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Epiretinal Membrane Progression Following Cataract Surgery

Bita Momenaei, MD[1], Abtin Shahlaee, MD[1,2], Michael K. Nguyen, BA[3], Julia Yu, BS[3], Jonathan Martin, BS[3], Rachel Israilevich, MD[3], Mitchell S. Fineman, MD[1], Carl D. Regillo, MD[1], Omesh P. Gupta, MD, MBA[1], Richard S. Kaiser, MD[1], Allen C. Ho, MD[1], and Jason Hsu, MD[1]

Abstract

Purpose: To investigate the progression of epiretinal membrane (ERM) following cataract surgery using optical coherence tomography (OCT)–based biomarkers. **Methods:** A retrospective review was conducted from January 2012 to February 2022, assessing eyes with preexisting idiopathic ERM that underwent uncomplicated cataract surgery. An established ERM grading scale was used, and OCT features, along with visual outcomes, were evaluated. **Results:** The study followed 67 eyes for an average of 47.8 months after cataract surgery. Initially, 83.6% of eyes had stage 1 ERM, 13.4% had stage 2, and 3% had stage 3. Nonsignificant ERM progression occurred 59 weeks postoperatively. Among stage 1 eyes, 16.1% progressed to stage 2; 11.1% of stage 2 eyes progressed to stage 3; and 50% of stage 3 eyes progressed to stage 4. Additionally, 10.4% developed or experienced worsened macular edema following cataract surgery, and 6% underwent vitrectomy. In eyes managed without vitrectomy, visual acuity (VA) improved 1 month after cataract surgery ($P = .018$) and remained stable over a 4-year period. **Conclusions:** Eyes with mild-stage ERM that demonstrate improved VA after cataract surgery tend to maintain these improvements over a 4-year period and do not typically progress.

Keywords

cataract, epiretinal membrane, optical coherence tomography, phacoemulsification

Introduction

Epiretinal membrane (ERM) is a common retinal disorder, with reported prevalence ranging from 4% to 34%.[1–3] Up to 90% of patients are asymptomatic, but some may experience blurred vision or metamorphopsia, prompting the need for surgery.[4]

Spectral-domain optical coherence tomography (SD-OCT) is crucial for ERM diagnosis, classification, and monitoring.[5] Although significant ERM cases require pars plana vitrectomy (PPV) with membrane peeling, milder stages are typically managed with periodic imaging and visual acuity (VA) assessments.[6,7]

Limited data exist on the factors affecting ERM progression, and concerns remain regarding the impact of cataract surgery on preexisting ERMs, potentially leading to less improvement in visual outcomes. Previous studies have provided limited insights, with 1 examining ERM progression up to 1 month after cataract surgery, and another excluding eyes with ERM affecting the fovea.[8,9] Therefore, the clinical prognosis for ERM present at the time of cataract surgery remains unclear. This study aims to evaluate ERM progression rates following cataract extraction.

Methods

This retrospective study was approved by the Wills Eye Hospital Institutional Review Board and adhered to the tenets of the Declaration of Helsinki. We conducted an extensive search of the electronic medical record system from January 2012 to February 2022 using International Classification of Diseases (ICD) codes (ICD-9 and ICD-10) for ERM. This

[1] The Retina Service of Wills Eye Hospital, Wills Eye Physicians Mid Atlantic Retina, Thomas Jefferson University, Philadelphia, PA, USA
[2] Department of Ophthalmology, The Permanente Medical Group, San Francisco, CA, USA
[3] Sidney Kimmel Medical College, Thomas Jefferson University, Philadelphia, PA, USA

Current affiliation: Rachel Israilevich is now affiliated to Mayo Clinic Department of Ophthalmology, Rochester, MN, USA.

Corresponding Author:
Jason Hsu, MD, Mid Atlantic Retina, The Retina Service of Wills Eye Hospital, Thomas Jefferson University, 840 Walnut St, Philadelphia, PA 19107, USA.
Email: jhsu@midatlanticretina.com

dataset was cross-referenced with lens status assessments to identify patients who subsequently underwent cataract surgeries. Eligible patients had a preoperative retinal clinic visit for ERM evaluation within 3 months prior to undergoing an uncomplicated cataract surgery and had at least 6 months of postoperative follow-up. In cases of bilateral ERM, 1 eye was randomly selected for inclusion.

Exclusions included patients with prior retinal surgeries, trauma- or uveitis-induced ERM, and those with concurrent or subsequent diagnoses of diabetic macular edema, retinal vein occlusion, central serous retinopathy, vitreomacular traction, full-thickness macular hole, or neovascular age-related macular degeneration. Patients who underwent combined PPV and cataract surgery were also excluded. Additionally, cases were excluded if ERM surgery occurred within 2 months of cataract surgery without documented ERM stage progression or if the surgery was primarily performed because of insufficient postoperative improvement in VA.

We evaluated the best available VA, using pinhole or habitual correction, alongside OCT parameters including ERM grading, microcystic changes, ellipsoid zone disruption, external limiting membrane disruption, presence of subretinal fluid, presence and thickness of ectopic inner foveal layer, and central foveal thickness (CFT) at both preoperative and postoperative visits. ERM gradings were assessed using a staging system introduced by Govetto et al,[5] which has been widely adopted in the field. CFT and ectopic inner foveal layer thickness were measured using ImageJ software (version 1.53a, National Institutes of Health).[10,11]

For statistical analysis, VA was converted from Snellen to logMAR. Paired sample *t* tests, χ^2 tests, and Fisher exact tests were used as appropriate. Eyes that underwent PPV for ERM were included in the ERM staging analysis only up to the time immediately prior to surgery. All data analyses were conducted using SPSS software (version 24, IBM Corp). Statistical significance was set at $P < .05$. Mean values are ± SD.

Results

Of the 1328 charts screened, exclusions included 244 patients with prior retinal surgeries, 23 with combined PPV and cataract surgery, and 3 who underwent PPV within 2 months after cataract surgery. Additionally, 757 patients with concurrent or subsequent maculopathies and 264 with insufficient preoperative visits or follow-up duration were excluded. Some patients met multiple exclusion criteria, resulting in a final cohort of 67 eyes from 67 patients. The patients had a mean age of 72.1 ± 9.8 years, with 52.2% being female. The mean time between the preoperative retinal visit and cataract surgery was 20 ± 15 days. Patients were followed for an average of 47.8 ± 26.5 months postoperatively.

Epiretinal Membrane Staging

Table 1 summarizes the changes in ERM gradings over the follow-up period. No statistically significant progression in ERM staging was observed at any timepoint. Specifically, 9 of 56 eyes with stage 1 ERM (16.1%) progressed to stage 2; 1 of 9 eyes with stage 2 ERM (11.1%) progressed to stage 3; and 1 of 2 eyes with stage 3 ERM (50.0%) progressed to stage 4. The median time to progression was 59 weeks after cataract surgery. Four eyes (6.0%) underwent PPV for ERM at 10, 11, 77, and 102 weeks after cataract surgery. Of these, 3 eyes progressed from stage 1 to stage 2 ERM, while 1 eye remained stable at stage 2 for 2 years before becoming visually significant. All 4 surgeries were performed during stage 2 ERM.

Optical Coherence Tomography Features

OCT structural characteristics are summarized in Table 2. The percentage of eyes exhibiting microcystic changes increased over the follow-up period, reaching statistical significance at the 24-month visit. At baseline, 2 eyes showed ectopic inner foveal layer with thicknesses of 240 μm and 83 μm, which increased to 313 μm and 220 μm, respectively, at 95 and 28 months following cataract surgery. Additionally, 2 other eyes that were initially diagnosed with stage 1 and stage 2 ERM progressed to stage 3 at 84 and 32 months postoperatively, with corresponding ectopic inner foveal layer thicknesses of 147 μm and 118 μm, respectively.

CFT measurements for observed eyes are summarized in Table 3. For the 4 eyes that eventually underwent PPV for ERM, the pre–cataract surgery CFT values were 339 μm, 362 μm, 424 μm, and 359 μm. These increased to 383 μm, 362 μm, 460 μm, and 391 μm, respectively, prior to PPV. One patient developed postoperative cystoid macular edema (CME) following PPV and received 1 intravitreal triamcinolone acetonide injection followed by an intravitreal dexamethasone implant (Allergan Inc). After the intravitreal triamcinolone acetonide injection, CFT measurement in this patient was 511 μm. Final CFT measurements for the 4 eyes were 180 μm, 212 μm, 306 μm, and 500 μm (1.5 months after Ozurdex implantation), respectively.

In total, 7 eyes (10.4%) developed or experienced worsening of macular edema (ME) following cataract surgery. Of these, 2 eyes received steroid injections: 1 patient received 3 intravitreal triamcinolone acetonide injections, and another received a combination of 1 sub-Tenon triamcinolone acetonide injection (Bristol Myers Squibb) and 1 intravitreal triamcinolone acetonide injection. Among the 4 eyes that underwent PPV, 2 were part of this subset that had previously received steroid injections for the treatment of CME. The remaining 5 eyes were treated with topical medications and showed subsequent improvement.

Visual Acuity Outcomes

Eyes with ERM that were observed after cataract surgery maintained the VA gains achieved postoperatively (Table 3). The mean logMAR VA in the observed group 1 month after cataract surgery was 0.25 ± 0.19 (20/36 Snellen), representing a significant improvement compared to the pre–cataract surgery VA of 0.32 ± 0.22 (20/42 Snellen) ($P = .018$). This improvement

Table 1. Post–Cataract Surgery Changes in ERM Grading and Visual Outcomes.

ERM Grading	Presurgery (n = 67)	Postsurgery at 3 Mo (n = 57)	Postsurgery at 6 Mo (n = 58)	Postsurgery at 12 Mo (n = 56)	Postsurgery at 24 Mo (n = 50)	Postsurgery at 36 Mo (n = 36)	Final Visit (n = 63)
Grade 1, n (%)	56 (83.6)	44 (77.2)	46 (79.3)	44 (78.6)	38 (76)	28 (77.8)	48 (76.2)
Grade 2, n (%)	9 (13.4)	10 (17.5)	11 (19)	10 (17.9)	8 (16.0)	6 (16.7)	11 (17.5)
Grade 3, n (%)	2 (3.0)	3 (5.3)	1 (1.7)	2 (3.6)	4 (8.0)	2 (2.8)	3 (4.5)
Grade 4, n (%)	0	0	0	0	0	0	1 (1.5)
P value	Reference	.77	.75	.88	.65	.78	.63
VA (logMAR), median (range) [Snellen equivalent]							
Grade 1	0.3 (0.0-1.3) [20/40]	0.18 (0.0-0.6) [20/30]	0.18 (0.0-0.4) [20/30]	0.1 (0.0-0.54) [20/25]	0.14 (0.0-0.54) [20/28]	0.14 (0.0-0.54) [20/28]	0.18 (0.0-0.7) [20/30]
Grade 2	0.3 (0.1-0.9) [20/40]	0.35 (0.1-0.7) [20/45]	0.18 (0.0-0.4) [20/30]	0.3 (0.1-0.6) [20/40]	0.18 (0.0-0.4) [20/30]	0.18 (0.0-0.3) [20/30]	0.18 (0.0-0.4) [20/30]
Grade 3	0.18[a] [20/30] and 0.4[a] [20/50]	0.18 (0.18-0.3) [20/30]	0.3[a] [20/40]	0.18[a] [20/30] and 0.3[a] [20/40]	0.7 (0.3-1.0) [20/100]	0.3[a] [20/40] and 0.48[a] [20/60]	0.7 (0.7-1.0) [20/100]
Grade 4	-	-	-	-	-	-	0.4[a] [20/50]

[a]Single values.
Abbreviations: ERM, epiretinal membrane; VA, visual acuity.

Table 2. Post–Cataract Surgery Changes in OCT Structural Characteristics of Eyes With ERM.

OCT Characteristics	Presurgery (n = 67)	Postsurgery at 3 Mo (n = 57)	Postsurgery at 6 Mo (n = 58)	Postsurgery at 12 Mo (n = 56)	Postsurgery at 24 Mo (n = 50)	Postsurgery at 36 Mo (n = 36)	Final Visit (n = 63)
Microcystic change							
n (%)	10 (14.9)	17 (29.8)	19 (32.8)	15 (26.8)	23 (46.0)	16 (44.4)	21 (33.3)
P value	Reference	.07	.05	.05	< .01	.04	.03
EZ disruption							
n (%)	1 (1.5)	0	1 (1.7)	5 (8.9)	3 (6.0)	2 (5.6)	6 (9.5)
P value	Reference	> .99	> .99	.06	.24	.49	.11
Ectopic inner foveal layers present							
n (%)	2 (3.0)	3 (5.3)	1 (1.7)	2 (3.6)	4 (8.0)	2 (2.8)	4 (6.3)
P value	Reference	> .99	> .99	> .99	.68	> .99	.68
External limiting membrane disruption							
n (%)	0	0	0	0	0	0	0
P value	Reference	-	-	-	-	-	-
SRF present							
n (%)	0	0	0	1 (1.8)	0	0	0
P value	Reference	-	-	> .99	-	-	-

Abbreviations: ERM, epiretinal membrane; EZ, ellipsoid zone; OCT, optical coherence tomography; SRF, subretinal fluid.

Table 3. VA Outcomes and CFT Measurements for Eyes With ERM Following Cataract Surgery.

Visit Timepoint	Mean VA (logMAR) ± SD (Snellen Equivalent)	*P* Value	Mean CFT (μm) ± SD	*P* Value
Presurgery (n = 63)	0.32 ± 0.22 (20/42)	Reference	240 ± 74	Reference
Postsurgery at 3 mo (n = 51)	0.19 ± 0.15 (20/31)	.001	246 ± 83	.019
Postsurgery at 6 mo (n = 58)	0.19 ± 0.14 (20/31)	< .001	252 ± 88	.009
Postsurgery at 12 mo (n = 54)	0.15 ± 0.12 (20/28)	< .001	250 ± 88	.218
Postsurgery at 24 mo (n = 50)	0.21 ± 0.22 (20/32)	.002	259 ± 94	.056
Postsurgery at 36 mo (n = 36)	0.17 ± 0.15 (20/30)	.002	268 ± 103	.279
Final visit (n = 63)	0.22 ± 0.20 (20/33)	.002	244 ± 98	.631

Abbreviations: CFT, central foveal thickness; ERM, epiretinal membrane; VA, visual acuity.

remained stable through the final follow-up visit, with a mean VA of 0.22 ± 0.20 (20/33 Snellen).

Regarding VA outcomes in the 4 eyes that underwent PPV for ERM, pre–cataract surgery VA was 20/40, 20/40, 20/30, and 20/150. One month postoperatively, VA changed to 20/30, 20/20, 20/200 (with a decline resulting from postoperative CME), and 20/70, respectively. At the visit immediately prior to PPV, VA was 20/40, 20/20 (with significant distortion), 20/25 (with significant distortion), and 20/100. At the final visit, VA measured 20/25, 20/40, 20/25, and 20/100, respectively.

Conclusions

Our study demonstrated that the risk of ERM progression following cataract surgery was minimal and rarely resulted in visual impairment requiring surgical intervention. Eyes with preexisting ERM generally experienced sustained improvements in VA over the follow-up period. Among OCT biomarkers, baseline microcystic changes were the only feature that displayed significant progression. Approximately 10% of eyes developed or experienced worsening of ME after cataract surgery.

Cataract surgery may influence ERM development or progression through several mechanisms. One theory suggests that mechanical forces during surgery may stimulate ERM formation by contributing to pathological vitreoretinal separation.[12] Even in cases with an apparent complete posterior vitreous detachment, residual vitreous remnants adhering to the internal limiting membrane may trigger cellular proliferation and migration.[3,13] Another theory involves inflammation-mediated effects.[12] Cataract surgery has been shown to alter the intraocular cytokine environment, with elevated cytokine levels observed in eyes with idiopathic ERM both before and after surgery—though more prominently postoperatively—suggesting an inflammatory and fibrotic environment.[14] Although intraocular inflammation is known to contribute to secondary ERM formation, the clinical significance of post–cataract surgery inflammation in ERM progression remains unclear.[15]

Anatomic progression of idiopathic ERM has been reported in 17% to 39% of patients within 2 years. Although cataract surgery may represent a potential risk factor for progression, improved fundus visualization postoperatively could act as a confounding variable.[3,16,17] High-resolution SD-OCT imaging enables sensitive detection of ERM even in eyes with significant cataracts. Hayashi and Hayashi[18] conducted a study comparing foveal thickness and macular volume changes in 43 eyes with preexisting ERM after cataract surgery with those in 41 eyes without cataract surgery, finding no significant differences during the first year of follow-up. These findings are consistent with our results; however, their shorter follow-up duration (1 year vs our 4-year average) and the absence of a recent ERM staging methodology, unavailable at the time of their study, limit direct comparisons.

Recent studies have used the OCT-based classification of ERM staging.[5] One study involving 53 eyes that underwent sequential cataract and ERM surgery reported stable ERM staging after cataract surgery in all patients.[9] The majority of eyes had stage 2 or stage 3 ERM, with only 8.9% having stage 1. However, this study had a short follow-up period of 1 month, which may not capture longer-term outcomes. In a Korean cohort study with a minimum 2-year follow-up, Kwon et al[8] reported a 7.5% incidence of new-onset ERM and a 6% progression rate of mild preexisting ERM following cataract surgery. This study included only eyes with non–fovea-involving ERM.

Although our study used the same grading system, we specifically included fovea-involving ERM. Contrary to previous findings, a recent study of 87 eyes found that cataract surgery might worsen ERM.[19] Prior to surgery, 44.8% of eyes had stage 1 ERM, 21.6% had stage 2, 21.6% had stage 3, and 11.6% had stage 4. After a mean follow-up of 1.37 months, progression rates included 15.4% from stage 1 to stage 2, 15.8% from stage 2 to stage 3, and 21.1% from stage 3 to stage 4.[19] Interestingly, our results showed that ERM stage progression was not statistically significant even after 4 years.

Notably, most of our patients' eyes were at stage 1 ERM at the preoperative evaluation. Assessing ERM staging shortly after cataract surgery may introduce bias owing to the surgery-induced inflammatory response. This inflammation, along with the possibility of pseudophakic CME, may lead to a misinterpretation of ERM progression. However, our study's longer follow-up period provides a more accurate perspective on ERM progression over time.

The natural history of the rate of ERM progression may also play a role unrelated to cataract surgery. One study on idiopathic ERM with baseline VA of 20/40 or better reported cumulative rates of progression to surgery of 2.9%, 5.6%, 12%, and 21% at years 1 through 4.[20] In our study, 6% of eyes underwent PPV and membrane peeling for ERM. The decision to proceed with surgery was likely influenced by various factors, including patient preferences, specific visual requirements, treating physician judgment, the estimated visual impact of the ERM, and observed progression rates over time. Notably, all 4 eyes that underwent PPV in our study had stage 2 ERM, whereas some eyes with higher-grade ERM were managed without surgical intervention.

Two distinct types of ME have been observed in eyes with ERM.[21] One type is microcystic ME, predominately located in the inner nuclear layer (INL). These inner microcystic changes are thought to arise from tractional forces and transsynaptic inner retinal degeneration.[22] This form of edema does not demonstrate leakage on fluorescein angiography (FA) and has been associated with poorer visual outcomes.[21] In our study, inner microcystic changes were the only OCT biomarker that showed progression among observed eyes with ERM. The increased tractional forces exerted by the ERM over time may account for this progression. Although we did not observe statistically significant ERM staging progression during the study period, the development of microcystic changes may indicate the potential for future ERM progression.

The other type of ME is CME, affecting both the INL and outer plexiform layer, resulting from blood–retinal barrier alterations and increased vascular permeability. CME typically demonstrates leakage on FA.[21,23] Clinically significant CME occurs in approximately 1% to 2% of cataract surgeries,[24] but its incidence is higher in eyes with ERM, potentially contributing to postoperative VA decline.[2,25] One study reported post–cataract surgery CME rates of 8.6% in eyes with ERM compared to 1.38% in those without ERM ($P < .001$).[2] Prior research has shown a significant association between elevated CFT and the presence of CME, as opposed to microcystic ME.[21] In our cohort, postoperative CME was observed in 10.4% of eyes. Close postoperative monitoring is crucial to promptly detect and manage CME.

Although prior studies have demonstrated that VA improvement following cataract surgery may be less pronounced in eyes with ERM compared to those without, the procedure still results in a substantial VA improvement, particularly benefiting those with a preoperative VA of 20/40 or worse, where the improvements are most significant.[2] Another study reported no worsening of VA in eyes with idiopathic ERM during the first year following cataract surgery.[18] Similarly, our cohort showed sustained VA improvement over the course of a 4-year follow-up period. These positive functional outcomes highlight the safety and efficacy of cataract surgery in eyes with mild-stage ERM.

This study has several limitations, including its retrospective design and relatively small sample size. Surgical decisions were influenced by multiple subjective factors that are difficult to quantify objectively. Additionally, the majority of our patients had stage 1 ERM, which may account for the limited progression after cataract surgery. Therefore, our conclusions may not apply to more advanced stages. Another limitation is the absence of FA, as we relied solely on OCT findings for the classification of intraretinal cystic changes. However, microcystic ME is primarily diagnosed through OCT, with distinctive features that can be reliably identified even without FA.[23] Finally, the lack of a control group of ERM eyes that did not undergo cataract surgery restricts our ability to draw definitive conclusions about the specific impact of cataract surgery on ERM progression.

Our findings suggest that uncomplicated cataract surgery is not typically associated with significant ERM progression. Eyes with mild-stage ERM are unlikely to experience worsening ERM after surgery and tend to achieve favorable and sustained visual outcomes over a nearly 4-year follow-up period. Further studies with larger sample sizes and inclusion of eyes with more advanced ERM stages could provide additional insights into this subject.

Ethical Approval

This study was approved by the Wills Eye Hospital Institutional Review Board and adhered to the tenets of the Declaration of Helsinki.

Statement of Informed Consent

The Institutional Review Board waived the requirement for informed consent owing to the retrospective design of the study.

Declaration of Conflicting Interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: The following disclosures have been reported: J.H.: consultant for IvericBio and Gyroscope Therapeutics; grant support from IvericBio, Aldeyra Therapeutics, and Genentech/Roche; O.G.: Consultant for Alcon; C.R.: 4DMT, Adverum, Alcon, Allergan, Annexon, Apellis, Clearside, Cognition, Eyepoint, Genentech, Iveric, Janssen, Kodiak, Merck, NGM, Novartis, Ocular Therapeutics, Ocugen, Ocuphire, Ocuterra, Ray, Regeneron, RegenXBio, Stealth, Thea, Zeiss; A.C.H.: Scientific Advisor for Alcon Surgical.

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ORCID iDs

Bita Momenaei https://orcid.org/0000-0002-5435-7369
Abtin Shahlaee https://orcid.org/0000-0001-7980-9109
Jason Hsu https://orcid.org/0000-0002-2761-4219

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