• Clinical Research •

Negative effects of enlarging internal limiting membrane peeling for idiopathic macular hole surgery

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Abstract

● **AIM:** To observe the effects of the different extents of internal limiting membrane (ILM) peeling on the surgical success and anatomical and functional outcomes of idiopathic macular hole (IMH).

● **METHODS:** In this retrospective cohort study, 36 patients were reviewed and divided into two groups according to the extent of ILM peeling: group A (18 patients), with the peeling area within one-half of the optic disc macular distance as the radius; group B (18 patients), with the peeling area larger than that of group A but did not exceed the optic disc macular distance as the radius. The main outcomes included the best corrected visual acuity (BCVA), light-adaptive electroretinography, macular hole (MH) closure rate, central macular thickness (CMT), retinal nerve fiber layer (RNFL) and ganglion cell complex (GCC) thickness [nine regions based on the Early Treatment of Diabetic Retinopathy Study (ETDRS) ring] before and 1, 3, and 6mo after surgery.

● **RESULTS:** The closure rate was 94.4% (17/18) both in groups A and B. The BCVA in both groups improved significantly compared with the preoperative values, but there was no difference between the two groups. The b-wave amplitude of the electroretinogram analysis was significantly improved in both groups compared to that of the preoperative period, with a greater increase in group A than in group B at 6mo (P=0.017). The CMT in both groups gradually decreased after surgery, and there was no difference between the two groups. The RNFL thickness of the temporal outer ring region in group B was significantly lower than that in group A at 3 and 6mo after surgery (P=0.010, 0.032). The GCC thickness of the temporal outer ring region in group B was significantly lower than that in group A at 6mo after surgery (P=0.038).

● **CONCLUSION:** Enlarging the extent of ILM peeling doesn't affect the IMH closure rate and visual acuity recovery, but the greater the extent of peeling, the greater the damage to the inner retinal structures.

● **KEYWORDS:** idiopathic macular hole; internal limiting membrane; light-adapted electroretinography; retinal nerve fiber layer; ganglion cell complex

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INTRODUCTION

Idiopathic macular holes (IMHs) are attributed to the adhesion of the vitreous macular interface[1]. The incidence of IMH is approximately 0.01% to 0.09%, and approximately two-thirds of patients are female[2]. It is known that tangential and anteroposterior vitreoretinal traction, posterior vitreous detachment, and persistent localized vitreomacular adhesions around the fovea are the main causes of most IMH[3].

At present, pars plana vitrectomy (PPV) is recognized as a major and effective treatment for IMH[4]. Eckardt *et al*[5] reported for the first time in 1997 that internal limiting membrane (ILM) peeling achieved good results in macular hole (MH) surgery and improved the closure rate[6]. Pars plana vitrectomy combined with ILM peeling is currently the most widely used surgical technique in the treatment of IMH, and its success rate is as high as 98%[7-9]. Pars plana vitrectomy (PPV) is believed to help MH closure by reducing anteroposterior vitreoretinal traction, while ILM peeling reduces tangential traction components[10].

The ILM is the basement membrane of Müller cells, located on the complex of the retinal nerve fiber layer (RNFL) and

ganglion cell layer (GCL) and plays an important role in the physiological functions of the retina[10-11]. Previous studies have shown that ILM peeling may cause mechanical damage to the RNFL and ganglion cell complex (GCC), and cause degeneration and thinning of the area over time, leading to anatomical and functional defects[3].

Given that the integrity of the RNFL-GCL complex has an important impact on postoperative visual acuity, our study divided the ILM peeling range into two areas based on the distance between the optic disc and the macula. Aiming to observe the success rate, the influence of anatomy, and functional results of different ILM peeling diameters, we compared the changes in RNFL and GCC thickness in nine regions based on the EDTRS ring.

SUBJECTS AND METHODS

Ethical Approval This retrospective cohort study was conducted at the Tianjin Medical University Eye Hospital. The Ethics Committee and Institutional Review Board of the Tianjin Medical University Eye Hospital approved the human patient research program in accordance with the Helsinki Declaration [ethical batch number: 2020KY(L)-11]. All patients had signed informed consent.

Participants Sixty-one patients with IMH who underwent vitrectomy combined with ILM peeling by a single surgeon at the Tianjin Medical University Eye Hospital between January 2018 and December 2019 were reviewed. Among them, 6 patients with retinal detachment, 4 patients with lamellar MH and 15 patients with incomplete medical records were excluded. The inclusion criteria were as follows: 1) age>18y; 2) diagnosis of IMH; 3) no objection to the research scheme; 4) postoperative follow-up of 6mo. Exclusion criteria were as follows: 1) high myopia (≤-6.0 D); 2) axial length (AL) >26.0 mm; 3) secondary MH; 4) history of intraocular surgery (included cataract surgery); 5) retinal detachment because of the MH; 6) patients with other diseases affecting visual function; 7) inability to coordinate postures after surgery.

Research Methods The patients were divided into two groups according to the extent of the ILM peeling. Patients with an extent of peeling in the area within the radius of one-half of the macular distance of the optic disc were included in group A, and those with an extent of peeling in the area larger than that of group A but within the radius of the macular distance of the optic disc were included in group B (Figure 1).

All patients were operated by the same surgeon and underwent a standard three-port, 25-gauge PPV (Constellation Vitrectomy System, Alcon, Fort Worth, TX, USA). Cataract surgery was performed according to the status of lens opacity and the patient's wishes. Following core vitrectomy, induction of posterior vitreous detachment with the assistance of triamcinolone acetonide was performed, ILM was stained with brilliant blue for 5s and peeled up to the edge of the MH, the flap initiation location was in the inferior temporal side approximately 1.5 mm away from the fovea of macula. Then, gas-liquid exchange was performed with 1 mL of C_3F_8 tamponade. All patients were instructed to maintain a strict prone position for 48h postoperatively. The extent of ILM peeling was reviewed by complete surgical videos.

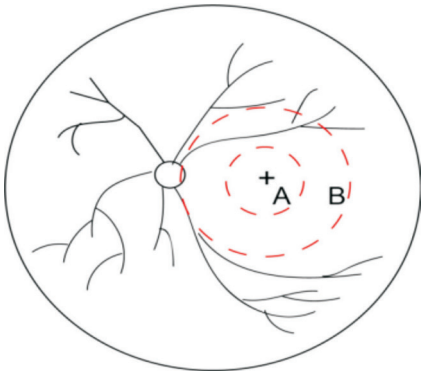

Figure 1 Grouping diagram of extent of the internal limiting membrane peeling.

Preoperative data obtained for all patients included age, sex, laterality, duration of symptoms, axial length, MH stage, best-corrected visual acuity (BCVA), intraocular pressure (IOP), slit lamp microscopy, fundus examination, lens status, full-field electroretinography (ERG), and optical coherence tomography (OCT; Topcon 3D-OCT-2000; Topcon Corporation, Tokyo, Japan), including minimum inner hole diameter (MD), basal diameter (BD), height (H), diameter hole index (DHI=MD/BD), macular hole index (MHI=H/BD), and tractional hole index (THI=H/MD). Postoperative data included BCVA, IOP, ERG, closure rate, central macular thickness (CMT), RNFL, and GCC thickness (nine regions based on EDTRS ring) at 1, 3, and 6mo.

Statistical Analysis SPSS 25.0 (IBM Corp., Armonk, NY, USA) and GraphPad Prism 7 (GraphPad Software Inc., San Diego, CA, USA) were used for the statistical analysis. Quantitative data with normal distribution were tested using the independent samples *t*-test, and abnormal distributions were compared using the Mann-Whitney *U* test. Categorical data were tested using the Chi-square test and Fisher's exact test. Multiple comparisons were performed using Wilcoxon rank-sum tests and Bonferroni correction. Differences were considered statistically significant at $P<0.05$.

RESULTS

Patient Characteristics Thirty-six eyes of 36 patients who underwent vitrectomy combined with ILM peeling for IMH were included, with 18 eyes in group A and 18 eyes in group B. All of the lens conditions are phakia. There were no significant differences between the two groups based on the demographic characteristics (sex, laterality, age, symptom duration), baseline

Table 1 Comparison of baseline characteristics between the two groups

Parameters	Group A, *n*=18	Group B, *n*=18	*t*/*Z*	*P*
Gender (male/female)	6/12	2/16	-	0.228
Age (y)	64.94±7.58	66.06±4.49	0.54	0.596
Duration of symptoms (mo)	2.50 (1.00, 4.25)	1.00 (0.90, 3.25)	1.68	0.093
Axial length (mm)	23.60 (23.08, 23.75)	23.37 (22.79, 23.77)	1.12	0.261
BCVA (logMAR)	0.90 (0.58, 1.00)	0.80 (0.50, 1.00)	0.29	0.773
Eye (phakia/pseudophakia)	18/0	18/0	-	-
Cataract surgery (yes/no)	14/4	12/6	-	0.711
Macular hole stage				0.812
I	-	-	-	
II	10	9	-	
III	2	4	-	
IV	6	5	-	
MD (μm)	480.00±161.48	396.56±171.74	1.50	0.142
BD (μm)	919.78±313.07	899.94±312.61	0.19	0.850
H (μm)	433.53±71.57	410.19±55.52	1.09	0.282
DHI (MD/BD)	0.52 (0.39, 0.65)	0.47 (0.34, 0.51)	1.27	0.206
MHI (H/BD)	0.50 (0.37, 0.58)	0.47 (0.45, 0.65)	0.16	0.874
THI (H/MD)	0.85 (0.64, 1.15)	1.13 (0.90, 1.40)	1.71	0.088

BCVA: Best-corrected visual acuity; MD: Minimum inner hole diameter; BD: Basal diameter; H: Height; DHI: Diameter hole index; MHI: Macular hole index; THI: Tractional hole index.

Table 2 Comparison of preoperative RNFL thicknesses in nine regions of the EDTRS ring μm, M (P25, P75)

Items	Group A	Group B	Median difference (95%CI)	Wilcoxon two-sample hierarchy test	
				Z	*P*
Cen	27.00 (11.25, 37.75)	23.50 (16.00, 41.25)	-3.5 (-16 to 9)	0.73	0.467
Sin	39.50 (33.50, 51.50)	36.00 (30.75, 47.50)	2 (-4 to 10)	0.84	0.401
Nin	41.00 (30.75, 58.75)	41.50 (35.50, 47.50)	1 (-8 to 12)	0.30	0.763
Iin	38.50 (32.75, 51.75)	42.50 (32.75, 61.50)	-2 (-15 to 6)	0.49	0.624
Tin	32.00 (29.50, 47.75)	36.50 (23.50, 47.00)	2.5 (-10 to 10)	0.51	0.612
Sout	42.00 (38.75, 51.25)	46.00 (40.50, 51.25)	-2 (-8 to 4)	0.81	0.419
Nout	51.50 (42.75, 59.00)	53.50 (48.25, 58.50)	-3 (-10 to 5)	0.67	0.506
Iout	45.50 (38.50, 50.50)	42.00 (37.50, 47.25)	3 (-4 to 8)	0.86	0.392
Tout	25.00 (24.00, 27.25)	26.00 (24.00, 30.75)	-1 (-3 to 1)	0.75	0.453

Cen: Central subfield; Sin: Superior inner ring; Nin: Nasal inner ring; Iin: Inferior inner ring; Tin: Temporal inner ring; Sout: Superior outer ring; Nout: Nasal outer ring; Iout: Inferior outer ring; Tout: Temporal outer ring.

characteristics (axial length, BCVA, and cataract surgery or not), and OCT data (MH stage, MD, BD, H, DHI, MHI, and THI; $P>0.05$; Table 1). In group A, 14 eyes were performed cataract surgery and the other 4 eyes were not performed cataract surgery during 6-month follow-up. In group B, 12 eyes were performed cataract surgery, and the other 6 eyes were not performed cataract surgery during 6-month follow-up.

Preoperative Thickness of Retinal Nerve Fiber Layer and Ganglion Cell Complex The ETDRS is centered on the macular fovea, with three concentric circles (diameter: 1, 3, and 6 mm), divided into four quadrants and a total of nine regions: the central subfield (Cen), superior inner ring (Sin), nasal inner ring (Nin), inferior inner ring (Iin), temporal inner ring (Tin), superior outer ring (Sout), nasal outer ring (Nout), inferior outer ring (Iout), and temporal outer ring (Tout). We compared the thickness of the RNFL and GCC in the nine regions preoperatively, and there was no statistically significant difference between the two groups (Tables 2 and 3).

Best-Corrected Visual Acuity There was no statistical difference in the BCVA between groups A and B preoperatively and at 1, 3, and 6mo postoperatively. There was an overall statistical difference in the BCVA in group A preoperatively and at 1, 3, and 6mo postoperatively, with statistically significant differences at 3 and 6mo compared to the preoperative values ($P=0.001$ and $P<0.001$, respectively). There was an overall statistical difference in the BCVA in group B preoperatively and at 1, 3, and 6mo postoperatively, with statistically significant differences at 3 and 6mo compared to the preoperative values ($P=0.001$, $P<0.001$; Table 4).

Electroretinogram Analysis ERG analysis revealed that

Table 3 Comparison of preoperative GCC thicknesses in nine regions of the EDTRS ring μm, M (P25, P75)

Items	Group A	Group B	Median difference (95%CI)	Wilcoxon two-sample hierarchy test	
				Z	*P*
Cen	73.50 (57.25, 127.50)	89.50 (64.75, 129.75)	-9.5 (-35 to 27)	0.65	0.516
Sin	132.50 (118.50, 144.50)	135.50 (123.00, 147.00)	-4 (-18 to 8)	0.86	0.393
Nin	131.50 (119.50, 140.25)	137.50 (123.75, 153.00)	-6.5 (-21 to 5)	1.12	0.261
Iin	130.50 (115.50, 142.75)	134.00 (123.50, 161.75)	-9.5 (-26 to 6)	1.25	0.211
Tin	119.50 (109.75, 129.75)	119.50 (111.00, 145.75)	-3 (-21 to 11)	0.32	0.752
Sout	107.50 (98.75, 123.25)	113.00 (101.00, 122.50)	-3 (-13 to 9)	0.43	0.669
Nout	122.50 (114.00, 129.00)	130.00 (117.25, 137.50)	-6 (-15 to 5)	1.19	0.235
Iout	105.50 (95.00, 117.00)	109.00 (98.00, 122.50)	-4 (-15 to 9)	0.62	0.537
Tout	94.00 (85.00, 103.50)	97.50 (86.00, 107.25)	-3 (-13 to 7)	0.67	0.506

Cen: Central subfield; Sin: Superior inner ring; Nin: Nasal inner ring; Iin: Inferior inner ring; Tin: Temporal inner ring; Sout: Superior outer ring; Nout: Nasal outer ring; Iout: Inferior outer ring; Tout: Temporal outer ring; GCC: Ganglion cell complex.

Table 4 Comparison of the best corrected visual acuity logMAR, M (P25, P75)

Group	Preoperative	1mo	3mo	6mo	*H*	*P*
Group A	0.90 (0.58, 1.00)	0.40 (0.38, 0.73)	0.35 (0.20, 0.43)[a]	0.20 (0.19, 0.43)[a]	24.47	<0.001
Group B	0.80 (0.50, 1.00)	0.50 (0.30, 0.70)	0.40 (0.20, 0.50)[a]	0.30 (0.10, 0.50)[a]	26.17	<0.001
Z	0.29	0.06	0.67	0.05		
P	0.773	0.949	0.505	0.961		

[a]Compared with the preoperative value, $P<0.05$.

Table 5 Comparison of the b-wave amplitude μV, mean±SD

Group	Preoperative	1mo	3mo	6mo	Difference
Group A	110.77±45.75	126.63±40.81	131.82±37.31	144.59±34.64	33.83±39.41
Group B	126.34±18.66	130.30±19.54	132.50±26.25	131.09±25.57	4.76±29.21
H	2.48	8.53	1.28	0.24	0.03
P	0.190	0.734	0.950	0.192	0.017

Table 6 Comparison of the implicit times ms, M (P25, P75)

Group	Preoperative	1mo	3mo	6mo	Difference
Group A	33.00 (32.00, 34.00)	33.00 (33.00, 34.00)	33.00 (33.00, 34.00)	33.00 (33.00, 34.00)	1.00 (0.00, 2.00)
Group B	33.00 (31.00, 34.00)	33.00 (33.00, 34.00)	33.00 (33.00, 34.00)	33.00 (33.00, 34.00)	0.00 (-1.00, 3.00)
Z	0.94	0.12	0.67	0.97	0.71
P	0.348	0.907	0.500	0.335	0.478

there was no statistical difference in the b-wave amplitudes between groups A and B preoperatively and at 1, 3, and 6mo postoperatively. The b-wave amplitude of the ERG analysis was significantly improved in both groups compared to that of the preoperative period, with a greater increase in group A than in group B at 6mo (Table 5).

ERG analysis revealed that there was no statistical difference in the implicit times between groups A and B preoperatively and at 1, 3, and 6mo postoperatively. The difference in implicit times in both groups postoperatively compared to that of the preoperative period was also not statistically different (Table 6).

Central Macular Thickness The CMT of the eyes gradually decreased in both groups postoperatively. There was no statistical difference in the CMT between groups A and B at 1, 3, and 6mo postoperatively. There was no statistically significant difference in the overall comparison of the CMT in group A. There was an overall statistical difference in the CMT in group B at 1, 3, and 6mo postoperatively, with statistically significant differences at 3 and 6mo compared to that at 1mo, respectively (Table 7).

Closure Rate The closure rates were 94.4% both in groups A and B. In the IMH with a diameter of less than 400 μm, the closure rate was 100% both in groups A and B. In the IMH with a diameter of more than 400 μm, the closure rate was 87.5% in group A and 88.9% in group B. The difference was not statistically significant (Table 8).

RNFL and GCC Thickness In group A, the RNFL thickness was significantly thinner in the Cen, inner ring regions (Sin, Nin, Iin, and Tin), and the Tout region ($P<0.001$, $P<0.001$, $P<0.001$, $P<0.001$, $P<0.001$, and $P=0.034$, respectively) as

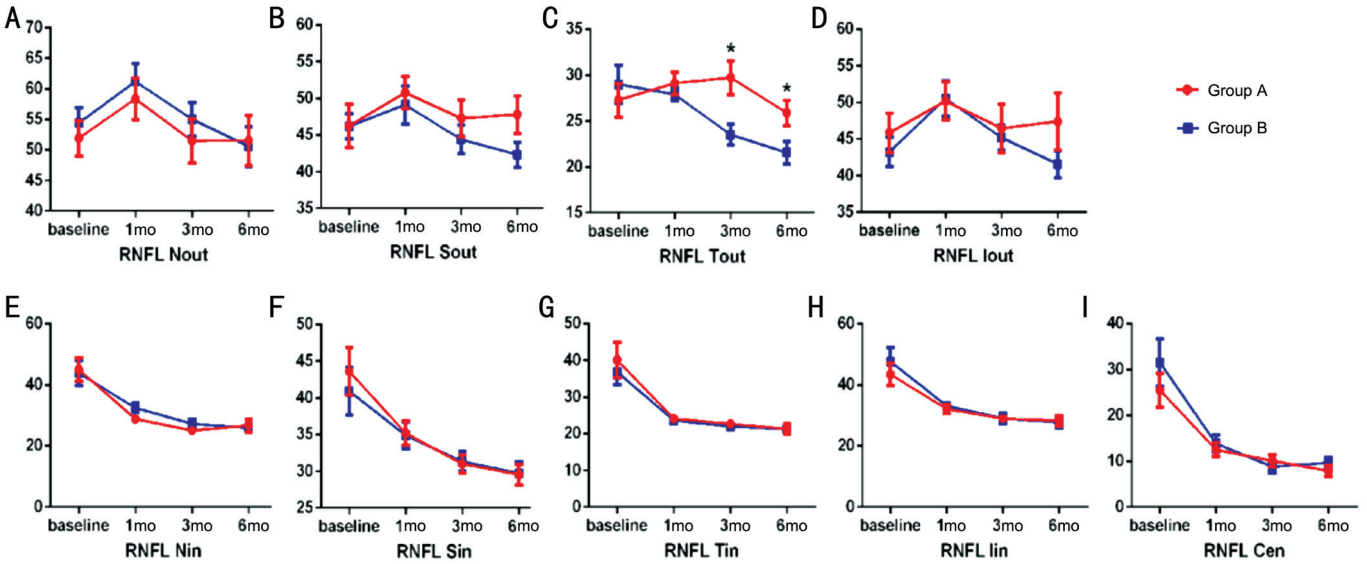

Figure 2 Preoperative and postoperative changes of the RNFL thickness in the nine regions A: Nout thickness of the RNFL; B: Sout thickness of the RNFL; C: Tout thickness of the RNFL; D: Iout thickness of the RNFL; E: Nin thickness of the RNFL; F: Sin thickness of the RNFL; G: Tin thickness of the RNFL; H: Iin thickness of the RNFL; I: Cen thickness of the RNFL. [a]*P*<0.05. RNFL: Retinal nerve fiber layer.

compared to that of the other regions. In group B, the RNFL thickness was significantly thinner in both the Cen and inner ring regions (Sin, Nin, Iin, and Tin) but also in the Nout, Iout, and Tout regions (*P*<0.001, 0.001, *P*<0.001, *P*<0.001, *P*=0.001, *P*=0.015, *P*=0.038, *P*<0.001) as compared to that of the other regions. The thickness of the Tout in group B was significantly lower than that in group A at 3 and 6mo after surgery, and the difference was statistically significant (*P*=0.010, 0.032; Figure 2).

In group A, the GCC thickness was significantly thinner in the Sin, Iin, and Tin regions (*P*=0.019, 0.017, 0.001) compared to that of the other regions. In group B, the GCC thickness was significantly thinner in both the Cen and inner ring regions (Sin, Nin, Iin, and Tin) but also in the Nout and Tout regions (*P*=0.002, *P*<0.001, *P*=0.007, *P*<0.001, *P*<0.001, *P*=0.033, *P*<0.001) compared to that of the other regions. The thickness of the Tout in group B was significantly lower than that in group A at 6mo after surgery, and the difference was statistically significant (*P*=0.038; Figure 3).

Table 7 Comparison of the CMT μm, mean±SD

Group	1mo	3mo	6mo	*F*	*P*
Group A	281.99±21.40	271.74±21.30	265.34±21.26	2.79	0.071
Group B	282.83±16.39	270.30±14.42[a]	262.97±11.49[a]	8.96	< 0.001
T	0.13	0.24	0.42		
P	0.895	0.814	0.680		

[a]Compared with that at 1mo, *P*<0.05.

Table 8 Comparison of the closure rate *n*

Parameters	Group A	Group B	*P*
Closure rate	17/18	17/18	1.000
<400 μm	10/10	9/9	-
≥400 μm	7/8	8/9	1.000

DISCUSSION

ILM peeling promotes MH closure through a variety of mechanisms, and previous studies have shown the importance of ILM peeling for MH closure[4,12]. ILM peeling removes the residual adherent vitreous cortex remnants, releases tangential traction, and increases the compliance of the retina to promote MH closure[13]. In addition, the injury of ILM peeling to Müller cells resulted in the proliferation of retinal glial cells to bridge and enhance MH closure. Moreover, ILM serves as a scaffold for fibroblasts and retinal pigment epithelium (RPE) cells. Glial cells may also migrate to the surface of the ILM, and the removal of ILM could inhibit the associated fibrocellular proliferation and prevent the formation of postoperative retinal membrane and the MH recurrences[3,14].

However, inner retinal defects occurred frequently after ILM peeling and did not regress once present. Goel and shukla[15] found inner retinal defects in the form of concentric macular dark spots. Liu *et al*[16] identified inner retinal dimples after ILM peeling with multimodal imaging of OCT, and the dimples corresponded to the dark spots. In addition to mechanical damage to the inner layer of the retina by ILM peeling, Tadavoni *et al*[17] found that ILM peeling may reduce the sensitivity of the retina and increase the incidence of microscotomas significantly, thus avoiding ILM peeling and minimizing the area when necessary. Terasaki *et al*[18] found that the amplitude of the focal ERG b-wave decreased with an implicit time delay shortly after ILM peeling. Some studies reported paracentral scotomas after ILM peeling and believed that it may be caused by nerve fiber damage during ILM peeling[1,19]. Akahori *et al*[20] showed that ILM peeling

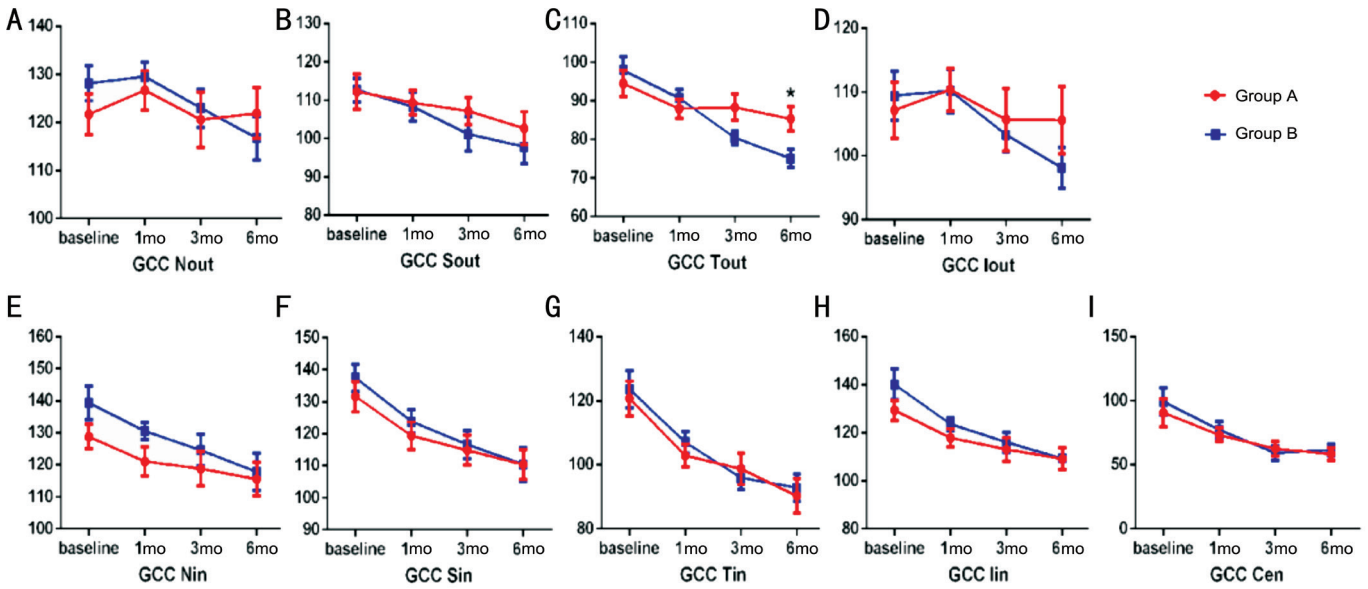

Figure 3 Preoperative and postoperative changes of the GCC thickness in the nine regions A: Nout thickness of the GCC; B: Sout thickness of the GCC; C: Tout thickness of the GCC; D: Iout thickness of the GCC; E: Nin thickness of the GCC; F: Sin thickness of the GCC; G: Tin thickness of the GCC; H: Iin thickness of the GCC; I: Cen thickness of the GCC. $^{a}P<0.05$. GCC: Ganglion cell complex.

enhances the displacement of the retina toward the optic disc postoperatively during MH closure. Considering these findings, it seems prudent to limit the size of ILM peeling to achieve the maximum visual effect.

Studies have also shown that more extensive and complete ILM peeling can facilitate MH closure[21]. Bae *et al*[22] showed a good degree of improvement in postoperative metamorphopsia with a larger extent of ILM peeling [3 disc diameter (DD)] compared to that of the group with a smaller extent (1.5 DD). Yao *et al*[13] divided the ILM peeling diameter into 2-DD and 4-DD groups, ILM peeling with 4 DD obtained better closure grading and visual outcomes in MH surgery than an ILM peel of 2 DD. Modi *et al*[10] divided the peel of the ILM into a 3-mm group and a 5-mm group and found that the two groups had similar MH closure rates, they concluded that increasing the size of the peel had no effect on the final anatomical closure rate. But the 3-mm group showed better functional improvement and better nerve fiber layer preservation at 3mo postoperative than that of the 5-mm group. They suggested reducing the ILM peeling as much as possible while ensuring the success rate.

Our results showed that there was no difference in the closure rate of IMHs with diameters greater or less than 400 μm in the different extents of ILM peeling. The postoperative BCVA was significantly improved compared with the preoperative BCVA, but the difference between the two groups was not statistically significant. ERG, which is more valuable than BCVA in assessing retinal function, showed that the b-wave amplitude in group B had limited and delayed recovery after ILM peeling compared to that in group A. Terasaki *et al*[18] found that the percentage increase in the b-wave amplitude was significantly greater in the ILM-on group than in the ILM-off group at 6mo postoperatively. The CMT of both groups gradually decreased over time after ILM peeling, which was consistent with the study of Takamura *et al*[23], but there was no difference between the two groups in our results. In group A, due to the small peeling area, the thickness of the RNFL was significantly thinner only in the Cen, four regions of the inner ring and Tout region, and the thickness of GCC was significantly thinner only in the Sin, Iin, and Tin regions, with little change in the rest of the regions. In group B, the RNFL thickness was significantly thinner not only in the Cen and four regions of the inner ring but also in the Nout, Iout, and Tout regions, and the thickness of GCC was significantly thinner in the Nout and Tout regions, except for the Cen and four regions of the inner ring. In our results, the RNFL and GCC thicknesses in the Tout region were significantly lower in group B than in group A postoperatively, and the differences were statistically significant.

ILM peeling was found to be more likely to affect the temporal region of the central macula. Kumagai *et al*[24] found that after vitrectomy with ILM peeling, the thickness of retina was significantly decreased in the temporal region compared to the normal fellow eyes. Faria *et al*[25] found that RNFL thinkness was significantly decreased in the temporal region compared to the nasal region 6mo after ILM peeling. Sabater *et al*[26] reported a significant thinning of the ganglion cell-inner plexiform layer in the temporal quadrant of the macula at a 6-month follow-up after ILM peeling. Given that the RNFL in the temporal region is thinner than in the nasal region, Sabater

et al[26] suggest that ganglion cells may be more exposed to the retinal surface and thus to the stain, which may be toxic to these cells, and in addition, ILM peeling may cause mechanical damage to the GCL, which is "less" protected by the RNFL in the temporal region. On the other hand, ILM usually flaps and peels from the temporal quadrant, which may contribute to mechanical damage in this region[27].

Previous studies reported that the fovea moves to the optic disc after successful vitrectomy with ILM peeling for MH[20,28]. Ishida *et al*[29] showed that the postoperative displacement of the temporal retina to the optic disc was larger than that of the nasal retina, suggesting that the temporal retina was more flexible and could retract to the optic disc when MH closed. Park *et al*[30] demonstrated that the extent of ILM peeling was an independent factor associated with postoperative displacement. In cases where the extent of ILM peeling is small, the fovea asymmetrically elongates to the optic disc. In cases where the extent of ILM peeling is large, the contraction force of retinal nerve fiber can displace the whole fovea to the optic disc. As the fovea is displaced toward the optic disc, the temporal retina gets stretched and thinned[22,30]. Based on previous studies, we speculate that the thickness of RNFL and GCC in the Tout region was significantly lower in the large-extent group than in the small-extent group, probably due to retinal contraction and movement toward the optic disc after ILM peeling.

Considering whether the thickness change was related to the number of flap initiations, we found that there was no statistical difference in the number of flap initiations between the two groups by looking back at the surgical video. Therefore, we speculate that the significant thinning of the RNFL and GCC in the Tout region in the large-extent ILM peeling group, compared to the small extent peeling group, may be due to the mechanical damage caused by flap initiation in this area, and that the larger peeling area causes greater displacement of the macula.

This study was based on macular fovea and optic disc distances, which are practical for guiding the ILM peeling range in operations. The effects of different ILM peeling ranges on retinal RNFL and GCC were analyzed by observing the RNFL and GCC thicknesses in nine regions of the EDTRS ring before and 1, 3, and 6mo after surgery. The results of this study showed that increasing the extent of ILM peeling did not affect the IMH closure rate and visual acuity recovery, but the greater the extent of peeling, the greater the damage to the inner retinal structures and b-wave amplitude recovery.

This study has some limitations. First, the retrospective nature and the small sample size of the patients leads to insufficient scientific evidence for the results. Second, the relationship between the thickness of RNFL and GCC layer with postoperative foveal displacement was not evaluated. Third, the postoperative follow-up time of 6mo may not elucidate whether ILM peel causes long-term damage to the anatomy of the retina. Finally, due to the limitations of our conditions, postoperative microperimetry and multifocal electrophysiology could not be performed.

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