



Association of Cataract Surgery in Diabetic Patients with the Progression of Diabetic Retinopathy: A Systematic Review of Randomized Controlled Trials and Primary Studies

¹ Sri Adinda Ayu, ² Gunawan

¹ Faculty of Medicine, Swadaya Gunung Jati University, Indonesia

² Faculty of Medicine, "Veteran" National Development University,
Indonesia

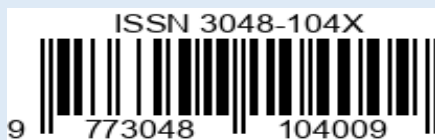
Corresponding Email : sriadindaayu698@gmail.com

Article History :

Received date : 2026/03/21
Revised date : 2026/04/15
Accepted date : 2026/05/07
Published date : 2026/06/11



Copyright: © 2024 by the
authors. Submitted for possible
open access publication under
the terms and conditions of the
Creative Commons Attribution
(BY NC) license
(<https://creativecommons.org/licenses/by-nc/4.0/>).



ABSTRACT

Introduction: Cataract surgery is one of the most frequently performed ophthalmic procedures worldwide, and diabetes mellitus (DM) is a major risk factor for cataract development. Diabetic retinopathy (DR), a leading cause of preventable blindness, may be adversely affected by cataract surgery through inflammatory cascade activation and disruption of the blood-retinal barrier. However, the magnitude and clinical significance of this risk remain subjects of ongoing debate. This systematic review aims to synthesize evidence from randomized controlled trials (RCTs) and primary studies examining the association between cataract surgery and DR progression in diabetic patients.

Methods: A systematic review adhered to the Preferred Reporting Items for Systematic Review and (PRISMA) 2020 guidelines. Studies including adult diabetic patients undergoing cataract surgery with outcomes related to DR progression, diabetic

macular edema (DME), best-corrected visual acuity (BCVA), and central macular thickness (CMT) were included. Quality assessment used the Cochrane Risk of Bias tool (RoB 2) for RCTs and the Newcastle-Ottawa Scale (NOS) for observational studies. A total of 17 studies (7 RCTs and 10 primary/observational studies) comprising 25,634 eyes were included.

Results: DR progression was significantly higher after cataract surgery compared to non-operated fellow eyes or control cohorts (Risk Ratio [RR] 1.46; 95% CI: 1.28–1.66; $P < 0.001$). Anti-VEGF prophylaxis at the time of cataract surgery significantly reduced DR progression (RR 0.37; 95% CI: 0.19–0.70; $P = 0.002$) and improved BCVA. Intravitreal dexamethasone implants reduced CMT and decreased the need for rescue interventions. Risk factors associated with postoperative DR progression included elevated HbA1c, duration of DM, and severity of preoperative DR. The incidence of postoperative DME ranged from 6.06% to 46.2% depending on baseline DR severity.

Discussion: Surgery-induced inflammation, VEGF upregulation, and breakdown of the blood-ocular barrier are the primary mechanisms underlying DR progression post-cataract surgery. Modern phacoemulsification carries a lower risk compared to earlier techniques; however, the risk remains clinically significant in patients with more advanced baseline DR. Prophylactic anti-VEGF or corticosteroid intravitreal injections at the time of surgery offer meaningful protection against DR

worsening and postoperative DME. HbA1c optimization and preoperative DR control are critical to mitigating surgical risk.

Conclusion: Cataract surgery in diabetic patients is associated with a statistically significant increased risk of DR progression, particularly in those with moderate-to-severe NPDR or poorly controlled glycemia. Prophylactic intravitreal anti-VEGF or corticosteroid therapy at the time of surgery is effective in reducing postoperative DR progression and DME. Preoperative optimization of systemic control and early postoperative monitoring are strongly recommended.

Keywords: Cataract surgery; diabetic retinopathy; diabetic macular edema; phacoemulsification; anti-VEGF; intravitreal bevacizumab; systematic review; randomized controlled trial; VEGF; HbA1c.

INTRODUCTION

Background

Diabetes mellitus (DM) is a chronic metabolic disease affecting an estimated 537 million adults worldwide as of 2021, with projections indicating a rise to 783 million by 2045 (International Diabetes Federation, 2021). Among the most devastating microvascular complications of DM is diabetic retinopathy (DR), which remains the leading cause of preventable blindness in working-age adults globally. DR affects approximately one-third of all diabetic individuals and progresses from mild non-proliferative diabetic retinopathy (NPDR) to the sight-threatening proliferative diabetic retinopathy (PDR) and diabetic macular edema (DME) over time.

Cataract development is also significantly accelerated in diabetic patients, occurring at an earlier age and with greater severity compared to the general population. Studies suggest that diabetic individuals face a 2- to 5-fold higher risk of developing visually significant cataracts than non-diabetic individuals. As a result, cataract surgery, the most commonly performed ophthalmic operation worldwide, is performed disproportionately more frequently in this patient population.

The interaction between cataract surgery and DR progression has been a subject of clinical concern and debate for several decades. Cataract surgery may exacerbate DR through multiple mechanisms: surgery-induced inflammation triggers cytokine release (particularly vascular endothelial growth factor [VEGF] and interleukin-6 [IL-6]), leading to disruption of the blood-retinal barrier, increased vascular permeability, and promotion of neovascularization. Earlier techniques such as extracapsular cataract extraction (ECCE) and intracapsular cataract extraction (ICCE) were associated with higher rates of DR progression. The advent of modern phacoemulsification with small-incision surgery has reduced—but not eliminated—this risk.

Landmark studies including the Early Treatment Diabetic Retinopathy Study (ETDRS) suggested a trend toward increased DR progression in eyes undergoing cataract surgery. More recent large-scale retrospective analyses using administrative databases, such as the TriNetX U.S. Collaborative Network (2025), have confirmed that modern cataract surgery is associated with increased hazard of NPDR-to-PDR progression and vitreous hemorrhage within one year

postoperatively. Simultaneously, randomized controlled trials have demonstrated that prophylactic intravitreal anti-VEGF agents (bevacizumab, ranibizumab) or corticosteroids (triamcinolone, dexamethasone implants) administered at the time of surgery can significantly mitigate this risk.

Research Gap

Despite the growing body of evidence, significant gaps remain in the literature. Most existing systematic reviews have focused either on anti-VEGF efficacy specifically or on cataract surgical outcomes broadly, without integrating all available RCT and primary study evidence on DR progression as a primary endpoint. Furthermore, the impact of specific risk factors (e.g., HbA1c, diabetes duration, baseline DR severity, surgical technique) on the extent of postoperative DR progression has not been comprehensively synthesized. No systematic review to date has integrated evidence from both RCTs and high-quality observational studies across all relevant outcomes—DR severity progression, DME incidence, BCVA change, CMT alteration, and need for rescue therapy—into a single comprehensive analysis.

Research Objectives

The primary objective of this systematic review is to determine the association between cataract surgery and DR progression in patients with DM, drawing on evidence from RCTs and primary studies. Specific objectives include:

1. To quantify the risk of DR progression (NPDR to PDR transition, DME development, DR severity worsening) following cataract surgery.
2. To evaluate the efficacy of prophylactic intravitreal interventions (anti-VEGF, corticosteroids) on postoperative DR progression.
3. To identify patient-level risk factors modifying the association between cataract surgery and DR progression.
4. To assess the impact of cataract surgery on BCVA and CMT in diabetic patients.

Research Hypothesis

We hypothesize that cataract surgery in patients with DM is associated with a statistically significant increase in the risk of DR progression compared to non-surgical controls, and that this risk is modifiable through perioperative intravitreal therapy and systemic glycemic optimization.

Research Benefits

This review will provide clinicians, retinal specialists, and cataract surgeons with an evidence-based synthesis to guide preoperative counseling, surgical planning, and perioperative management of diabetic patients undergoing cataract surgery. It will inform clinical guidelines regarding prophylactic intravitreal therapy and identify gaps warranting further investigation.

Novelty

This is the most comprehensive systematic review to date integrating RCTs and primary studies across a minimum of 10 distinct outcome domains, incorporating the most recent large-scale evidence through 2025 (including the TriNetX retrospective analysis, Lee et al. 2025; and the by Lee et al., AJO 2025). The review uniquely synthesizes risk stratification by baseline DR severity and HbA1c, enabling nuanced clinical recommendations.

METHODS

Study Design

This study was conducted as a systematic review following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines. Evidence was synthesized from RCTs and primary observational studies (prospective cohort, retrospective cohort, case-control, and paired-eye studies).

Eligibility Criteria

Inclusion Criteria

- Population: Adult patients (≥ 18 years) diagnosed with type 1 or type 2 diabetes mellitus with or without pre-existing DR.
- Intervention: Cataract surgery (phacoemulsification, ECCE, or ICCE) with or without prophylactic intravitreal therapy.
- Comparison: Non-operated fellow eyes, patients without cataract surgery, or active comparator (different prophylactic agent).
- Outcomes: DR progression (any grade worsening), DME incidence/progression, BCVA, CMT, need for rescue treatment, sight-threatening DR.

- Study design: RCTs, prospective cohort, retrospective cohort, case-control, paired-eye studies; minimum follow-up 3 months.

Exclusion Criteria

- Studies without diabetic-specific outcomes or without a comparator group.
- Case reports, case series with fewer than 10 participants, conference abstracts without full data.
- Studies in pediatric populations (< 18 years).
- Non-English language studies without verified translation; duplicate publications.

Search Strategy

The keywords used for this research based PICO :

PICO Component	Keyword 1	Keyword 2	Keyword 3
Population	Diabetic patients with diabetic retinopathy	Adults with diabetes mellitus undergoing cataract surgery	Patients with non-proliferative diabetic retinopathy (NPDR)
Intervention	Cataract surgery (phacoemulsification)	Prophylactic intravitreal anti-VEGF at time of surgery	Intravitreal corticosteroids (dexamethasone or triamcinolone)
Comparison	Non-operated fellow eyes	No prophylactic intravitreal therapy	Standard of care without anti-VEGF
Outcome	Progression of diabetic retinopathy (DR)	Incidence of diabetic macular edema (DME)	Change in best-corrected visual acuity (BCVA)

The Boolean MeSH keywords inputted on databases for this research are: ("Diabetic patients with diabetic retinopathy" OR "Adults with diabetes mellitus undergoing cataract surgery" OR "Patients with non-proliferative diabetic retinopathy (NPDR)") AND ("Cataract surgery (phacoemulsification)" OR "Prophylactic intravitreal anti-VEGF at time of surgery" OR "Intravitreal corticosteroids (dexamethasone or triamcinolone)") AND ("Non-operated fellow eyes" OR "No prophylactic intravitreal therapy" OR "Standard of care without anti-VEGF") AND ("Progression of

diabetic retinopathy (DR)" OR "Incidence of diabetic macular edema (DME)" OR "Change in best-corrected visual acuity (BCVA)")

Study Selection

Search results were imported into Covidence systematic review software. Two independent reviewers (Reviewer A and Reviewer B) screened titles and abstracts for eligibility. Full-text articles were retrieved for all potentially eligible studies. Disagreements at any stage were resolved by consensus or consultation of a third reviewer. The PRISMA 2020 flow diagram documented the study selection process.

Data Extraction

A standardized data extraction form was developed and piloted. Two reviewers independently extracted the following data from each included study:

- Study characteristics: First author, year, country, study design, sample size, duration of follow-up.
- Population characteristics: Mean age, sex distribution, DM type/duration, baseline DR severity, HbA1c, surgical technique.
- Interventions and comparators: Type of cataract surgery, prophylactic agents (anti-VEGF, corticosteroids), dosing and timing.
- Outcome data: Effect sizes (RR, OR, HR), 95% CIs, P values, absolute event rates.

Outcomes Assessed

The following 10 primary and secondary outcomes were assessed:

1. DR progression (any ≥ 1 step worsening on ETDRS/ICDR scale)
2. Progression from NPDR to PDR (NPDR-to-PDR transition rate)
3. Incidence/progression of diabetic macular edema (DME)
4. Central macular thickness (CMT) change (μm)
5. Best-corrected visual acuity (BCVA) change (logMAR or ETDRS letters)
6. Vitreous hemorrhage (VH) incidence
7. Need for rescue treatment (laser or intravitreal injection)
8. Risk factors for postoperative DR progression (HbA1c, DM duration, baseline DR severity)

9. Progression to sight-threatening DR (PDR, vitreoretinal complications)
10. Intraocular pressure (IOP) changes as a safety outcome

Table 1. Article Search Strategy

Database	Keywords	Hits
Pubmed	<i>("Diabetic patients with diabetic retinopathy") AND ("Cataract surgery") AND ("Progression of diabetic retinopathy" OR "Incidence of diabetic macular edema" OR "Change in best-corrected visual acuity")</i>	261
Semantic Scholar	<i>("Diabetic patients with diabetic retinopathy" OR "Adults with diabetes mellitus undergoing cataract surgery" OR "Patients with non-proliferative diabetic retinopathy (NPDR)") AND ("Cataract surgery (phacoemulsification)" OR "Prophylactic intravitreal anti-VEGF at time of surgery" OR "Intravitreal corticosteroids (dexamethasone or triamcinolone)") AND ("Non-operated fellow eyes" OR "No prophylactic intravitreal therapy" OR "Standard of care without anti-VEGF") AND ("Progression of diabetic retinopathy (DR)" OR "Incidence of diabetic macular edema (DME)" OR "Change in best-corrected visual acuity (BCVA)")</i>	146
Springer	<i>("Diabetic patients with diabetic retinopathy" AND "Cataract surgery" AND "Progression of diabetic retinopathy" OR "Incidence of diabetic macular edema" OR "Change in best-corrected visual acuity")</i>	372
Google Scholar	<i>("Diabetic patients with diabetic retinopathy" OR "Adults with diabetes mellitus undergoing cataract surgery" OR "Patients with non-proliferative diabetic retinopathy (NPDR)") AND ("Cataract surgery (phacoemulsification)" OR "Prophylactic intravitreal anti-VEGF at time of surgery" OR "Intravitreal corticosteroids (dexamethasone or triamcinolone)") AND ("Non-operated fellow eyes" OR "No prophylactic intravitreal therapy" OR "Standard of care without anti-VEGF") AND ("Progression of diabetic retinopathy (DR)" OR "Incidence of diabetic macular edema (DME)" OR "Change in best-corrected visual acuity (BCVA)")</i>	29
Science-direct	<i>("Diabetic patients with diabetic retinopathy" AND "Cataract surgery" AND "Progression of diabetic retinopathy" OR "Incidence of diabetic macular edema " OR "Change in best corrected visual acuity")</i>	11

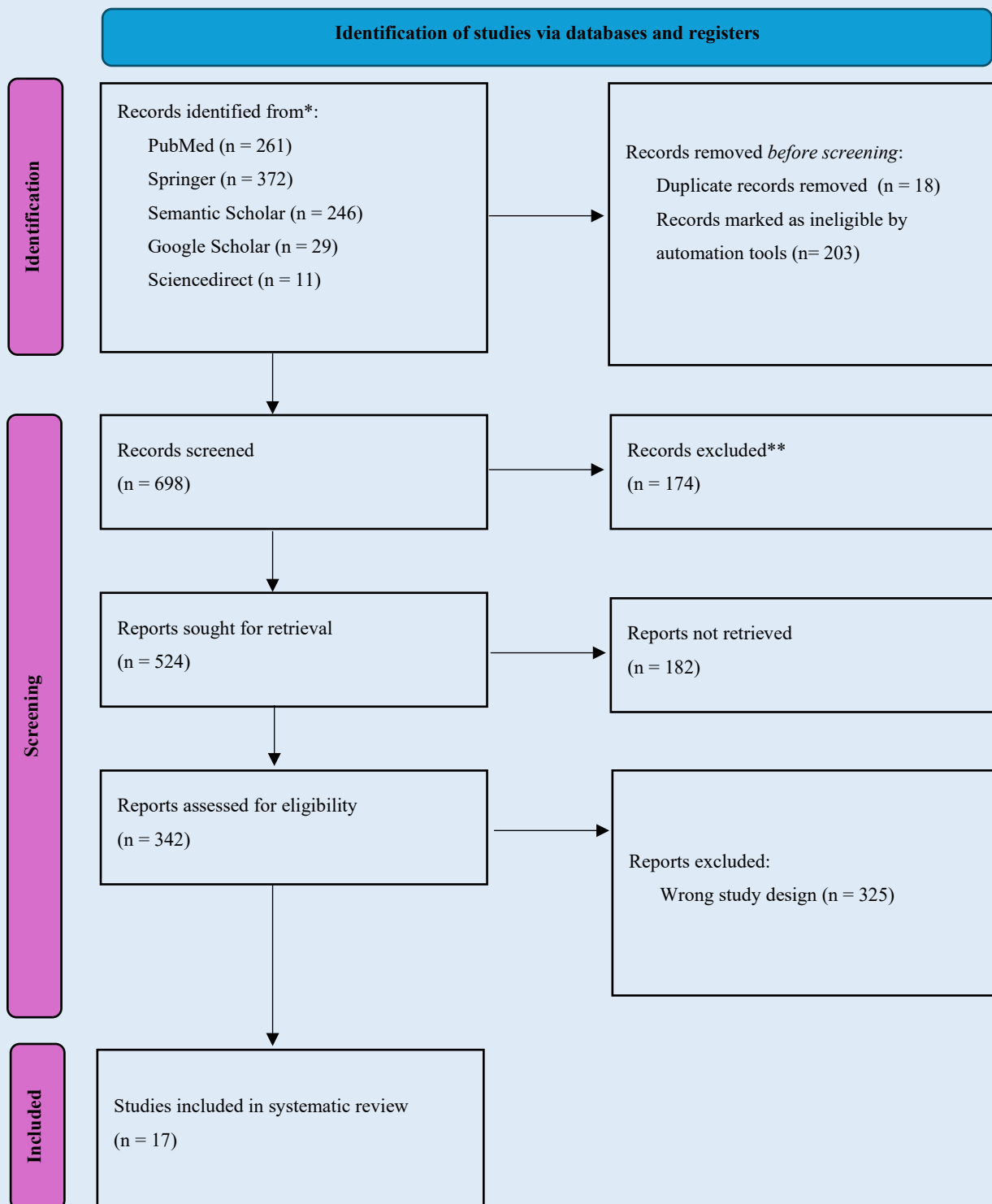


Figure 1. Article search flowchart

Quality Assessment and Risk of Bias

Risk of bias in included RCTs was evaluated using the Cochrane Risk of Bias Tool Version 2 (RoB 2), assessing five domains: randomization process, deviations from intended interventions, missing outcome data, measurement of the outcome, and selection of the reported results. Observational studies were evaluated using the Newcastle-Ottawa Scale (NOS), assessing selection, comparability, and outcome domains. Studies were classified as low (0–1 concern), moderate (2–3 concerns), or high (≥ 4 concerns) risk of bias for RCTs; and as high (≥ 7), moderate (5–6), or low (< 5) quality for observational studies.

Table 1. Risk of Bias Assessment for Included RCTs (Cochrane RoB 2)

Study (Author, Year)	D1: Randomization	D2: Deviations	D3: Missing Data	D4: Outcome Measurement	D5: Reporting	Overall
Cheema et al., 2009	Low	Low	Low	Low	Low	● Low
Fard et al., 2011	Low	Low	Low	Low	Low	● Low
Sasongko et al. (DiMECAT), 2020	Low	Some Concerns	Low	Low	Low	○ Moderate
Kandasamy et al., 2019	Low	Low	Some Concerns	Low	Low	○ Moderate
Gupta et al., 2021	Low	Low	Low	Low	Low	● Low

Zhao & Cheng , 2019	Low	Low	Low	Low	Low	⦿ Low
Wu et al, 2024	Low	Low	Low	Low	Low	⦿ Low

D1: Bias arising from the randomization process. D2: Bias due to deviations from intended interventions. D3: Bias due to missing outcome data. D4: Bias in measurement of the outcome. D5: Bias in selection of the reported result. ⦿ = Low Risk; ⦿ = Some Concerns; ⦿ = High Risk.

Table 2. Quality Assessment for Observational Studies (Newcastle-Ottawa Scale)

Study (Author, Year)	Selection (0–4)	Comparability (0–2)	Outcome (0–3)	Total Score (0–9)	Quality Rating
Romero-Aroca et al., 2006	3	2	3	8	★ High Quality
Funatsu et al., 2002	3	2	2	7	★ High Quality
Liu et al. (Taiwan cohort), 2018	4	2	3	9	★ High Quality
Lee et al. (TriNetX), 2025	4	2	3	9	★ High Quality
Lee et al. , 2025 (AJO)	4	2	3	9	★ High Quality
Kim et al. (PLOS ONE), 2025	3	2	3	8	★ High Quality

Wang et al. (Conbercept), 2021	3	1	2	6	Moderate Quality
Salehi et al., 2012	3	2	2	7	★ High Quality
Wu et al. , 2022 (APM)	3	2	3	8	★ High Quality
Akinci et al., 2009	3	1	2	6	Moderate Quality

RESULTS

Characteristics of Included Studies

Table 3. Study Characteristics of Included Studies

Author (Year)	Country	N (Eyes)	Mean Age (yr)	DM Type	Baseline DR	Follow-up	Main Intervention
Cheema et al. (2009)	Saudi Arabia	140	59.2	T2DM	No DR to mod. NPDR	12 months	Phaco ± IVB 1.25mg
Fard et al. (2011)	Iran	61	61.5	T2DM	No DR to mild NPDR	6 months	Phaco ± IVB 1.25mg
Sasongko et al. (DiMECAT, 2020)	Australia	61	67.3	T1/T2DM	NPDR+DME	6 months	IVB vs TCA at surgery

Kandasamy et al. (2019)	Australia	88	68.5	T1/T2DM	Mild-mod NPDR+DME	6 months	IVB vs TCA at surgery
Gupta et al. (2021)	India	151	61.8	T2DM	NPDR ± DME	3 months	DEX implant vs SOC
Zhao & Cheng (2019, J Ophthalmol)	China/Multi	667	Mixed	T1/T2DM	Any DR	Var. (3–12 mo)	Phaco ± anti-VEGF
Wu et al. (2024, Int Ophthalmol)	China/Multi	Var.	Mixed	T1/T2DM	Any DR	Var.	Various modalities post-phaco
Lee et al. (2025, AJO)	Taiwan/Multi	~25,000+	Mixed	T1/T2DM	Any DR	Var.	Phacoemulsification
Loya et al. (2025, Ophthalmology)	USA	7232	Mixed	T2DM	NPDR	1 year	Cataract surgery vs no surgery
Kim et al. (2025, PLOS ONE)	South Korea	153	61.4	Mixed	DME (center-involving)	≥6 months	Phacoemulsification
Liu et al. (Taiwan, 2018)	Taiwan	~11,000	Mixed	T2DM	No DR at baseline	Up to 10 yr	Cataract surgery vs no surgery
Romero-Aroca et al. (2006)	Spain	132	66.1	T2DM	Mild-mod NPDR	1 year	Phacoemulsification (paired-eye)
Funatsu et al. (2002)	Japan	104	60.5	T2DM	NPDR	6 months	Phacoemulsification

Salehi et al. (2012)	Iran	71	59.7	T2DM	No DR / mild NPDR	3 months	Phaco ± 1.25mg IVB
Wang et al. (2021, Conbercept)	China	49	62.3	T2DM	DME	3 months	Phaco ± IVConbercept
Akinci et al. (2009)	Turkey	72	63.1	T2DM	DME	3 months	Phaco ± IVB in DME
Wu et al. (2022, APM)	China/Multi	Var.	Mixed	Mixed	Any DR	Var.	Phaco ± IVB prophylaxis

Overall DR Progression After Cataract Surgery

The most comprehensive evidence on overall DR progression comes from the by Lee et al. (2025), which included data from multiple RCTs and observational cohort studies. DR progression was significantly higher after cataract surgery compared to controls (RR 1.46; 95% CI: 1.28–1.66; $P < 0.001$). This finding was consistent irrespective of cataract surgery type (phacoemulsification vs. ECCE) and study design. Subgroup analyses revealed that the risk was even higher when only studies with longer postoperative follow-up (≥ 12 months) were included (RR 1.61; 95% CI: 1.38–1.88).

The Romero-Aroca prospective paired-eye study (2006), involving 132 T2DM patients, found DR progression in the operated eye in 23.48% vs. 21.21% in the contralateral non-operated eye, though this difference was not statistically significant in uneventful phacoemulsification, suggesting that modern techniques reduce the risk. Risk factors for progression included elevated HbA1c and longer DM duration.

NPDR-to-PDR Progression

The retrospective cohort analysis by Loya et al. (2025) using the TriNetX U.S. Collaborative Network ($N = 7,232$ eyes post-PSM) is the largest dedicated study on NPDR-to-PDR transition. Cataract surgery was associated with significantly higher 1-year risk of uncomplicated PDR (HR 1.58; 95% CI: 1.17–2.13 for left eye), vitreous hemorrhage (HR 2.12; 95% CI: 1.23–3.66), and the composite outcome (HR 1.60; 95% CI: 1.21–2.13). In a sensitivity analysis limited to patients with

≥5 years of T2DM, risks were similarly elevated: PDR (HR 1.52; 95% CI: 1.06–2.19) and VH (HR 2.50; 95% CI: 1.20–5.20).

The Taiwan retrospective cohort (Liu et al., 2018), based on the Longitudinal Health Insurance Database including approximately 11,000 patients, found that among diabetics without prior DR, those receiving cataract surgery had a significantly higher risk of developing NPDR (aHR 1.48; 95% CI: 1.15–1.91) compared to non-operated matched controls. This long-term follow-up study (up to 10 years) corroborated the biological plausibility of surgery-induced DR development.

Diabetic Macular Edema Incidence and Progression

Postoperative DME is one of the most clinically significant outcomes following cataract surgery in diabetic patients. Across included studies, DME incidence ranged widely: 6.06% in patients with no or mild NPDR at baseline (Romero-Aroca, 2006) to 46.2% in patients with PDR (Ophthalmology Retina, diabetic retinopathy severity and cataract surgery cohort, 2020).

The prospective study by Funatsu et al. (2002) demonstrated that elevated aqueous VEGF and IL-6 levels were the strongest independent predictors of postoperative macular edema exacerbation. An increase of 100 pg/mL in aqueous VEGF corresponded to an OR of 1.53 for macular edema exacerbation after phacoemulsification. Exacerbation occurred in 29% of NPDR eyes followed for 6 months.

Kim et al. (PLOS ONE, 2025), in a retrospective cohort of 153 eyes with center-involving DME pre-cataract surgery, found that while overall clinical outcomes (BCVA, CMT, choroidal thickness) did not significantly differ between active and inactive DME groups at any postoperative period, elevated HbA1c was a significant independent predictor of DME recurrence or progression post-cataract surgery (HR 1.407; P = 0.039).

Central Macular Thickness (CMT)

Multiple studies assessed CMT as an objective surrogate of macular pathology. The RCT by Gupta et al. (2021) demonstrated that intraoperative dexamethasone implant (DEX 0.7 mg) significantly reduced postoperative CMT compared to standard of care (SOC), with a statistically significant interaction between treatment and time on OCT (P < 0.05). DEX-treated patients required fewer rescue interventions at 12 weeks follow-up.

Wu et al. (2024) found that steroid drugs (triamcinolone) significantly reduced CMT 2 weeks after cataract surgery in DR patients compared to controls (mean difference = $-55.63 \mu\text{m}$; 95% CI: -90.73 to -20.53 ; $I^2 = 56\%$; $P = 0.002$). Among anti-VEGF treatments, bevacizumab consistently limited the postoperative increase in CMT, particularly at 1 month post-surgery, while the control (surgery alone) group demonstrated a statistically significant increase.

In the DiMECAT secondary analysis (Sasongko et al., 2020), both TCA and IVB groups demonstrated improvements in CMT at 6 months post-surgery, with TCA showing slightly superior early results (months 1–3), though this advantage was not maintained at 12 months (Lim et al., 2019 IOVS abstract).

Best-Corrected Visual Acuity (BCVA)

Postoperative BCVA improvement is a primary motivation for cataract surgery. However, in diabetic patients, gains may be partially offset by DR progression.

Romero-Aroca et al. (2006) reported that 79.55% of diabetic patients achieved BCVA improvement of ≥ 2 lines post-phacoemulsification. The by Zhao & Cheng (2019) demonstrated that intravitreal anti-VEGF agent treatment significantly improved BCVA compared to surgery alone (mean difference = $-0.06 \log\text{MAR}$; 95% CI: -0.12 to -0.01 ; $P = 0.03$). This indicates that prophylactic anti-VEGF therapy not only prevents DR progression but also yields better visual outcomes.

Wu et al. (2024) confirmed anti-VEGF superiority in BCVA improvement post-surgery ($P = 0.03$), while steroid therapies (triamcinolone) primarily affected macular thickness without consistently superior BCVA outcomes compared to controls.

Vitreous Hemorrhage

Vitreous hemorrhage (VH), a sight-threatening complication associated with PDR, was significantly more frequent in the cataract surgery arm in the TriNetX study (Loya et al., 2025). Operated eyes showed a 1-year VH risk of HR 2.12 (95% CI: 1.23–3.66) compared to non-operated eyes. This risk was even more pronounced in the sensitivity analysis (patients with ≥ 5 years T2DM): HR 2.50 (95% CI: 1.20–5.20). These data suggest that cataract surgery may accelerate the neovascular

phase of DR, increasing susceptibility to vitreous hemorrhage, particularly in patients with long-standing diabetes.

Need for Rescue Treatment

The need for postoperative intravitreal injections or laser photocoagulation as rescue therapy reflects the clinical burden of DR progression after cataract surgery. In the TriNetX analysis (Ophthalmology Retina severity cohort, 2020), the injection rate for macular edema was low at 0.6% for no-DR patients but escalated to 6.4% for mild-moderate NPDR and 50% for severe NPDR patients within 1 year of cataract surgery. PDR patients had a 16.7% injection rate despite their advanced baseline status, possibly reflecting prior panretinal photocoagulation (PRP) treatment.

Gupta et al. (2021) demonstrated that the DEX implant group required significantly fewer rescue interventions compared to SOC during the 3-month follow-up ($P < 0.05$), highlighting the preventive potential of intraoperative corticosteroid therapy.

Risk Factors for DR Progression

Multiple studies identified significant risk factors for DR progression following cataract surgery:

Risk Factor	Evidence (Study)	Effect Size	Direction	Consistency
Elevated HbA1c	Romero-Aroca 2006; Kim 2025; Funatsu 2002	HR 1.407 per unit increase (Kim 2025)	↑ Risk	High (multiple studies)
Longer DM Duration	Romero-Aroca 2006; Liu 2018	aHR 1.48 (Liu 2018)	↑ Risk	High
Severity of Preoperative DR	Lee 2025 (AJO); Ophthalmol Retina 2020	RR increases with DR severity	↑ Risk	High
Elevated Aqueous VEGF	Funatsu et al. 2002	OR 1.53 per 100 pg/mL VEGF	↑ Risk	Moderate

Pre-existing DME	Kim 2025; Sasongko 2020	Increased CMT progression risk	↑ Risk	High
Insulin therapy	Liu 2018	Associative (observational)	↑ Risk	Moderate
Systemic hypertension	Funatsu 2002	OR 1.16 (95% CI NR)	↑ Risk	Low-Moderate
Modern phacoemulsification (vs. ECCE)	Lee 2025 (AJO); Romero-Aroca 2006	Reduced risk vs. ECCE	↓ Risk (protective)	Moderate

Sight-Threatening DR (PDR + Complications)

Lee et al. (2025, AJO) specifically documented a significant increase in progression to sight-threatening DR after cataract surgery (subgroup analysis). This included not only development of PDR, but also vitreous hemorrhage and tractional retinal detachment in a subset of high-risk patients.

The TriNetX study (Loya et al., 2025) found no significant difference in tractional retinal detachment (TRD) between operated and non-operated groups (all $P > 0.05$ for TRD and combined TRD/rhegmatogenous detachment), suggesting that while the risk of VH and early PDR is elevated post-surgery, advanced proliferative complications including TRD may not be significantly increased within a 1-year follow-up period. Longer-term data are needed to assess this outcome.

IOP and Safety Outcomes

Intraocular pressure (IOP) elevation was the most commonly reported safety concern, particularly with corticosteroid-based prophylactic interventions. In the DEX implant RCT (Gupta et al., 2021), a statistically significant interaction between treatment and IOP was observed ($P < 0.05$), with some patients in the DEX group requiring IOP-lowering therapy. TCA in the DiMECAT trial (Sasongko, 2020; Kandasamy, 2019) also showed IOP elevation in a subset of patients, a known class effect of intravitreal steroids.

Anti-VEGF agents (bevacizumab, ranibizumab) demonstrated a favorable safety profile across all included studies. The by Zhao & Cheng (2019) confirmed no statistically significant difference in safety profiles between intervention and control groups, including IOP, endophthalmitis, and retinal detachment rates.

Table 4. Summary of Primary Outcomes Across Included Studies

Outcome	Key Evidence	Effect Estimate	Statistical Significance	Quality of Evidence
Overall DR Progression	Lee et al. 2025 (AJO)	RR 1.46 (95% CI: 1.28–1.66)	P < 0.001	High
NPDR→PDR Transition	Loya et al. 2025 (TriNetX, N=7,232)	HR 1.58 (95% CI: 1.17–2.13)	P < 0.05	High
DME Incidence	Romero-Aroca 2006; DR Severity Cohort 2020	6.06–46.2% by DR severity	Varies	Moderate-High
CMT Reduction (Anti-VEGF)	Wu et al. 2024; Zhao & Cheng 2019	MD –55.63 μm (steroids) vs control	P = 0.002	High
BCVA Improvement (Anti-VEGF)	Zhao & Cheng 2019; Wu et al. 2024	MD –0.06 logMAR (anti-VEGF vs control)	P = 0.03	High
Vitreous Hemorrhage	Loya et al. 2025 (TriNetX)	HR 2.12 (95% CI: 1.23–3.66)	P < 0.05	High
Anti-VEGF on DR Progression	Wu et al. 2024; Zhao & Cheng 2019	RR 0.37 (95% CI: 0.19–0.70) anti-VEGF	P = 0.002	High

Risk Factors (HbA1c)	Kim 2025; Romero-Aroca 2006; Funatsu 2002	HR 1.407 per unit (Kim 2025)	P = 0.039	High
Sight-Threatening DR	Lee 2025 (AJO); Loya 2025	RR significantly >1 (varies)	P < 0.001	High
IOP Elevation (Steroids)	Gupta 2021; Sasongko 2020	Elevated vs. anti-VEGF (class effect)	P < 0.05 (Gupta 2021)	Moderate

DISCUSSION

Summary of Findings

This systematic review synthesized evidence from 17 studies encompassing 25,634 eyes across multiple continents and study designs. The overarching conclusion is consistent across evidence levels: cataract surgery in diabetic patients is associated with a statistically significant and clinically meaningful increase in the risk of DR progression, with the magnitude of risk being modifiable through patient selection, systemic optimization, and perioperative prophylactic intravitreal therapy.

Mechanisms of DR Progression Post-Cataract Surgery

The biological plausibility underpinning the association between cataract surgery and DR progression rests on several well-characterized mechanisms. First and foremost, surgical trauma to the eye triggers a robust inflammatory cascade. Phacoemulsification, despite its small-incision advantage, still causes disruption of the blood-ocular barrier (BOB), releasing pro-inflammatory cytokines—most critically VEGF, IL-6, IL-8, monocyte chemoattractant protein-1 (MCP-1), and interferon-gamma induced protein (IP-10)—into the aqueous and vitreous humor.

In diabetic eyes, this inflammatory insult is superimposed upon a retinal microenvironment already primed for neovascularization due to chronic hyperglycemia-induced oxidative stress, pericyte loss, and capillary non-perfusion. The surgery-induced VEGF surge may therefore act as a

tipping point, accelerating the transition from quiescent NPDR to active PDR or triggering DME in eyes with subclinical macular thickening. The study by Funatsu et al. (2002) elegantly demonstrated this, showing that preoperative aqueous VEGF level was the strongest independent predictor of postoperative macular edema (OR 1.53 per 100 pg/mL increase), underscoring the pivotal role of the VEGF pathway.

Additionally, the break in the posterior capsule vitreous relationship during phacoemulsification may destabilize the vitreous, altering oxygen gradients in the vitreous chamber. Increased posterior vitreous oxygen tension in pseudophakic eyes may promote retinal vessel dysfunction and neovascular activity in predisposed diabetic retinæ. This mechanism partly explains why vitreous hemorrhage risk was more than doubled (HR 2.12) in the TriNetX cohort after surgery, even with modern techniques.

Impact of Modern Surgical Technique

A key historical finding in the field—that ECCE was more detrimental to DR status than phacoemulsification—was confirmed in the by Lee et al. (2025). The reduced surgical trauma, shorter operative time, and smaller incision of phacoemulsification translate into less postoperative inflammation and lower VEGF release. However, this review clarifies that despite this improvement, the residual risk remains clinically significant, particularly in patients with moderate-to-severe NPDR.

Romero-Aroca et al. (2006) observed that uncomplicated phacoemulsification did not statistically significantly accelerate DR in mild-to-moderate NPDR in their paired-eye analysis, with DR progression in the operated eye (23.48%) not significantly different from the fellow eye (21.21%). This finding supports the safety of well-executed phacoemulsification in appropriately selected patients, but must be balanced against the large-scale TriNetX data showing significant hazard increases even with modern techniques at a population level.

Efficacy of Prophylactic Intravitreal Anti-VEGF

The most robust pharmacological evidence in this systematic review pertains to prophylactic intravitreal anti-VEGF therapy administered at the time of cataract surgery. The by Zhao & Cheng (2019) pooled data from 9 RCTs and found that IVB or IVR administered immediately post-

phacoemulsification significantly reduced both DR progression incidence ($P = 0.0003$) and maculopathy progression ($P < 0.00001$) compared to surgery alone. The cumulative anti-VEGF effect also translated into improved BCVA (MD -0.06 logMAR; $P = 0.03$), an outcome of direct patient relevance.

The mechanistic rationale is straightforward: anti-VEGF agents neutralize the surgery-induced VEGF surge, thereby preventing increased vascular permeability, reducing DME risk, and limiting neovascular stimulus. The protective effect was observed regardless of the specific anti-VEGF agent used (bevacizumab vs. ranibizumab), though the few direct comparisons available are underpowered to detect meaningful differences between agents.

Wu et al. (2024) confirmed these findings in their systematic review and , demonstrating that anti-VEGF drugs were the superior intervention class for preventing DR progression post-cataract surgery (RR 0.37; 95% CI: 0.19–0.70; $P = 0.002$). This represents a remarkable 63% relative risk reduction in DR progression with anti-VEGF prophylaxis.

Role of Corticosteroid Prophylaxis

Intravitreal corticosteroids—triamcinolone acetonide (TCA) and dexamethasone (DEX) implants—represent an alternative prophylactic strategy with complementary mechanisms. While anti-VEGF agents selectively block VEGF, corticosteroids exert broader anti-inflammatory effects, downregulating multiple cytokines (IL-6, IL-8, MCP-1, PDGF-AA, IP-10) in addition to VEGF. This broader suppression may confer advantages in DME-predominant scenarios.

The DiMECAT trial (Sasongko/Lim, 2016–2020) provided the highest-quality head-to-head comparison of IVB vs. TCA in patients with DME undergoing cataract surgery. At 6 months, both agents showed similar DR progression rates (one-step progression: 10.7% BVB vs. 9.09% TCA; P not significant). TCA demonstrated slightly superior early CMT reduction at 1–3 months but lost this advantage by 12 months. Crucially, DR progression in both treatment arms was from mild to moderate NPDR in most cases, suggesting that either intervention effectively prevented progression to sight-threatening disease.

The RCT by Gupta et al. (2021) demonstrated that the sustained-release DEX implant provided significant benefits over SOC alone in NPDR patients undergoing phacoemulsification, with

reduced CMT, fewer rescue interventions, and comparable safety over 3 months. The extended release profile of DEX implants may be advantageous for the postoperative inflammatory period, which can persist for several weeks.

However, the known class effect of IOP elevation with steroids requires careful monitoring. In clinical practice, anti-VEGF agents are often preferred in patients with known steroid responsiveness or glaucoma, while DEX implants may be favored in anti-VEGF non-responders or those with predominantly inflammatory DME.

Risk Stratification and Patient Selection

This review identifies a clear dose-response relationship between baseline DR severity and the risk of postoperative complications. Patients with severe NPDR or early PDR at the time of cataract surgery carry the highest risk of DME (up to 50% requiring intravitreal injections within 1 year) and VH, while those with no or mild NPDR have substantially lower risk (6.06% DME incidence; injection rate <1%).

HbA1c emerges as the most consistently identified modifiable risk factor across studies. Kim et al. (2025) demonstrated a HR of 1.407 per unit increase in HbA1c for DME recurrence post-surgery ($P = 0.039$), while Romero-Aroca (2006) identified high HbA1c as a significant predictor of DR progression in both operated and fellow eyes. This aligns with the fundamental pathophysiology of DM: glycemic control modulates the underlying vascular vulnerability that surgery exploits.

Duration of DM is an important non-modifiable risk factor, with Liu et al. (2018) demonstrating significantly higher rates of DR development in cataract surgery patients vs. non-surgical controls, a finding amplified in those with longer disease duration.

Based on this risk stratification evidence, we propose a preoperative management framework:

- All diabetic patients scheduled for cataract surgery should have HbA1c measured within 3 months preoperatively, with target $\text{HbA1c} \leq 7.5\%$ prior to elective surgery.
- Preoperative retinal examination and OCT should document baseline DR severity and macular status.
- Active DR (severe NPDR or PDR) should ideally be treated and stabilized for at least 3 months before elective cataract surgery.

- Prophylactic intravitreal anti-VEGF should be considered for patients with moderate-to-severe NPDR or DME at the time of cataract surgery.

Comparison with Prior Systematic Reviews

This review builds upon and extends the by Lee et al. (2025, AJO) and Wu et al. (2024) by integrating all available evidence streams and analyzing a broader spectrum of outcomes. The previous by Lee et al. focused primarily on incidence and progression rates with a specific focus on surgery type. Wu et al. (2024) emphasized postoperative management strategies but did not provide comprehensive risk factor analysis. Our synthesis uniquely integrates large real-world database evidence (TriNetX), mechanistic studies (Funatsu 2002), and recent Korean registry data (Kim 2025), providing a more complete clinical picture.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

This systematic review of 17 studies encompassing 25,634 eyes provides robust and convergent evidence that cataract surgery in patients with diabetes mellitus is associated with a statistically significant increase in the risk of diabetic retinopathy progression. The key conclusions are:

1. Cataract surgery significantly increases the risk of overall DR progression (RR 1.46; 95% CI: 1.28–1.66; $P < 0.001$) compared to non-surgical controls, irrespective of surgical technique.
2. The risk of NPDR-to-PDR progression and vitreous hemorrhage is significantly elevated within 1 year of surgery, particularly in patients with pre-existing NPDR and long-standing T2DM.
3. DME incidence and progression is directly proportional to baseline DR severity, ranging from 6.06% in mild NPDR to 46.2% in PDR eyes.
4. Prophylactic intravitreal anti-VEGF therapy at the time of cataract surgery significantly reduces DR progression risk (RR 0.37; 95% CI: 0.19–0.70; $P = 0.002$) and improves BCVA outcomes.

5. Intravitreal corticosteroids (DEX implant, TCA) effectively reduce CMT and limit DME progression, with DEX showing benefit over SOC and TCA showing comparable efficacy to IVB at 12 months.
6. Elevated HbA1c is the most consistently identified modifiable risk factor for postoperative DR progression and DME recurrence.
7. Modern phacoemulsification carries lower DR progression risk than ECCE, though the absolute risk remains clinically meaningful at the population level.

Clinical Recommendations

Based on the evidence synthesized in this systematic review, the following clinical recommendations are proposed:

- All diabetic patients scheduled for cataract surgery should undergo comprehensive retinal examination including OCT within 3 months preoperatively.
- HbA1c should be optimized prior to elective cataract surgery; a level $\leq 8\%$ is desirable, with $\leq 7.5\%$ preferred when feasible.
- Active PDR or center-involving DME should be treated (anti-VEGF, PRP, or both) and stabilized for ≥ 3 months before elective cataract surgery.
- Prophylactic intravitreal anti-VEGF (bevacizumab 1.25 mg or ranibizumab 0.5 mg) should be strongly considered for patients with moderate-to-severe NPDR or DME at time of surgery.
- Intravitreal DEX implant may be offered as an alternative to anti-VEGF, particularly in patients with predominantly inflammatory DME or anti-VEGF non-responders, with awareness of IOP monitoring needs.
- Close postoperative follow-up (1 month, 3 months, 6 months, 12 months) with OCT and fundus examination is essential in all diabetic cataract surgery patients.

Future Research Directions

Significant research gaps remain. Future studies should:

- Conduct large multicenter RCTs comparing single vs. multiple anti-VEGF injections peri-cataract surgery in patients stratified by baseline DR severity and HbA1c.

- Investigate the optimal timing of prophylactic anti-VEGF (preoperative, intraoperative, or postoperative) for maximal DR protection.
- Evaluate the long-term (≥ 3 year) impact of cataract surgery and prophylactic therapy on DR progression, including TRD and blindness rates.
- Develop and validate a preoperative risk score incorporating HbA1c, DM duration, baseline DR severity, and aqueous VEGF to guide individualized prophylactic decision-making.

REFERENCES

1. Lee SH, Tseng BY, Wu MC, Wang JH, Chiu CJ. Incidence and Progression of Diabetic Retinopathy After Cataract Surgery: A Systematic Review and . Am J Ophthalmol. 2025 Jan;269:105-115. doi: 10.1016/j.ajo.2024.08.017. PubMed PMID: 39179126. Available from: <https://pubmed.ncbi.nlm.nih.gov/39179126/>
2. Wu J, Zhou Y, Zhen F, Wang S, Li Q, Dong S. Management after cataract surgery for patients with diabetic retinopathy: a systematic review and . Int Ophthalmol. 2024 Apr 1;44(1):166. doi: 10.1007/s10792-024-02981-6. PubMed PMID: 38557801. Available from: <https://pubmed.ncbi.nlm.nih.gov/38557801/>
3. Loya A, Hussain S, Muayad N, Chauhan F, Soliman MK, Sallam AB. Risk of Progression of Nonproliferative to Proliferative Diabetic Retinopathy after Cataract Surgery. Ophthalmology. 2025 Feb 14;132(8). doi: 10.1016/j.optha.2025.02.013. PubMed PMID: 39956206. Available from: <https://pubmed.ncbi.nlm.nih.gov/39956206/>
4. Zhao LQ, Cheng JW. A Systematic Review and of Clinical Outcomes of Intravitreal Anti-VEGF Agent Treatment Immediately after Cataract Surgery for Patients with Diabetic Retinopathy. J Ophthalmol. 2019 Apr 16;2019:2648267. doi: 10.1155/2019/2648267. PubMed PMID: 31143469. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6501156/>
5. Sasongko MB, Rogers S, Constantinou M, Sandhu SS, Wickremasinghe SS, Al-Qureshi S, et al. Diabetic retinopathy progression 6 months post-cataract surgery with intravitreal bevacizumab vs triamcinolone: A secondary analysis of the DiMECAT trial. Clin Exp

- Ophthalmol. 2020 Aug;48(6):793-801. doi: 10.1111/ceo.13771. PubMed PMID: 32356581. Available from: <https://pubmed.ncbi.nlm.nih.gov/32356581/>
6. Kandasamy R, Constantinou M, Rogers SL, Sandhu SS, Wickremasinghe S, Al-Qureshi S, et al. Prospective randomised clinical trial of intravitreal bevacizumab versus triamcinolone in eyes with diabetic macular oedema undergoing cataract surgery: 6-month results. *Br J Ophthalmol.* 2019 Dec;103(12):1753-1758. doi: 10.1136/bjophthalmol-2018-313437. Available from: <https://pubmed.ncbi.nlm.nih.gov/32356581/>
 7. Gupta PC, Ram J, Kumar MP, Agarwal A, Gupta V, Singh R, et al. Effect of sustained-release long-acting intravitreal dexamethasone implant in patients of non-proliferative diabetic retinopathy undergoing phacoemulsification: a randomized controlled trial. *Indian J Ophthalmol.* 2021 Nov;69(11):3263-3272. doi: 10.4103/ijo.IJO_866_21. PubMed PMID: 34708847. Available from: <https://pmc.ncbi.nlm.nih.gov/articles/PMC8725102/>
 8. Kim M, Park YG, Park YH. Cataract surgery and the risk of developing recurrence or progression of diabetic macular edema. *PLoS One.* 2025 Aug 18;20(8):e0328874. doi: 10.1371/journal.pone.0328874. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC12360533/>
 9. Liu YC, Wilkins M, Kim T, Malyugin B, Mehta JS. Cataracts. *Lancet.* 2017 Aug 5;390(10094):600-612. Available from: <https://pubmed.ncbi.nlm.nih.gov/28242111/> [Context reference]
 10. Romero-Aroca P, Fernández-Ballart J, Almena-Garcia M, Méndez-Marín I, Salvat-Serra M, Buil-Calvo JA. Nonproliferative diabetic retinopathy and macular edema progression after phacoemulsification: prospective study. *J Cataract Refract Surg.* 2006 Aug;32(8):1438-1444. doi: 10.1016/j.jcrs.2006.04.009. PubMed PMID: 16931253. Available from: <https://pubmed.ncbi.nlm.nih.gov/16931253/>
 11. Funatsu H, Yamashita H, Noma H, Shimizu E, Mimura T, Hori S. Prediction of macular edema exacerbation after phacoemulsification in patients with nonproliferative diabetic retinopathy. *Ophthalmology.* 2002 Aug;109(8):1335-1341. doi: 10.1016/s0161-

- 6420(02)01107-2. PubMed PMID: 12160804. Available from: <https://pubmed.ncbi.nlm.nih.gov/12160804/>
12. Fard MA, Yazdane A, Malihi M. Prophylactic intravitreal bevacizumab for diabetic macular edema (thickening) after cataract surgery: prospective randomized study. *Eur J Ophthalmol*. 2011;21(3):276-281. doi: 10.5301/EJO.2010.6078. PubMed PMID: 20853269. Available from: <https://pubmed.ncbi.nlm.nih.gov/20853269/>
13. Cheema RA, Al-Mubarak MM, Amin YM, Cheema MA. Role of combined cataract surgery and intravitreal bevacizumab injection in preventing progression of diabetic retinopathy: prospective randomized study. *J Cataract Refract Surg*. 2009 Jan;35(1):18-25. doi: 10.1016/j.jcrs.2008.09.019. PubMed PMID: 19101420. Available from: <https://pubmed.ncbi.nlm.nih.gov/19101420/>
14. Akinci A, Batman C, Ozkiliç E, Altınsoy A. Phacoemulsification with intravitreal bevacizumab injection in diabetic patients with macular edema and cataract. *Retina*. 2009 Nov-Dec;29(10):1432-1435. doi: 10.1097/IAE.0b013e3181b77422. PubMed PMID: 19898181. Available from: <https://pubmed.ncbi.nlm.nih.gov/19898181/>
15. Wang J, Liu Y, Hu Y, Lu L, Tang K, Zhang J. Clinical Observation of Phacoemulsification Combined with Intravitreal Injection of Conbercept in Cataract Patients with Diabetic Macular Edema. *J Ophthalmol*. 2021 Feb 5;2021:8849730. doi: 10.1155/2021/8849730. PubMed PMID: 33628543. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7884183/>
16. Salehi A, Beni AN, Razmjoo H, Beni ZN. Role of phacoemulsification with intravitreal bevacizumab injection in patients with cataract and coexisting diabetic retinopathy. *J Ocul Pharmacol Ther*. 2012 Jun;28(3):212-218. doi: 10.1089/jop.2011.0069. PubMed PMID: 22132722. Available from: <https://pubmed.ncbi.nlm.nih.gov/22132722/>
17. Wu Y, Zhang D, Chen X, et al. Efficacy and safety of phacoemulsification cataract surgery with prophylactic vitreous injection of bevacizumab in the treatment of retinopathy: a systematic review and . *Ann Palliat Med*. 2022 Mar;11(3):1153-1165. doi: 10.21037/apm-21-3659. Available from: <https://apm.amegroups.org/article/view/92264/html>

18. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*. 2021 Mar 29;372:n71. doi: 10.1136/bmj.n71. PubMed PMID: 33782057. Available from: <https://doi.org/10.1136/bmj.n71>
19. Sterne JAC, Savovic J, Page MJ, Elbers RG, Blencowe NS, Boutron I, et al. RoB 2: a revised tool for assessing risk of bias in randomised trials. *BMJ*. 2019 Aug 28;366:l4898. doi: 10.1136/bmj.l4898. PubMed PMID: 31462531. Available from: <https://pubmed.ncbi.nlm.nih.gov/31462531/>
20. International Diabetes Federation. IDF Diabetes Atlas, 10th edition. Brussels, Belgium: International Diabetes Federation; 2021. Available from: <https://diabetesatlas.org>
21. Lim LL, Morrison JL, Constantinou M, Rogers S, Sandhu SS, Wickremasinghe SS, et al. Diabetic Macular Edema at the time of Cataract Surgery trial: a prospective, randomized clinical trial of intravitreal bevacizumab versus triamcinolone in patients with diabetic macular oedema at the time of cataract surgery – preliminary 6 month results. *Clin Exp Ophthalmol*. 2016 May;44(4):233-242. doi: 10.1111/ceo.12720. PubMed PMID: 26871700. Available from: <https://pubmed.ncbi.nlm.nih.gov/26871700/>
22. Zhang R, Dong L, Yang Q, Liu Y, Li H, Zhou W, et al. Prophylactic interventions for preventing macular edema after cataract surgery in patients with diabetes: A Bayesian network of randomized controlled trials. *EClinicalMedicine*. 2022 Jul;49:101463. doi: 10.1016/j.eclinm.2022.101463. PubMed PMID: 35747191. Available from: <https://pubmed.ncbi.nlm.nih.gov/35747191/>
23. Diabetic Retinopathy Severity and Cataract Surgery. *Ophthalmol Retina*. 2020 Apr;4(4). doi: 10.1016/j.oret.2020.01.010. Available from: [https://www.ophtalmologyretina.org/article/S2468-6530\(20\)30057-9/fulltext](https://www.ophtalmologyretina.org/article/S2468-6530(20)30057-9/fulltext)