium may require a relatively longer time to form in some eyes. The results from our study support this hypothesis.

The limitations of the current study include its retrospective design, the lack of randomisation, and the limited number of cases. However, the homogeneous nature of the studied patients allows us to conclude that our results are suggestive on differential CME rates between eyes receiving SF_6 gas and eyes receiving C_3F_8 gas tamponade for repair of stage-2 MH.

Conflicts of Interest

No author in this study has property interest.

Bibliography

1. Gass JDM. "Idiopathic senile macular hole. Its early stages and pathogenesis". *Archives of Ophthalmology* 106.5 (1988): 629-639.

2. Thompson JT., *et al*. "Intraocular tamponade duration and success of macular hole surgery". *Retina* 16.5 (1996): 373-382.

3. Kelly NE and Wendel RT. "Vitreous surgery for idiopathic macular holes. Results of a pilot study". *Archives of Ophthalmology* 109.5 (1991): 654-659.

4. Wendel RT., *et al*. "Vitreous surgery for macular holes". *Ophthalmology* 100.11 (1993): 1671-1676.

5. Mittra RA and Pollack JS. "Preferences and trends Membership Survey". Paper presented at: 24th Annual ASRS Meeting and the 6th Annual EVRS Meeting September 9, 2006 Cannes, France (2006).

6. Wong R. "Novel surgical technique for closure of large full-thickness macular holes". *Retina* 33.9 (2013): 1977-1979.

7. Avery RL., *et al*. "Natural history of subfoveal subretinal hemorrhage in age-related macular degeneration". *Retina* 16.3 (1996): 183-189.

8. Tranos PG., *et al*. "Macular hole surgery without prone positioning". *Eye* 21.6 (2007): 802-806.

9. Berger JW and Brucker AJ. "The magnitude of the bubble buoyant pressure: implications for macular hole surgery". *Retina* 18.1 (1998): 84-86.

10. Schubert HD., *et al*. "Macular holes: migratory gaps and vitreous as obstacles to glial closure". *Graefe's Archive for Clinical and Experimental Ophthalmology* 235.8 (1997): 523-529.

11. Smiddy WE., *et al*. "Internal limiting membrane peeling in macular hole surgery". *Ophthalmology* 108.8 (2001): 1471-1476.

12. Haritoglou C., *et al*. "Long-term follow-up after macular hole surgery with internal limiting membrane peeling". *American Journal of Ophthalmology* 134.5 (2002): 661-666.

13. Madgula IM and Costen M. "Functional outcome and patient preferences following combined phaco-vitrectomy for macular hole without prone posturing". *Eye* 22.8 (2008): 1050-1053.

14. Ellis JD., *et al*. "Surgery for full-thickness macular holes with short-duration prone pos- turing: results of a pilot study". *Eye* 14.3 (2000): 307-312.

15. Tornambe PE., *et al*. "Macular hole surgery without face-down positioning. A pilot study". *Retina* 17.3 (1997): 179-185.

16. Krohn J. "Duration of face-down positioning after macular hole surgery: a comparison between 1 week and 3 days". *Acta Ophthalmologica Scandinavica* 83.3 (2005): 289-292.

17. Verma D., *et al*. "Evaluation of posturing in macular hole surgery". *Eye* 16.6 (2002): 701-704.

18. Rubinstein A., *et al*. "Vitrectomy without postoperative posturing for idiopathic macular holes". *Clinical and Experimental Ophthalmology* 35.5 (2007): 458-461.

19. Merkur AB and Tuli R. "Macular hole repair with limited non supine positioning". *Retina* 27.3 (2007): 365-369.

20. Wickens JC and Shah GK. "Outcomes of macular hole surgery and shortened face down positioning". *Retina* 26.8 (2006): 902-904.

21. Spaide RF. "Closure of an outer lamellar macular hole by vitrectomy: hypothesis for one mechanism of macular hole formation". *Retina* 20.6 (2000): 587-590.

22. Mulhern MG., *et al*. "Visual and anatomical success with short-term macular tamponade and autologous platelet concentrate". *Graefe's Archive for Clinical and Experimental Ophthalmology* 238.7 (2000): 577-583.

23. Brooks HL Jr. "Macular hole surgery with and without internal limiting membrane peeling". *Ophthalmology* 107.10 (2000): 1939-1948.

24. Kim SS., *et al*. "Outcomes of sulfur hexafluoride (SF6) versus perfluoropropane (C3F8) gas tamponade for macular hole surgery". *Retina* 28.10 (2008): 1408-1415.

25. Gass JDM and Norton EWD. "Follow-up study of cystoid macular edema following cataract extraction". *Transactions - American Academy of Ophthalmology and Otolaryngology* 73.4 (1969): 665-681.

Volume 10 Issue 8 August 2019