ORIGINAL ARTICLE

Comparison between Efficacy of Sulfur hexafluoride (SF6) Gas Tamponade and Air Tamponade after Pars Plana Vitrectomy in Fresh Rhegmatogenous Retinal Detachment

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Abstract:

Objective: To compare the efficacy of gas (SF6) tamponade vs. filtered air tamponade after PPV "pars plana vitrectomy" in cases of fresh RRD "Rhegmatogenous Retinal detachment", in terms of anatomical attachment of retina and Best Corrected Visual Acuity assessment.

Methodology: A Randomized controlled trial was conducted in Ophthalmology Department Unit-I, Lahore General Hospital, Lahore, from January 2020 to January 2022. Patients of fresh rhegmatogenous retinal detachment fulfilling inclusion criteria were admitted from Eye OPD. Patients were divided into two groups. All the patients were evaluated for anatomical success by dilated fundus examination. SPSS v25.0 was used to analyze the data.

Results: In group A (SF6 gas), the mean value of BCVA post-operative (1 month) was 0.19±0.40 and in group B (filtered air) was 0.22±0.42. In group A (SF6 gas) 24 (88.9%) patients had attached retina after one month of surgery and similarly in group B (filtered air) 24 (88.9%) patients had attached retina after one month of surgery. The results showed that there was no significant difference in both groups. Both the treatment procedures had same efficacy.

Conclusion: Efficacy of gas (SF6) vs. filtered air after PPV "pars plana vitrectomy" in cases of fresh RRD "Rhegmatogenous Retinal detachment" in terms of anatomical attachment of retina and best corrected visual acuity assessment, was same. *Al-Shifa Journal of Ophthalmology 2023; 19(3): 106-114.*

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Introduction:

A rhegmatogenous retinal detachment is caused by a tear in retina that permits fluid from vitreous space to enter sub-retinal space in between the RPE (Retinal Pigment Epithelium) and sensory retina. Vitreous traction usually causes these breaks in retina.[1]

Symptoms of RRD (Rhegmatogenous Retinal Detachment) are flashes of light and floaters that may progress to curtain-like peripheral field defect and then involve central field of vision. Occasionally, the patient may have light flashes that may be triggered by altering the patient's gaze direction.[2]

Risk factors of RRD (Rhegmatogenous Retinal Detachment) are myopia, previous intraocular surgery and trauma[1,2,3] . Scleral buckling and pars plana vitrectomy are commonly used techniques to repair rhegmatogenous retinal detachment.[3] After

PPV, for internal tamponade, silicon oil and long-acting gases (SF6 & C3F8) are commonly used [3,4]. These tamponades provide constant pressure on the retina to reattach retina with underlying RPE. The benefit of silicon oil is that it keeps the tamponade fixed and prevents it from expanding, but the disadvantages include the need for surgical removal, obscured vision, and increased intraocular pressure[5,6] .

While using gases like SF6 "sulfur hexafluoride" and C3F8 "perfluoro propane" in the complete gas fluid exchange, these tamponading agents resorb naturally, over the period of ~2 weeks for 20% SF_6 and ~8 weeks for 14% C_3F_8.[3,5]

Because of their low specific gravities (0.001 g/mL), gases float in the vitreous cavity and have far greater buoyancy "upward force" than silicone oil.[7]

SF6 and C3F8 gases are expansile, they increase IOP and patients require longer prone posturing.[8] Some researchers used filtered air, as an alternative to expansile gases to lessen the vitreous disturbance and the result was acceptable.[9] Air absorbs earlier than SF6 gas, so it causes early visual recovery and less period of posturing with equivalent tamponade. It provides a transparent visual axis and better visual acuity.[10]

Injected filtered air offers a number of benefits over long-acting gases. It saves surgery time and is cost-effective. As far as gases are concerned, these require additional purchasing, storage, and dilution[11,12].

The rationale of this study was to know the effectiveness of the tamponading effect of filtered air in cases of fresh Rhegmatogenous Retinal detachment after Pars plana vitrectomy, so that it can be used as an alternative to SF6 gas, in settings where this gas is not available or affordable. In Pakistan, no clinical trial has yet compared Air and sulfur hexafluoride (SF6) gas and Sulfur hexafluoride (SF6) gas is usually used for the tamponade. As it is expensive, and, in settings where SF6 gas is not available/affordable, such as distant areas, air would be a reasonable substitute.

Materials and Methods:

It was a randomized controlled trial, conducted at Ophthalmology Department Unit -I, Lahore General Hospital, Lahore, from January 2020 to January 2022. Sample size was calculated with 95% confidence level, 80% power of study and mean Best corrected visual acuity i.e 1.38 ± 0.4 with gas and 1.11 ± 0.3 with air (Pak et al., 2017) by using following formula:

$$n = \frac{\left(Z_{1-\beta} + Z_{1-\frac{\alpha}{2}}\right)^2 (\sigma_1^2 + \sigma_2^2)}{(\mu_1 - \mu_2)^2}$$

Non-probability convenience sampling followed by randomization by lottery method was used. After approval from the ethical committee, the data collection was started. Informed consent was taken from patients. After history and visual acuity, complete anterior and posterior segments examination was done on slit lamp. Fundi were examined on slit lamp biomicroscopy with 90 D lens and Indirect biomicroscopy with 20 D lens. Retinal detachment with associated holes/tears was identified and patients were confirmed to have fresh rhegmatogenous retinal detachment.

Patients with age range 20 to 70 years, both males and females, with fresh rhegmatogenous retinal detachment associated with proliferative vitreoretinopathy Grade A and retinal break within the superior 6 clock hours (9 to 3 O'clock) were included in the study.

Patients who refused consent, Rhegmatogenous retinal detachment with pre-existing proliferative vascular retinal disease like diabetic retinopathy, glaucoma, dense cataracts, corneal opacities, those with history of any intraocular surgery except pseudophakic cataract surgery, those with Grade B or C Proliferative vitreoretinopathy, those not fit for proper prone positioning and those with Giant retinal tear were excluded from the study.

Patients fulfilling the inclusion criteria

were admitted through eye OPD. They were divided into 2 groups through lottery method. Group-A patients were planned for PPV with Cryotherapy/Endolaser and 20% SF6 gas was to be injected for internal tamponade. All the patients of Group B were planned for PPV with Cryotherapy/Endolaser and filtered Air was to be injected for internal tamponade.

As far as surgical procedure is concerned, all patients were operated under local anesthesia with or without sedation unless there was a need for general anesthesia due to age or other factors including patient's choice. All patients received a 5 ml peribulbar or retrobulbar bolus injection of a 50-50 mixture of 2% lidocaine and 0.75% bupivacaine. After scrub and drape under full aseptic measures, sclerotomies were created, vitrectomy was done, subretinal fluid was drained, breaks were sealed with endolaser or transconjunctival cryotherapy, Group-A patients were injected with 20% SF6 gas for internal tamponade. All the patients of Group-B were injected with filtered air for internal tamponade.

All the patients were operated by single consultant vitreoretinal surgeon, data was recorded in a pre-designed proforma. All patients were evaluated for anatomical success (by dilated fundus examination using slit lamp biomicroscope with 90 D lens after 1 day, 1 week and 1 month of surgery) and for BCVA after 1 week and 1 month of surgery.

With the help of SPSS 25 v data analysis was performed. For quantitative variables mean and standard deviation was calculated (age, BCVA). Frequencies and percentages were calculated for qualitative variables (gender, re-attachment of retina). The normality of the data was checked by Kolmogorov Smirnov/Shapiro wilk Test. In normal distribution, independent T test was applied for comparison between groups. P value ≤ 0.05 was considered as significant.

Results:

In our study 54 patients were enrolled, 27 in each group. In group A (SF6 gas), the mean logMAR value of BCVA post-operative (1 month) was 0.19±0.40 and in group B (filtered air) was 0.22±0.42. In group A (SF6 gas) 24 (88.9%) patients had attached retina after one month of surgery and similarly in group B (filtered air) 24 (88.9%) patients had attached retina after one month of surgery. All the collected data had normal distribution as shown by Kolmogorov-Smirnov and Shapiro-Wilk tests. The p-value in each variable was significant. After the normality test, t-test and chi square test were applied to check the significant difference in both the groups regarding BCVA and retina attached, the results showed that there was no significant difference in the groups. Both treatment procedures had same efficacy.

In our study fifty four patients were enrolled, 27 in each group. The results showed that in group A (SF6 gas), the mean age of the patients was 61.59±5.85years and in group B (filtered air) was 61.96±6.15years. The overall mean age of patients was 61.78±5.95years. Figure 1.

In group A (SF6 gas), 15(55.6%) were male and 12(44.4%) were female, while in group B (filtered air), 17(63.0%) were male and 10(37.0%) were female. Total 32(59.3%) were male and 22(40.7%) were female in our study.

Table-1: Comparison of BCVA post-operative (1 month) between groups

Groups	n	Mean	SD
Group-A (SF6 Gas)	27	0.19	0.396
Group-B (Filtered air)	27	0.22	0.424
Total	54	0.21	0.415

Table-2: Comparison of retina attached (1st post-operative month) between groups

Retina attached (1st post operative month)	Groups		Total
	Group-A (SF6 Gas)	Group-B (Filtered air)	
Attached	24	24	48
	88.9%	88.9%	88.9%
Not attached	3	3	6
	11.1%	11.1%	11.1%
Total	27	27	54
	100.0%	100.0%	100.0%

In group-A patients, duration of intra-ocular gas stay was 15±3 days after surgery, while in group-B filtered air tamponade dissipated by 9±2 days after surgery.

All the collected data had normal distribution as showed by Kolmogorov-Smirnov and Shapiro-Wilk tests. The p-value in each variable was significant. After the normality test, we applied t-test and chi-square test to check the significant difference in both the groups regarding BCVA and retina attached, results showed that there was no significant difference in both the groups. Both treatments had same efficacy. Table 3,4.

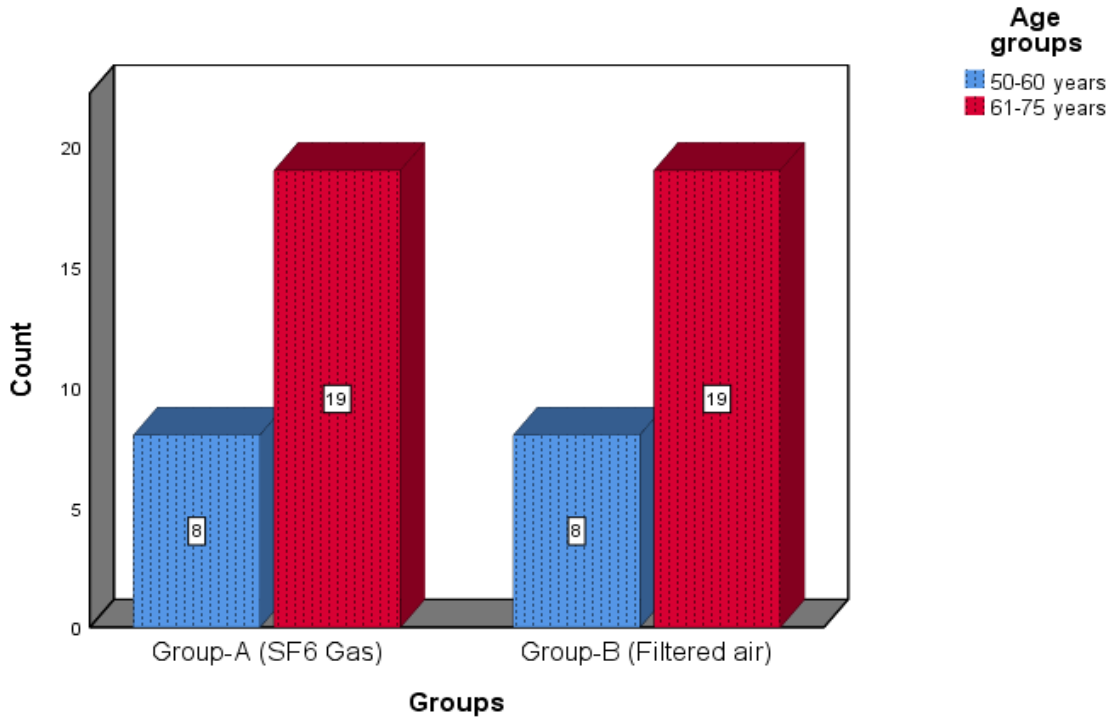

Figure 1: Age distribution among two groups

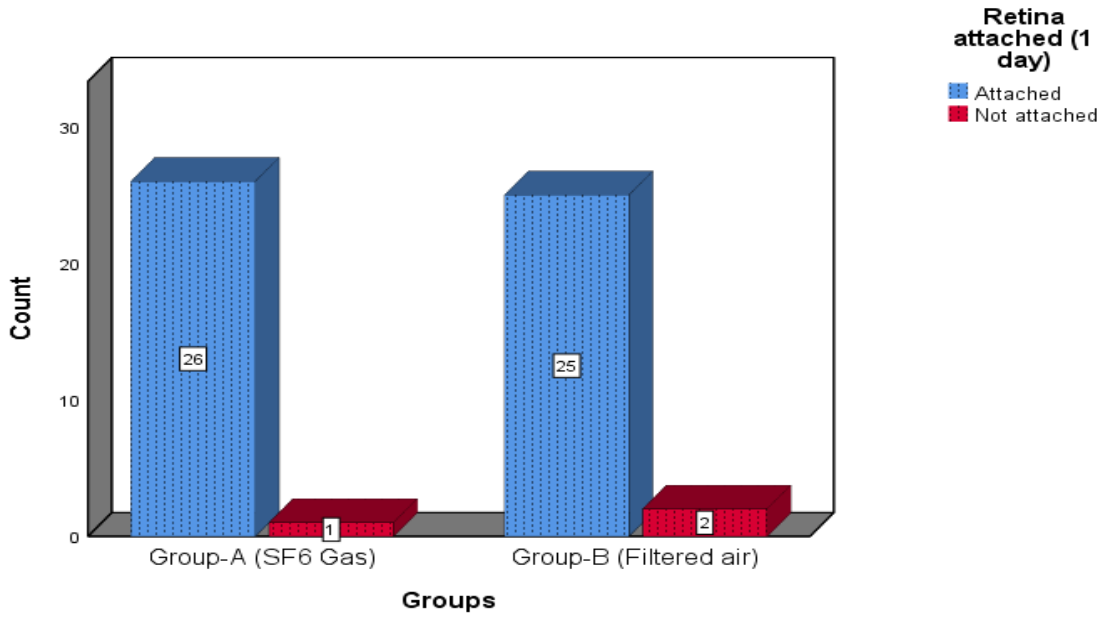

Figure 2: Comparison of retina attached (1st post-operative day) between groups

Table-3: Results of comparison of BCVA in study groups

BCVA	Groups	n	Mean	SD	p-value
BCVA Pre-operative	Group A (SF6 Gas)	27	1.22	0.424	0.493
	Group B (Filtered air)	27	1.15	0.362	
BCVA Post-operative (1 week)	Group A (SF6 Gas)	27	0.30	0.465	0.775
	Group B (Filtered air)	27	0.33	0.480	
BCVA Post-operative (1 month)	Group A (SF6 Gas)	27	0.19	0.396	0.741
	Group B (Filtered air)	27	0.22	0.424	

Table-4: Results of comparison of Retina attached in study groups

Retina attached		**Groups**		**p-value**
		Group-A (SF6 Gas)	Group-B (Filtered air)	
Retina attached (1 day)	Attached	26	25	0.552
		96.3%	92.6%	
	Not attached	1	2	
		3.7%	7.4%	
Retina attached (1 week)	Attached	25	24	0.639
		92.6%	88.9%	
	Not attached	2	3	
		7.4%	11.1%	
Retina attached (1 month)	Attached	24	24	1.000
		88.9%	88.9%	
	Not attached	3	3	
		11.1%	11.1%	

Discussion:

Retinal detachment is defined as separation of neurosensory retina from the retinal pigment epithelium. Tamponade is an internal pressure that helps in adhesion between the neurosensory retina and retinal pigment epithelium. It acts as a barrier for movement of fluid between vitreous cavity and subretinal space, so fluid doesn't enter the space. This barrier is no longer needed after the adhesion develops [3]. Tamponade should remain until SRF is absorbed. Otherwise, the unabsorbed SRF, can disturb the RPE-Retina adhesion[3].

Nishi K, et al's study has shown same results as ours, saying that air tamponade has a very good therapeutic effect in eyes with rhegmatogenous retinal detachment associated with PVR grade A and B, irrespective of the location of the tear [13].

Singh, et al included cases of rhegmatogenous retinal detachments with superior, inferior and multiple breaks who underwent vitrectomy with air tamponade in some and SF6 tamponade in others and concluded that air tamponade was effective in 85% of the cases and SF6 20% tamponade in 80.3% of cases. This proves the effectiveness of air tamponade which supports our study [14].

When small gauge pars plana vitrectomy is done with air tamponade in some cases of relatively simple primary Rhegmatogenous retinal detachment, it's quite effective in getting the successful results of the surgery. There is need to verify the efficacy of this surgical technique in comparatively complicated cases like those with giant retinal tears [15].

Uemura A, et al noticed that there was no significant difference between single surgery anatomical success rate i.e re-attachment of retina and also the visual acuity when air tamponade is compared with SF6 gas used in pars plana vitrectomy. These parameters were observed in cases of uncomplicated rhegmatogenous retinal detachment with inferior retinal breaks [16]. These results support our results.

Another study supporting our study was study of Nakamura M, et al. They also concluded by supporting the effectiveness of air tamponade and also stated that air tamponade reduces the time period of post-operative prone positioning. Along with that, the risk of ocular hypertension is also reduced. There was no difference between air group 99.4%; 155/156 eyes) and the SF6 group (96.5%; 135/138 eyes; $P = 0.102$) as far as anatomical re-attachment of the retina is concerned[17].The data of Lee JJ's study also supports the effectiveness of air tamponade and also describes that air tamponade stays in vitreous cavity for an average of 11.1 days [18].

As far as research of Uemura A, et al. is concerned, they included 116 eyes of 116 patients. Air tamponade was used in 52 eyes and gas tamponade was used in 64 eyes. Single surgery anatomical success rate was observed in 50 eyes (96.2%) of air group and 60 eyes of gas group (93.8%). As far as mean Snellen's visual acuity is concerned, it was similar in both groups summarizing the results, no significant difference was found between two groups in terms of anatomical attachment and visual acuity, which means that both are equally effective[19].

Many studies support our results saying that air tamponade is very effective, and as effective as gas tamponade but study of Yao Y, et al does not support our results saying SF6 tamponade is more effective than air tamponade but it is mainly true when it is used for macular holes>520 micrometres[20].

Tabi AA et al, conducted a study on same lines as ours and concluded with similar results saying that both air and gas tamponade are equally good as far as final visual outcome is concerned. Air is less expensive with less time duration of post-operative prone positioning. A disadvantage of gas tamponade is that cataract progression is higher in these cases[21].

Tetsumoto A, et al. also showed results similar to ours and concluded by saying that

both air and gas groups' postoperative retinal re-attachment was the same in 27-gauge pars plana vitrectomy done for rhegmatogenous retinal detachment irrespective of the location of the retinal break and so, there was statistically no difference in success rates between the two groups (p = 1). The best corrected visual acuity (BCVA) (logMAR) at 12 months after surgery was -0.02 ± 0.14 in Group A and -0.03 ± 0.27 in Group B. The BCVA between the groups was not statistically different (p = 0.27)[22].

A group of researchers used air tamponade in cases of fresh Rhegmatogenous detachment with superior retinal breaks and found it as an effective management in these cases. Another advantage of air tamponade is that postoperatively, ultra-widefield fundus imaging can be done which can detect postoperative retinal breaks in air-filled eyes. It is a very useful technique to do follow-ups after PPV with air tamponade. Adding to this, the duration of face-down position is also less in cases of air tamponade [23,24].

In cases where fluorinated gases are used as tamponade in PPV, especially in cases done with SF6, there is a higher emission of carbon which has a bad impact on environment [25].

The only cases where gas tamponade is better than air tamponade, are the cases of macular holes. Otherwise, in all other cases of fresh retinal detachments, air tamponade is better than or equally effective as far as anatomical re-attachment and visual acuity are concerned [26].

Conclusion:

Efficacy of gas (SF6) vs. filtered air after PPV "pars plana vitrectomy" in cases of fresh RRD "Rhegmatogenous Retinal detachment" which includes anatomical attachment of retina and Best Corrected Visual Acuity assessment is the same. No difference was found in both of the groups. Air tamponade can be used as an alternative to SF6 gas tamponade, especially in settings where this gas is not available or cannot be afforded. As it is expensive, so in settings where SF6 gas is not available such as in peripheries (distant areas), air would be a reasonable substitute.

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