

Descemet membrane detachment during phacoemulsification. A Review

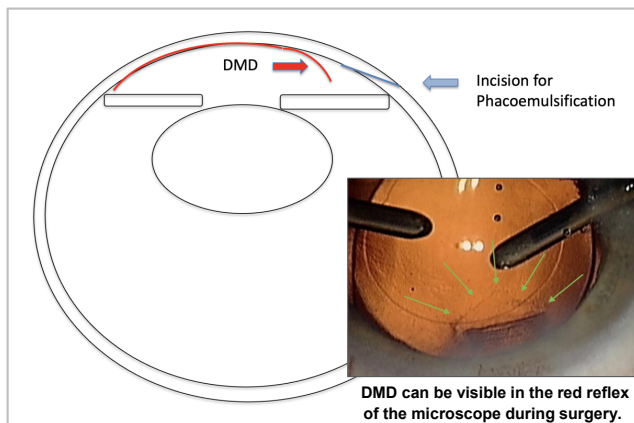
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Descemet membrane detachment (DMD) is an uncommon but clinically significant complication of cataract surgery, particularly phacoemulsification. This review summarizes current evidence on the incidence, risk factors, diagnosis, and management of DMD associated with cataract surgery. A narrative literature review identified 28 relevant publications between 1995 and 2025 across PubMed Medline, Cochrane Library Database, and Scopus, including retrospective and prospective studies, review articles, and case reports.

Most cases of DMD result from mechanical trauma at the clear corneal incision site, although spontaneous detachments have also been reported. Recognized risk factors include poor incision architecture, repeated or forceful instrument manipulation, blunt surgical instruments, elevated ultrasound energy, and limited surgical experience. Advances in anterior segment optical coherence tomography (AS-OCT) have significantly improved detection and classification, particularly in cases obscured by corneal edema.

Management depends on the extent and morphology of detachment. Small, peripheral, and planar detachments may resolve with conservative treatment, whereas extensive, central, or scrolled detachments usually require surgical intervention, most commonly descemetopexy with intracameral air or gas tamponade. Careful wound construction, meticulous surgical technique and prompt diagnosis are essential to reduce the incidence and visual consequences of this complication.

DESCEMET MEMBRANE DETACHMENT (DMD) IN CATARACT SURGERY – A REVIEW



Narrative review of published evidence (1995–2025)

- DMD is an uncommon but clinically significant complication of phacoemulsification
- Incidence varies depending on diagnostic method and definition of DMD
- Main risk factors: incision architecture, instrument-related trauma, ultrasound energy, surgeon experience
- AS-OCT is the current gold standard for diagnosis
- Small peripheral detachments may resolve spontaneously; extensive or scrolled DMD usually require intervention

Early recognition and appropriate management preserve corneal transparency and visual outcomes. Meticulous surgical technique remains the most effective prevention strategy.

Bulir P, Studeny P., doi: 10.5507/bp.2026.026

Graphical Abstract

Biomedical Papers
<https://biomed.papers.upol.cz>

Key words: descemet membrane detachment, cataract surgery, phacoemulsification, clear corneal incision, anterior segment OCT

Received: April 12, 2026; Revised: July 22, 2026; Accepted: August 12, 2026; Available online: August 25, 2026

<https://doi.org/10.5507/bp.2026.026>

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INTRODUCTION

The Descemet membrane (DM) is a crucial part of the cornea that serves as the basement membrane of the corneal endothelium, which maintains corneal dehydration and transparency. Disorders of the human corneal endothelium (HCE) or DM can lead to corneal edema, painful corneal bullae, scarring, and permanent decrease in visual acuity.

Cataract surgery is the most commonly performed surgery worldwide; however, cataracts remain a leading cause of blindness. During cataract surgery, a clear corneal incision (CCI) is commonly used to access the anterior chamber. Although generally safe, improper wound construction or intraoperative mechanical trauma at the incision site may predispose to Descemet membrane detachment (DMD), a potentially serious complication of cataract surgery. Accordingly, this review aims to contextualize DMD in phacoemulsification, emphasizing clinically relevant mechanisms, detection strategies, and therapeutic approaches.

Searching methods

The literature search for this review was designed to identify studies addressing Descemet membrane detachment (DMD) in the context of cataract surgery, particularly phacoemulsification. Electronic searches were performed using the PubMed/MEDLINE, Cochrane Library, and Scopus databases for publications from January 1995 through March 2025. The search terms included combinations of “Descemet membrane detachment”, “phacoemulsification”, “cataract surgery”, “incision-related DMD”, “descemetopexy”, “anterior seg-

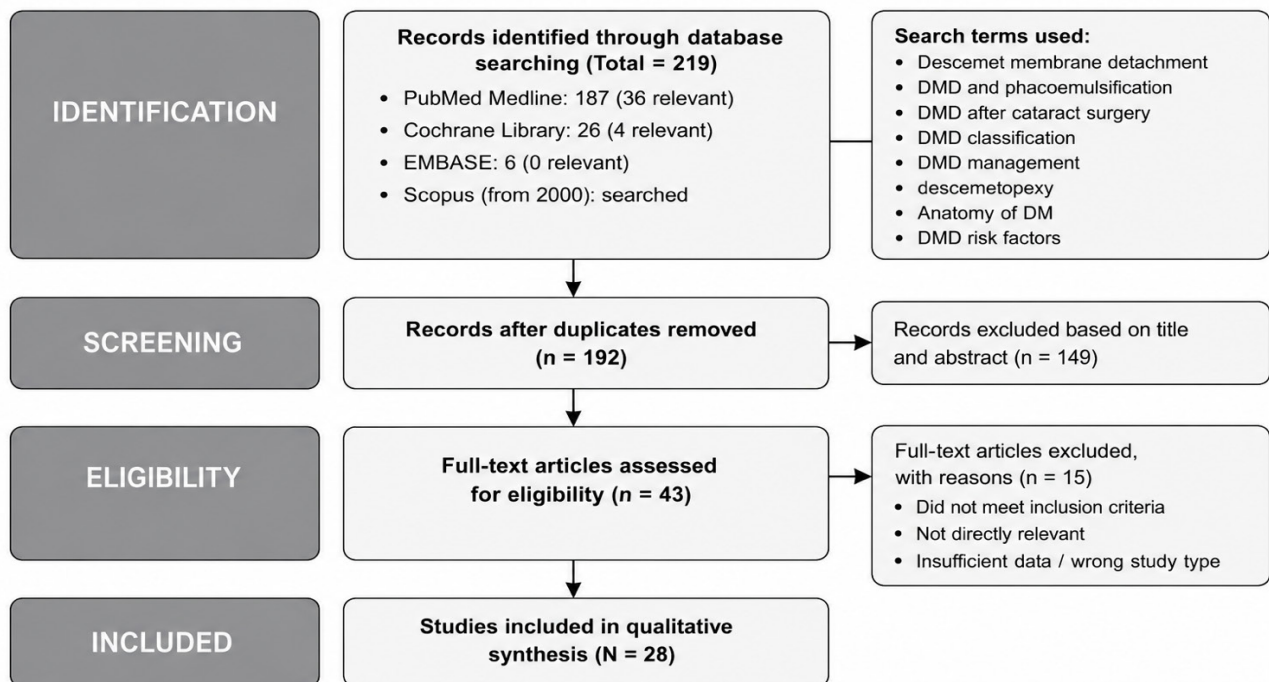
ment optical coherence tomography” and “DMD management”. Reference lists of selected articles were also manually screened to identify additional relevant studies.

Publications were eligible for inclusion if they provided clinically relevant data on the incidence, pathophysiology, diagnosis, risk factors, or management of DMD associated with cataract surgery. Eligible sources included original research articles, review papers, meta-analyses, and case reports published in peer-reviewed journals. Duplicate records, studies unrelated to cataract surgery, publications with limited clinical relevance, and non-English articles without accessible abstracts or full-text availability were excluded (Fig. 1.)

Titles and abstracts were initially screened for relevance, followed by full-text evaluation of potentially eligible studies. In total, 219 publications were identified, of which 28 (Table 1.) the most clinically relevant studies were included in this qualitative review.

Pathophysiology of DMD

Most cases of DM detachment (DMD) occur because of traumatic tears in the DM during cataract surgery, with the influx of aqueous humor causing further central detachment. However, there are also spontaneous¹ or familial cases of DMDs (ref.²). In these instances, abnormalities in the DM-stromal interface or the fibrillary attachment between the DM and posterior corneal stroma can lead to weak adhesions, which are more vulnerable to external forces. Genetic mutations, such as those affecting TGF- β -induced genes, can lead to dysfunction of the keratopithelin protein, further weakening these attachments³.



DM = Descemet membrane; DMD = Descemet membrane detachment

Fig. 1. Flow diagram of study selection.

Table 1. Studies included in qualitative synthesis.

Study Title / Author	Year	Study Type	Number of Cases	Key Findings
Complex Descemet's Membrane Tears and Detachment during Phacoemulsification (Faik Orucoglu)	2015	Case Report	1	Complex tears and detachment during surgery; successful air bubble treatment
Study on classification of Descemet membrane detachment (P. Guo)	2018	Retrospective Study	26	Classification using AS-OCT; prognosis depends on detachment extent
Incidence of Incision-Related Descemet Membrane Detachment (Y Dai)	2021	Randomized Clinical Trial	130	trapezoid incision shape significantly reduced the incidence of incision-related DMD
Descemet's Membrane Detachment After Cataract Surgery (AS Marcon)	2002	Retrospective Study	15	Analysis of causes and treatment of DMD after cataract surgery
Descemet's membrane detachment (A Beniwal)	2024	Review Article		Comprehensive review of pathogenesis, diagnosis and management
Case report on DMD during phacoemulsification (Mulhern M)	1995	Case Report	1	Full detachment case report during surgery
Outcomes of descemetopexy with air for Descemet detachment after cataract surgery (Odayappan)	2018	Retrospective Study	112	Success rates of air descemetopexy after cataract surgery
Treatment algorithm for Descemet membrane detachment post-cataract surgery (Li)	2022	Retrospective Study	13	Treatment algorithm proposal
Descemet membrane detachment during cataract surgery: review (Benatti)	2017	Review Article		Complications, prevention, and treatment overview
Descemet membrane detachment in cataract surgery - review (Singhal)	2020	Review Article		Etiology and treatment overview
Descemet detachment after phacoemulsification (Mulhern)	1996	Case Report	1	Clinical case report
Management of Descemet detachment after phacoemulsification: 3 cases (Kim)	2005	Case Report	3	Treatment results for 3 cases
Series of Descemet detachments post-cataract (Sukhija)	2010	Case Series	11	Management and outcomes
Descemet detachment after phacoemulsification and air tamponade (Weng)	2017	Case Report	1	Air tamponade treatment effectiveness
Case of Descemet detachment post-cataract (Chiu)	2018	Case Report	1	Single case report
Descemet membrane detachment treated with gas tamponade (Doi)	2021	Case Report	1	Successful treatment using gas tamponade
Successful Treatment of Post-Phacoemulsification Descemet Membrane Detachment Assessed by AS-OCT (Doi et al.)	2021	Case Report	1	AS-OCT used for diagnosis and monitoring; successful SF6 treatment
Height-, extent-, length-, and pupil-based (HELP) algorithm (Kumar et al.)	2015	Prospective Case Series	161	AS-OCT guided management algorithm for DMD post-phacoemulsification
Descemet's Membrane Detachment: An Intraoperative Complication (González et al.)	2020	Case Report	1	Intraoperative complication; managed with SF6
Safety of femtosecond laser-assisted cataract surgery versus conventional phacoemulsification Meta-analysis (Xu et al.)	2022	Meta-analysis (37 studies)	24806	Lower incidence of Descemet membrane tear/trauma in FLACS ($P=0.02$); overall similar safety to CPS
A Simple Repair Algorithm for Descemet's Membrane Detachment Performed at the Slit Lamp (Li et al.)	2022	Retrospective Case Series	12	AS-OCT and Pentacam-guided air descemetopexy at slit lamp achieved 100% reattachment; minor transient IOP rise

Table 1. (Continued)

Study Title / Author	Year	Study Type	Number of Cases	Key Findings
Successful Treatment of Post-Phacoemulsification DMD Assessed by AS-OCT (Doi et al.)	2021	Case report	1	Extensive DMD successfully treated with intracameral 20% SF ₆ gas; full reattachment, endothelial cell loss 45%
A Comparative Study between Air Bubble Tamponade Alone vs with Fluid Aspiration for Nonplanar DMD after Phacoemulsification (Gab-Alla)	2021	Prospective Randomized Clinical Trial	30	Success rate 92.6% with air + fluid aspiration vs 56% with air only; 2.2% incidence of clinically significant DMD
Case of Late-Onset Fluid-Filled Descemet Membrane Detachment After Cataract Surgery and Its Management Using the Nd:YAG Laser (Rathi et al.)	2016	Case Report	1	Late-onset DMD 19 months post-phaco; fluid drained by Nd:YAG descemetotomy; complete resolution
Incision-Site Descemet Membrane Detachment During and After Phacoemulsification (Sharma et al.)	2015	Prospective Study	43	Incision-site DMD observed in 32% (planar, self-resolving); higher risk with ultrasound time >60 s (OR 7.6)
Anterior Segment OCT-Guided Management Algorithm for Descemet Membrane Detachment After Intraocular Surgery (Sharma et al.)	2015	Prospective Interventional Study	25	AS-OCT guided air or C3F ₈ descemetopexy achieved 100% DM reattachment in 16 ± 7 days
Consecutive Descemet Membrane Detachment After Successive Phacoemulsification (Kansal & Sugar)	2001	Case Report	2	Bilateral DMD after separate phaco surgeries; repaired with intracameral air/SF ₆ ; anatomical predisposition suspected
Impact of Clear Corneal Incision Morphology on Incision-Site Descemet Membrane Detachment in Conventional and Femtosecond Laser-Assisted Phacoemulsification (Titil)	2017	Prospective Study	129	Ragged morphology of proximal opening of CCI is the most important predictive factor for incision-site DMD.

Classification

DMD classification has evolved over time with improvements in diagnostic tools and a deeper understanding of its clinical significance.

Samuels et al. (1928) divided DMD into active, passive and detachments because of the differences in elasticity⁴. Mackool and Holtz classified DMD into two main types: planar (separation <1 mm) and nonplanar (separation >1 mm). These were further divided into peripheral and central types. The planar type was associated with better outcomes without surgical intervention⁵. Asia et al. categorized DMD into two groups based on the presence or absence of scrolled edges, with the non-scrolled type having a better prognosis for spontaneous reattachment⁶. Jain et al. divided DMD into three groups based on the extent of detachment (25%, 25-50%, >50%), correlating the extent with visual outcomes⁷.

When Anterior Segment - Optical Coherence Tomography (AS-OCT) was implemented, categorization of DMD was based on this examination method.

Jacob et al. using AS-OCT introduced a classification system based on rhegmatogenous, tractional, and bullous detachments⁸. Kumar et al. developed the height-, extent-, length-, and pupil (HELP) based algorithm, based on AS-OCT findings. These consider the height, extent, length, and pupil-based location of DMD (ref.⁹).

Sharma et al. proposed an AS-OCT based classification method. This is designed for the management of

corneal edema persisting for more than two weeks due to DMD. For surgical management by planar configuration air is used, for the type with scrolled edges we use expansile intraocular gas 14% sulfur hexafluoride (SF₆). DMDs extending to the inferior half, as well as DMDs with central involvement, are treated with expansile intraocular gas perfluoropropane (C3F₈) anterior chamber instillation¹⁰.

Incidence

The incidence of DMD after cataract surgery is reported as between 0.44% (ref.¹¹) 0.52% (ref.⁹) 32% (ref.¹²) 67.6% (ref.¹⁰). The incidence of DMD following cataract surgery remains highly variable, reflecting differences in study design, diagnostic sensitivity, timing of evaluation, and clinical interpretation of what constitutes a detachment. The spectrum ranges from transient microscopic incision-site separations detectable only by intraoperative OCT to extensive vision-threatening detachments.

Early large clinical observations, such as Sharma et al. (2015), demonstrated incision-site DMD in 32% of eyes undergoing conventional phacoemulsification, all planar and spontaneously resolving, whereas a parallel AS-OCT-based study from the same group identified DMD in 67.6% of postoperative eyes with corneal edema. These results illustrate that the use of high-resolution imaging dramatically increases the detection rates, capturing clinically silent changes that would be missed by the slit lamp.

More recent institutional series have shown substan-

tially lower rates when only clinically significant detachments are included. Li et al. (2022) reported a 0.24% incidence among over 5,000 phaco cases, whereas Gab-Ala (2021) documented a 2.2% yearly incidence of non-planar vision-affecting DMD requiring intervention. Doi et al. (2021) cited a population-based rate of 0.044% per year, and Rathi et al. (2016) described a singular late-onset, fluid-filled DMD nearly two years postoperatively – an exceptional presentation.

Taken together, published data indicate that the apparent incidence of DMD ranges from <0.05% to >60%, depending on how, when, and by which modality the cornea is examined. Microscopic incision-site detachments are extremely common and transient when intraoperative or early postoperative OCT is performed. When the definition is restricted to clinically relevant, visually significant DMD, the incidence consistently falls below 1% in modern phacoemulsification practices. Surgical techniques, particularly incision morphology, stromal hydration, ultrasound time, and the precision of femtosecond laser incisions further modulate the risk¹³.

Thus, the “true” incidence of Descemet’s membrane detachment is not a single value but rather a continuum, determined by the diagnostic threshold, timing of assessment, and interpretation of what constitutes a detachment.

Risk factors and prevention

The occurrence of DMD during cataract surgery is multifactorial, reflecting the interplay between corneal anatomy, surgical technique, and intraoperative mechanical stress.

Nevertheless, there are also other possibilities for DMD, such as spontaneous or familiar non-surgical and late-onset post-surgical DMD, which cause intrinsic DM anomalies.

From the earliest description of DMD, this phenomenon has been linked to a shallow anterior chamber. Among the presumed risk factors were forceful or uncontrolled introduction of instruments into the incisions and the use of dull blades during the creation of the primary corneal incision, inappropriate incisions (oblique, excessively anterior, or shelved incisions), tight main incisions that do not fit the phaco probe, engagement of DM during the irrigation/aspiration stage, intraocular lens or phaco probe insertion, unexpected injection of antibiotics, saline or viscoelastic into the space between the deep stroma and DM, and surgeon’s inexperience¹⁴.

Among surgical risk factors, the architecture of the clear corneal incision has emerged as a critical predictor of incision-related DMD. Also, based on Singhal femtosecond-laser, CCIs have less incision-site DMD compared to keratome-assisted CCIs (ref.³). A similar finding is reported by Grewal et al. that femtosecond laser-generated CCIs had significantly lower endothelial gaping, endothelial misalignment, DMD, and posterior wound retraction than keratome-created CCIs and were within 10% of the intended length, depth, and angle measurements¹⁵. However, DMD has also been described after femtosecond laser-assisted cataract surgery, as reported by

Nosé et al., suggesting that this rare complication is not limited to conventional phacoemulsification¹⁶.

In addition, the implantation technique plays a role in the incidence of DMD. The use of an automated pre-loaded injector ensures less trauma to the wound and contributes to preserving the endothelial side of the incision, even during the implantation of high-power intraocular lenses (IOLs) and in the early postoperative period¹⁷.

Dai et al. in this study, OCT was used during the surgery, and it was found that friction caused by the surgical instruments had the greatest association with incisional DMD. Decreasing ultrasonic energy and phacoemulsification time may also reduce the severity of incisional DMD (ref.¹⁸).

In a previous study, Dai et al modified CCI by widening 2.2 mm intracameral part to 3 mm in order to reduce friction forces and their findings suggest that modified 2.2-mm trapezoid incision phacoemulsification reduces the incidence of DMD for hard nuclear age-related cataract at postoperative day 1 and might be considered in patients at high risk of incision-related DMD (ref.¹⁹).

Based on a study by Felipe et al., DMD among siblings with a predisposition to DMD among relatives may be linked to hereditary morphological abnormalities in their corneas².

Chen et al. compared the effects of longitudinal and torsional phacoemulsification on incision, and the torsional ultrasound mode may provide a lower level of phacoemulsification time and energy, and induce less incisional corneal thickness caused by thermal injury in the early postoperative period. During the long-term follow-up, no difference in wound healing was observed between the ultrasound modes²⁰.

Lee et al. compared the effect of using a metal blade knife versus a diamond blade knife for creating CCI. Corneal thickness at the incision site was significantly different between the two groups. Both groups achieved structural stabilization. There was no significant difference in the incidence of DMD between groups. The incidence of DMD was equal in meaning yes/no but not quantified in the meaning of the area²¹.

Sharma et al. reported a 32% incidence of DMD in 43 cataract surgeries. The higher rate compared with previous studies was probably related to their broader definition of incision-site DMD (ref.^{11,9}).

The results of this study showed a significantly higher rate of DMD in cases of phacoemulsification with a total ultrasound time greater than 60 s (ref.¹²).

Titiyal et. al.²² studied the morphology of CCI using AS-OCT and showed that ragged morphology of the proximal opening of the CCI is the most important predictive factor for incision-site DMD. Femtosecond laser CCIs have fewer incision-site DMDs than keratome-assisted CCIs.

Ho et. al. studied the impact of postoperative patching on incision architecture and epithelial gaping and concluded that DMD was associated with postoperative hypotony²³.

In an experimental rabbit-eye study, Vasavada et al.²⁴ compared phacoemulsification performed through a 2.2-

mm clear corneal incision using torsional ultrasound (Group 1) with surgery performed through a 1.8-mm incision using longitudinal ultrasound (Group 2). Histological analysis demonstrated epithelial disruption together with Descemet membrane detachment (DMD) at the internal aspect of the incision in Group 1, whereas only epithelial disruption was observed in Group 2, with the Descemet membrane remaining intact.

Xu et al.²⁵ reported a significantly lower incidence of Descemet membrane tears or trauma following femtosecond laser-assisted cataract surgery (FLACS) compared with conventional cataract surgery (69 vs. 115 cases).

FLACS itself may occasionally cause DMD during laser creation of the corneal incision. This occurs when air bubbles generated by the cavitation effect dissect into the potential space between the corneal stroma and Descemet's membrane. Ventura et al. described the management of this rare complication²⁶.

Detection methods

Intraoperative Detection: DMDs adjacent to the CCI or paracentesis can be recognized intraoperatively under the operating microscope by the characteristic appearance of the detached Descemet membrane against the red reflex or by its mobility.

Postoperatively, DMD can be identified as a mobile transparent layer near the cornea during slit-lamp examination. However, in most cases, the only thing we can see is corneal edema over the area of DMD that persists for more than two weeks. To identify DMD as a cause of persistent edema, some authors dehydrated the cornea by instillation of topical glycerin to visualize DMD (ref.⁵). Gonioscopy can help diagnose small peripheral DMD.

In cases where dense corneal edema blocks visualization of DMD, ultrasound biomicroscopy (UBM) can be a helpful tool for establishing and locating DMD (ref.²⁷).

Currently, the gold standard for establishing DMD is anterior segment optical coherence tomography (AS-OCT). Compared to UBM, this method is contactless; it is superior in speed, ease, and image quality. Compared with slit-lamp examination, AS-OCT detected DMD in an additional 68% of cases that were missed on slit-lamp examination. The principle of optical coherence tomography is based on the optical scattering of different ocular tissues¹⁰.

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Dai et al.¹⁸ used AS-OCT with an operating microscope during cataract surgery to monitor the incidence of DMD during different steps of the cataract procedure.

Treatment

The treatment of DMD is based on the reattachment of the DM called descemetopexy. Depending on the extent of the area, height, shape of the detachment, and degree of DMD, it is necessary to decide whether to apply a conservative approach or surgical treatment.

Considering planar, small, and peripheral DMD, spontaneous resolution of DMD is often possible⁶. Couch et al. reported a case of bilateral DMD following cataract

surgery in both eyes, with spontaneous reattachment observed in one eye.

The authors suggested that temperature-dependent aqueous humor circulation may facilitate spontaneous reattachment by promoting fluid resorption from the pre-Descemet's space²⁸. Because DMD impairs endothelial pump function and causes corneal edema, conservative management usually includes hypertonic saline (5% eye drops or 6% ointment) to reduce stromal edema until the membrane reattaches.

Topical corticosteroid eye drops are commonly prescribed to reduce inflammation and minimize fibrosis and corneal scarring^{5,12}.

According to the AS-OCT-based HELP algorithm, conservative management is recommended for planar DMDs <100 µm in height and <1 mm in length, as well as for detachments measuring 100–300 µm in height and 1–2 mm in length that spare the visual axis. This strategy achieved a reported success rate of 96.9% (ref.⁹).

Primary surgical treatment is reserved for DMDs with scrolled edges, nonplanar detachments longer than 2 mm, or detachments involving the visual axis. Persistent DMD despite conservative treatment is also an indication for surgical intervention.

Spontaneous reattachment is uncommon in DMDs with scrolled edges, as reported by Mackool et al. and Assia et al.^{5,6} According to the AS-OCT-based HELP algorithm, surgical treatment is recommended for DMDs measuring 1–2 mm in length and 100–300 µm in height within the central 5 mm of the cornea, as well as for detachments >2 mm in length and >300 µm in height within the central 8 mm. Surgical intervention is also advised for persistent DMDs that fail to resolve after 4 weeks of conservative treatment⁹.

The goal of surgical treatment is not only anatomical reattachment of the Descemet membrane but also restoration of corneal transparency and visual function.

In addition to achieving reattachment, intracameral air tamponade may also improve corneal wound healing. Yuksel et al.²⁹ demonstrated that the use of an intracameral air bubble after cataract surgery reduced the incidence of DMD as well as the epithelial and endothelial wound gaps during the early postoperative period.

Rajat et al. compared intracameral air with 14% perfluoropropane (C₃F₈) for the treatment of DMD (ref.⁷).

The results suggest that DMD after cataract surgery can be treated effectively, and good visual outcomes can be expected if the patient is treated in time with an anterior chamber injection of gas. Given its similar or greater effectiveness compared to C₃F₈, and the absence of pupillary block risk, air is recommended⁷.

Intracameral air descemetopexy has consistently shown high anatomical success rates across several retrospective studies. Odayappan et al. reported favorable outcomes in 112 patients, while Ti et al. achieved restoration of corneal clarity in 14 of 16 surgically treated eyes. Chaurasia et al. observed successful reattachment in 13 of 14 patients treated with 100% intracameral air. Failure of primary air descemetopexy appears to be uncommon; however, Akin et al. reported successful reattachment

after secondary treatment with 14% perfluoropropane (C_3F_8) (ref.^{11,30-32}).

Additional techniques have been described for the management of complex or refractory DMD. Li et al.³³ demonstrated that intracameral air descemetopexy can be safely performed at the slit lamp in selected patients. Case reports have also described successful descemetopexy using lower concentrations of perfluoropropane (10% C_3F_8) and 20% sulfur hexafluoride (SF_6) (ref.³⁴⁻³⁶). Gab-Alia et al.³⁷ compared conventional intracameral air tamponade with air tamponade combined with intracameral drainage of residual interface fluid in eyes with nonplanar DMD. The combined technique achieved higher reattachment rates and may therefore be considered a preferred first-line approach for advanced nonplanar detachments. Other reported techniques include Nd:YAG-assisted drainage of interface fluid, venting corneal incisions combined with intracameral air tamponade, and direct suturing of the Descemet membrane in selected refractory cases³⁸⁻⁴⁰.

DISCUSSION

DMD remains an under-recognized yet clinically important complication of cataract surgery. Although the reported incidence is relatively low, the actual occurrence may be underestimated owing to the frequent presence of small, clinically insignificant detachments that resolve spontaneously and often escape detection without advanced imaging. The increasing availability of anterior segment optical coherence tomography (AS-OCT) has revealed that focal detachments at the internal edge of the clear corneal incision are more common than previously assumed and occur to some degree in nearly all cases. These findings suggest that DMD is not solely a rare adverse event but may represent a spectrum of tissue responses to surgical trauma.

Risk factors appear to be multifactorial. Incision construction and architecture remain critical, as excessively steep or shelved entries predispose individuals to endothelial and Descemet trauma. Instrumental factors, including blunt keratomes or repeated manipulations through a tight incision, further increase this risk. The energy load during phacoemulsification, particularly in dense cataracts, has also been implicated, although its role is less well-defined. Importantly, surgeon experience and careful attention to tissue handling significantly reduce the likelihood of clinically significant detachment.

The clinical course of DMD is highly variable, with outcomes largely determined by the extent, location, and morphology of the detachment. Conversely, large, central, or scrolled detachments carry a higher risk of corneal edema, delayed visual rehabilitation, or even permanent endothelial decompensation. Descemetopexy with air or gas remains the treatment of choice; however, repeated procedures may be necessary in refractory cases. Novel techniques, including the use of viscoelastic tamponade and tissue adhesives, have been explored with varying success rates.

From a diagnostic perspective, AS-OCT has revolutionized the ability to detect and characterize DMD. Beyond its clinical utility, it offers potential as a research tool to better quantify the extent of detachment and correlate it with surgical techniques, incision design, or patient-specific factors, such as corneal biomechanics.

Further research should prioritize prospective investigations that systematically assess both clinically significant and subclinical manifestations of DMD. Standardization of classification systems incorporating morphological and topographic features would improve comparability across studies and guide management algorithms. Preventive strategies, including refinement of incision design, improvements in surgical instrumentation, and surgeon training, remain the key to reducing the burden of this complication.

In conclusion, although DMD after cataract surgery is often self-limiting, it should not be underestimated. Careful prevention, early recognition, and appropriate intervention are essential to preserve corneal transparency and to ensure optimal surgical outcomes.

CONCLUSION

DMD in the setting of phacoemulsification spans a continuum from clinically insignificant transient incision-site separations to clinically significant vision-threatening detachments. Its occurrence is shaped by what is considered DMD, when it is assessed, and how it is detected. Sensitive imaging, particularly AS-OCT, reveals many planar, self-resolving incision-site changes that inflate incidence figures compared with slit-lamp-based postoperative assessments. This explains why prospective, imaging-rich series report high rates of incision-site DMD (e.g., ~32% planar, self-resolving) and substantial postoperative detection when edema is specifically worked up with AS-OCT, whereas routine clinical series confined to visually significant events report incidences well under 1%.

Risk is modifiable. Incision construction and morphology are pivotal; ragged proximal wound architecture predicts DMD, and femtosecond-created CCIs appear to reduce incision-site trauma relative to keratome incisions. On a broader level, a meta-analysis suggests lower odds of Descemet membrane tear/trauma with laser-assisted corneal incisions, even though overall safety between FLACS and conventional surgery remains comparable. These data, together with the association between longer ultrasound time and DMD, support meticulous wound design, reduced instrument-incision friction, and energy-sparing techniques.

Diagnosis and management have been standardized and improved using AS-OCT-guided pathways. Tailored descemetopexy (air vs. non-expansile/expansile gas) achieves high anatomic reattachment in algorithm-driven care, and pragmatic refinementssuch as slit-lamp air descemetopexy for timely outpatient interventionextend access while maintaining excellent outcomes. In more extensive, nonplanar detachments, pairing air tamponade with internal fluid aspiration increases the success

compared with air tamponade alone. Individual case reports further illustrate the role of SF and highlight the endothelial safety considerations.

Clinical implications are clear:

- Prevention optimizes the CCI architecture, minimizes wound manipulation and ultrasound time, and considers femtosecond incisions when resources and indications align.
- Early recognition: AS-OCT is used liberally when edema persists or visualization is limited; many “silent” detachments are only visible with imaging.
- Tiered treatment: observe small planar/peripheral DMD; escalate promptly for central, scrolled, or extensive cases with air/gas tamponade, and add fluid aspiration for nonplanar, large detachments. Pragmatic outpatient protocols can safely expedite care.

Future work should prioritize consensus on the definitions of clinically meaningful DMD, standardized timing of assessment, and uniform imaging endpoints to harmonize incidence reporting and enable meta-analysis across techniques. Prospective trials comparing wound designs and energy-reduction strategies with predefined AS-OCT outcomes are likely to yield the most actionable guidance for further reducing clinically significant DMD and preserving visual outcomes.

Search strategy and selection criteria

Our search strategy aimed to identify published studies addressing Descemet membrane detachment (DMD) associated with cataract surgery, particularly phacoemulsification. Electronic searches were conducted in the PubMed/MEDLINE, Cochrane Library, EMBASE, and Scopus databases for articles published between January 1995 and March 2025. The search terms included combinations of “Descemet membrane detachment”, “DMD”, “phacoemulsification”, “cataract surgery”, “incision-related DMD”, “descemetopexy”, “anterior segment optical coherence tomography” and “DMD management”. Reference lists of selected publications were also manually screened to identify additional relevant studies. Original research articles, review articles, meta-analyses, and case reports published in peer-reviewed journals were considered eligible if they provided clinically relevant information on the incidence, pathophysiology, diagnosis, risk factors, or management of DMD related to cataract surgery. Duplicate records, studies unrelated to cataract surgery, publications with limited clinical relevance, and non-English articles without accessible abstracts or full-text availability were excluded. A total of 219 records were identified, of which 28 clinically relevant studies were included in this qualitative review.

Author contributions: All authors contributed substantially to this work in accordance with the ICMJE guidelines. PB: conceived and designed the study, acquired the data, performed the analysis and interpretation, and drafted the initial version of the manuscript; PS: contributed to drafting the manuscript and revised it critically for impor-

tant intellectual content. Both authors approved the final version to be published and agree to be accountable for all aspects of the work.

Conflict of interest statement: The authors state that there are no conflicts of interest regarding the publication of this article.

Declaration of generative AI and AI-assisted technologies: The authors used generative artificial intelligence (AI)-assisted technology during the preparation of this manuscript for language editing, stylistic refinement, and improvement of readability. The authors reviewed and edited the generated content as necessary and take full responsibility for the final content of the manuscript.

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