

COMPARATIVE STUDY BETWEEN ANATOMICAL AND VISUAL OUTCOMES OF SILICONE OIL VERSUS GAS TAMPONADE FOR MACULAR HOLE SURGERY

By

Ahmed Abd El-Gawad Ahmed Mohamed, Mohamed Anwar Al-Massry and Ahmad El-Sayed Hodieb

Departments of Ophthalmology, Faculty of Medicine, Al-Azhar University

Corresponding author: Ahmed Abd El-Gawad Ahmed Mohamed;

Mobile: 01092211097, **E-mail:** ahmedabdelgawad91@gmail.com

ABSTRACT

Background: Anatomical and surgical outcomes of macular hole surgery are influenced by multiple factors. These factors include the size and chronicity of the macular hole, use of biologic adjuvants, peeling of internal limiting membrane (ILM), the choice of intraocular tamponade and duration of postoperative positioning.

Objective: To compare the effectiveness of pars plana vitrectomy (PPV) with either silicone oil or gas tamponade for the treatment of macular holes on visual and anatomical outcome.

Patients and methods: This study included 10 eyes whom were operated on by PPV with ILM peeling for repair of macular holes with either silicone oil tamponade (five patients) (50%) or sulfur hexafluoride (SF6) gas tamponade (five patients) (50%). The age of patients ranged from 24 to 72 years (mean 59 ± 14). Female to male ratio was 6 to 4. Following up, the visual acuity and anatomical outcomes by Optical coherence tomography (OCT) have been done at 1 month and 6 months postoperatively.

Results: The rate of hole closure after the primary operation showed a higher closure rate for gas-treated eyes 100% (5 of 5) than for silicone oil tamponade 80% (4 of 5). The final postoperative improvement in visual acuity for the gas group was better than for the oil group by 1 line in Early Treatment Diabetic Retinopathy Study (ETDRS) visual acuity chart.

Conclusion: Gas tamponade was more successful in anatomical closure of macular holes than silicone oil tamponade. Eyes with macular holes surgically repaired with gas tamponade showed more improvement in visual acuity compared with eyes treated with silicone oil tamponade.

Keywords: Macular hole, silicone oil versus gas tamponade, vitrectomy

INTRODUCTION

The macular hole is a full thickness defect of the retinal tissue involving the fovea (*Lumi et al., 2020*). Macular holes could be idiopathic, traumatic, myopic or due to other uncommon causes (*Ghoraba et al., 2012*).

Stage 1 MH can be spontaneously resolved in some occasions. However, they need to be under close observation. Stage 2 and higher are usually indications for surgical correction to get better surgical results (anatomical and functional) (*Bikbova et al., 2019*).

The repair of stage 2 to 4 macular holes has traditionally been accomplished by vitrectomy with gas tamponade and strict facedown positioning. Many patients were not tolerant of this difficult postoperative positioning requirement or unable to do so because of physical or medical reasons. Therefore, alternative materials to gas tamponade were developed (*Bor'i et al., 2017*).

Pieczynski et al. (2018) had reported on silicone oil as an agent for tamponade with a closure rate of 83% and of 3.4 lines for stage 3 to 4 macular holes.

In 1996 Liesenhoff and associates showed, that the removal of an epiretinal membrane associated with an idiopathic macular hole significantly improved the surgical outcome. Histologic examination of removed epiretinal membranes disclosed that continuous pieces of internal limiting membrane (ILM) were features of such membranes. The improvement of visual and anatomic success by ILM peeling in all stages of recent and chronic macular holes was also reported by Brooks (*Chatziralli et al., 2018*).

The present work aimed to compare anatomical and visual outcomes of

silicone oil versus sulfur hexafluoride (SF6) gas tamponade for macular hole vitrectomy surgery.

PATIENTS AND METHODS

This study included 2 groups of 10 eyes with stage 2,3 and 4 full thickness macular hole whom treated by vitrectomy surgery with internal limiting membrane (ILM) peeling (**Table 1 & Figures 1-6**).

Technique: The 10 eyes have been divided into two equal groups according to substance of tamponade at the end of the surgery: Group A in whom silicone oil was used for tamponade, and Group B in whom SF6 gas was used for tamponade.

Inclusion criteria: Stage 2, 3 and 4 full thickness macular hole. The preoperative best corrected visual acuity (BCVA) is 6/36 or less. The Age group 20 to 75 years old.

Exclusion criteria: Associated RD. Age related macular degeneration (AMD) patients. Intra ocular surgery (including glaucoma surgery, previous vitrectomy, corneal transplantation) except cataract surgery. Previously done retinal argon laser. Active intraocular inflammation. Drop of vision as a result of other causes. Media opacity.

Table (1): Stages and preoperative vision of group A,B

Groups \ Cases	Case 1	Case 2	Case 3	Case 4	Case 5
Group A					
Preoperative vision	0.032	0.1	0.032	0.1	0.05
Stage of macular hole	Stage 3	Stage 2	Stage 4	Stage 2	Stage 4
Group B					
Preoperative vision	0.16	0.05	0.1	0.05	0.05
Stage of macular hole	Stage 2	Stage 4	Stage 4	Stage 4	Stage 4

Follow up:

Patients were followed up by best corrected visual acuity (BCVA), fundus and macular OCT examination within one

month and 6 months after surgery (cases of silicone filled eyes the silicone oil removal has been done within 3 to 4 months after surgery).

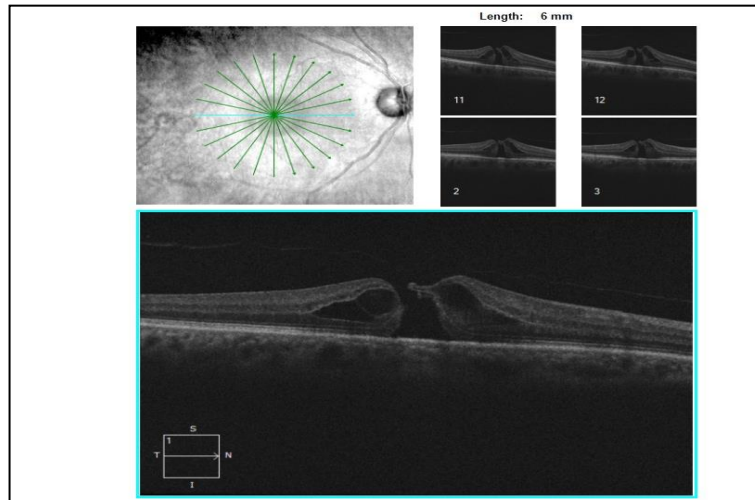


Figure (1): Preoperative OCT Image of case no 2 in group A.

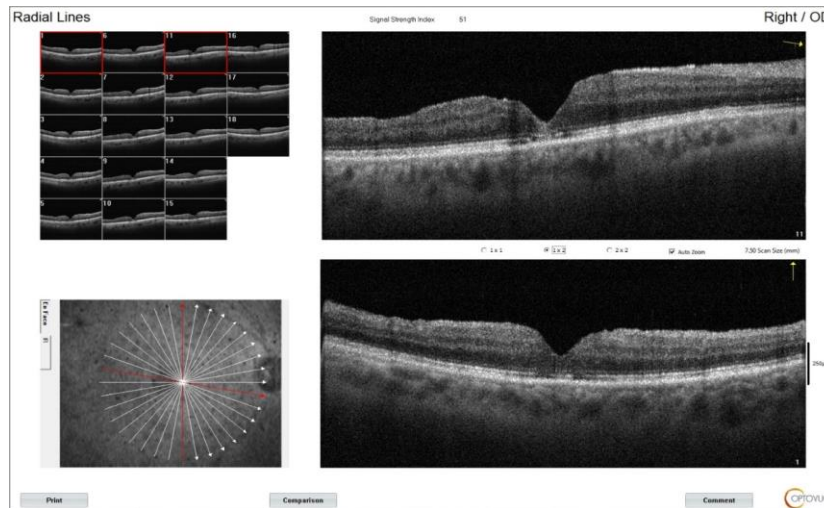


Figure (2): Postoperative OCT Image of case no 2 in group A.

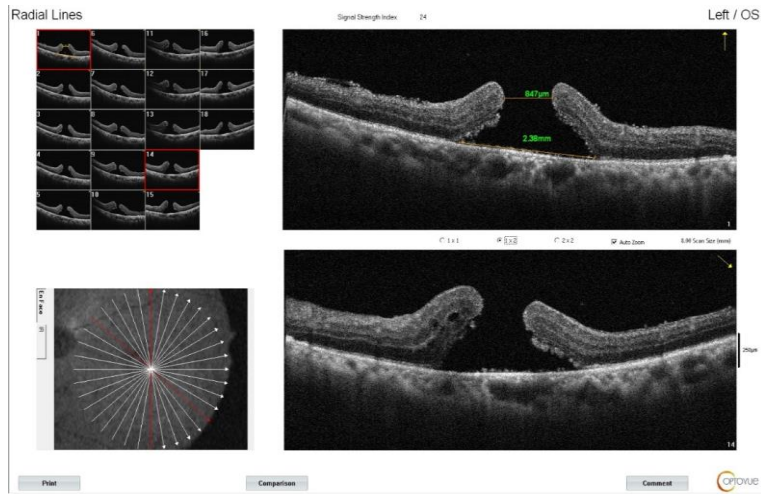


Figure (3): Preoperative OCT image of case no 3 in group A.

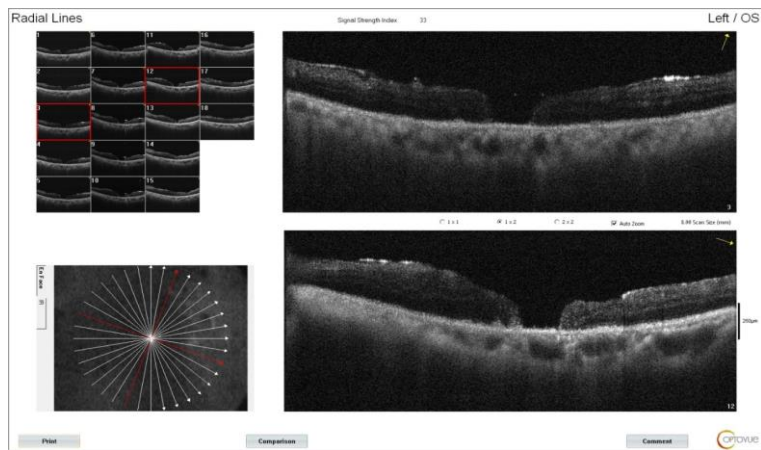


Figure (4): Postoperative OCT image of case no 3 in group A: (The hole decreased in size but fail to close with no improvement of vision)

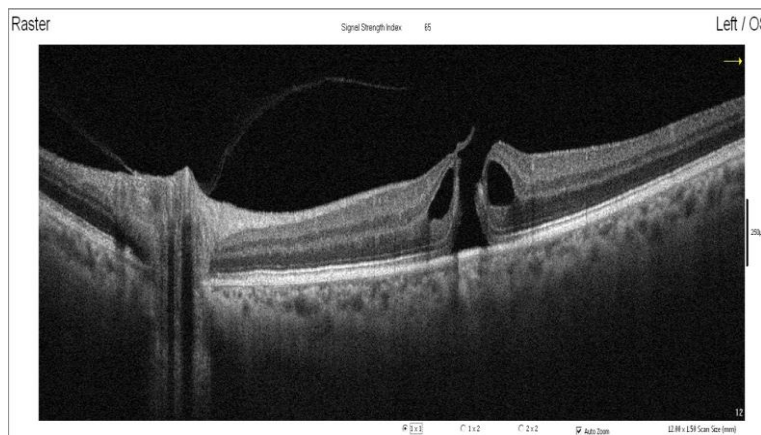


Figure (5): Preoperative OCT Image of case no 1 in group B.

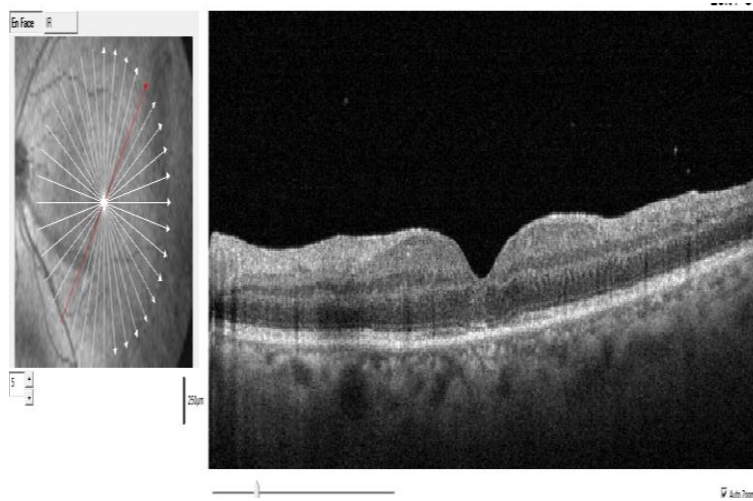


Figure (6): Postoperative OCT Image of case no 1 in group B.

Statistical analysis:

Data were collected, revised, coded and entered to the Statistical Package for the Social Sciences (IBM SPSS) version 23. The quantitative data were presented as mean, standard deviations and ranges. Also, qualitative variables were presented as number and percentages. The

comparison between groups regarding qualitative data was done by using Fisher's exact test. The comparison between two groups regarding quantitative data was done by using Mann-Whitney test. P value < 0.05 was considered significant.

RESULTS

Ten eyes were reviewed to assess anatomical and visual outcomes of macular hole surgery with silicone oil tamponade versus SF6 gas tamponade. Five eyes were performed with silicone oil tamponade (Group A) and five with gas tamponade (Group B). Patients age ranged from 24 to 72 years (mean 59 ± 14.03 years). Female patients accounted for

(60%) and male patients accounted for 40%. Eighty percent (80%) of macular hole in the study were of idiopathic type, Ten percent 10% were of traumatic type and ten 10 % were of myopic type. Macular hole stages were: 60% stage 4, 30% stage 2 and 10% satge 3. The pre-operative vision ranges from 0.07-0.04 with mean 0.03 ± 0.16 (**Table 2**).

Table (2): Demographic data

		No. = 10
Age	Mean±SD	59 ± 14.03
	Range	24 – 72
Sex	Female	6 (60.0%)
	Males	4 (40.0%)
Type	Idiopathic	8 (80%)
	Traumatic	1 (10%)
	Myopic	1 (10%)
Vision Preoperative	Mean ± SD	0.07 ± 0.04
	Range	0.03 – 0.16
Stage	II	3 (30.0%)
	III	1 (10.0%)
	IV	6 (60.0%)

In the silicone oil-treated group, 4 of 5 (80%) macular holes were sealed after the primary operation, while 5 of 5 (100%) of the gas-treated group were sealed in a

single operation. The overall primary closure rate was 90% (9 of 10). The non-closure rate for the silicone oil group was 20 % (1 of 5) (**Table 3**).

Table (3): Closure rate for group A and group B.

One month postoperativelg		Groups	Group A	Group B	P-value
			No. = 5	No. = 5	
Anatomical Outcome	Successfully closed		4 (80.0%)	5 (100.0%)	0.292
	Fail to close		1 (20.0%)	0 (0.0%)	

The preoperative vision for silicon oil group (Group A) range 0.03 – 0.1 (mean 0.06 ± 0.03) and the preoperative vision

for sf6 gas group (Group B) range 0.05 – 0.16 (mean 0.08 ± 0.05) (**Table 4**).

Table (4): Preoperative visual acuity.

Vision preoperativelg		Groups	Group A (silicon oil)	Group B (SF6 Gas)
			No. = 5	No. = 5
Mean±SD			0.06 ± 0.03	0.08 ± 0.05
Range			0.03 – 0.1	0.05 – 0.16

The postoperative mean visual acuity at 1 month was 0.11 ± 0.07 for the

silicone oil group and 0.22 ± 0.10 for the gas-treated group (**Table 5**).

Table (5): Visual and anatomical outcomes 1 month after surgery.

One month postoperativelg		Groups	Group A	Group B	P-value
			No. = 5	No. = 5	
Vision	Mean±SD		0.11 ± 0.07	0.22 ± 0.10	0.034
	Range		0.03 – 0.16	0.16 – 0.4	

*: Chi-square test; †: Mann-Whitney test

The postoperative mean visual acuities at 6 months were 0.23 ± 0.15 for the silicone oil group, while the postoperative

mean visual acuities at 6 months were 0.32 ± 0.04 for the gas-treated group (Table 6).

Table (6): Comparison of visual outcome 6 months after surgery.

Six months postoperative		Groups		P-value
		Group A No. = 4	Group B No. = 5	
Vision	Mean±SD	0.23 ± 0.15	0.32 ± 0.04	0.345
	Range	0.03 – 0.4	0.3 – 0.4	

#: Mann-Whitney test

DISCUSSION

Pars plana vitrectomy has been used for more than a decade to treat full-thickness macular holes (Parravano et al., 2015). Hole closure rates are high at over 90% but various factors are known to reduce the success rate, in particular the size of the hole. A number of surgical variations and adjunctive procedures have been described to improve hole closure rates including post-operative face down positioning, longer acting tamponade, surgical creation of ILM flaps, and other biological membranes and platelets (Steel et al., 2021).

In the present study, ten cases of macular hole were repaired by vitrectomy surgery and ILM peeling, reviewed in a comparative study showed a higher closure rate for gas-treated eyes (100%) than for silicone oil tamponade (80%) in a single operation. The lower rate of hole closure by silicone oil tamponade might be due to the hole failed to close was the largest in this study or may the patient was incompliant in maintaining a strict postoperative face-down position.

Ghoraba et al. (2012) showed that higher closure rate for gas-treated eyes (92.3%) than for silicone oil tamponade (66.67%) in a single operation. Bor'i et al.

(2017) showed that closure rate for gas-treated eyes (94%: 15 of 16) and closure rate for silicone oil tamponade (90%: 9 of 10) in a single operation which is almost the same rate for gas and silicone however, the slight difference in the percentage could be due to the different number of eyes included in the 2 studied groups.

The pre- and postoperative visual acuities were reviewed. Each group showed a gradual improvement in visual acuities at 1 month and 6 months.

In the silicone oil group after 1 months the mean visual acuity improved from 0.06 ± 0.03 preoperative to 0.11 ± 0.07 , and after 6 months mean visual acuity improved to 0.23 ± 0.15 , These findings correlate to 5 lines in ETDRS visual acuity chart increase with Silicone oil repair after 6 months follow up.

In the SF6 Gas group after 1 months the mean visual acuity improved from 0.08 ± 0.05 preoperative to 0.22 ± 0.10 , and after 6 months mean visual acuity improved to 0.32 ± 0.04 . These findings correlate to a 6 lines in ETDRS visual acuity chart increase with gas repair after 6 months follow up.

Ghoraba et al. (2012) showed that after 1 year follow up the silicone oil

group improved 3 line in ETDRS visual acuity chart, and 4-line increase with gas repair, it also shows more improvement in visual acuity in gas treated group than silicone oil treated group. *Bor'i et al. (2017)* showed that after 6 months follow up, the silicone oil group improved from 0.16 to 0.5 which correlate to a 5 lines in ETDRS visual acuity chart, the gas treated group improved from 0.08 to 0.63 which correlate to 8 lines in ETDRS visual acuity chart. More improvement in visual acuity was in gas-treated group than silicone oil-treated group.

The better visual outcomes in gas-treated eyes than in silicone-treated eyes may be due to the fact that silicone oil is in contact with the bare retinal pigment epithelium (RPE) and photoreceptors in macular hole surgery and has been found to be toxic to RPE and photoreceptors in previous studies (*Ghoraba et al. 2012*).

CONCLUSION

Gas tamponade was more successful in anatomical closure of macular holes than silicone oil tamponade. Eyes with macular holes surgically repaired with gas tamponade showed more improvement in visual acuity compared with eyes treated with silicone oil tamponade.

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دراسة في مقارنة نتائج إلتئام الماقولة و مستوي الرؤية بعد إستخدام زيت السيليكون أو الغاز لملء العين وذلك بعد عملية إستئصال الجسم الزجاجي لعلاج ثقب الماقولة

أحمد عبد الجواد أحمد محمد، محمد أنور المصري، أحمد السيد هديب

قسم طب وجراحة العيون، كلية الطب، جامعه الأزهر

التليفون: 01092211097، E-mail: ahmedabdelgawad91@gmail.com

خلفية البحث: نجاح عملية إستئصال الجسم الزجاجي لعلاج ثقب الماقولة من حيث التركيب التشريحي و التحسن بالرؤية يتأثر بعدة عوامل و منها حجم الثقب و مدته، إستخدام مواد بيولوجية مساعدة، و تقشير الغشاء الداخلي المحدد للشبكية، و المادة المستخدمة لملء العين في نهاية العملية، و مدة الوضعية التي يجب علي المريض إتخاذها بعد العملية.

الهدف من البحث: عقد مقارنة بين مدي التأثير على الالتئام التشريحي للماقولة ومستوي الرؤية عند إستخدام كلا من غاز سادس فلوريد الكبريت أو زيت السيليكون لملء العين بعد عملية إستئصال الجسم الزجاجي لعلاج ثقب الماقولة.

المرضي وطرق البحث: هذه الدراسة شملت علي مجموعتين مكونتين من عشرة أعين يعانون من ثقب الماقولة تم علاجهم جراحيا بعملية إستئصال الجسم الزجاجي مع تقشير الغشاء الداخلي المحدد للشبكية. و شملت المجموعة الأولى 5 أعين تم إستخدام زيت السيليكون لملء الأعين به، و شملت المجموعة الثانية 5 أعين تم إستخدام غاز سادس فلوريد الكبريت لملء الأعين به. و تراوحت أعمار المرضي بالدراسة من 24 - 72 سنة بمتوسط 59 ± 14.03 ، و كانت نسبة النساء للرجال

4 / 6 و تم متابعة المرضى بعد شهر و 6 اشهر من إجراء العملية بقياس حدة الأبصار و عمل أشعة مقطعية علي مركز الأبصار.

نتائج البحث: كان معدل الالتئام التشريحي للماقولة عند إستخدام غاز سادس فلوريد الكبريت هو 100%، بينما كان معدل الالتئام عند إستخدام زيت السيليكون هو 80%. و كان مستوي تحسن الرؤية افضل عند إستخدام الغاز من إستخدام زيت السيليكون.

الإستنتاج: إستخدام الغاز لملء العين بعد عملية إستئصال الجسم الزجاجي لعلاج ثقب الماقولة أنجح من إستخدام زيت السيليكون في الالتئام التشريحي للماقولة، وكذلك نسبة التحسن في مستوي الرؤية عند استخدام الغاز أعلي من نسبة التحسن عند استخدام زيت السيليكون.

الكلمات الدالة: ثقب الماقولة، عملية إستئصال الجسم الزجاجي، زيت السيليكون أو الغاز لملء العين.