Research Square

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Final visual acuity versus visual gain after idiopathic epiretinal membrane surgery: a 12-month retrospective study

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Abstract

Background

The apparent success of epiretinal membrane (ERM) surgery may differ depending on whether final visual acuity or improvement from baseline is used. We examined both outcomes in a consecutive surgical cohort.

Methods

We retrospectively evaluated 51 eyes of 47 patients undergoing vitrectomy with ERM and internal limiting membrane peeling by one surgeon. Best-corrected visual acuity (BCVA) and central retinal thickness (CRT) were followed for 12 months. Exploratory subgroup comparisons and multivariable linear regression with patient-clustered standard errors were performed.

Results

Mean BCVA improved from 0.318 ± 0.274 to 0.203 ± 0.251 logMAR at 12 months (paired $p < 0.001$). Eyes with baseline Snellen BCVA ≥ 0.5 (n = 32) had better final logMAR than eyes with BCVA < 0.5 (n = 19; 0.090 vs 0.395; exploratory $p = 0.00042$), but less visual gain (0.054 vs 0.216 logMAR; $p = 0.00976$). Baseline BCVA (adjusted B = 0.326, 95% CI 0.042–0.610; $p = 0.024$) and 1-month BCVA (B = 0.449, 95% CI 0.129–0.769; $p = 0.006$) were associated with final BCVA.

Conclusions

Better preoperative acuity was associated with better final vision, whereas worse preoperative acuity was associated with greater measured improvement. These complementary outcomes may be useful for counseling, but this retrospective surgical cohort cannot establish an optimal intervention threshold.

Background

Idiopathic epiretinal membrane (ERM) is a vitreomacular interface disorder associated with reduced acuity, metamorphopsia, and impaired vision-related quality of life [1, 2]. Vitrectomy with membrane peeling can improve visual function, but surgical timing remains individualized [3, 4]. Patients may judge success by the vision ultimately achieved or by the magnitude of improvement from their preoperative state. These endpoints are related but not interchangeable.

Optical coherence tomography (OCT) biomarkers, including central retinal thickness (CRT), photoreceptor integrity, ectopic inner foveal layers, and inner retinal disorganization, have been investigated as prognostic factors [5–9]. Preoperative acuity remains a widely accessible predictor,

whereas thickness alone is less consistently informative [6]. We investigated whether baseline acuity relates differently to final vision and visual gain, while accounting for early postoperative acuity, OCT thickness, lens status, cataract surgery, and staining dye in a consecutive single-surgeon cohort.

Methods

This retrospective consecutive series included patients undergoing pars plana vitrectomy with ERM and internal limiting membrane peeling for idiopathic ERM at China Medical University Hospital between December 1, 2021, and December 1, 2024. The institutional review board approved the study (CMUH114-REC1-106) and waived informed consent for retrospective anonymized data; procedures followed the Declaration of Helsinki. All operations were performed by a single surgeon (M.C.H.). BCVA was measured using Snellen charts and converted to logMAR. CRT was measured using OCT at baseline and 1, 3, 6, and 12 months. Recorded covariates were age, baseline IOL status, follow-up cataract surgery, and ILM dye.

Data were analyzed at the eye level. Four patients contributed two eyes each; the age entered once for these patients was assigned to their fellow eye based on the shared patient identifier. Binary variables were interpreted using the investigator-confirmed reversed 0/1 coding. Visual gain was defined as baseline minus 12-month logMAR (positive values indicate improvement), rather than using the inconsistent pre-existing change field. Continuous outcomes are mean ± standard deviation. Paired t-tests compared baseline and 12-month measurements. Exploratory groups were defined by Snellen 0.5 (baseline logMAR ≤ 0.30103 versus > 0.30103), with Welch two-sample tests. Multivariable ordinary least squares models included baseline BCVA, baseline CRT, 1-month BCVA, 1-month CRT, age, baseline IOL status, cataract surgery during follow-up, and dye; standard errors and Wald confidence intervals were clustered by patient (47 clusters). Two-sided $p < 0.05$ was used descriptively; exploratory comparisons were not adjusted for multiplicity. Analyses were performed in Python using pandas, SciPy, and statsmodels.

Study limitations inherent to the data include the absence of a nonsurgical comparison group. The precise eligibility criteria, OCT acquisition protocol, operative details, and timing of cataract surgery should be confirmed against the source records before submission.

Results

The cohort included 51 eyes of 47 patients (four bilateral cases), with mean eye-level age 63.0 ± 8.3 years. Thirty-one eyes were right eyes and 20 were left eyes. After applying the confirmed reverse coding, the dataset classified 14 eyes as having a baseline intraocular lens and 37 as not having one; 25 eyes were classified as having cataract surgery during follow-up. The dye variable classified 22 eyes as indocyanine green and 29 as Brilliant Blue G. These counts differ from those in the previously submitted manuscript and should be verified against operative records before submission.

Mean BCVA improved from 0.318 ± 0.274 logMAR preoperatively to 0.203 ± 0.251 logMAR at 12 months (paired t-test, p = 0.000034); mean gain was 0.114 ± 0.179 logMAR. Mean CRT declined from 366.2 ± 83.1 to 336.3 ± 53.0 µm (paired t-test, p = 0.000833). Serial outcomes are presented in Table 1.

Table 1
Serial visual acuity and retinal thickness

Measure	Baseline	1 month	3 months	6 months	12 months
BCVA, logMAR	0.318 ± 0.274	0.315 ± 0.225	0.308 ± 0.234	0.338 ± 0.257	0.203 ± 0.251
CRT, µm	366.2 ± 83.1	368.6 ± 67.9	352.9 ± 61.0	336.1 ± 52.6	336.3 ± 53.0
Values are mean ± standard deviation; BCVA in logMAR; CRT in µm.					

In an exploratory comparison using baseline Snellen BCVA 0.5, 32 eyes had baseline acuity ≥ 0.5 and 19 eyes had acuity < 0.5. The better-baseline-acuity group had a lower (better) mean final logMAR (0.090 versus 0.395; Welch p = 0.00042), whereas the worse-baseline-acuity group had a larger mean gain (0.216 versus 0.054 logMAR; Welch p = 0.00976). The comparison was not corrected for multiple testing and is not a validated treatment threshold (Table 2).

Table 2
Exploratory comparison by baseline Snellen acuity

Outcome	Baseline ≥ 0.5 (n = 32)	Baseline < 0.5 (n = 19)	Welch p
Final BCVA, logMAR	0.090 ± 0.102	0.395 ± 0.307	0.00042
Visual gain, logMAR	0.054 ± 0.092	0.216 ± 0.239	0.00976
Exploratory, unadjusted Welch tests; no multiple-testing correction. The 0.5 cutoff is not a validated surgical threshold.			

In the multivariable regression model for final 12-month logMAR, baseline BCVA (B = 0.326, 95% CI 0.042–0.610, p = 0.024) and 1-month BCVA (B = 0.449, 95% CI 0.129–0.769, p = 0.006) were associated with final acuity. Baseline CRT, 1-month CRT, age, baseline IOL status, cataract surgery during follow-up, and dye were not statistically significant (Table 3). The corresponding visual-gain model is shown in Table 4; its baseline-acuity coefficient is mathematically coupled to the change-score definition and should not be interpreted as independent evidence for a surgical threshold.

Table 3
Factors associated with final visual acuity

Covariate	B	Clustered SE	95% CI	p
Baseline BCVA	0.3259	0.1448	0.0421 to 0.6097	0.0244
Baseline CRT	0.0005	0.0005	-0.0004 to 0.0014	0.2504
1-month BCVA	0.4490	0.1633	0.1288 to 0.7691	0.0060
1-month CRT	0.0001	0.0006	-0.0011 to 0.0013	0.8964
Age	0.0038	0.0023	-0.0006 to 0.0083	0.0925
Baseline IOL (reversed coding)	0.0259	0.0505	-0.0731 to 0.1250	0.6079
Cataract surgery during follow-up (reversed coding)	-0.0577	0.0449	-0.1457 to 0.0303	0.1985
Dye (reversed coding)	0.0414	0.0395	-0.0360 to 0.1188	0.2946

Multivariable linear regression with patient-clustered standard errors; eight predictors in 51 eyes. BCVA in logMAR.

Table 4
Factors associated with visual gain

Covariate	B	Clustered SE	95% CI	p
Baseline BCVA	0.6741	0.1448	0.3903 to 0.9579	< 0.0001
Baseline CRT	-0.0005	0.0005	-0.0014 to 0.0004	0.2504
1-month BCVA	-0.4490	0.1633	-0.7691 to -0.1288	0.0060
1-month CRT	-0.0001	0.0006	-0.0013 to 0.0011	0.8964
Age	-0.0038	0.0023	-0.0083 to 0.0006	0.0925
Baseline IOL (reversed coding)	-0.0259	0.0505	-0.1250 to 0.0731	0.6079
Cataract surgery during follow-up (reversed coding)	0.0577	0.0449	-0.0303 to 0.1457	0.1985
Dye (reversed coding)	-0.0414	0.0395	-0.1188 to 0.0360	0.2946
Visual gain = baseline minus 12-month logMAR. This change score is mathematically coupled to baseline BCVA; interpret cautiously.				

Discussion

The principal observation is that the apparent benefit of ERM surgery depends on the outcome selected. Eyes with relatively good preoperative acuity tended to achieve better final acuity, whereas eyes with worse preoperative acuity showed larger numerical improvements. These findings should not be framed as a contradiction: an eye starting near good vision has less room for measurable improvement, and an eye starting with poor vision can gain more lines while still having limited final acuity.

This distinction is relevant to preoperative counseling. An outcome defined solely by change in logMAR may undervalue surgery in eyes with good starting acuity, whereas final acuity alone may understate meaningful gains in eyes with worse baseline function. The associations support reporting both measures rather than presenting a single acuity cutoff as the optimal time for intervention. Importantly, a surgical cohort without an observation or delayed-surgery comparison group cannot establish whether operating earlier causes better outcomes.

Baseline and 1-month BCVA remained associated with final vision after adjustment for CRT and recorded clinical factors, consistent with the clinical relevance of functional measures [3, 4, 10, 11]. The absence of a statistically significant CRT coefficient does not exclude the prognostic value of more detailed OCT

morphology, which was not graded in this dataset. Cataract surgery and lens status may influence measured acuity over time; their effects cannot be confidently excluded in this modest sample.

Long-term visual improvement has also been reported after membrane surgery in patients with good preoperative acuity [12].

Strengths include a consecutive single-surgeon series, serial OCT and acuity measurements, and a common 12-month endpoint. Limitations include the retrospective design, 51-eye sample, eight covariates in the adjusted model, four bilateral cases, absence of systematic OCT microstructural grading, and lack of patient-reported metamorphopsia or quality-of-life measures. Clustered standard errors account for within-patient correlation in variance estimation but do not remove model instability or confounding. Visual gain is mathematically related to baseline acuity, and the exploratory 0.5 split is sensitive to outcome choice and multiple testing. Cataract surgery during follow-up is a post-baseline variable and should not be used to claim a purely preoperative prediction model.

In conclusion, preoperative acuity was associated with both final visual acuity and the magnitude of measured improvement after idiopathic ERM surgery, but in different directions of clinical desirability. Presenting these outcomes together may improve counseling. Prospective comparative studies are required to determine whether any particular preoperative acuity constitutes an optimal surgical timing threshold.

Conclusions

The choice of endpoint changes how visual outcome after ERM surgery is interpreted. Better starting acuity was associated with better final acuity, whereas worse starting acuity showed greater measured gain. Neither association establishes a causal benefit of earlier surgery or a validated visual-acuity cutoff.

Abbreviations

BCVA, best-corrected visual acuity; CRT, central retinal thickness; ERM, epiretinal membrane; ILM, internal limiting membrane; IOL, intraocular lens; OCT, optical coherence tomography; PPV, pars plana vitrectomy.

Declarations

Ethics approval and consent to participate

Approved by the Institutional Review Board of China Medical University Hospital (CMUH114-REC1-106). The board waived informed consent for retrospective anonymized data. The study was conducted in accordance with the Declaration of Helsinki.

Consent for publication

Not applicable.

Availability of data and materials

The datasets analyzed are available from the corresponding author on reasonable request, subject to institutional and ethical requirements.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

M.C.H. performed the surgeries, analyzed and interpreted the data, and drafted the manuscript. H.Y.L., C.C.C., Y.W.C., J.H.C.H., and Y.Y.T. critically revised the manuscript. All authors reviewed and approved the final manuscript.

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