Anatomical and Functional Outcomes of Anterior Chamber Gas Tamponade in Central Planar Descemet Membrane Detachments Developing After Cataract Surgery

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ABSTRACT

Purpose: To evaluate the anatomical and functional outcomes and complications of anterior chamber gas tamponade in centrally located planar Descemet membrane detachment (DMD) following cataract surgery.

Materials and Methods: This retrospective study included 12 eyes of 12 patients who developed DMD after cataract surgery between January 2023 and June 2025 and were treated with anterior chamber gas tamponade using 20% sulfur hexafluoride (SF_6) or 14% perfluoropropane (C_3F_8). DMD was diagnosed by slit-lamp biomicroscopy and anterior segment optical coherence tomography (AS-OCT). Only centrally located planar DMD cases were included. Anatomical success was defined as complete Descemet membrane reattachment, and functional success as an improvement of at least two Snellen lines in best-corrected visual acuity (BCVA).

Results: The mean patient age was 75 ± 8.83 years. Anatomical success was achieved in 11 eyes (91.6%). A single gas injection was sufficient in 75% of cases, while four patients required a second injection. Mean BCVA in logMAR (0.70±0.73) after DMD resolution was significantly higher than pre-treatment (2.11±0.54) and early postoperative (1.80±0.83) values (p:0.001, p:0.003). A transient increase in intraocular pressure was observed on postoperative day one, with no permanent pressure-related complications. The only unsuccessful case had low preoperative endothelial cell count and Fuchs endothelial dystrophy.

Conclusion: Anterior chamber gas tamponade is a safe and effective treatment for centrally located planar DMD after cataract surgery, providing high anatomical success and significant visual improvement. Adequate endothelial reserve is critical for treatment success.

Key words: Anterior Chamber, Descemet Membrane Detachment, Gas Tamponade, Optical Coherence Tomography

INTRODUCTION

Cataract surgery is one of the most frequently performed procedures in ophthalmology today, with a high success rate. Surgical safety has significantly improved thanks to the development of minimally invasive techniques, modernization of phacoemulsification devices, and advances in intraocular lens design [1]. However, some rare complications can negatively impact visual prognosis. One of these complications, Descemet's membrane detachment (DMD), can lead to permanent corneal changes if not recognized early but is often manageable with appropriate treatment [2].

Descemet's membrane lies between the stroma and endothelial layers of the cornea. It is a basement membrane that is critical for maintaining corneal transparency [3]. DMD can occur when Descemet's membrane detaches from the stroma during cataract surgery due to factors such as anterior chamber manipulation, blade impacts, viscoelastic material injection, wound entry site structure, or endothelial weakness. Major risk factors for the

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development of DMD have been identified as cataract overdensity, aging, preoperative endothelial dysfunction, a narrow anterior chamber, or anatomical factors that increase surgical difficulty [4, 5].

DMD is diagnosed using biomicroscopic examination and anterior segment optical coherence tomography (AS-OCT). According to Mackool and Holtz, DMD is classified as planar (<1 mm detachment) or non-planar (>1 mm detachment) based on its morphology and central or peripheral based on its location [6]. While planar and peripheral DMDs generally heal spontaneously, non-planar and/or centrally extending DMDs carry the risk of severe vision loss and corneal edema and therefore require early and appropriate treatment [7]. Central DMDs affect the visual axis, and if not treated promptly, persistent detachment, endothelial loss, and corneal decompensation can occur. Therefore, early and appropriate treatment is essential in clinically significant DMD cases [8].

Various treatment approaches are available for the management of DMD. Conservative management or hyperosmotic agents may be sufficient in mild cases, while more extensive and nonplanar detachments require surgical intervention [9]. Air or gas tamponade (descemetopexy) in the anterior chamber, the most frequently preferred and minimally invasive approach, promotes reattachment of Descemet's membrane to the stroma [10]. While the ease of application of air offers advantages, gases such as SF_6 (sulfur hexafluoride) and C_3F_8 (perfluoropropane), which offer a longer-lasting tamponade effect, have been reported to have higher success rates in certain cases [11, 12]. However, studies evaluating efficacy based on gas type, volume, time of application, and DMD morphology are limited.

Studies directly analyzing the outcomes of gas tamponade in patients with DMD following cataract surgery are scarce in the literature, and the available data are heterogeneous. There is no clear consensus on which cases the procedure is more effective in, the strength of its association with visual improvement, or its complication profile. Therefore, new studies demonstrating the clinical efficacy of gas tamponade in this patient group are needed.

This study aims to evaluate the effectiveness, anatomical success rates, visual outcomes, and possible complications of gas tamponade applied to the anterior chamber in cases of DMD developing after cataract surgery.

MATERIAL AND METHODS

This is a retrospective clinical study conducted at the Ophthalmology Clinic of Trakya University Faculty of Medicine between January 1, 2023, and June 1, 2025. The medical records of patients who developed Descemet's membrane detachment (DMD) after phacoemulsification surgery and underwent anterior chamber gas tamponade were reviewed.

The study was conducted in accordance with the principles of the Declaration of Helsinki (Approval No: TÜTF-GÖBAEK 2025/551). Informed consent forms were obtained from all patients before the procedure.

The study included patients aged 18 years and older with a minimum follow-up period of 6 months, whose diagnosis of DMD was confirmed by biomicroscopic examination and AS-OCT after cataract surgery. Patients with a history of previous ocular surgery or trauma, eyes that underwent combined surgery, patients who developed serious postoperative complications other than DMD, and cases with incomplete clinical data were excluded from the study. The patients' ages, genders, and the eye they had surgery on were recorded.

Preoperative corneal endothelial count, cataract severity, and presence of pseudoexfoliation were recorded in the patients' files. Intraoperatively, the phacoemulsification technique used (phaco chop/stop chop), whether intraoperative floppy iris syndrome (IFIS) developed, and whether posterior capsule perforation occurred were noted. It was also noted which day after cataract surgery the gas injection was administered on the day DMD was detected.

All patients underwent BCVA before gas application, on the first postoperative day, and after hospitalization, and completed biomicroscopic examination. Intraocular pressure (IOP) was measured using Goldmann applanation tonometry at all visits, including pre-gas tamponade evaluation, postoperative day 1, and after DMD resolution. All measurements were performed under standardized clinical conditions. In patients whose Descemet's membrane had resolved and whose cornea appeared clear but who still did not have complete vision, the cause of their

reduced vision was investigated and noted. The localization (central/peripheral) and morphology (planar/non-planar) of DMD were assessed using AS-OCT (SD-OCT; Cirrus HD-OCT 5000, Carl Zeiss Meditec, Dublin, CA, USA), and membrane height was manually measured twice at the point of highest separation and averaged. Only planar and central DMDs were included in the study. According to the HELP procedure described by Kumar et al. [13], gas tamponade was applied to patients for whom surgical indication was identified. In accordance with the HELP algorithm, central involvement of DMD was considered the principal prerequisite for intervention. Intracameral gas tamponade was performed in eyes with a DMD separation distance >300 µm irrespective of visual acuity. In eyes with a separation distance between 200 and 300 µm, intervention was considered in the presence of diffuse corneal edema accompanied by reduced visual acuity (logMAR >1.30). Anatomical success was defined as complete reattachment of the Descemet membrane by biomicroscopy and AS-OCT. Functional success, consistent with the literature, was defined as achieving at least two Snellen lines of improvement in BCVA after gas tamponade [14].

Gas tamponade procedures were performed by experienced surgeons under topical anesthesia. During the procedure, a 27-gauge needle was inserted into the anterior chamber through the peripheral cornea, and SF_6 20% or C_3F_8 14% was injected to fill the anterior chamber to approximately two-thirds capacity. All patients were advised to remain in a supine position for the first 24–48 hours after the procedure. Following intracameral gas tamponade, all patients were treated with topical dexamethasone eye drops 8 times daily and topical moxifloxacin eye drops 4 times daily as standard postoperative treatment.The type of gas used, the number of days after cataract surgery when the gas was applied, and the need for additional intervention were evaluated from the records. Due to the retrospective nature of the study, the selection of SF_6 or C_3F_8 gas was primarily based on availability at the time of intervention rather than predefined clinical criteria. In cases requiring repeat gas injection, C_3F_8 was preferred because of its longer tamponade duration.

Primary outcome measures were defined as anatomical reattachment ratio and final visual acuity, while secondary outcome measures were evaluated as reattachment time, need for additional gas injection, and postoperative complications.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA). The normality of continuous variables was assessed using normality tests and distribution plots. Repeated measurements of BCVA and intraocular pressure across different time points were analyzed using repeated measures analysis of variance (repeated measures ANOVA). Pairwise comparisons between time points were performed when appropriate. Continuous variables are presented as mean ± standard deviation (SD), whereas categorical variables are summarized as frequencies and percentages. A p value <0.05 was considered statistically significant.

RESULTS

The study included 12 eyes from 12 patients, 7 of whom were women (58.3%) and 5 were men (41.7%). The average age of the patients was determined to be 75±8.83 (min:60 max:94). 5 patients had right eye involvement (41.7%), and 7 had left eye involvement (58.3%).

When the pre-operative examination findings of the patients were evaluated, the mean corneal endothelial cell count was 2305.17±366.06 (min: 1345, max: 2688). Pseudoexfoliation was present in 2 patients (16.7%). Regarding cataract grade, 5 patients (41.7%) had grade 2, 3 patients (25%) had grade 3, 1 patient had grade 4 (8.3%), and 3 patients (25%) had white cataract.

When peroperative surgical techniques were examined, it was observed that the phaco chop technique was used in 9 patients (75%) and the stop chop technique in 3 patients (25%). Regarding intraoperative difficulties, IFIS developed in 2 patients (16.7%), and 1 patient (8.3%) developed posterior polar cataract and peroperative posterior capsule perforation; anterior vitrectomy was added to the case, and a 3-piece intraocular lens was placed in the sulcus.

When the time elapsed between cataract surgery and gas application was examined, it was observed that an average of 24.67±25.66 (min: 3, max: 90) days had passed after cataract surgery. The extent of separation of the DMD detected by AS-OCT from the corneal stroma was measured at the widest point of separation and was found

to be an average of 311.17±102.37 µm (min: 180, max: 576) (Figure 1).

In 5 patients, 14% C_3F_8 gas was applied to the anterior chamber (41.7%), and in 7 patients, 20% SF_6 gas was applied (58.3%) (Figure 2). The mean BCVA values in logMAR of the patients before gas application were found to be 2.11±0.54. On the first day after gas application, the mean BCVA values were measured as 1.80±0.83. Excluding one patient in whom reconnection could not be achieved, the mean BCVA value obtained after DMD reconnection was 0.70±0.73. The mean BCVA values were statistically compared among themselves. It was found that the mean BCVA obtained after DMD resolution was significantly higher than the mean BCVA of the patients before gas application and the mean BCVA on the first postoperative day after gas application (p:0.001, p:0.003). It was also found that the mean BCVA on the first postoperative day

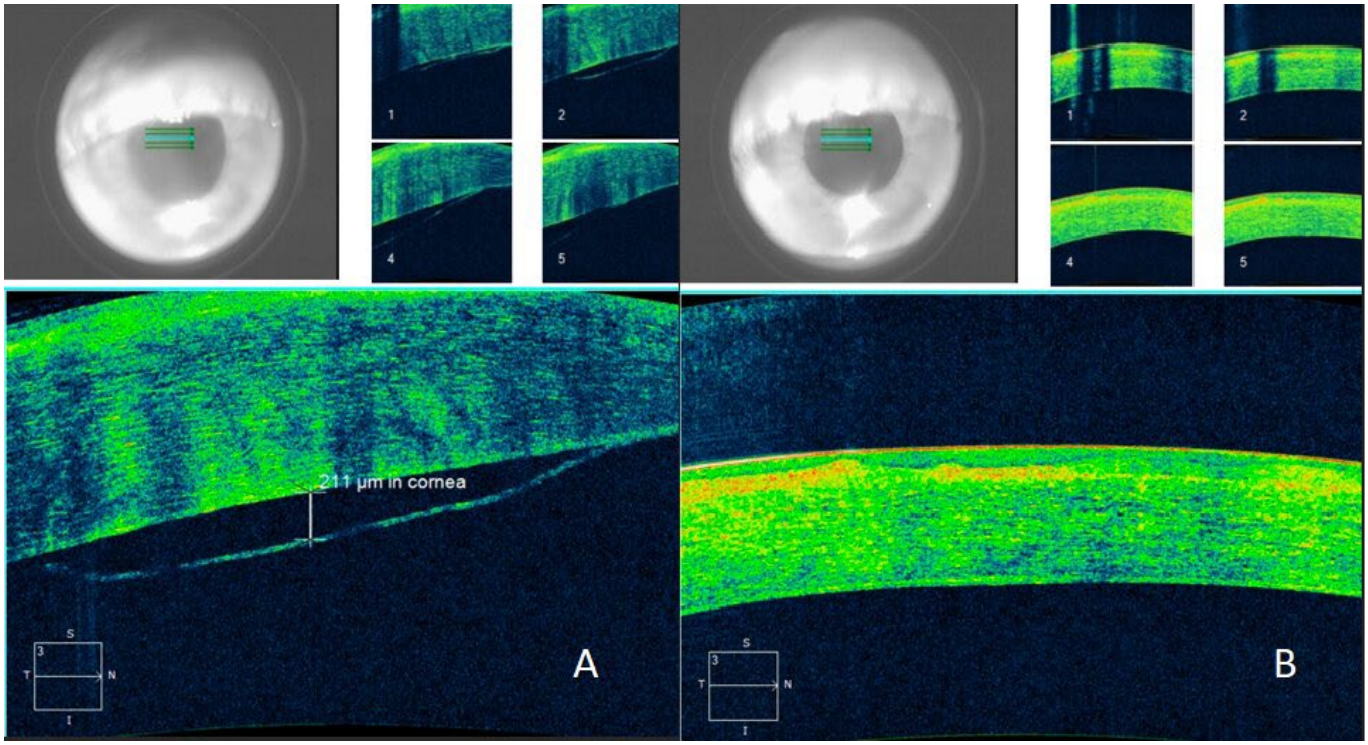

Figure 1. *Anterior segment optical coherence tomography images: A) Descemet membrane is seen detached from the stroma by 211 µm. B) Descemet membrane is seen to have reattached one month postoperatively after gas application.*

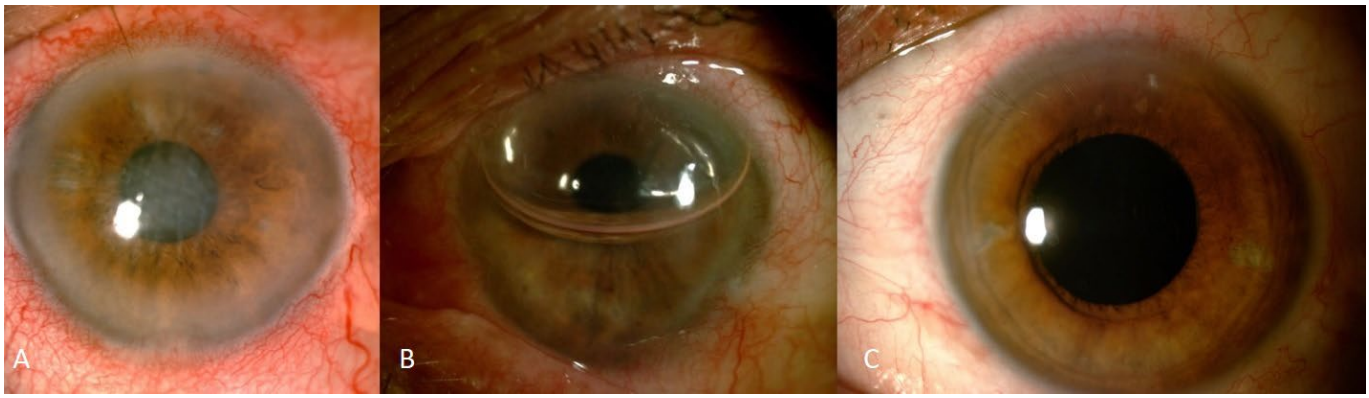

Figure 2. *Slit-lamp images: A) Stromal edema due to descemet's membrane detachment detected one month after cataract surgery. B) Postoperative day 1 after application of 14% C_3F_8 gas to the anterior chamber. C) Corneal transparency showing reattachment of the Descemet's membrane after gas withdrawal one month postoperatively.*

after gas application was higher than the mean BCVA of the patients before gas application, but this difference was not statistically significant (p:0.189).

When the average intraocular pressures were examined, they were determined as 13.33±2.67 (min:10, max:19), 16.33±3.44 (min:11, max:20), and 11.25±2.56 (min:7, max:17) mmHg preoperatively, on the first postoperative day, and after DMD resolution, respectively. Average intraocular pressures were also statistically compared among themselves. The average intraocular pressure after DMD correction was found to be statistically significantly lower than both preoperative and postoperative day 1 (p:0.028, p:0.004). Furthermore, the average intraocular pressure on the first postoperative day was statistically significantly higher than preoperative (p:0.023).

Anterior chamber gas implantation was performed on 12 patients for DMD, and it was successful in 11 patients (91.6%). The time between gas application for DMD and the resolution of DMD and corneal transparency was found to be an average of 18.36±11.60 days (min: 7, max: 40). The patient who was unsuccessful had an endothelial cell count of 1345 measured preoperatively under specular microscopy and was diagnosed with Fuchs dystrophy. In all 11 patients where Descemet's membrane was resolved, an increase of at least 2 lines in BCVA was observed, indicating that the procedure was successful.

In 8 out of 12 patients (75%), the Descemet membrane settled and the cornea became clear after the first gas application. In 4 patients, the Descemet membrane was still detached even after gas removal in the first week, so a second gas application was performed. While 3 patients settled after the second application, corneal edema persisted in one patient. Three of these were in the SF_6 gas group, while one was in the C_3F_8 gas group; the repeated injections were performed with C_3F_8 gas. When the patients' final BCVA scores were examined, it was observed that 3 patients achieved full vision, 1 patient continued to have corneal edema despite repeated gas applications, 7 patients showed signs of age-related macular degeneration causing decreased vision, and 1 patient had a pallor of the optic disc (Table 1). The anatomically unsuccessful case had pre-existing Fuchs endothelial dystrophy with a low endothelial cell count (1345 cells/mm²), no documented intraoperative complications during cataract surgery, and underwent intracameral gas tamponade 90 days after cataract surgery.

Table 1. *Clinical information of patients according to the order of admission*

	Age	Sex	Preop. endothelial cell count	DMD separation distance	Time (Day)*	Type of gas	Re-applying gas / Total number of operations	Preop. BCVA	Preop. IOP (mmHg)
1	94	F	2569	245	3	SF_6	Yes / 2 (C_3F_8)	HM	17
2	75	M	2037	311	25	SF_6	No	HM	10
3	69	M	2222	405	8	C_3F_8	No	2 CFM	13
4	70	F	2581	576	8	C_3F_8	No	,10	14
5	80	F	1345	285	90	SF_6	Yes / 2 (C_3F_8)	HM	12
6	71	F	2222	180	15	SF_6	No	HM	10
7	75	F	2300	295	10	SF_6	No	½ CFM	12
8	85	F	2200	354	60	C_3F_8	Yes / 2 (C_3F_8)	,05	15
9	72	M	2688	280	30	SF_6	No	1 CFM	12
10	69	M	2322	211	30	C_3F_8	No	½ CFM	12
11	80	F	2551	312	8	SF_6	Yes / 2 (C_3F_8)	1 CFM	14
12	60	M	2625	280	9	C_3F_8	No	½ CFM	19

to be continued...

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Table 1. *Clinical information of patients according to the order of admission*

	Success	1st day BCVA	1st day IOP (mmHg)	Time DMD reattached	Final BCVA	Final IOP (mmHg)	Causes of low vision
1	Yes	,05	12	26	,05	17	AMD
2	Yes	1 CFM	16	9	1 CFM	10	Optic atrophy
3	Yes	,05	20	7	1,0	12	None
4	Yes	½ CFM	11	35	1,0	11	None
5	No	,30	16	-	HM	10	BK
6	Yes	HM	13	10	,40	13	AMD
7	Yes	,30	13	10	,70	11	AMD
8	Yes	½ CFM	19	10	,40	11	AMD
9	Yes	,10	16	40	,70	8	AMD
10	Yes	HM	20	20	,30	12	AMD
11	Yes	HM	20	25	,80	7	AMD
12	Yes	HM	20	10	1,0	13	None

*The time elapsed between cataract surgery and gas application.
AMD: Age-related macular degeneration, BCVA: Best corrected visual acuity, BK: Bullous keratopathy, CFM: counting fingers from a meter, DMD: Descemet's membrane detachment, F: Female, HM: Hand movement, IOP: Intraocular pressure, M:Male

DISCUSSION

This study evaluated the anatomical and functional outcomes of anterior chamber gas tamponade in patients with centrally located planar Descemet membrane detachment (DMD) developing after cataract surgery. The findings suggest that intracameral gas tamponade may provide favorable anatomical reattachment and visual improvement in appropriately selected cases of clinically significant DMD.

A review highlighted that most DMDs are peripheral and usually resolve spontaneously; however, large and central DMDs can lead to corneal decompensation and permanent opacification if left untreated [2]. In this study, anterior chamber gas application was performed on patients requiring surgery according to the HELP algorithm developed by Kumar et al.[13] to make surgical intervention decisions in cases developing DMD. The fact that this study evaluated only centrally located planar DMD cases according to the HELP algorithm suggests that the positive results obtained belong to a clinically significant patient group.

Significant visual improvement was observed following anatomical reattachment of Descemet membrane. Mean BCVA after DMD resolution was significantly better than both pre-treatment values and early postoperative measurements. In contrast, visual acuity on the first postoperative day did not significantly differ from pre-treatment levels. This finding may be explained by persistent corneal edema in the early postoperative period and the temporary visual obstruction caused by intracameral gas occupying the pupillary axis. These findings suggest that functional recovery may lag behind anatomical improvement and becomes more apparent after corneal clarity is restored. Similar studies have also reported delayed visual recovery following successful anatomical reattachment [15].

In the present study, SF_6 and C_3F_8 gases were used, and high success rates were obtained with both gases. The rate of complete resolution of DMD after the first gas application was found to be 75%. Since these gases are mostly used in vitreoretinal surgery, the study examining the duration of intraocular gas injections found that the average was 2 weeks for SF_6 in 20% of cases and 2 months for C_3F_8 in 14% of cases [16]. It is noteworthy that SF_6 was used in

the first application in 75% of cases requiring repeated gas injections. In these cases, C_3F_8 was preferred for the second injection, and while anatomical success was achieved in three patients, it was not successful in the patient with Fusch endothelial dystrophy. The shorter absorption time of SF_6 may be the reason for its preference for initial use. Most case series reported for DMD have initially preferred SF_6 [17, 18]. Although repeat injections were more commonly performed using C_3F_8 because of its longer tamponade duration, the limited number of cases precludes any conclusion regarding comparative efficacy between gas types. Further comparative studies with larger cohorts are needed.

Previous studies have reported that a common side effect of SF_6 or C_3F_8 injection into the anterior chamber for Descemet's membrane detachment is acute IOP elevation, primarily due to pupillary block or anterior chamber overfilling, and that iridotomy may be necessary [19-21]. In this study, when IOP changes were evaluated, a transient pressure increase was observed on the first day following gas application, no cases required additional intervention, and a significant decrease in pressure values was detected after DMD resolution. The absence of permanent glaucoma or serious pressure-related complications in any case supports the safety of this method with appropriate gas volume use and close monitoring.

It is noteworthy that the only unsuccessful case in this study was a patient with Fuchs endothelial dystrophy who had a low preoperative endothelial cell count. This finding highlights the critical role of endothelial reserve in the treatment of DMD. It has been reported that the risk of decompensation after cataract surgery is high in eyes with Fuchs dystrophy and/or pre-existing damaged endothelium, and earlier endothelial graft planning is advocated in these patients [22]. Consistent with the literature, it is thought that gas tamponade may be insufficient in cases with advanced endothelial insufficiency, and that more advanced surgical options such as endothelial keratoplasty should be considered early in these patients.

The interval between cataract surgery and gas tamponade varied substantially among patients, reflecting real-world clinical practice. In some cases, delayed presentation may occur because patients attribute reduced vision to the expected postoperative recovery process. Although earlier intervention has generally been recommended for visually significant central DMDs, favorable anatomical outcomes were still achieved in several delayed cases in the present cohort [23, 24]. However, prolonged detachment may increase the risk of irreversible endothelial damage and should be interpreted cautiously.

This study has several limitations, including its retrospective design, limited sample size, absence of a control group, and lack of standardized criteria for gas selection. These limitations restrict the generalizability of the findings. Nevertheless, the study provides real-world clinical data regarding the management of centrally located planar DMD and may contribute to the limited literature regarding gas tamponade outcomes in this selected subgroup.

CONCLUSION

Anterior chamber gas tamponade in centrally located planar Descemet's membrane detachment following cataract surgery is a safe and effective treatment method that provides high anatomical success and significant visual improvement. Treatment success can be increased with appropriate patient selection, careful evaluation of endothelial status, and the use of long-acting gases when necessary.

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