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Long-term retrospective analysis of visual acuity and optical coherence topographic changes after single versus double peeling during vitrectomy for macular epiretinal membranes

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Abstract

Purpose—To determine the long-term effect of internal limiting membrane (ILM) with associated epiretinal membrane (ERM) peeling versus single peeling alone in terms of best-correct visual acuity (BCVA) and anatomical outcomes on spectral-domain optical coherence tomography (SD-OCT).

Methods—This retrospective comparative cohort study of patients who had follow-up >1 year and underwent surgery for ERM by a single surgeon (SC) from January 1st, 2008-December 31st, 2012 compared cases in which the ILM was stained with brilliant blue G (BBG) to facilitate "double peeling" (n=42) to "single peeling" (n=43) of the ERM alone for up to 3 years of follow-up. For continuous variables, an independent 2-tailed t-test was performed. For binary variables, the Fisher exact test was performed. Statistical significance was defined as $p<0.05$.

Results—Eighty-five of 142 patients fit the inclusion criteria. At last follow-up, the single peeling group (SPG) were more likely to have ERM remaining in the central fovea postoperatively (p=0.0020, becoming significant by postoperative year 1, p=0.022) and less likely to develop inner retinal dimpling (IRD) (p=0.000, becoming significant by postoperative month 3, p=0.015). At 3 years, central foveal thickness had decreased in the SPG by −136.9-μm and by −84.1-μm in the double peeling group (DPG) respectively, which was not significantly different (p=0.08). Mean BCVA improved in both groups at all time points. There was no statistically significant difference between the two groups at 3 years (p=0.44, SPG=0.32±0.42, Snellen 20/42 (mean±standard deviation); DPG=0.23±0.27, Snellen 20/34).

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Conclusion—BBG-assisted ILM peeling for ERM results in a more thorough removal of residual ERM around the paracentral fovea. However, there is no difference in long-term BCVA at 3 years and a greater likelihood of IRD.

Keywords

Brilliant blue g; dimpling of nerve fiber layer; epiretinal membrane; inner retinal dimpling; internal limiting membrane; optical coherence tomography; membrane peeling; vitrectomy

Idiopathic epiretinal membranes (ERM) are proliferations of fibroblasts, glial cells and astrocytes on the internal limiting membrane (ILM) of the macula.[1] Commonly found in patients over 50 years of age,[2] their etiology remains unclear; however, as ERMs are frequently associated with posterior vitreous detachments, some postulate that they are associated with an anomalous vitreous separation.[3] Mediated by growth factors and cytokines, the proliferation and migration of glial cells through defects in the internal limiting membrane (ILM) is believed to be a pathophysiologic mechanism.[4] Because of their central location on the macula, contraction of ERMs can be responsible for significant visual disability in the form of micropsia, macropsia, monocular diplopia, metamorphopsia and decline in visual acuity.[5]

Vitrectomy with membrane peel as a treatment for ERM has been performed for over 30 years.[2] Visual acuity improvements are seen in 65-90% of patients undergoing the procedure, with a recurrence rate of only 1-5%.[1, 6, 7] Complete removal of ERM reduces the recurrence rate, as ERM recurrence seems to be associated with residual ERM.[8, 9] Currently, the surgical techniques for vitrectomy with membrane peeling have evolved. During vitrectomy with “single peeling,” surgeons typically use triamcinolone to visualize the ERM after the posterior hyaloid is removed. Triamcinolone lodges between fibers in the cortical vitreous or ERM, but it does not stain the ILM.[10] As an adjunct to reduce recurrence, most surgeons utilize a “double peeling” technique, which includes removal of the ILM.[5, 9, 11-13] Dyes utilized to stain the ILM include indocyanine green (ICG), trypan blue and brilliant blue G (BBG).[14] ILM peeling is believed to reduce the retinal striae seen postoperatively. Additionally, studies argue that the ILM may serve as a scaffold for fibrovascular re-proliferation and that the second peel of the ILM reduces the recurrences.[12] However, the long-term visual and anatomic prognosis of dye-assisted ILM peeling remains unclear with several studies reporting loss of peripapillary retinal nerve fiber layer (RNFL) and associated visual field defects.[15-18]

The recent advancement in optical coherence tomography (OCT) including spectral-domain OCT (SD-OCT) with an axial resolution of 3 to 7-μm has allowed clinicians to monitor for recurrence (or residual ERM)[9] and evaluate the anatomical changes after ILM peeling.[19] Recently, studies with OCT have shown that ILM peeling for both idiopathic macular hole and macular pucker can cause the development of dissociation of the nerve fiber layer (DONFL) or otherwise known as inner retinal dimpling (IRD).[20-22] Their functional significance remains controversial with previous studies showing no difference in visual acuity, sensitivity thresholds or microperimetry;[21, 23, 24] but more recent work by Ripandelli and associates, demonstrated that ILM peeling for ERM resulted in an overall decreased

mean retinal sensitivity and increased number of microscotomas measured with microperimetry with 12 months of follow-up.[5]

Given these observations, long-term follow-up comparing single versus double peeling in idiopathic ERM may be important but remains lacking within the literature. Most studies that follow the development of IRD have not extended past 12 months.[5, 9, 20-22, 25, 26] This current study investigated the long-term follow-up of patients who underwent macular pucker surgery by a single surgeon (SC) either with or without BBG dye-assisted second peel of the ILM and analyzed the visual and anatomic outcomes of these patients over 3 years.

Methods

Institutional review board approval was obtained from the Edward S. Harkness Eye Institute, Columbia University College of Physicians and Surgeons, New York, NY for this retrospective, comparative cohort study. It complied with the Health Insurance Portability and Accountability Act of 1996 and followed the tenets of the Declaration of Helsinki.

Patients and Surgical Technique

Eighty-five of 142 consecutive patients who underwent surgery for idiopathic macular pucker by a single surgeon (SC) from January 1st, 2008 to December 31st, 2012 and had > 1 year of follow-up were included in the analysis. Initial exclusionary criteria included anterior segment comorbidities and posterior segment pathologies that could affect visual acuity and anatomical outcomes, such as corneal pathologies, media opacities, proliferative diabetic retinopathy, diabetic macular edema, advanced glaucoma, macular hole, previous macular surgery and high myopia (axial length ? 25.00 mm or refraction < −6.00 diopters). Of the selected 142 patients with idiopathic ERM without ocular comorbidities, patients were further excluded if they had ≤ 1 year of follow-up (SPG = 18, DPG = 25) or did not have macular SD-OCTs at baseline (SPG = 6, DPG = 8). Baseline and follow-up clinical evaluation included best-corrected visual acuity (BCVA) with Snellen charts, anterior slit-lamp examination, dilated fundus examination and SD-OCT (Cirrus, Carl Zeiss Meditec, Inc., Dublin, CA, USA) evaluation.

All patients identified underwent 23-gauge vitrectomy with membrane peeling followed by injection of air and face-down position (1-2 days). For some patients, this procedure was combined with phacoemulsification with intraocular lens insertion. Air tamponade was used to seal the sclerotomy incisions internally and decrease the likelihood of postoperative hypotony and endophthalmitis. As previously reported in May 2010, the primary surgeon (SC) changed from the practice of single peeling utilizing triamcinolone (10 mg/ml) to highlight the ERM, to double peeling in which triamcinolone was used to highlight the ERM, and then BBG was subsequently used to stain and remove the ILM.[9]

Primary and Secondary Outcome Measurement

Cases in which the ILM was stained with BBG to facilitate “double peeling” (n=42) were compared to cases without the use of BBG (“single peeling,” n=43). A retrospective review was performed to obtain the patients’ preoperative and post-operative BCVA converted to

logarithm of the minimum angle of resolution (LogMAR) at 0.25, 0.5, 1, 2 and 3 years. The SD-OCT macular cube scans at each time-point (or closest date within 6 weeks) were evaluated. The Early Treatment Diabetic Retinopathy Study (ETDRS) macular subfield thicknesses in each of the 9 quadrants of the parafoveal (radius of curvature 2.22 mm) and perifoveal area (radius of curvature 3.45 mm), central foveal thickness (CFT, radius of curvature 1 mm), total volume and average thickness were recorded.[27] SD-OCT findings including the presence or absence of: residual ERM within the parafoveal area of the macular cube scan, IRD,[22] retinal thinning (blue or red signal due to thinning on the ETDRS macular grid), cystoid macular edema (CME, intraretinal cysts), restoration of the shape of the umbo, lamellar or pseudohole at last follow-up and preservation of the outer photoreceptor segments (continuity of the external limiting membrane and ellipsoid line). For the purposes of this study "recurrence" of ERM is defined as the presence of ERM on postoperative SD-OCT, which would include both persistent residual pre-operative ERM as well as post-operative ERM regrowth. Two independent readers (JJJ and EDG) evaluated all of the SD-OCT scans for these categorical variables measured at baseline and last follow-up, and if there were any differences, they were then arbitrated by a third reader (QVH).

Data Analysis

Data were analyzed with the Stata 13.0 statistical package (StataCorp LP, College Station, TX, USA). For continuous variables, an independent 2-tailed *t* test was performed, and for binary variables, the Fisher exact test was performed. Statistical significance was defined as $p \leq 0.05$.

Results

There were no statistically significant differences between the single peeling group (SPG) and double peeling group (DPG) with respect to potentially confounding variables such as age (p = 0.30, n = 85), sex (p = 0.39), preoperative BCVA (p = 0.78), preoperative central foveal thickness (p = 0.14) or combined phacoemulsification with PPV (p = 0.83). Follow-up ranged from 13 to 56 months in the SPG and from 15 to 46 months in the DPG, which differed due to the recent change in surgical technique in May 2010 therefore limiting the total amount of follow-up time in the DPG (Table 1).

Postoperative LogMAR BCVA did not differ between the DPG and SPG at postoperative month 3 (p = 0.67, n = 83), month 6 (p = 0.18, n = 66), month 12 (p = 0.54, n = 71), month 24 (p = 0.071, n = 71) or month 36 (p = 0.44, n = 55) (Table 2). Change from baseline in CFT and para- and peri-foveal ETDRS subfields did not significantly differ between the DPG and SPG at any of the measured time points (Table 3). When analyzing the decrease in CFT from baseline, at postoperative year 1, the decrease in the DPG was −86.2 +/−90.0 μm, and in the SPG was −130.2 +/−108.5 μm (p = 0.078, n = 66). This difference was also not significant at postoperative year 2 (p = 0.22, DPG: −136.5 +/−116.1 μm versus SPG: −105.0 +/−90.5 μm, n = 67) or postoperative year 3 (p = 0.076, DPG: −136.9 +/−110.5 μm versus SPG: −84.1 +/−90.2 μm, n = 55)

Based on SD-OCT findings on last follow-up visit, patients in the SPG were more likely to have residual ERM in the central fovea postoperatively (p = 0.0020, n = 85; becoming

significant by postoperative year 1, p = 0.022) and less likely to develop IRD (p = 0.000, n = 85; becoming significant by postoperative month 3, p = 0.015). The two groups did not significantly differ in terms of the likelihood of other SD-OCT outcome measures examined (retinal thinning, CME, umbo shape restoration, presence of lamellar/pseudohole on last follow-up and preservation of outer photoreceptor segments, Table 4).

Discussion

Previous publications have analyzed the postoperative anatomical and functional outcomes, but most are limited to 1 year of follow-up.[5, 9, 19-22, 25, 26, 28-31] Inoue and colleagues retrospectively analyzed a cohort of patients who underwent vitrectomy with ICG-assisted ILM peeling over a 2 year period but the conclusions were limited by an overall small number of patients (n = 17) and did not compare single versus double peeling.[32] Similarly, Treumer and colleagues retrospectively analyzed 33 eyes after vitrectomy with ILM peeling but without use of vital-dye stain for idiopathic ERM with a mean follow-up of 46 ± 13 months; however, they only analyzed the OCT changes in terms of macular thickness and did not compare single versus double peeling results.[33] In comparison, this current study presents the 2- and 3-year follow-up comparing single versus double peeling for idiopathic ERM including visual and anatomical SD-OCT outcomes. The double-peeling procedure effectively removing the ILM resulted in a more thorough peeling of the parafoveal ERM compared to single-peeling with triamcinolone alone, without effecting long-term BCVA, but it resulted in an increased frequency of observed anatomic IRD.

Pars plana vitrectomy (PPV) with ILM peeling has become commonplace for the treatment of idiopathic ERM[34] although the safety of ILM peeling remains controversial. Recently, several reports have described structural changes in the retinal architecture after ILM peeling, including formation of postoperative central and eccentric macular holes.[26] They have also reported numerous arcuate striae directed along the optic nerve fibers after ILM peeling for idiopathic ERM, referred to as dissociated optic nerve fiber layer[20] and inner retinal dimples.[21, 22, 26] Studies have proposed several mechanisms on the development of IRD including intraoperative ILM staining with dyes[17] or surgical manipulation;[20, 22, 25] but IRD may occur after ICG staining, BBG staining or adjunct-free peeling.[26]

Given that the ILM is a basal lamina that represents the footplates of the Müller cells, it has been proposed that ILM peeling causes widespread trauma and leads to injury or loss of the Müller cells with an increased number of footplates observed on histological samples of peeled ILM with use of dyes including ICG and BBG.[35-37] Furthermore, it is also possible that patients with the “single peel” technique may also develop IRD[38] due to associated ILM peeling in conjunction with their macular pucker due to their tight adhesions.[39] We observed that IRD developed diffusely and were present in 51% of eyes with single peel and 88% of eyes with double peel. The difference in IRD prevalence between the two groups was significant as early as postoperative month 3 (p = 0.015). The mechanical peeling of the ILM appears to be the highest risk factor for IRD development throughout the macula. Based on these proposed pathophysiologic mechanisms and the consistent development of more IRD even beyond 6 months in the SPG and DPG, a greater amount of ILM peeling for idiopathic ERM likely leads to further traumatic Müller cell injury and encourages IRD development.

The visual significance of IRD still remains unclear. Mitamura and Ohtsuka compared patients that had IRD after idiopathic macular hole repair with ILM peeling versus those that had repair without ILM peeling and did not develop IRD and found that there was no difference in the final vision or static microperimetry after 6 months of follow-up.[23] In contrast, Ripandelli and associates followed their cohort for 12 months and demonstrated that ILM peeling resulted in decreased mean retinal sensitivity and increased number of microscotomas measured with static microperimetry.[5] Our long-term follow-up of this cohort at 1-, 2- and 3-years found that there were no significant visual differences in the patients that had a “single” versus “double” peel, and all eyes had significant improvement in BCVA; but due to the retrospective nature of the study, we were unable to analyze any changes that may have occurred with static microperimetry.

Several studies have also analyzed other SD-OCT parameters that may be correlated to good postoperative BCVA such as restoration of inner retinal architecture,[40] recovery of the ellipsoid junction and macular thickness. Preoperative and postoperative intact photoreceptor inner segment/outer segment junction (or ellipsoid layer) on SD-OCT has been shown to predict good visual outcomes,[41] but there has been a report showing that even a normal appearance of the photoreceptors on SD-OCT may be associated with a lack of improvement in vision.[42] When comparing single versus double peeling and analyzing the final SD-OCT, we did not find a difference in the integrity of the ellipsoid layer with either surgical technique. Both groups had a high percentage of intact ellipsoid layers and improvement in final BCVA (Table 4). The categorical presence or absence of a foveal umbo may not specifically analyze the restoration of the inner retinal layers and may not be accurate enough to correlate with corresponding visual recovery.

Recurrence or persistence preoperative idiopathic ERM after primary PPV ranges from 7.5% to 56% after removal of ERM alone and as low as 0% to 9% after double peeling of both the ERM and ILM.[43] Similarly, this study found that double peeling results in a more effective removal of the entire ERM with no residual parafoveal tissue or recurrence (0/42, 0.0%) compared to single peeling with triamcinolone alone (9/43, 20.9%, 4 of these 9 cases were persistent ERM, Table 4). Previously, Chang and colleagues noted this same finding after three months of follow-up,[9] and we demonstrated that after 3 years of follow-up, recurrence or persistence of ERM tissue in the parafoveal region is less likely when both ERM and ILM are initially peeled. In this cohort, there were no eyes that required repeat PPV for recurrence of or clinically significant residual ERM in the SPG.

Postoperative BCVA did not significantly differ between the two groups at any time point measured over the 3 years of follow-up. We acknowledge that the absence of detecting a difference in BCVA may be limited by the number of patients at each interval of follow-up in this retrospective study. However, compared to the current literature, this study has the highest number of patients analyzed at 2 years (n = 71) and 3 years (n = 55) of follow-up. Even with the more complete removal of ERM in the DPG, there was no clinically significant difference from the SPG eyes that were more apt to show residual parafoveal ERM. As previously mentioned, the additional ILM peeling resulted in increased incidence of IRD, but did not affect the long-term ellipsoid layer, macular or central foveal thickness and final BCVA. Macular thickness has been shown to vary significantly with age and

gender,[42] but in this comparative cohort study, there were no significant preoperative differences in these demographic factors in between groups (Table 1) and therefore, they are less likely to have influenced the long-term findings.

Surgeons who decide to perform a double peel are faced with a choice in the vital dye stain selection. In our study, we chose to use BBG over ICG and trypan blue both for its high tendency to bind to the ILM at low concentrations and the low apparent retinal toxicity.[44] Previous reports have implicated that ICG may result in increased light-induced oxidative stress and decreased photoreceptor,[45] Müller cells[46] and retinal pigment epithelial cell viability leading to reduced retinal function.[47] Given these previous studies, the surgeon (SC) elected to utilize a uniform vitrectomy technique with BBG-dye assisted ILM peeling for idiopathic ERM. This decreased the likelihood that any long-term visual effects or anatomic changes noted on SD-OCT in this DPG could have been attributed to vital-dye toxicity.

Limitations to our study include its retrospective nature, relatively small sample size and subjective end point intervals up to 6 weeks before or after each time point. Given that this study was a retrospective analysis, 14 patients did not complete follow-up at 2 years and 30 patients did not complete follow-up at 3 years. This possibly introduces a potential selection bias that may have affected the analysis of the visual and anatomical outcomes. Even though this limitation is inherent to any retrospective analysis, our study still provides the largest comparative cohort analysis at each of these long-term time points therefore possibly decreasing this biases' effect on the study. Also, the lack of precise uniformity in every macular peeling surgery may have affected the amount of residual peripheral ERM tissue, and conversely, in some SPG cases a part of the ILM may have also have been removed when the ERM was peeled.[39] A single surgeon (SC) performed all of the operations with the same vital-dye staining for the SPG and DPG, and the surgical technique, learning curve and surgical platform were uniform for both procedures therefore limiting the individual differences between cases.

The duration of symptoms and severity of preoperative ERM were also not evaluated but would most likely be distributed evenly between the two groups. Other potential confounders that could have affected final BCVA such combined phacoemulsification and PPV procedures were also evenly distributed and baseline BCVA was not statistically different between the two groups (Table 2). Lastly, we were unable to mask OCT reviewers to the type of intervention as more recent cases used the double-peeling procedure; but objective study endpoints such as BCVA and central foveal thickness would not have been biased by the absence of masking. In this study, we also utilized Snellen BCVA as the measure of visual acuity, potentially missing other types of visual disability that may have resulted from retinal damage during the ILM peel. Further long-term testing at 2 or 3 years with static microperimetry may be warranted to elicit the full visual differences between single and double peeling.

In conclusion, the 2- and 3-year follow-up comparing a SPG versus DPG for idiopathic ERM suggests that the DPG has a more complete ERM removal, but may increase the incidence of IRD. Although the long-term overall macular thickness and BCVA are not

significantly different between the two groups, the benefits of ILM removal, which limits the amount of residual or recurrent ERM, is still unclear given the possible visual ramifications of IRD, especially in susceptible groups such as glaucoma patients and should be further analyzed. Surgeons should be cautious in the amount of ILM removed during surgery for ERM.

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Summary

Brilliant blue g-assisted internal limiting membrane, “double peeling,” for idiopathic macular pucker results in less residual epiretinal membrane (ERM) in the parafovea compared to “single peeling” of only the ERM. While there is no significant difference in final best-correct visual acuity at 2 and 3 years, “double peeling” results in a greater likelihood of inner retinal dimpling of the nerve fiber layer observed on spectral-domain optical coherence tomography.

Table 1

Baseline Characteristics of Patients Undergoing Single versus Double Peeling Macular Pucker Surgery

Variable	Single Peel	Double Peel
Age, years	68.6 (n = 43)	71.5 (n = 42)
Follow-up, months	36.3	29.9
Male Gender (%)	20/43 (47%)	24/42 (57%)
Combined Phaco/PPV	20/43 (47%)	21/42 (50%)

n = number; phaco = phacoemulsification; PPV = pars plana vitrectomy

Table 2

Preoperative and Postoperative Visual Acuity of Patients Undergoing Single versus Double Peeling Macular Pucker Surgery

Variable	Single Peel	Double Peel	p-Value
Baseline LogMar BCVA (Snellen); (n = 85)	0.53 (20/68)	0.52 (20/66)	0.78
1-3 Month follow-up LogMar VA (Snellen)	0.41 (20/51)	0.38 (20/48)	0.67
DBCVA from Baseline (3 Months); (n = 83)	−0.13	−0.14	0.80
6 Month follow-up LogMar VA (Snellen)	0.35 (20/45)	0.27 (20/37)	0.18
DBCVA from Baseline (6 Months); (n = 66)	−0.18	−0.22	0.52
12 Month follow-up LogMar VA (Snellen)	0.38 (20/48)	0.33 (20/43)	0.54
DBCVA from Baseline (12 Months); (n = 71)	−0.16	−0.18	0.83
24 Month follow-up LogMar VA (Snellen)	0.33 (20/43)	0.18 (20/30)	0.071
DBCVA from Baseline (24 Months); (n = 71)	−0.24	−0.31	0.35
36 Month follow-up LogMar VA (Snellen)	0.32 (20/42)	0.23 (20/34)	0.44
DBCVA from Baseline (36 Months); (n = 55)	−0.23	−0.24	0.92

BCVA = best corrected visual acuity; DBCVA= difference in best corrected visual acuity (LogMAR units); LogMAR = logarithm of the minimum angle of resolution; n = number. The last column reports the p-value of the t-test of the difference between Single Peel and Double Peel. P-value < 0.05 was determined as statistically significant.

Table 3

Change in Spectral Domain-OCT Measurements from Preoperative Baseline in Patients Undergoing Single versus Double Peeling Macular Pucker Surgery

	ΔCFT	ΔS-Para	ΔN-Para	ΔI-Para	ΔT-Para	ΔS-Peri	ΔN-Peri	ΔI-Peri	ΔT-Peri	ΔTV	ΔMT
Postoperative OCT Characteristics (1-3 months); (n=81)											
Single Peel	−95.7	−76.9	−54.8	−63.4	−85.8	−28.3	−19.0	−18.5	−40.0	−1.0	−31.2
Double peel	−67.4	−57.9	−54.4	−67.4	−67.4	−35.3	−22.2	−25.6	−39.4	−1.2	−33.5
p-value	0.12	0.21	0.98	0.76	0.76	0.59	0.75	0.49	0.96	0.51	0.73
Postoperative OCT Characteristics (year 1); (n=66)											
Single Peel	−130.2	−100.9	−86.6	−97.4	−109.9	−54.0	−41.0	−45.2	−54.4	−1.9	−54.6
Double peel	−86.2	−93.5	−80.4	−93.7	−95.1	−69.7	−49.0	−59.5	−73.4	−2.1	−57.2
p-value	0.08	0.69	0.75	0.84	0.47	0.40	0.51	0.30	0.36	0.71	0.80
Postoperative OCT Characteristics (year 2); (n=67)											
Single Peel	−136.5	−98.7	−91.8	−101.6	−108.9	−51.3	−43.5	−43.3	−53.9	−1.9	−54.3
Double peel	−105.0	−106.7	−80.2	−103.9	−126.0	−66.5	−48.0	−63.4	−74.4	−2.3	−62.7
p-value	0.22	0.68	0.57	0.91	0.37	0.39	0.70	0.10	0.22	0.32	0.41
Postoperative OCT Characteristics (year 3); (n=55)											
Single Peel	−136.9	−104.7	−88.6	−97.0	−110.5	−58.6	−53.4	−53.2	−66.0	−2.0	−56.6
Double peel	−84.1	−91.1	−74.3	−93.3	−111.4	−59.1	−52.1	−64.4	−63.9	−2.1	−57.6
p-value	0.08	0.55	0.55	0.86	0.97	0.98	0.92	0.41	0.92	0.91	0.94

CFT (radius of curvature 1 mm) = central foveal thickness (microns); EDTRS (Early Treatment Diabetic Retinopathy Study): Parafoveal subfields (radius of curvature 2.22 mm): S-Para = superior parafoveal, N-Para = nasal parafoveal, I-Para = inferior parafoveal, T-Para = temporal parafoveal. Perifoveal subfields (radius of curvature 3.45 mm): S-Peri = superior perifoveal, N-Peri = nasal perifoveal, I-Peri = inferior perifoveal, T-Peri = temporal perifoveal; MT = macular thickness (average retinal thickness measurement on macular cube analysis); n = number; OCT = optical coherence tomography; TV = total volume measurement on macular cube analysis. ‘Δ’ prefix = “change in” the listed variable relative to pre-operative levels. The last row of each panel reports the p-value of the t-test of the difference between Single Peel and Double Peel; $p < 0.05$ was defined as statistically significant.

Table 4

Postoperative Spectral-Domain OCT Findings at Last Follow-up

Variable	Single Peel (%); n = 43	Double Peel (%), n = 42	p-value
Parafoveal ERM	9/43 (21%)	0/42 (0%)	**0.0020***
ERM (at POM3)	0/39 (0%)	0/42 (0%)	----
ERM (at POM6)	3/39 (8%)	0/42 (0%)	0.107
ERM (at POM12)	5/39 (13%)	0/42 (0%)	**0.022***
ERM (at POM24)	5/39 (13%)	0/42 (0%)	**0.022***
ERM (at POM36)	5/39 (13%)	0/42 (0%)	**0.022***
Inner Retinal Dimpling	22/43 (51%)	37/42 (88%)	**0.000***
IRD (at POM3)	4/43 (9%)	13/42 (31%)	**0.015***
IRD (at POM6)	9/43 (21%)	23/42 (55%)	**0.002***
IRD (at POM12)	16/43 (37%)	31/42 (74%)	**0.001***
IRD (at POM24)	18/43 (42%)	37/42 (88%)	**0.000***
IRD (at POM36)	22/43 (51%)	37/42 (88%)	**0.000***
Retinal Thinning	9/43 (21%)	8/42 (19%)	1.00
CME/IRC	17/43 (40%)	15/42 (36%)	0.82
Umbo Restoration	17/43 (40%)	13/42 (31%)	0.50
Lamellar/pseudohole at last follow-up	3/43 (7%)	1/42 (2%)	0.62
Outer Segment Preservation	35/43 (81%)	37/42 (88%)	0.55

CME = cystoid macular edema; ERM = persistent/recurrent epiretinal membrane; IRC = inner retinal cysts; IRD = inner retinal dimpling; n = number; OCT = optical coherence tomography; POM = postoperative month. The last column reports the p-value of the Fisher exact test of the difference between Single Peel and Double Peel;

*denotes significance at the 0.05 level.