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ORIGINAL ARTICLE

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Visual outcome after vitrectomy for small idiopathic macular hole: Results from the Small idiopathic MAcuLar hoLe (SMALL) study

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Abstract

Purpose: To investigate visual outcomes after surgery for small idiopathic full-thickness macular holes (FTMHs) exploring associated clinical variables.

Methods: Multicentre, retrospective study including eyes with FTMH ≤250 μm treated with anatomically successful vitrectomy with a 12-month follow-up. The primary outcome was the incidence rate of normal vision outcome, defined as a postoperative best-corrected visual acuity (BCVA) ≤0.1 logMAR and to explore clinical variables associated with it. Rates of suboptimal visual outcome (final BCVA >0.3 logMAR) and intermediate visual outcome (final BCVA >0.1 and ≤0.3 logMAR) were considered as secondary outcomes along with associated clinical variables.

Results: Of 539 included eyes, 219 eyes (40.6%) achieved a normal vision outcome. An intermediate visual outcome was shown in 205 eyes (38%) and a suboptimal visual outcome in 115 eyes (21.3%). Vitrectomy with conventional internal limiting membrane (ILM) peeling was performed in 308 eyes (57%), while an inverted flap technique was used in 193 eyes (36%). Thirty-eight eyes (7%) underwent vitrectomy without ILM peeling. Clinical variables associated with normal vision were a better preoperative BCVA and conventional ILM peeling. No ILM peeling vitrectomy proved to be a factor associated with normal vision. Inverted flap technique and a worse preoperative BCVA were associated with suboptimal visual outcome.

Conclusion: Surgical treatment of small FTMHs has to be recommended since an excellent final visual outcome has been shown in 40% of cases. Vitrectomy with conventional ILM peeling should be considered the treatment of choice, while the inverted flap technique would not be advisable. Further studies are needed to confirm the role of vitrectomy without ILM peeling.

KEYWORDS
ILM peeling, inverted flap, macular hole, small hole, visual outcome, vitrectomy

1 | INTRODUCTION

The aims of macular hole (MH) surgery are represented by the anatomic closure of MH and visual improvement (Fallico et al., 2021; Meng et al., 2011). Significant advance in vitreoretinal surgery has been made since 1999 when internal limiting membrane (ILM) peeling was shown to be a crucial step in macular hole surgery (Park et al., 1999). Such progress allowed us to achieve excellent outcomes with regard to anatomic success. The surgery yields a closure rate as high as 90% of cases, providing even better results in small MHs (Baumann et al., 2021; Essex et al., 2016; Fallico et al., 2024; Ventre et al., 2022). Nonetheless, functional results after anatomically successful MH surgery tend to be more variable.

A normal visual acuity has been reported in about 28% of cases after successful MH surgery, being the most relevant factors associated with it a shorter symptom duration and a smaller hole diameter (Fallico et al., 2021). Small idiopathic full-thickness macular holes (FTMHs)

SMALL Study Group members and affiliations are shown in Appendix S1.

have more chance to achieve an excellent visual outcome after surgery compared with medium and large FTMHs (Fallico et al., 2021, 2024; Marolo et al., 2025). Understanding which clinical variables might have an influence on visual recovery after surgical treatment of small FTMHs would help to increase the proportion of eyes that achieve such optimal outcomes and, as a consequence, to reduce the risk of unsatisfactory results. To date, the evidence on this issue is poor.

The vitrectomy in SMALL study is a retrospective, multicentre study that collected data on more than 600 cases of idiopathic FTMHs with a diameter ≤250 μm. The purpose of the present report was to explore visual outcomes after surgical treatment of small FTMHs and to investigate which clinical variables are associated with either poor or excellent visual results.

2 | METHODS

The vitrectomy in SMALL study is a multicentre study (Fallico et al., 2024; Marolo et al., 2025) that included a total of 42 vitreoretinal units in Europe (Appendix S2). Data of consecutive eyes affected a small idiopathic FTMH and treated with primary pars plana vitrectomy between January 2019 and June 2022 were retrospectively reviewed.

The protocol of the study conformed to the tenets of the Declaration of Helsinki and was approved by the institutional Review Board at each participating institution, unless anonymized data collection was deemed to be part of a local audit or service evaluation.

The inclusion criteria of the present report were as follows: (a) idiopathic FTMH with a size ≤250 μm treated with primary pars plana vitrectomy; (b) macular hole closure after primary vitrectomy; (c) pseudophakic status at the time of surgery or phakic eyes treated with combined phaco-vitrectomy; (d) follow-up period ≥12 months; (e) preoperative and postoperative data on best-corrected visual acuity (BCVA) and spectral domain optical coherence tomography (sd-OCT) imaging. The following exclusion criteria were considered: silicone oil tamponade; OCT scans of poor quality; high myopia (axial length >25.5 mm and/or spherical equivalent ≥−6 dioptres); traumatic MH; MH secondary to other conditions; glaucoma; amblyopia; any eye disease that might affect visual acuity; prior intraocular surgery excluding uneventful cataract surgery.

A complete ophthalmologic assessment was performed at baseline before surgery and throughout the follow-up. This consisted of best-corrected visual acuity (BCVA) measurement, intraocular pressure (IOP) measurement by Goldmann applanation tonometry, slit lamp examination and dilated fundus examination. The early treatment diabetic retinopathy study (ETDRS) charts were used to assess BCVA, which was converted into logarithm of minimum angle (logMAR) values. Spectral domain OCT was carried out at baseline and at each postoperative visit. The minimum linear diameter (MLD) on OCT imaging was considered as the distance between the hole edges at the narrowest point at mid-retina level, parallel to the retinal pigment epithelium (RPE), measured on the scan containing the largest hole dimension. Macular hole basal diameter was measured at RPE level. All phakic eyes underwent a combined phaco-vitrectomy. Follow-up visits were classified as 1 month (1 month ± 1 week), 6 months (6 months ± 2 weeks) and 1 year (12 months ± 4 weeks).

At each site, two researchers reviewed clinical records in an independent fashion. The following preoperative data were collected: age; gender; lens status; diabetic condition; baseline BCVA; OCT data such as MLD, basal diameter, the presence of vitreomacular traction (VMT), the presence of epiretinal membrane (ERM) and the presence of macular hole associated epiretinal proliferation (MHEP). Surgical data included vitrectomy gauge; type of surgery (combined phaco-vitrectomy or vitrectomy alone); type of tamponade (gas or air); type of dye used (none, blue or green); type of ILM peeling (conventional ILM peeling, inverted flap, no ILM peeling). The following postoperative clinical variables were collected: MH closure and BCVA. Adverse events occurring intraoperatively and postoperatively were also recorded, including retinal tear; vitreous haemorrhage; retinal detachment; endophthalmitis; and cystoid macular oedema. In case of disagreement in eligibility assessment and/or data collection, a third investigator was consulted to address the issue.

The conventional ILM peeling had an extension of peeling within two-disc diameters from the fovea centre. The inverted flap technique involved the creation of an ILM flap: the ILM was peeled circumferentially within two-disc diameters from the fovea centre and left attached to hole edges. The flap was trimmed, inverted and left to cover the hole, with no attempt to insert it inside the hole. No perfluorocarbon liquids (PFCLs) nor viscoelastic devices were adopted to stabilize and/or flatten the ILM flap. Eyes were excluded in case of any deviation from inverted flap protocol.

According to postoperative BCVA, patients were divided into three groups. A postoperative BCVA ≤0.1 logMAR was considered a 'normal vision' outcome and identified the 'normal vision' group (Fallico et al., 2021). A postoperative BCVA >0.3 logMAR was considered a suboptimal visual outcome, identifying the 'suboptimal vision' group. The remaining eyes with a postoperative BCVA >0.1 and ≤0.3 logMAR were included in the 'intermediate visual outcome' group.

The primary outcome was to investigate the incidence rate of a normal vision outcome at 12-month follow-up and to explore which clinical variables could be associated with it. The incidence rates of suboptimal and intermediate visual outcomes at 12 months were considered as secondary outcomes along with the assessment of which clinical variables could be associated with a suboptimal visual recovery.

2.1 | Statistical analysis

Continuous variables were analysed by means and standard deviations, while percentages were computed for categorical variables.

Within each group, clinical variables that could be associated with visual outcome were individually analysed by univariate analyses. The Shapiro–Wilk test was fitted to analyse the normal distribution of continuous variables; the *U* Mann–Whitney test was used for non-parametric variables. Categorical variables were analysed by the means of the chi-squared test, using the Fisher's exact test when necessary. Odds ratio (OR) and 95% confidence intervals (CI) were reported. Variables that proved significant with a p value <0.2 in the univariate analysis were further tested in a logistic regression analysis to assess the independence between risk factors and outcome. A p value ≤0.05 was considered statistical significant. IBM SPSS Statistics (Version 21.0; IBM Corp, Armonk, NY) was used for analyses.

3 | RESULTS

The present report included 539 eyes. Clinical information along with surgical data of all included eyes is shown in Table 1.

3.1 | Visual outcome groups

Of 539 eyes, 219 eyes (40.6%) were included in the normal vision group, 205 eyes (38%) in the intermediate vision group and 115 eyes (21.3%) in the suboptimal vision group (Figure 1). Mean postoperative BCVA was 0.06±0.05 logMAR in the normal vision group, 0.23±0.05 logMAR in the intermediate vision group and 0.59±0.21 logMAR in the suboptimal vision group (p<0.001). Clinical and surgical characteristics of each group are reported in Table 2. Overall, 38 out of 539 eyes (7%) were treated with vitrectomy with no ILM peeling, while 501 eyes (93%) underwent ILM peeling. Of these eyes, a conventional ILM peeling was performed in 308 eyes (61.5%), while an inverted flap technique was used in 193 eyes (38.5%).

Results from univariate analysis comparing normal vision eyes versus others are shown in Table 3. Baseline BCVA was sharper in the normal vision group compared with non-normal vision eyes (0.48±0.21 logMAR vs. 0.67±0.29 logMAR, p<0.001). Macular hole MLD was smaller in the normal vision group compared with non-normal vision eyes (177.13±57.89 vs. 191.37±51.94, p<0.001). A vitrectomy with no ILM peeling was performed in 27 eyes (12.3%) in the normal vision group versus 11 eyes (3.4%) in the non-normal vision group (p<0.001). ILM peeling was performed in 192 eyes (87.7%) in the normal vision group and in 309 non-normal vision eyes (96.6%). Of these eyes treated with ILM peeling, a conventional ILM peeling was performed in 70% of normal vision eyes versus 56% of non-normal vision eyes (p=0.001). An inverted flap technique was used in 30% of normal vision eyes versus 44% of non-normal vision eyes (p=0.001). According to multivariate logistic regression analyses, a better mean baseline BCVA, no peeling technique and conventional ILM peeling were clinical variables significantly associated with normal vision outcome (Table 4).

Results from univariate analysis comparing suboptimal vision eyes versus other cases are shown in Table 5. Baseline BCVA was poorer in the suboptimal vision group compared with other cases (0.74±0.35 logMAR vs. 0.55±0.24 logMAR, p<0.001). Macular hole MLD was slightly larger in the suboptimal vision group compared with other cases (193.09±51.26 vs. 183.54±55.65, p=0.050). A vitrectomy with no ILM peeling was performed in three eyes (2.6%) in the suboptimal vision group versus 35 eyes (8.3%) in the remaining group (p=0.036). ILM peeling was performed in 112 eyes (97.4%) of the suboptimal vision group and in 389 remaining cases (91.7%). Of these eyes treated with ILM peeling, a conventional ILM peeling was performed in 48.2% of suboptimal vision eyes versus 65.3% of other cases (p=0.001). An inverted flap technique was used in 51.8% of suboptimal vision eyes versus 34.7% of other cases (p=0.001).

According to multivariate logistic regression analyses, a worse mean baseline BCVA and inverted flap

TABLE 1 Baseline characteristics of the study population.

Characteristics	*N*=539
Women, *n* (%)	292 (54.2)
Age, mean (±SD)	69.05 (±8.37)
Diabetes, *n* (%)	52 (9.6)
Lens status, *n* (%)	
Pseudophakic	262 (48.6)
MH minimum linear diameter (μm), mean (±SD)	182.21 (±56.15)
MH basal diameter (μm), mean (±SD)	478.84 (±240.06)
ERM, *n* (%)	180 (33.4)
VMT, *n* (%)	173 (32.1)
Epiretinal proliferation, *n* (%)	108 (20.0)
Baseline BCVA (logMAR), mean (±SD)	0.59 (±0.28)
Postoperative BCVA (logMAR), mean (±SD)	0.24 (±0.22)
Combined phacovitrectomy, *n* (%)	277 (51.4)
Vitrectomy caliper size, *n* (%)	
23 gauge	116 (21.5)
25 gauge	349 (64.7)
27 gauge	74 (13.7)
No ILM peeling, *n* (%)	38 (7.0)
Type of peeling, *n* (%)	501 (93.0)
Conventional peeling	308 (61.5)
Inverted flap	193 (38.5)
Tamponade, *n* (%)	
Air	52 (9.6)
Gas	487 (90.4)
Type of gas tamponade, *n* (%)	
SF_6	378 (77.6)
C_3F_8	80 (16.4)
C_2F_6	29 (6.0)

Abbreviations: BCVA (logMAR), best-corrected visual acuity (logarithm of the minimum angle of resolution); ERM, epiretinal membrane; MH, macular hole; SD, standard deviation; VMT, vitreomacular traction.

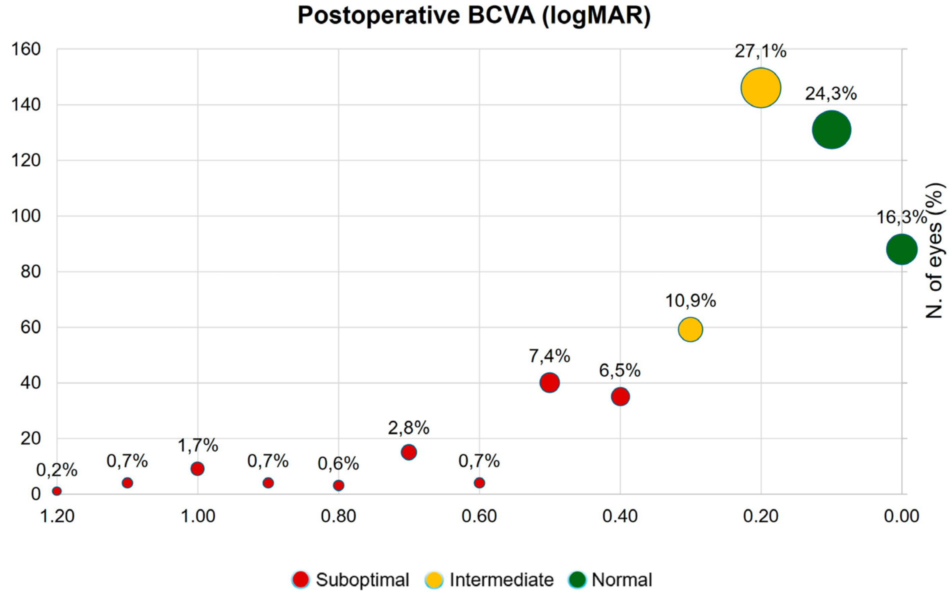

FIGURE 1 Postoperative best-corrected visual acuity (BCVA) in the visual outcome groups. Dots size is proportional to the number of eyes in each group.

TABLE 2 Comparison between visual outcome groups.

Characteristic	Normal vision (N = 219)	Intermediate vision (N = 205)	Suboptimal vision (N = 115)	p Value
Women, n (%)	124 (56.6)	106 (51.7)	62 (53.9)	0.596
Age, mean (±SD)	68.60 (±8.52)	68.49 (±7.59)	69.60 (±8.45)	0.293
Diabetes, n (%)	18 (8.2)	23 (11.2)	11 (9.6)	0.577
Lens status, n (%)				
Pseudophakic	106 (48.4)	99 (48.3)	57 (49.6)	0.973
MH minimum linear diameter (μm), mean (±SD)	177.13 (±57.89)	190.40 (±52.42)	193.09 (±51.26)	<0.001
MH basal diameter (μm), mean (±SD)	400.06 (±216.02)	479.86 (±241.97)	524.51 (±224.32)	<0.001
ERM, n (%)	68 (31.1)	72 (35.1)	40 (34.8)	0.633
VMT, n (%)	66 (30.1)	70 (34.1)	37 (32.2)	0.677
Epiretinal proliferation, n (%)	48 (21.9)	41 (20.0)	19 (16.5)	0.509
Baseline BCVA (logMAR), mean (±SD)	0.48 (±0.21)	0.63 (±0.25)	0.74 (±0.35)	<0.001
Postoperative BCVA (logMAR), mean (±SD)	0.06 (±0.05)	0.23 (±0.05)	0.59 (±0.21)	<0.001
Combined phacovitrectomy, n (%)	113 (51.6)	106 (51.7)	58 (50.4)	0.973
Vitrectomy caliper size, n (%)				
23 gauge	46 (21.0)	48 (23.4)	22 (19.1)	0.016
25 gauge	147 (67.1)	136 (66.3)	66 (57.4)	
27 gauge	26 (11.9)	21 (10.2)	27 (23.5)	
No ILM peeling, n (%)	27 (12.3)	8 (3.9)	3 (2.6)	<0.001
Type of peeling, n (%)	192 (87.7)	197 (96.1)	112 (97.4)	<0.001
Conventional peeling	135 (70.3)	119 (60.4)	54 (48.2)	
Inverted flap	57 (29.7)	78 (39.6)	58 (51.8)	
Tamponade, n (%)				
Air	17 (7.8)	21 (10.2)	14 (12.2)	0.403
Gas	202 (92.2)	184 (89.8)	101 (87.8)	
Type of gas tamponade, n (%)				
SF_6	166 (82.2)	136 (74.0)	76 (75.2)	0.317
C_3F_8	27 (13.4)	36 (19.5)	17 (16.8)	
C_2F_6	9 (4.5)	12 (6.5)	8 (7.9)	

Abbreviations: BCVA (logMAR), best-corrected visual acuity (logarithm of the minimum angle of resolution); ERM, epiretinal membrane; MH, macular hole; SD, standard deviation; VMT, vitreomacular traction.

TABLE 3 Comparison between normal vision group and other cases.

Characteristics	Normal vision (*N* = 219)	Others (*N* = 320)	*p* Value
Women, *n* (%)	124 (56.6)	168 (52.5)	0.379
Age, mean (±SD)	68.60 (±8.52)	68.89 (±7.92)	0.718
Diabetes, *n* (%)	18 (8.2)	34 (10.6)	0.373
Lens status, *n* (%)			
Pseudophakic	106 (48.4)	156 (48.7)	0.937
MH minimum linear diameter (μm), mean (±SD)	177.13 (±57.89)	191.37 (±51.94)	<0.001
MH basal diameter (μm), mean (±SD)	400.06 (±216.02)	495.91 (±236.40)	<0.001
ERM, *n* (%)	68 (31.1)	112 (35.0)	0.354
VMT, *n* (%)	66 (30.1)	107 (33.4)	0.453
Epiretinal proliferation, *n* (%)	48 (21.9)	60 (18.8)	0.382
Baseline BCVA (logMAR), mean (±SD)	0.48 (±0.21)	0.67 (±0.29)	<0.001
Postoperative BCVA (logMAR), mean (±SD)	0.06 (±0.05)	0.36 (±0.22)	<0.001
Combined phacovitrectomy, *n* (%)	113 (51.6)	164 (51.3)	0.937
Vitrectomy caliper size, *n* (%)			
23 gauge	46 (21.0)	70 (21.9)	0.524
25 gauge	147 (67.1)	202 (63.1)	
27 gauge	26 (11.9)	48 (15.0)	
No ILM peeling, *n* (%)	27 (12.3)	11 (3.4)	<0.001
Type of peeling, *n* (%)	192 (87.7)	309 (96.6)	0.001
Conventional peeling	135 (70.3)	173 (56.0)	
Inverted flap	57 (29.7)	136 (44.0)	
Tamponade, *n* (%)			
Air	17 (7.8)	35 (10.9)	0.238
Gas	202 (92.2)	285 (89.1)	
Type of gas tamponade, *n* (%)			
SF_6	166 (82.2)	212 (74.4)	0.127
C_3F_8	27 (13.4)	53 (18.6)	
C_2F_6	9 (4.5)	20 (7.0)	

Abbreviations: BCVA (logMAR), best-corrected visual acuity (logarithm of the minimum angle of resolution); ERM, epiretinal membrane; MH, macular hole; SD, standard deviation; VMT, vitreomacular traction.

technique were clinical variables significantly associated with a suboptimal visual outcome (Table 6).

3.2 | Adverse events

Adverse events occurring in the three groups are reported in Table 7. Rates of adverse events were comparable between the three groups.

4 | DISCUSSION

The SMALL study was designed to collect clinical data on surgical treatment of small idiopathic FTMHs (Fallico et al., 2024; Marolo et al., 2025). The present report investigated visual outcomes and included a total of 539 eyes with a 12-month follow-up. An excellent visual acuity with a final BCVA ≤0.1 logMAR was shown in 40% of eyes, while a suboptimal outcome with a final BCVA >0.3 logMAR was found in 21% of eyes.

TABLE 4 Results for logistic regression analysis with normal vision group as dependent variable.

	p Value	Exp(B)
MH minimum linear diameter	0.385	0.998
MH basal diameter	0.075	0.999
Mean baseline BCVA (LogMAR)	<0.001	0.069
No ILM peeling	<0.001	8.374
Inverted flap	0.018	0.366

Abbreviation: MH, macular hole.

Improvements in macular hole surgery have provided remarkable results in terms of both anatomical and functional success. Recent evidence showed a closure rate ranging between 96% and 100% in small and medium FTMHs after surgery (Chou et al., 2022; Fallico et al., 2024; Lindtjørn et al., 2022; Rizzo et al., 2018; Ventre et al., 2022). Ever-increasing attention has been paid to visual outcomes in the last few years. Past studies

TABLE 5 Comparison between suboptimal vision group and other cases.

Characteristics	Suboptimal vision (N = 115)	Others (N = 424)	p Value
Women, n (%)	62 (53.9)	230 (54.2)	0.949
Age, mean (±SD)	69.60 (±8.45)	68.55 (±8.08)	0.126
Diabetes, n (%)	11 (9.6)	41 (9.7)	0.966
Lens status, n (%)			
Pseudophakic	57 (49.6)	205 (48.3)	0.817
MH minimum linear diameter (μm), mean (±SD)	193.09 (±51.26)	183.54 (±55.65)	0.050
MH basal diameter (μm), mean (±SD)	524.51 (±224.32)	438.64 (±232.12)	<0.001
ERM, n (%)	40 (34.8)	140 (33.0)	0.739
VMT, n (%)	37 (32.2)	136 (32.1)	0.984
Epiretinal proliferation, n (%)	19 (16.5)	89 (21.0)	0.356
Baseline BCVA (logMAR), mean (±SD)	0.74 (±0.35)	0.55 (±0.24)	<0.001
Postoperative BCVA (logMAR), mean (±SD)	0.59 (±0.21)	0.14 (±0.10)	<0.001
Combined phacovitrectomy, n (%)	58 (50.4)	219 (51.7)	0.817
Vitrectomy caliper size, n (%)			
23-gauge	22 (19.1)	94 (22.2)	0.003
25-gauge	66 (57.4)	283 (66.7)	
27-gauge	27 (23.5)	47 (11.1)	
No ILM peeling, n (%)	3 (2.6)	35 (8.3)	0.036
Type of peeling, n (%)	112 (97.4)	389 (91.7)	0.001
Conventional peeling	54 (48.2)	254 (65.3)	
Inverted flap	58 (51.8)	135 (34.7)	
Tamponade, n (%)			
Air	14 (12.2)	38 (9.0)	0.301
Gas	101 (87.8)	386 (91.0)	
Type of gas tamponade, n (%)			
SF_6	76 (75.3)	302 (78.2)	0.627
C_3F_8	17 (16.8)	63 (16.3)	
C_2F_6	8 (7.9)	21 (5.5)	

Abbreviations: BCVA (logMAR), best-corrected visual acuity (logarithm of the minimum angle of resolution); ERM, epiretinal membrane; MH, macular hole; SD, standard deviation; VMT, vitreomacular traction.

on visual results after macular hole surgery were focused on an outcome of 20/40 Snellen (Essex et al., 2018; Gupta et al., 2009; Wakely et al., 2012). In recent years, expectations have grown and research interest has been targeted on a final visual outcome ≥20/25 Snellen (Fallico et al., 2021).

Such an excellent visual outcome after surgery for idiopathic FTMHs of any size has been shown in about 28% of cases (Fallico et al., 2021). The findings of the present report demonstrated an excellent visual gain after surgery in 40% of small idiopathic FTMHs. Idiopathic FTMHs of small size have a great chance to achieve an excellent visual recovery after surgery because a smaller size has been shown to be associated with a better visual gain (Fallico et al., 2021). Additionally, small FTMHs are likely to present with a higher preoperative visual acuity and a shorter symptom duration compared with larger holes, which are factors related to a sharper visual gain.

Spontaneous closure of small idiopathic FTMHs has been recently acknowledged (Neubauer et al., 2024). Neubauer et al. reported a spontaneous closure in up to 25% of small idiopathic FTMHs over a median time of 44 days (Neubauer et al., 2024). Best-corrected visual acuity after spontaneous closure improved from 0.40 logMAR to 0.29 logMAR, which is equal to 20/40 Snellen (Neubauer et al., 2024). There is no information as to whether a further improvement of visual acuity could happen on a long-term follow-up after spontaneous closure. However, according to the results of the present report, a final visual acuity ≤0.3 logMAR was

TABLE 6 Results for logistic regression analysis with suboptimal vision group as dependent variable.

	p Value	Odds ratio
MH minimum linear diameter	0.527	1.001
MH basal diameter	0.278	1.002
Mean baseline BCVA (LogMAR)	<0.001	10.753
No ILM peeling	0.102	0.486
Inverted flap	0.025	2.841

Abbreviation: MH, macular hole.

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TABLE 7 Adverse events.

	Normal vision (N = 219)	Intermediate vision (N = 205)	Suboptimal vision (N = 115)	p Value
Retinal tear	4 (1.8)	4 (1.9)	2 (1.7)	0.990
Endophthalmitis	0	0	0	/
Cystoid macular oedema	2 (0.9)	6 (2.9)	4 (3.5)	0.220
Retinal detachment	0	2 (1.0)	1 (0.9)	0.162
Vitreous haemorrhage	3 (1.4)	3 (1.5)	2 (1.7)	0.965

found in about 80% of small idiopathic FTMHs after surgical treatment and a final visual acuity ≤0.1 logMAR was found in 40% of cases: two of five small FTMHs presented an excellent visual recovery after surgical treatment. On this basis, surgery has to be considered the treatment of choice, while close observation could be considered in individual cases where surgical treatment has been delayed.

Given the favourable outcomes of surgery in small idiopathic FTMHs, understanding which clinical variable might have an influence on visual recovery is of primary relevance in clinical settings. According to our analyses, a better preoperative visual acuity and a smaller hole size were associated with an excellent visual outcome, while a worse preoperative visual acuity and a larger hole size were associated with a suboptimal visual result. The predicting role of preoperative visual acuity and macular hole diameter has been largely demonstrated in macular hole surgery (Fallico et al., 2021; Gupta et al., 2009; Wakely et al., 2012). Our findings corroborated the role of these factors in small hole surgery as well.

Interestingly, our findings shed the light on the influence of peeling technique on visual outcome. The present report showed that a vitrectomy with no ILM peeling was associated with an excellent visual outcome in small macular holes. The relevance of this factor was confirmed by multivariate logistic regression analyses. A previous report on small holes demonstrated a better visual gain in eyes treated with vitrectomy with no ILM peeling compared with ILM peeling; however, ILM peeling was associated with a higher macular hole closure rate (Marolo et al., 2025). In the present report, only eyes with postoperative macular hole closure were included because the purpose was to primarily investigate the visual outcome and potential predicting factors. Thus, no analyses were conducted on anatomical outcome. Additionally, a vitrectomy with no ILM peeling was performed in 38 of 539 eyes. The fact that a no-ILM peeling technique was adopted in only 7% of included eyes has to be acknowledged as a significant limitation to the strength of this finding.

Besides, according to our analyses, the inverted flap technique is associated with a poorer visual outcome in small macular hole compared with conventional ILM peeling. About 40% of included eyes were treated with the inverted flap technique. An excellent visual outcome was associated with conventional ILM peeling over the inverted flap technique, while a suboptimal visual outcome was associated with the inverted flap technique over conventional ILM peeling. The inverted flap technique provides undoubted advantages in large macular hole (Bleidißel et al., 2021; Gu & Qiu, 2018), while the role of this technique in macular hole of medium size is controversial (Baumann et al., 2021; Bleidißel et al., 2022; Chou et al., 2022; Ventre et al., 2022; Yamada et al., 2022). Technical aspects of this peeling technique need to be taken into account. On the one hand, the use of a viscoelastic device and PFCLs has been proposed to flatten and stabilize the ILM flap and to avoid the migration of the flap underneath the hole's minimum aperture (Chou et al., 2021, 2022). The adoption of this single layer inverted flap technique associated with the use of a viscoelastic device and PFCL seems to provide a faster functional recovery in small- and medium-sized macular holes (Chou et al., 2022). On the other hand, a fill-in inverted flap technique with ILM insertion inside the hole has been demonstrated to provide worse functional results (Iwasaki et al., 2020; Park et al., 2019). In all eyes included in the present report, neither viscoelastic nor perfluorcarbon liquids were used to stabilize the flap. Furthermore, the ILM flap was inverted and left to cover the hole, with no filling into the hole. Evidence on the use of the inverted flap technique with no ILM insertion into the hole showed no advantages compared with conventional ILM peeling in macular holes with a size ≤400 μm, with a delay in restoration of external retinal layers and worse functional outcomes on microperimetry (Ventre et al., 2022). A previous report on macular holes with a size ≤250 μm showed a better functional outcome in eyes undergoing conventional ILM peeling compared with the inverted flap technique, with comparable closure rates (Iuliano et al., 2023). Postoperative restoration of external retinal layers was impaired in small macular holes treated with the inverted flap technique. Foveal sensitivity on microperimetry proved better in small holes treated with conventional ILM peeling compared with the inverted flap technique (Iuliano et al., 2023). The findings of the present report confirm the choice of performing a conventional ILM peeling over an inverted flap technique in small idiopathic macular holes.

The main limitation of this study was the retrospective design, which reduced the strength of the evidence being a source of bias. The adoption of a systematic study protocol helped to limit this risk. Additionally, the multicentre design was a potential source of bias with regard to the technical aspects of ILM peeling. The adoption of strict inclusion criteria helped to reduce this risk, being excluded cases where viscoelastic device or PFCL were used during peeling manoeuvres as well as those where the ILM flap was inserted inside the hole. A further limitation of the preciseness of our findings was the small sample size of eyes treated with vitrectomy and no

ILM peeling, which reduced the robustness of the analyses conducted on no-ILM peeling variable. The strength of this study was based on the large sample size, with more than 500 eyes included. Moreover, included cases were homogenously distributed across the three visual outcome groups, supporting the quality of our analyses.

In conclusion, idiopathic macular holes of small size have a great chance of achieving an excellent visual outcome after surgery, with 40% of cases showing a final BCVA ≤0.1 logMAR. Surgical treatment of this condition has to be recommended. Vitrectomy with conventional ILM peeling should be preferred over inverted flap technique since the latter is associated with a poor visual outcome. Further studies are needed to confirm the role of vitrectomy without ILM peeling in small macular holes.

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DATA AVAILABILITY STATEMENT

The data sets analysed during the current study are available from the corresponding author on reasonable request.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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