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Changes in retinal sensitivity following inverted internal limiting membrane flap technique for large macular holes

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Abstract:

PURPOSE: The aim of this study was to evaluate the effect of inverted internal limiting membrane (ILM) flap technique and measure the retinal sensitivity using microperimetry-1 (MP-1) test in patients with large macular hole (MH).

MATERIALS AND METHODS: We enrolled patients undergoing surgery for idiopathic MHs from January 2016 to October 2019. Only patients having a minimum diameter of idiopathic MH exceeding 500 μm were included in this study. All patients underwent complete preoperative ophthalmologic examinations, optical coherence tomography (OCT), and best-corrected visual acuity (BCVA) measurements. Postoperative OCT and BCVA were evaluated at least 3 months postoperatively. In addition, these patients also received MP-1 pre- and postoperatively for retinal sensitivity measurement.

RESULTS: Totally ten patients (ten eyes) were included for analysis. The mean retinal sensitivity within central 12° and 40° was statistically improved after surgery ($P < 0.05$). The number of absolute or relative scotoma (stimulus values ≤ 4 dB) within central 4° showed a significant reduction postoperatively. There was also a significant increase in visual acuity postoperatively.

CONCLUSION: Patients with large MH have a great successful rate by receiving inverted ILM flap technique. In our study, all MHs of ten eyes were closed postoperatively. The results also demonstrated that ILM flap technique improves both the functional and anatomic outcomes.

Keywords:

Inverted internal limiting membrane flap technique, large macular hole, microperimeter, microperimetry-1, retinal sensitivity, vitrectomy

Introduction

In 1991, Kelly and Wendel first reported successful closure of idiopathic macular holes (MHs) using vitrectomy combined with gas tamponade.^[1] Pars plana vitrectomy (PPV) with peeling of the internal limiting membrane (ILM) has been widely used for MH correction.^[2-4] The MH diameter influences the postoperative functional and anatomic results. For MHs with a minimum diameter more than 250 μm , the final visual acuity is commonly no better than 0.2, and reoperations are

occasionally required.^[5-7] Michalewska *et al.* stated the efficacy of the inverted ILM flap technique in patients with idiopathic large MHs in 2010.^[8] The technique using inverted ILM flap avoids the flat-open appearance of MHs postoperatively and recovers both the anatomic and functional results of PPV for those having MHs more than 400 μm in diameter.^[8] Studies of animal models^[9] demonstrated that inverted ILM flap facilitates Müller cell activation and promotes MH closure.

Most studies on macular surgery have used visual acuity for measurement of the functional outcome.^[3,4,10-17] Functional evaluation of retinal sensitivity and central

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retinal field function on microperimetry (MP) is more informative than the visual acuity test.^[18,19] The recently introduced fundus-related MP, MP-1, can be used to obtain quantitative and reliable functional measurements of retinal sensitivity by tracking eye movements while the patient fixates at a target.^[20] The aim of this study was to evaluate changes in retinal sensitivity using MP-1 in patients with large MHs before and after a surgery using the inverted ILM flap technique.

Materials and Methods

We retrospectively enrolled a consecutive series of patients undergoing a surgery for correction of idiopathic MHs from January 2016 to October 2019. The inclusion criteria were the presence of minimum diameter of idiopathic MH more than 500 μm , intraocular pressure <21 mmHg, and clinical presentation without retinal detachment. The exclusion criteria were a history of any kind of retinal surgery, vitreous hemorrhage, optic atrophy, ocular tumors, and glaucoma. Patients with mild cataract of nuclear opacity, defined as nuclear opalescence (NO) Grade 1 according to the Lens Opacities Classification System III (LOCS III), or those with mild to none nonproliferative diabetic retinopathy were not excluded from our study. All patients under hole closure went comprehensive preoperative ophthalmologic examination, including the best-corrected visual acuity (BCVA) test, slit-lamp examination, and ophthalmoscopy. The study was approved by the Institutional Review Board, and the patients provided informed consent. Institutional Review Board 20200410 (202000606B0).

BCVA was measured using a 5-m Landolt C acuity chart. The diagnosis of MH was established on spectral-domain optical coherence tomography (SD-OCT) (Spectralis; Heidelberg Engineering, Heidelberg, Germany), and the minimum MH diameter was measured. The minimum MH diameter was defined as the narrowest portion of

the MH parallel to the underlying hyperreflective line of pigment epithelium in the horizontal direction. We also recorded the recovery of the ellipsoid zone (EZ) line, which was confirmed through SD-OCT images over the fovea area, and the recovery of EZ line was defined as completely hyperreflective line with no gap revealed in the vertical and horizontal direction of the fovea cut on SD-OCT images. Otherwise, the EZ line would be defined as unrecovered if there was a gap interrupting the EZ line integrity. MH closure was defined as the absence of neurosensory defects in the fovea. MP-1 (Nidek Technologies, Padova, Italy) was performed with an automatic fundus-related perimeter. The parameters setting were as follows: background illumination of 1.27 cd/m^2 ; a target for fixation comprising a red cross by 2° in diameter; and Goldman III stimulus, under a projection time of 200 ms. A 4-2 staircase strategy was chosen. The initial attenuation of stimulus light was fixed at 10 dB. Stimuli of light were randomly presented through the examination, consistent with the standard static perimetry. A light stimulus for false-positive test was projected on the optic nerve head area to check for a false-positive result. All patients underwent MP with dilated pupils. The retinal sensitivity was measured with 45 stimuli (13 central stimuli within 4°, 16 central stimuli at 4°–8°, and 16 central stimuli at 8°–12°). The mean retinal sensitivity (overall and within 4°) was assessed and analyzed.

All eyes enrolled in our study were treated with conventional 23G three-port PPV by one surgeon (YJC). Initially, the vitreous detachment over the posterior pole was created, then followed by elimination of the remaining thin premacular vitreous cortex. The vitreous body over the peripheral portion was also excised. ILM was peeled off in a circular fashion for approximately two disc diameters temporal to MH after indocyanine green (ICG) staining (0.125% solution of ICG). We use the flush methods to stain ICG dye over the macular area under wet environment. In this way, the ICG dye

Table 1: Demographic data of ten eyes with hole diameter exceeding 500 μm

Patient No./age range/gender	D (mo)	BCVA (logMAR)		Lens	Phaco & IOL	MD (μm)	BD (μm)	MH	EZ line
		Pre	Post						
1/60s/F	0.5	2.0	1.30	Phakic (NO1)	Yes	834	1252	closed	(-)
2/60s/F	12	1.30	0.70	Phakic (NO1)	Yes	754	1155	closed	(-)
3/50s/F	3	2.0	1.52	Phakic (clear)	Yes	730	1521	closed	(-)
4/60s/M	2	1.0	0.52	Phakic (NO1)	Yes	727	1278	closed	(+)
5/60s/F	12	1.0	0.40	Phakic (NO1)	Yes	645	1352	closed	(-)
6/60s/F	1	1.0	0.30	Phakic (clear)	Yes	545	757	closed	(-)
7/50s/F	3	1.0	0.52	IOL	No	540	385	closed	(+)
8/40s/F	3	1.0	0.52	Phakic (clear)	No	528	1008	closed	(-)
9/60s/M	4	1.30	1.0	IOL	No	521	827	closed	(-)
10/70s/F	25	1.0	0.70	IOL	No	673	1021	closed	(-)

D=duration of symptoms; BCVA=best-corrected visual acuity; Pre=preoperative; Post=postoperative; Lens=preoperative lens status; NO=Lens nuclear opalescence grade according to Lens Opacities Classification System III (LOCS III); IOL=intraocular lens; Phaco&IOL=concomitant surgery with phacoemulsification and intraocular lens implantation; MD=minimum diameter; BD=base diameter; MH=macular hole; EZ line=Recovery of EZ line

would be flushed to the macular area from the syringe and then be washed out immediately through one patent trocar. The duration of ICG dye contacting the retina is <30 s. During the circumferential peeling, ILM was peeled around the superior macula and incompletely apart from the retina and kept attached to the superior edge of MH. A viscoelastic agent (Viscoat®; Alcon Surgical, Ft. Worth, TX, USA) was injected to push the superior rolled ILM flap edge until the MH was covered with the flat inverted ILM flap. If an epiretinal membrane (ERM) was present, MH was covered with the inverted ILM and ERM flaps. After fluid-air exchange, the air was replaced with 15% C3F8 gas. The patients were advised to maintain the face-down position for 2 weeks. Combined surgery of phacoemulsification with intraocular lens implantation was usually performed to avoid secondary surgery for cataract after PPV. In the 1-week and 1-, 3-, and 6-month follow-ups, the patients received slit-lamp examination, visual acuity measurement, indirect ophthalmoscopy, and OCT. MP-1 was performed at the 3- and 6-month follow-ups. The preoperative and 6-month postoperative BCVAs and retinal sensitivities measured on MP-1 were analyzed. BCVA was documented in decimals, and for statistical analyses, these values were converted to the logarithm of the minimal angle of resolution (logMAR).

As for the primary endpoint of our study, it was the change of MP-1 at 6 months postoperatively. The secondary outcome measurement was change in BCVA from baseline at 6-month follow-up.

To evaluate the surgical effects, preoperative and postoperative BCVAs (logMAR values) and retinal sensitivities measured on MP-1 were analyzed using the Wilcoxon signed-rank test. $P < 0.05$ was considered statistically significant. Statistical analyses included the Spearman's correlation coefficient r to investigate the correlation between the MH diameter and BCVA.

Table 2: Baseline clinical factors of ten eyes with hole diameter exceeding 500 μm [mean (range) or n]

Age (years)	61.5 (40-75)
Gender	
Male	2 (20%)
Female	8 (80%)
Minimum diameter of the hole (μm)	649.7 (521-834)
Base diameter of the hole (μm)	1055.6 (385-1521)
Duration of symptoms (months)	6.45 (0.5-25)
BCVA before surgery (logMAR)	1.26 (1.00-2.00)
BCVA after surgery (logMAR)	
Final lens status	0.75 (0.30-1.52)
Phakic	1 (10%)
Intraocular lens	9 (90%)

BCVA: Best corrected visual acuity

Results

A total of 36 eyes of 36 patients underwent a surgery for idiopathic MHs during the study period. Ten patients (ten eyes) with a minimum MH diameter more than 500 μm were included for the analysis. Table 1 shows the clinical characteristics and demographics of the patients. In all ten eyes, MH closed in at least 6 postoperative months without recurrence or major complications. The patient age ranged from 40 to 75 years (mean age: 61.5 years). Two patients were men, and eight patients were women. The duration of symptoms ranged from 0.5 to 25 months (mean duration: 6.45 months). Three eyes were already pseudophakic at the time of the MH surgery. The cataract surgery was performed simultaneously in five eyes and later in one eye for nuclear sclerosis. Nine eyes (90%) were pseudophakic at the last follow-up. No MH recurred in the follow-up period [Table 2]. In cases of combined cataract surgery, the lens opacity was mild, and the maximum retinal sensitivity to the 45 stimuli was 20 dB. The postoperative recovery rate of EZ line was 20% (2/10) 6 months later after surgery.

The mean retinal sensitivity to stimuli within 12° (45 central stimuli) and 4° (13 central stimuli) statistically improved after the surgery ($P < 0.05$). The number of absolute or relative scotoma (0 dB or ≤ 4 dB) with stimuli within 4° showed a significant reduction after the surgery. The visual acuity also significantly increased after the surgery [Table 3]. Table 4 reveals the demographic data of ten eyes on MP-1 before and after surgery.

Case 1

A 65-year-old woman presented with MH in the left eye. Initial BCVA was 20/200. The minimum size of MH was 545 μm, and the basal diameter was 757 μm. Preoperative MP-1 revealed that the mean sensitivity of central 45 stimuli and 13 stimuli was 16.2 dB and 10.31 dB, respectively, and the number of 0 dB and ≤ 4 dB within the central 4° fovea were both 2 stimuli. The PPV was performed with the inverted ILM flap technique. One month later, MH was sealed and closed completely with a thin and hyperreflective line, supposed to be the inverted ILM flap, on SD-OCT images. Small striae of hyperreflective tissues were found scattering from the ILM flap, which might have characterized the proliferating glial cells [Figure 1]. Six months after the surgery, BCVA improved to 20/40. Following MP-1, the results revealed that the mean sensitivity of central 45 stimuli and 13 stimuli was 16.5 dB and 14 dB, respectively. As for the number of 0 dB and ≤ 4 dB within the central 4° fovea, they were both 0 stimuli. The follow-up SD-OCT showed stationary images of the fovea with complete external limit membrane (ELM) line and interrupted EZ line, and

Table 3: Comparison of ten eyes before and after the surgery [median (IQR)]

	Pre-operation	Post-operation	P
Mean sensitivity (dB) of 45 stimuli	11.15 (10~12.88)	13.65 (10.28~16.65)	0.022
Mean sensitivity (dB) within 4° (13 stimuli)	5.77 (3.6~7.48)	9.15 (6.7~14.21)	0.008
0 dB stimulus number within 4° (13 stimuli)	2.5 (1.75~7.0)	0.5 (0.0~2.25)	0.011
≤4 dB stimulus number within 4° (13 stimuli)	5.5 (3.75~8.0)	2.5 (0.0~5.0)	0.018
BCVA (logMAR)	1.26 (1.00~1.46)	0.75 (0.49~1.08)	0.007

BCVA: Best corrected visual acuity.

Table 4: Demographic data of ten eyes on MP-1

Patient No./age range/sex	Pre-operative MP-1				Post-operative MP-1			
	Mean sens. (dB) of 45 stimuli	Within 4°(13 stimuli)			Mean sens. (dB) of 45 stimuli	Within 4°(13 stimuli)		
		Mean sens. (dB)	0 dB number	≤4 dB number		Mean sens. (dB)	0 dB number	≤4 dB number
1/60s/F	10	0.08	12	13	8.9	0.46	10	13
2/60s/F	12.1	7.23	3	6	13.9	8.62	3	5
3/50s/F	13.7	1.46	10	11	15.3	6.85	2	5
4/60s/M	10.2	6.23	1	3	13.4	12.15	0	1
5/60s/F	9.6	4.31	2	7	17.2	14.85	0	0
6/60s/F	16.2	10.31	2	2	16.5	14.00	0	0
7/50s/F	10	6.23	1	4	10.2	6.23	1	4
8/40s/F	12.6	8.23	2	5	17.1	16.38	0	0
9/60s/M	10	5.15	6	7	10.3	9.69	0	1
10/70s/F	12.5	5.30	3	4	13	7.85	2	4

sens.=sensitivity

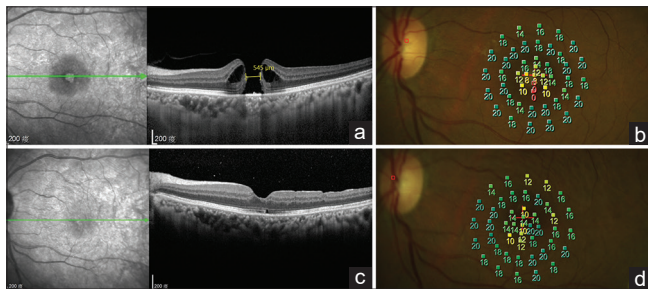


Figure 1: A 65-year-old woman had central scotoma of her left eye. (a) The minimum size of macular hole was 545 μm on optical coherence tomography preoperatively. (b) Retinal sensitivity obtained from MP-1 (45 stimuli within 16°) preoperatively. (c) Three months after the surgery, macular hole closed with clear internal limiting membrane flap covered. (d) Fifteen months after the surgery, retinal sensitivity of microperimetry-1 revealed central 13 stimuli within 2° improved significantly

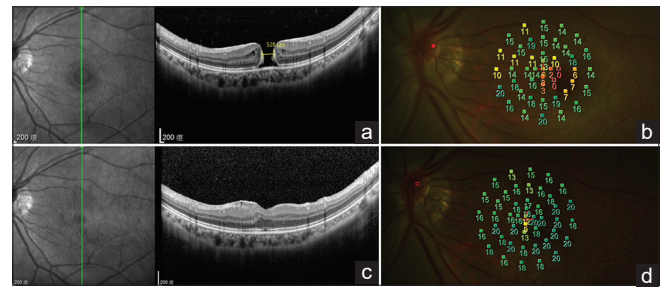


Figure 2: A 40-year-old woman had a long-standing macular hole of her left eye. (a) Optical coherence tomography revealed flat hole edge without intraretinal cystic space and the minimum size of macular holes was 528 μm preoperatively. (b) Retinal sensitivity obtained from microperimetry-1 (45 stimuli within 16°) preoperatively. (c) Three months after the surgery, macular hole sealed successfully with clear internal limiting membrane flap covered (d) Eight months after the surgery, retinal sensitivity of central 13 stimuli within 2° improved significantly

the eye stayed stable during the 18-month follow-up period.

Case 2

A 40-year-old woman with a long-standing MH (flat hole edge without intraretinal cystic space on SD-OCT) for over 3 months presented with an initial BCVA of 20/200 in the left eye. Meanwhile, the MP-1 demonstrated that the mean sensitivity of central 45 stimuli and 13 stimuli was 12.6 dB and 8.23 dB, respectively. The number of 0 dB and ≤4 dB within the central 4° fovea was 2 and 5 stimuli, respectively. The minimal MH diameter was 528 μm, and the basal MH diameter was 1008 μm. One month after a vitrectomy with the inverted ILM flap technique, the BCVA improved to 20/70. After 6 postoperative months, SD-OCT demonstrated MH closure with clear

retinal layers from the base to the top with thicker ILM flap able to be seen over the inferior fovea portion. The hyperreflective lines inducing mild retinal folding and cysts in the top layers were consistent with the ILM flap surgery. The complete ELM line and nearly intact EZ line also could be noted on OCT images [Figure 2]. MP-1 of 6-month later visit revealed that the mean sensitivity of central 45 stimuli and 13 stimuli was 17.1 dB and 16.38 dB, respectively, and the number of 0 dB and ≤4 dB within the central 4° fovea were both 0 stimuli. The eye remained stable during the 12-month follow-up period.

Case 3

A 74-year-old woman had idiopathic large MH of her left pseudophakic eye. The BCVA of her left eye

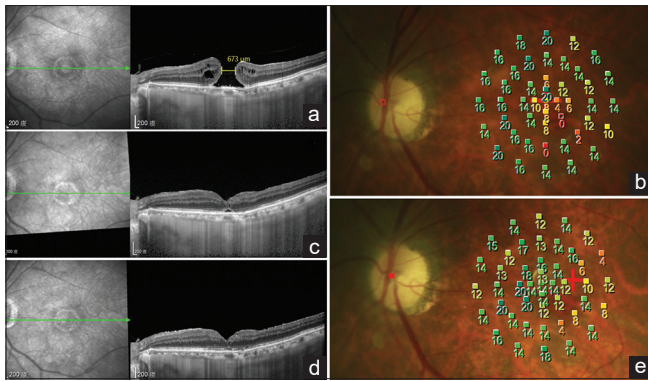


Figure 3: A 74-year-old woman had a large macular hole of her left eye. (a) Optical coherence tomography revealed a macular hole with intraretinal cystic space and the minimum size was 673 μm preoperatively. (b) Retinal sensitivity obtained from microperimetry-1 (45 stimuli within 16°) preoperatively. (c) Three months after the surgery, macular holes sealed successfully with residual subretinal fluid. (d) Six months later, the fovea attached well with intact external limit membrane. (e) Retinal sensitivity of central 13 stimuli within 2° improved significantly, 6 months after surgery

was recorded 20/200, and SD-OCT demonstrated a MH with intraretinal cystic space. The minimum diameter of the MH was 673 μm , and the basal diameter was 1021 μm . The mean sensitivity of central 45 stimuli and 13 stimuli of preoperative MP-1 was 12.5 dB and 5.30 dB, respectively. The number of 0 dB and ≤ 4 dB within the central 4° fovea was 3 and 4 stimuli, respectively.

Postoperatively, MH was closed with residual intraretinal cyst and few subretinal fluids. Furthermore, there were two overlapped hyperreflective lines, believed to be inverted ILM flap, on the SD-OCT 3 months later. Six months after surgery, the fovea attached well with fewer intraretinal cyst. The irregularity of overlapped ILM line became smoother. The ELM line was complete, but the EZ line was interrupted. BCVA of her left eye improved to 20/100 half a year later. Regarding MP-1, the mean sensitivity of central 45 stimuli and 13 stimuli was 13.0 dB and 7.85 dB, respectively. The number of 0 dB and ≤ 4 dB within the central 4° fovea was 2 and 4 stimuli, respectively. Her eye remained stable in clinical follow-up [Figure 3].

Discussion

For MHs with a minimum diameter more than 250 μm , the final BCVA is usually <0.2 , and some of them required further reoperations occasionally.^[5-7] Variations in the postoperative MH closure type influence the postoperative outcome.^[6,7] Among them, the U-shape closures, comprising 45% of the cases, are related to the best functional prognosis. There are nearly 19%–39% of cases having flat MH margin on the top and a bare retinal pigment epithelium on the bottom, and they were divided into the W-type closure, flat-closed MHs, and flat-open MHs observed on OCT images.^[6,7,21] The

visual acuity is worse than expected in these eyes despite successful MH surgery. The inverted ILM flap technique prevents the postoperative flat-open appearance of MHs and improves both the functional and anatomic outcomes of PPV for MHs with a diameter more than 400 μm .^[8,22] There were 70% of cases (7/10) in our study whose final BCVA was equal to and better than 0.2 after the surgery, and all of MHs maintained closed through at least 6-month follow-up after surgery without requirement of reoperation.

In our study, we find the absolute scotoma in the central bottom of closed U-shape MHs preoperatively, and its values still remain zero in MP-1 in those large MHs with U-shape closures even a few months after the operation. However, the peri-MH area presenting zero (absolute scotoma) prior to the surgery will reveal improved values in retinal sensitivity after the operation. This peri-MH area with absolute scotoma is previously detached retinal layers on OCT images. These detached retinal layers postoperatively reveal attached and shrink the size of U-shape MH closure, which tallied with the area of improved retinal sensitivity. This finding regarding decreased area of absolute scotoma may indicate that the improvement of retinal sensitivity is related to the MH closure.

The reason we did not exclude the three patients with diabetic retinopathy is not only due to the mild to none diabetic retinopathy change found in fundus examination but also the general improvement in the total sensitivity beyond the 13 central stimuli (4°) postoperatively. These findings demonstrated that the function of the retina other than the MH remained hardly affected by the mild to none diabetic retinopathy. Stunf Pukl *et al.*^[28] also concluded that the result of MP did not be influenced in patients with underlying diabetes but no diabetic retinopathy in fundus. There is another situation that should be taken into consideration, which is diabetic macular ischemia. Patients with such disease will have irreversible and severe visual loss. These three cases with mild to none diabetic retinopathy revealed improvement in macular sensitivity after the surgery. Therefore, it is reliable to believe they do not have diabetic macular ischemia.

As for impaction of preoperative lens status on MP-1, MP-1 shows 0 dB in the scotoma area, which means that scotoma is not affected by cataract. In addition, Richter-Mueksch *et al.*^[29] mentioned that MP results correlated to density of nuclear cataract. Lighter density of cataract induced fewer effect on MP-1 results. In our study, we only included patients with mild nuclear sclerosis type (NO1, LOCS III). Preoperative MP-1 results revealed many stimuli with 20 dB of retinal sensitivity beyond the MH area in these patients, and the amount

of 20 dB stimuli is similar to postoperative MP-1 results. Since the upper limit of MP-1 values is set at 20 dB and the stimulus values beyond the MH area reach 20 dB pre- and postoperatively, the impact of mild cataract may be neglected in our study.

Most studies on macular surgery have used visual acuity for measurement of the functional outcome.^[3,4,10-17] However, visual acuity test provides general retinal performance rather than specific area of scotoma in the zone of a MH. Functional evaluation of the central retinal field on MP is more informative than the visual acuity test.^[18,19] In our study, the increased central retinal sensitivity and the reduced scotoma area were found on MP-1 images in those cases receiving the ILM flap technique surgery.

The anatomical and visual outcomes of our study, including the visual acuity and retinal sensitivity, improved in patients with a large MH (minimum size more than 500 μm) after surgery using the ILM flap technique. A previous study in animal models^[9] illustrated the role of inverted ILM flap in MH closure. It acts as a bridge for the migration and proliferation of Müller cell and promotes the activity of Müller cell. Neurotrophic factors and basic fibroblast growth factor released by activated Müller cell provided an appropriate environment for MH close. The perspective of this study helped us realize the potential mechanism of this technique in large MH promoting the high success rates postoperatively. Nevertheless, it still remains controversial how large the size of MHs should the ILM flap technique be indicated and unclear in mechanism of recovery of the EZ.

Previous studies indicated the improvement of BCVA and MH closure rates are limited and marginally significant while comparing to conventional ILM peeling surgical technique.^[25,26] The mean gain of BCVA in Yuan *et al.*^[25] revealed -0.20 logMAR in the ILM flap (cover) technique group ($n = 6$) postoperatively. They enrolled patients with a minimum MH diameter equal to and more than 400 μm to receive surgeries and observed them for at least 6 months postoperatively. In another study of Narayanan *et al.*,^[27] the mean gain of BCVA presented -0.36 logMAR in the ILM flap technique group postoperatively 6 months later. They included patients with baseline vision of -0.48 logMAR, idiopathic MH basal diameter more than 800 μm , and minimum follow-up of 6 months. The MH closure rate was 88.9% (16/18) in the inverted ILM flap group, while in our study, the mean gain of BCVA is -0.52 logMAR, and all of our cases remained MHs closed 6 months after surgery. Our results demonstrated the postoperative prognosis of BCVA and MH closure rates were noninferior to previous study results.^[25,26]

The EZ line (ellipsoid layer) on OCT images is believed to be the crucial retinal layer capable of visual phototransduction, but the mechanism of recovery stays unknown so far.^[9] Postoperative observation showed that EZ line in OCT will become clear and restored gradually in our study and other studies,^[23-26] where EZ line on OCT images is considered as the recovery of retinal MHs. The recovery rate of EZ line in the inverted ILM flap group was low to 0% ($n = 6$) in Yuan *et al.*,^[25] while our result showed 20% of cases (2/10) with EZ line recovery. Nevertheless, the EZ lines only represent one dimension of macular anatomy on OCT images. The scotoma area in MHs characterized area of blindness, which means two dimensions conceptually and would be expressed its function more properly on the microperimeter. Meanwhile, the corresponding section of restored EZ line is compatible with improved retinal sensitive stimuli in MP-1. These results prove the MP-1 as a good indicator for retinal functional outcome.

The limitations of our study include retrospective nature of the analysis, small sample size, no control group, and no MHs over 900 μm in diameter. Additional limitations included measurements for the BCVA with no use of Early Treatment Diabetic Retinopathy Study charts.

Conclusion

Inverted ILM flap technique has improvement in visual acuity and MHs closure rate in patients with large MHs more than 500 μm in minimal diameter. Theologically, the anatomic result is essential for functional result. The results from the microperimeter are more informative and compatible with macular anatomic and functional performance. Accordingly, MP may provide proper quantification and functional indicator of the retinal sensitivity improvement and decline of the scotoma area of MH after inverted ILM flap technique. Further studies are required to elucidate the role of inverted ILM flap in MH closure.

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Nil.

Conflicts of interest

The authors declare that there are no conflicts of interests of this paper.

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