

Microperimetry as a Sensitive Tool for Assessing Functional Outcomes after Idiopathic Macular Hole Surgery

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SUMMARY

Aims: To evaluate changes in retinal sensitivity and fixation parameters in patients with idiopathic macular hole using microperimetry before surgery and 3 months after pars plana vitrectomy with internal limiting membrane (ILM) peeling.

Material and Methods: This prospective study included 11 eyes of 11 patients. All patients underwent 25-gauge pars plana vitrectomy with conventional circular ILM peeling extending approximately 2–3 optic disc diameters around the macular hole and SF6 gas tamponade. Best-corrected visual acuity (BCVA), retinal sensitivity measured by MAIA microperimetry, and fixation parameters (P1, P2, BCEA 63% and BCEA 95%) were evaluated. Microperimetry was performed preoperatively and 3 months postoperatively. The Wilcoxon signed-rank test was used for paired comparisons, the Mann–Whitney U test for subgroup analysis, and Spearman's rank correlation coefficient for correlation analysis.

Results: The mean age was 67.2 ± 7.6 years; the cohort included 9 women and 2 men. Anatomical closure of the macular hole was achieved in all eyes. BCVA improved from 0.31 ± 0.11 to 0.67 ± 0.22 ($p = 0.001$). One patient was excluded from the primary microperimetry analysis because of postoperative cataract progression. In the remaining 10 eyes, mean retinal sensitivity increased from 16.72 ± 4.48 to 19.68 ± 4.27 dB ($p = 0.006$). No statistically significant changes were observed in the fixation parameters. The improvement in retinal sensitivity was numerically greater in larger macular holes ($>400 \mu\text{m}$; 3.97 vs. 1.95 dB; $p = 0.222$). A statistically significant inverse correlation was observed between macular hole size and baseline retinal sensitivity ($\rho = -0.83$; $p = 0.003$).

Conclusion: Microperimetry represents a valuable complementary method for evaluating functional outcomes after idiopathic macular hole surgery. It enables the detection of changes in macular retinal sensitivity that may not be fully reflected by BCVA alone. In our cohort, both visual acuity and retinal sensitivity improved significantly after surgery, whereas fixation parameters showed no statistically significant change.

Keywords: idiopathic macular hole, microperimetry, MAIA, ILM peeling, pars plana vitrectomy, best-corrected visual acuity

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INTRODUCTION

Idiopathic macular hole is a serious disorder of the central retina, that primarily affects older patients and leads to a deterioration of central visual acuity, impaired reading ability, metamorphopsias and reduced quality of vision [1–4]. From a pathophysiological perspective, it most commonly occurs as a consequence of vitreomacular traction, in which a combination of anteroposterior and tangential forces acts on the foveola, leading to dehiscence of the retinal layers and formation of a defect in the foveal region [2]. Sutureless pars plana vitrectomy with ILM peeling and gas tamponade currently represents the standard therapeutic approach, with a high

anatomical success rate and usually an improvement in visual acuity [5–8]. Postoperative outcomes are assessed primarily using BCVA as the main functional parameter, and morphological imaging methods, particularly optical coherence tomography (OCT) [9]. Lately, OCT angiography has also been used to evaluate the foveolar avascular zone, density of the capillary plexuses and changes of the choriocapillaris before and after surgery [10–14]. However, assessment of anatomical closure and BCVA alone may not fully reflect the actual functional recovery of the macula [15]. A patient with a successfully closed macular hole and improved BCVA may continue to experience reduced quality of vision, unstable fixation, reading difficulties or the subjective perception of a central visual deficit

[4,16,17]. Similarly, OCT may not always correspond fully with the functional status of the macula [12,18].

Microperimetry enables more precise functional mapping of the macular region [19,20]. In comparison with conventional perimetry, it combines the projection of stimuli onto a predefined retinal area with real-time monitoring of the eye position using fundus tracking thereby allowing retinal sensitivity to be correlated with specific anatomical locations [21]. In addition to mean retinal sensitivity, it also provides information about the stability and localization of fixation [22–24]. In patients with macular hole microperimetry enables the identification of functional changes in the immediate vicinity of the fovea, and provides a more detailed description of the postoperative development of macular function. Even though microperimetry provides us with valuable information, its role in routine clinical assessment has not been clearly delineated to date, and the number of studies focusing on early postoperative changes remains limited [25–28]. Moreover, the relationship between macular hole size and postoperative functional outcomes has not yet been fully clarified. While larger macular hole width is generally associated with a worse baseline function, its influence on the early postoperative course of microperimetric parameters and fixation stability in the first months after surgery remains uncertain [25,29,30].

The aim of this study was to assess changes in retinal sensitivity and fixation parameters in patients with idiopathic macular hole using microperimetry before surgery and 3 months after pars plana vitrectomy with ILM peeling. We also evaluated changes in visual acuity, the relationship between functional parameters and macular hole size, and the contribution of microperimetry to the assessment of surgical outcomes.

MATERIAL AND METHODS

This prospective study included 11 eyes of 11 patients who underwent surgery for idiopathic macular hole at

the Department of Ophthalmology 3rd Faculty of Medicine Charles University and Thomayer University Hospital, between December 2024 and December 2025. The cohort comprised nine women and two men. The mean age was 67.2 ± 7.6 years (range, 57–78 years). Six eyes were pseudophakic and five were phakic. None of the phakic eyes had clinically significant cataract at the time of macular hole surgery. Cataract surgery was initially performed in patients with more advanced lens opacification. None of the patients underwent a combined procedure.

Only idiopathic macular holes were included in the study. The macular hole size was determined using the minimum linear diameter (MLD), measured at the narrowest point of the hole on preoperative OCT. For subgroup analysis, the eyes were pragmatically divided into two groups based on an MLD cutoff of 400 μm . This division does not fully correspond to the standard three-stage IVTS classification. Traumatic macular holes and other significant macular pathologies were excluded. Patient no. 5, who exhibited dystrophic changes consistent with age-related macular degeneration, was retained in the cohort to reflect the characteristics of the real-world clinical population. The baseline characteristics of the cohort are summarized in Table 1.

In all cases, 25-gauge pars plana vitrectomy was performed with conventional circular ILM peeling extending approximately 2–3 disc diameters around the macular hole (Figure 1), followed by SF6 gas tamponade. The procedures were performed under either retrobulbar or general anesthesia, depending on the patient's clinical condition and preference. Endolaser photocoagulation was performed in two patients to treat peripheral retinal degenerations or retinal tears; these additional procedures were not considered to have affected the postoperative visual outcomes. All surgeries were performed by two experienced vitreoretinal surgeons.

Conventional ILM peeling was preferred in our cohort because it is an established surgical technique with a high anatomical closure rate, good reproducibility, and

Table 1. Baseline Characteristics of the Study Cohort

Parameter	Value
Number of eyes / patients	11 / 11
Age, mean $\pm$ SD (years)	67.2 ± 7.6
Sex, F/M	9 / 2
Operated eye, OD/OS	5 / 6
Lens status, phakic/pseudophakic	5 / 6
Anesthesia RBA/GA	7 / 4
Tamponade type (SF6)	11 / 11
Anatomical closure of macular hole	11 / 11 (100%)
IOP before surgery, mean $\pm$ SD (mmHg)	15.6 ± 3.2
IOP after surgery, mean $\pm$ SD (mmHg)	16.1 ± 3.9

SD – standard deviation, F – female, M – male, OD – right eye, OS – left eye, RBA – retrobulbar anesthesia, GA – general anesthesia, IOP – intraocular pressure. All phakic eyes had no clinically significant cataract preoperatively. In patients with advanced lens opacity, cataract surgery was performed prior to vitrectomy.

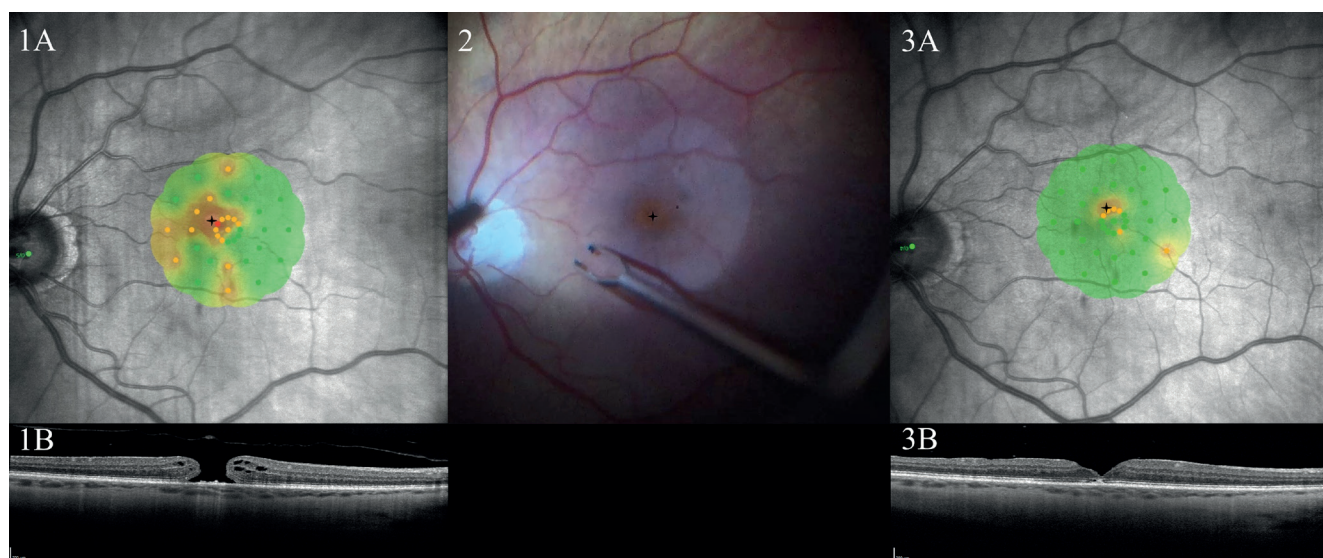


Figure 1. Functional and morphological changes in patient no. 4 before and 3 months after macular hole surgery.

1. **(A)** Preoperative microperimetry (MAIA) showing reduced retinal sensitivity in the area of the macular hole. The black asterisk indicates the location of the macular hole. Extrafoveal fixation is present. **(B)** Preoperative OCT demonstrating a macular hole with MLD of 356 μm .

2. Intraoperative image during 25G pars plana vitrectomy showing the extent of ILM peeling corresponding to the microperimetry area.

3. **(A)** Postoperative microperimetry at 3 months demonstrating increased retinal sensitivity in the central macular region. **(B)** Postoperative OCT confirming anatomical closure of the macular hole. Color coding of retinal sensitivity: green (25 dB), orange (15 dB), red (5 dB)

OCT – optical coherence tomography, MLD – minimum linear diameter, dB – decibel

lower technical complexity. Although an inverted ILM flap technique may improve anatomical outcomes in large or otherwise high-risk macular holes, its functional benefits in routine macular holes remain uncertain, with several studies reporting outcomes comparable to those achieved with conventional ILM peeling [31–34].

A comprehensive ophthalmological examination was performed in all patients before surgery and three months postoperatively. The examination included BCVA, expressed as a decimal Snellen value, intraocular pressure measurement, refraction, slit-lamp examination of the anterior segment, and fundus examination. Preoperative and postoperative imaging included OCT, OCT angiography, fluorescein angiography, and color fundus photography.

Microperimetry was performed using the MAIA (Macular Integrity Assessment, CenterVue) device in a dark room following pharmacological pupil dilation. A macular test pattern covering the central 10° with 37 stimulus points was used. Goldmann III size stimuli were presented against a background luminance of 4 apostilbs (asb), with a maximum luminance of 1000 asb and a dynamic range of 36 decibels (dB). Stimulus presentation was performed using the “4-levels fixed” strategy, with predefined stimulus intensified of 25, 15, 5 and 0 dB, without adaptive threshold determination. Mean retinal sensitivity was assessed. Fixation stability was evaluated using the bivariate contour ellipse area (BCEA), specifically BCEA 63% and BCEA 95%, as well as P1 and P2 fixation stability parameters, representing the percentage of fixation points located within circles with diameters of 1° and

2° , respectively, centered on the preferred retinal locus.

Patient no. 9 was excluded from the primary microperimetry analysis because of postoperative cataract progression, which could have affected the measurement of retinal sensitivity. The patient remained included in the overall clinical cohort and in the analyses of visual acuity and the anatomical outcome.

Continuous variables are presented as the mean $\pm$ standard deviation or median, as appropriate, according to the distribution of the data. The Wilcoxon signed-rank test was used to compare preoperative and postoperative values. The Mann-Whitney U test was used to compare changes between the two subgroups, and a Spearman’s rank correlation coefficient was used to assess correlations between variables. A p-value < 0.05 was considered statistically significant.

RESULTS

The analysis included 11 eyes of 11 patients with idiopathic macular hole. The cohort comprised nine women and two men, with a mean age of 67.2 ± 7.6 years. Mean intraocular pressure was 15.6 mmHg preoperatively and 16.1 mmHg postoperatively, with no statistically significant difference between the two time points ($p = 0.604$) (Table 1).

Anatomical closure of the macular hole was achieved in all eyes and confirmed by postoperative OCT (Figure 1 and 2). BCVA improved in all patients. Mean BCVA increased from 0.31 ± 0.11 preoperatively to 0.67 ± 0.22 postoperatively ($p = 0.001$) (Table 2).

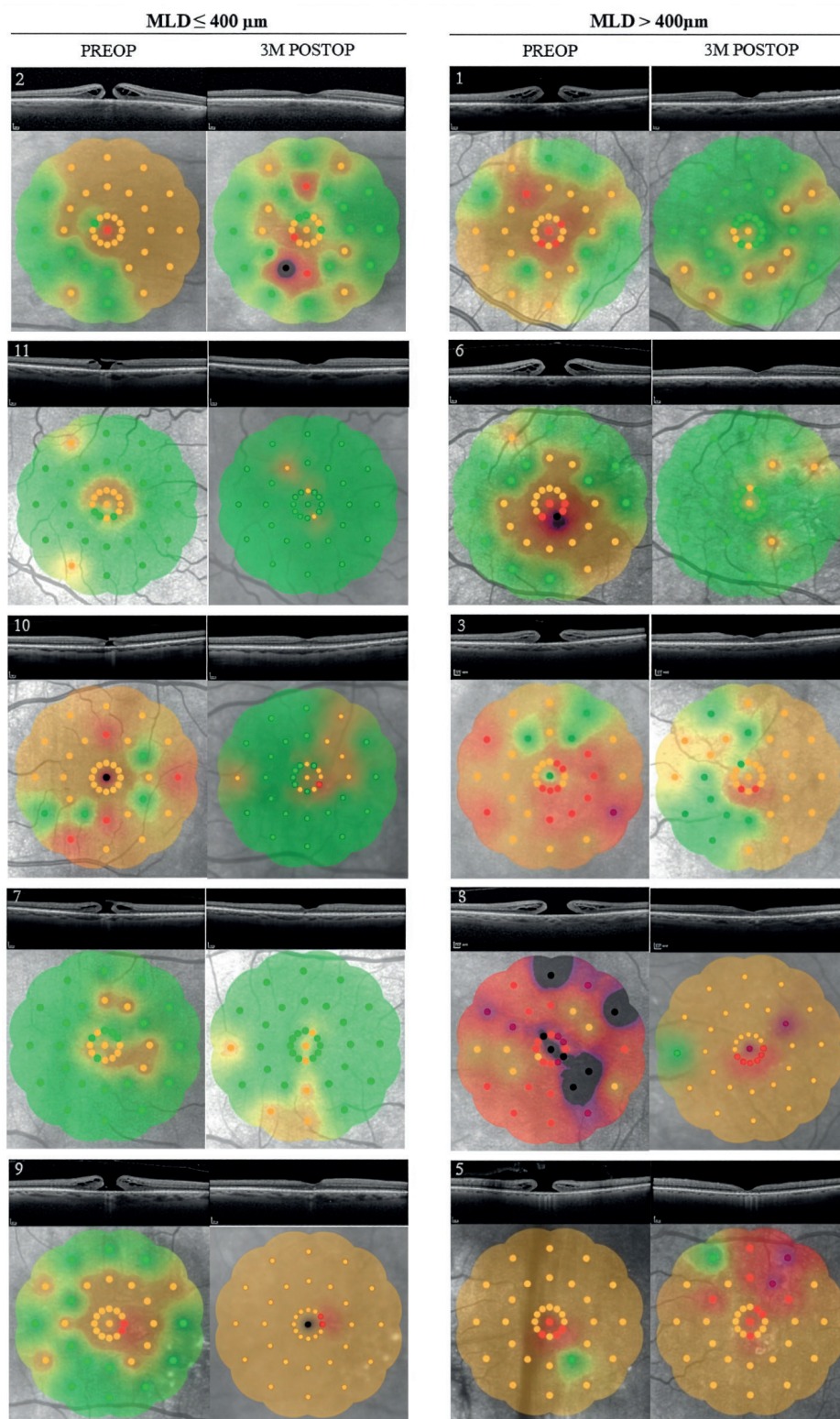


Figure 2. Graphical representation of individual changes in retinal sensitivity assessed by microperimetry and corresponding OCT findings in patients no. 1–3 and 5–11 before surgery (preop) and at 3 months (3M) postoperatively (postop). The figure summarizes individual microperimetric results (patients identified by number), stratified into two groups according to MLD, and illustrates the variability of postoperative functional response. A general trend toward improved retinal sensitivity is observed in most patients; however, some eyes exhibit persistent focal or diffuse deficits. Patient No. 9 is included for illustrative purposes, demonstrating a typical decrease in retinal sensitivity associated with progression of nuclear cataract, but was excluded from the main statistical analysis of microperimetric parameters. Color coding of retinal sensitivity: green (25 dB), orange (15 dB), red (5 dB), purple (0 dB), black (< 0 dB)

OCT – optical coherence tomography, 3M – 3 months, postop – postoperatively, MLD – minimum linear diameter, No – number, dB – decibel

Mean retinal sensitivity increased from 16.72 ± 4.48 dB preoperatively to 19.68 ± 4.27 dB at 3 months postoperatively ($p = 0.006$). The mean change was $+2.96$ dB, with a median change $+2.53$ dB (Table 2, Figures 1 and 2). Correlation analysis showed no statistically significant association between the change in BCVA and the change in mean retinal sensitivity (Spearman $\rho = -0.012$; $p = 0.973$) (Graph 1).

No statistically significant changes were observed in the fixation parameters. P1 was $76.8 \pm 20.2\%$ preoperatively and $79.5 \pm 25.9\%$ postoperatively ($p = 0.461$),

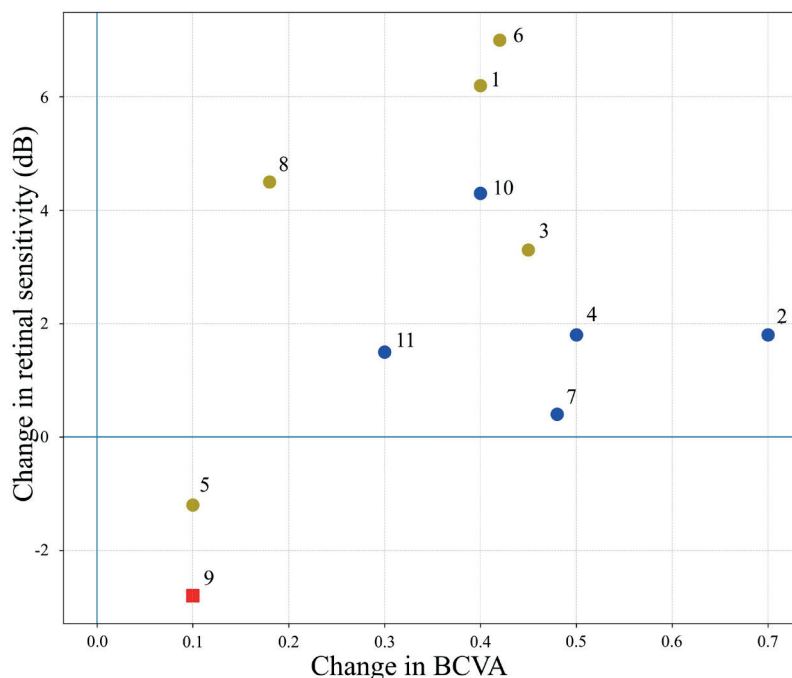
while P2 was $93.3 \pm 8.8\%$ and $93.7 \pm 11.1\%$, respectively ($p = 0.281$). BCEA 63% was 3.18 ± 3.38 preoperatively and 3.34 ± 5.04 postoperatively ($p = 0.160$), whereas BCEA 95% was 9.51 ± 10.11 and 9.95 ± 15.09 postoperatively ($p = 0.160$) (Table 3). Extrafoveal fixation was present in 8 of 11 patients preoperatively (Table 2).

Given the small sample size, the quantitative analysis was supplemented by a qualitative assessment of individual microperimetric findings. This analysis demonstrated considerable interindividual variability in the postoperative

Table 2. Individual Clinical and Functional Characteristics of Patients

Patient	Age (years)	Sex	Lens status	Fixation shift	MLD (μ m)	BCVA pre	BCVA post	Sensitivity pre (dB)	Sensitivity post (dB)
1	67	F	pseudophakic	yes	417	0.10	0.50	15.54	21.76
2	64	M	phakic	no	232	0.30	1.00	16.89	18.65
3	75	F	pseudophakic	yes	579	0.25	0.70	13.04	16.35
4	60	F	pseudophakic	yes	356	0.50	1.00	21.35	23.11
5	78	M	pseudophakic	yes	443	0.25	0.32	14.19	13.04
6	64	F	phakic	no	546	0.20	0.63	16.35	23.38
7	63	F	phakic	no	297	0.32	0.80	22.30	22.70
8	76	F	pseudophakic	yes	620	0.32	0.50	8.31	12.77
9	76	F	phakic	yes	336	0.40	0.50	16.82	14.05
10	59	F	phakic	yes	270	0.40	0.80	16.49	20.81
11	57	F	pseudophakic	yes	268	0.32	0.63	22.70	24.19

F – female, M – male, MLD – minimum linear diameter, BCVA – best-corrected visual acuity, dB – decibel



Graf 1. Relationship between changes in BCVA and retinal sensitivity

The graph shows the relationship between changes in best-corrected visual acuity (BCVA) and mean retinal sensitivity (dB) 3 months after surgery. Each point represents one patient. Blue points indicate $MLD \leq 400 \mu$ m, yellow points $MLD > 400 \mu$ m, and the red square represents patient No. 9 (excluded from the main analysis due to postoperative cataract progression). No correlation between BCVA and retinal sensitivity change was observed

BCVA – best-corrected visual acuity, dB – decibel, MLD – minimum linear diameter

functional response (Figure 2). In patient no. 2, a paracentral scotoma was detected on postoperative microperimetry, corresponding to changes in the retinal layers observed on OCT and consistent with neurodegenerative remodeling, which may have been associated with ILM peeling or minor perioperative trauma. In patient no. 4 extrafoveal fixation was observed (Figure 1), which is a common finding in patients with macular holes and reflects a change in fixation

strategy following impairment of central macular function. Patient no. 5 showed an improvement in BCVA but continued to exhibit reduced retinal sensitivity in the presence of dystrophic macular changes (Figure 2). Despite an overall postoperative increase in retinal sensitivity, patient no. 8 showed a relative reduction in sensitivity in the inferior half of the fovea (Figure 2). Symptoms suggestive of a postoperative perfusion disorder were observed on day 9 af-

Table 3. Comparison of Preoperative and Postoperative Functional Parameters

Parameter	Preoperative	Postoperative	p-value
BCVA	0.31 ±0.11	0.67 ±0.22	0.001
Retinal sensitivity (dB)*	16.72 ±4.48	19.68 ±4.27	0.006
P1 (%)*	76.8 ±20.2	79.5 ±25.9	0.461
P2 (%)*	93.3 ±8.8	93.7 ±11.1	0.281
BCEA 63% area*	3.18 ±3.38	3.34 ±5.04	0.160
BCEA 95% area*	9.51 ±10.11	9.95 ±15.09	0.160
IOP (mmHg)	15.6 ±3.2	16.1 ±3.9	0.604

BCVA – best-corrected visual acuity, dB – decibel, P1 – fixation stability within 1° (defined as the percentage of fixation points within a 1° diameter circle centered on the preferred retinal locus – PRL), P2 – fixation stability within 2° (defined as the percentage of fixation points within a 2° diameter circle centered on the PRL), BCEA – bivariate contour ellipse area, BCEA 63%/95% – area of the ellipse encompassing 63% and 95% of fixation points around the PRL, respectively, IOP – intraocular pressure. Data are presented as mean ± standard deviation (SD). p-values were calculated using the Wilcoxon signed-rank test. Patient No. 9 was excluded from the analysis due to postoperative cataract progression

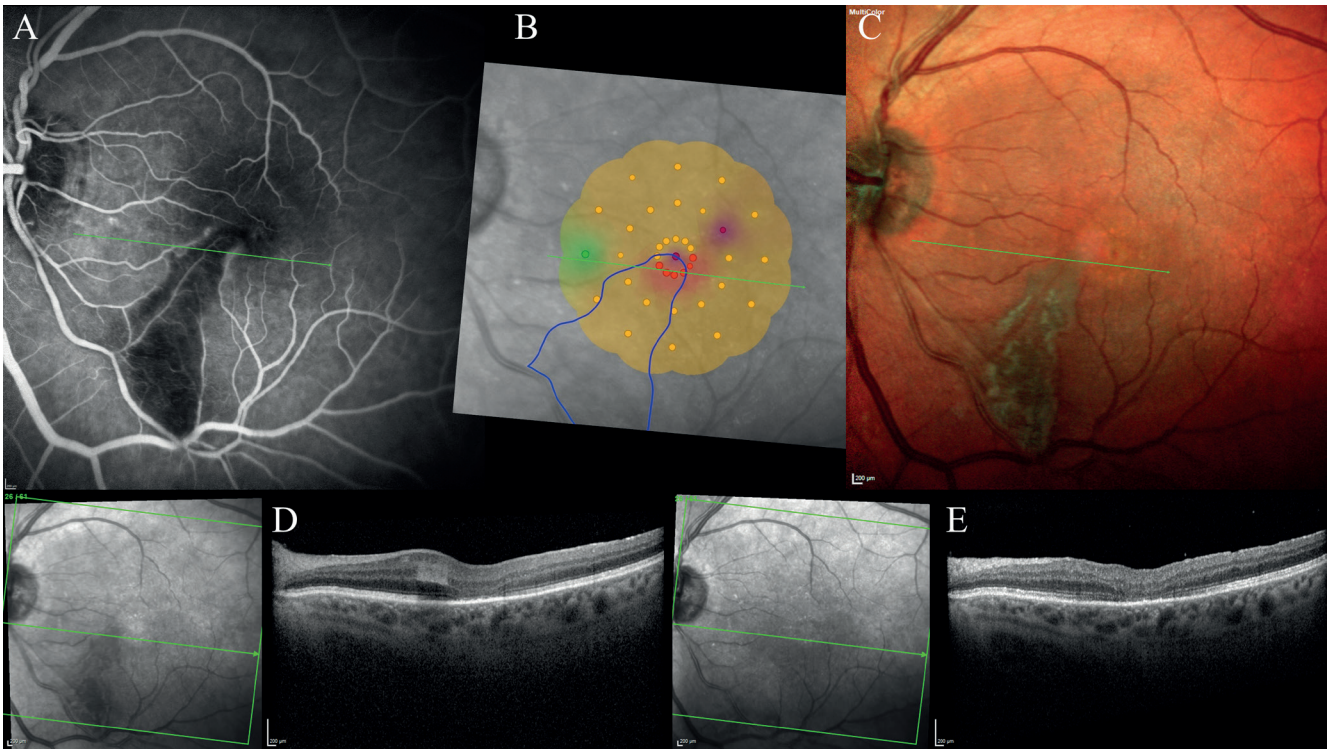
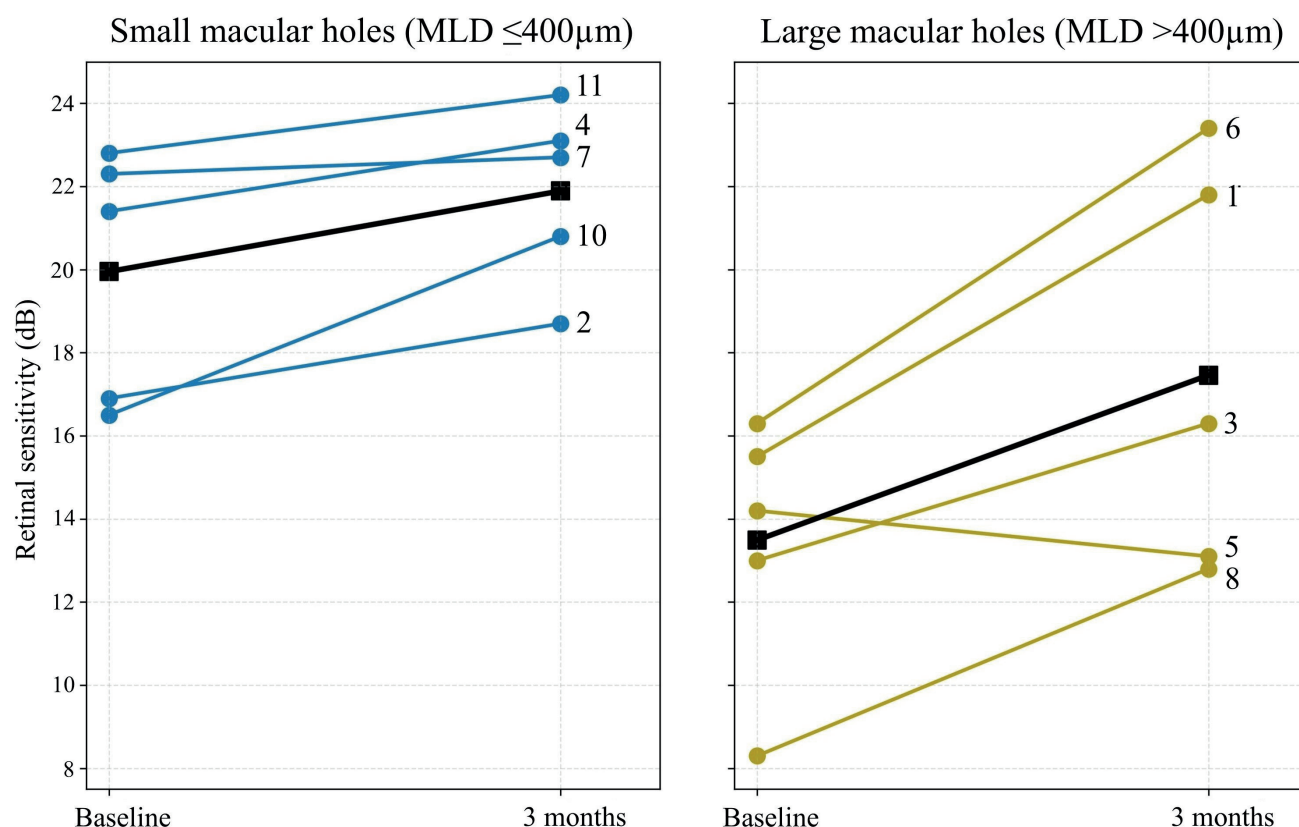


Figure 3. Postoperative perfusion abnormality in patient no. 8. (A) Fluorescein angiography performed on postoperative day 9 (1.18 minutes) demonstrating an area of hypoperfusion in the territory of the inferior temporal arcade branch. (B) Microperimetry at 3 months postoperatively with projection of the tested area, showing reduced retinal sensitivity corresponding to the location of the perfusion abnormality. The hypoperfused area is highlighted in blue. Color coding of retinal sensitivity: green (25 dB), orange (15 dB), red (5 dB), and purple (0 dB). (C) OCT multicolor image obtained on postoperative day 9 demonstrating a whitish lesion corresponding to the affected retinal area. (D) OCT of the macula on postoperative day 9 showing focal hyperreflectivity and thickening of the inner retinal layers, consistent with early ischemic involvement. (E) OCT at 3 months postoperatively demonstrating thinning and disorganization of the inner retinal layers in the region of the previous perfusion deficit, consistent with post-ischemic atrophy

dB – decibel, OCT – optical coherence tomography



Graph 2. Change in retinal sensitivity according to macular hole size.

The graph shows changes in mean retinal sensitivity (dB) before and 3 months after surgery in patients with small (blue) and large (yellow) macular holes. Individual lines represent patients; black line indicates group mean

dB – decibel

ter surgery, with corresponding abnormalities in the same region on fundus examination, fluoresceine angiography, and OCT (Figure 3). In patient no. 9, diffuse deterioration of retinal sensitivity was noted in association with progression of nuclear cataract (Figure 2). In contrast, patients no. 10 and 11, who had smaller macular holes, demonstrated marked postoperative recovery of retinal sensitivity (Figure 2).

In the subgroup analysis according to macular hole size, baseline retinal sensitivity was higher in eyes with smaller macular holes than in those with larger holes (19.95 ± 3.02 dB vs. 13.49 ± 3.16 dB, respectively; Table 2). A statistically significant inverse correlation was observed between MLD and baseline retinal sensitivity (Spearman $\rho = -0.83$; $p = 0.003$). The postoperative increase in retinal sensitivity was numerically greater in eyes with larger macular holes ($+3.97$ dB) than in those with smaller holes ($+1.95$ dB). However, the correlation between MLD and the magnitude of change in retinal sensitivity was not statistically significant (Spearman $\rho = 0.42$; $p = 0.228$; Graph 2).

DISCUSSION

In recent years, microperimetry has become an established method for evaluating macular function in

a variety of retinal diseases. Its clinical significance has been demonstrated, among others, in diabetic macular edema [35–37], central serous chorioretinopathy [38,39], and age-related macular degeneration [40,41], where it enables a more precise correlation between morphological findings and local retinal function. Following macular hole surgery, retinal sensitivity measured by microperimetry may provide a more detailed assessment of functional recovery than BCVA alone [42–45].

In our cohort, pars plana vitrectomy with ILM peeling and SF6 tamponade resulted in favorable anatomical and functional outcomes. Macular hole closure and improvement of BCVA were achieved in all operated eyes at three months postoperatively. In addition, the main microperimetric analysis demonstrated a statistically significant increase in retinal sensitivity in the macular region. The combination of anatomical closure, improved BCVA and increased retinal sensitivity suggests that surgical treatment of idiopathic macular hole results not only in morphological restoration of the fovea, but also in early functional recovery of the macula.

ILM peeling primarily relieves tangential traction and increases macular compliance, while also affecting the Müller cell endfeet and potentially resulting in microstructural changes of the inner retina [46]. The most

commonly described morphological consequences are SANFL (Swelling of the Arcuate Nerve Fiber Layer) and DONFL (Dissociated Optic Nerve Fiber Layer) [47–49]. SANFL-like changes are usually transient and resolve within 2–3 months, whereas DONFL may persist as a long-term structural finding without a clearly established functional correlate [50]. The functional consequences of ILM peeling remain controversial. Some studies have reported reduced retinal sensitivity and a higher incidence of microscotomas following ILM peeling [51], whereas others have found no significant functional deficit or even an improvement in retinal sensitivity postoperatively [45,52,53].

Previous studies evaluating functional outcomes after macular hole closure have focused predominantly on BCVA [54–57]. Although BCVA is generally considered the primary measure of central visual function, it is influenced by several factors, including macular hole size, the extent of photoreceptor layers disruption, and postoperative retinal repair processes [25,58]. In addition, after macular hole closure, the interpretation of BCVA may be influenced by changes in fixation strategy, particularly a shift of the preferred retinal locus toward the edge of the macular hole [30]. The high frequency of extrafoveal fixation observed in our cohort (8/11 eyes) suggests that idiopathic macular hole may be associated not only with reduced central retinal sensitivity, but also with altered fixation behavior.

The main contribution of our study is the inclusion of microperimetry alongside conventional outcome measures such as BCVA and OCT. Whereas visual acuity provides global information about central visual function, microperimetry allows a more precise topographic assessment of retinal sensitivity and can identify localized functional abnormalities that may be clinically relevant. This approach is particularly valuable in macular hole, as anatomical closure of the defect does not necessarily indicate complete restoration of central retina [25].

In our cohort, mean retinal sensitivity increased by almost 3 dB during the first three months after surgery. This finding is consistent with previously published data showing that microperimetry can detect early functional improvement within a relatively short postoperative period [25].

We did not observe a statistically significant change in fixation parameters, whereas retinal sensitivity improved significantly. This discrepancy suggests that different components of macular function may not recover in parallel and that changes in fixation stability may lag behind improvements in retinal sensitivity and visual acuity [25,30,44,59]. However, the small sample size and relatively high variability of fixation parameters may have limited the statistical power to detect more subtle changes.

Macular hole closure may be evident on OCT within the first 24 hours after surgery, although the timing of the closure varies between patients [60]. Anatomical closure, however, does not necessarily indicate complete reorganization of the individual retinal layers. Significant microstructural changes, especially in the outer retinal layers, occur during the first 12 months after surgery [25,61,62], whereas functional restoration may

continue over a considerably longer period, potentially for several years [63–65].

No significant correlation between an improvement in BCVA and in microperimetric retinal sensitivity was observed in our cohort. This finding further supports the concept that both methods assess different aspects of macular function and that microperimetry may provide complementary functional information beyond visual acuity alone.

Bacherini et al. reported a significant association between preoperative MLD and postoperative retinal sensitivity measured by microperimetry, with larger macular holes associated with lower postoperative sensitivity [12]. In our cohort, larger macular holes were associated with lower baseline retinal sensitivity, suggesting a greater degree of preoperative functional impairment. In contrast, smaller macular holes showed higher baseline sensitivity, a smaller postoperative increase in sensitivity, and higher postoperative sensitivity compared with large holes. This pattern may reflect less severe preoperative functional impairment and a possible ceiling effect. Although a trend toward greater improvement in retinal sensitivity was observed in eyes with larger macular holes, the small sample size prevented us from demonstrating a statistically significant association between MLD and the magnitude of postoperative change of sensitivity.

The interpretation of our findings also requires consideration of individual patient characteristics. Patient no. 9 developed progressive nuclear cataract during the postoperative period. Although anatomically successful macular hole closure and improvement in BCVA were achieved, microperimetry showed a generalized deterioration of retinal sensitivity. This case illustrates that microperimetric results may be influenced not only by macular function, but also by other ocular factors.

Similarly, the postoperative course of retinal sensitivity in patient no. 5 may have been influenced not only by macular hole closure but also by concurrent atrophic and dystrophic changes associated with age-related macular degeneration.

Patient no. 8 demonstrated a pronounced postoperative improvement in retinal sensitivity; however, a relative reduction in sensitivity persisted in the inferior foveal region. This finding may be related to a suspected partial branch retinal artery occlusion involving the inferotemporal arcade. The perfusion disturbance may have been associated with the anatomical configuration of affected vessels, together with hemodynamic changes during the early postoperative period and expansion of SF6 gas [66,67]. These individual cases emphasize that microperimetric findings should always be interpreted within the broader clinical context.

The main strengths of our study include its prospective design, standardized surgical technique, uniform use of SF6 tamponade, and standardized postoperative follow-up period. The principal limitation is the small sample size, which reduces the statistical power of the analysis, particularly for subgroup comparisons and correlation analyses.

Another limitation is the relatively short follow-up period. Anatomical restoration of the macula may precede functional recovery, and further changes in retinal sensitivity, fixation stability, and subjective visual function may occur after a longer period. Therefore, the three-month follow-up period may not fully capture the extent of postoperative functional restoration. Future studies should include longer follow-up and should ideally compare conventional ILM peeling with the inverted ILM flap technique.

Despite these limitations, we consider our findings to be clinically relevant. They support the use of microperimetry as a complementary method for evaluating postoperative outcomes in patients with idiopathic macular hole. Its main advantage is the ability to provide detailed topographic mapping of macular function and to identify functional abnormalities that may not be fully explained by anatomical findings and BCVA alone.

CONCLUSIONS

Pars plana vitrectomy with ILM peeling and SF6 tamponade resulted in anatomically successful closure of idiopathic macular hole in all patients in our cohort and was associated with improvement in BCVA in all opera-

ted eyes. In addition, the main microperimetric analysis demonstrated a statistically significant increase in retinal sensitivity in the macular region. These findings support the role of microperimetry as a useful complementary method for assessing postoperative macular function in patients with idiopathic macular hole. In addition to quantifying mean retinal sensitivity, microperimetry enables the identification of localized functional abnormalities, persistent scotomas, and changes in fixation behavior that may not be apparent from OCT findings or BCVA alone. At the same time, early anatomical restoration does not necessarily coincide with complete functional restoration. The three-month follow-up period represents only an early phase of postoperative recovery, and further changes in retinal sensitivity and fixation may occur over a longer period. Further prospective studies involving larger patient cohorts and extended observation are needed to further clarify the role of microperimetry in assessing functional recovery after surgery for idiopathic macular hole.

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