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Macular hole surgical outcomes at a retinal centre in Johannesburg, South Africa

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Background: A full-thickness macular hole (FTMH) causes central vision loss. Although modern vitrectomy techniques achieve high closure rates, functional recovery remained variable.

Aim: This study aimed to describe the surgical outcomes of FTMH repair in patients treated at a retinal centre in South Africa.

Setting: The study was conducted at a predominantly retinal private-sector centre in Johannesburg, South Africa.

Methods: This retrospective case series evaluated anatomical and visual outcomes of patients who underwent FTMH repair at Northcliff Eye Centre over 10 years.

Results: The study included 157 eyes. The median patient age was 67 years, and 72% were female. The median FTMH size was 422 μm, with 54% classified as large according to the International Vitreomacular Traction Study (IVTS) classification. Anatomical closure was achieved in 90% at 1 month and 98.7% at 3 months. The median visual acuity improved from 0.7 Logarithm of the Minimum Angle of Resolution (logMAR) to 0.22 logMAR at 3 months, a gain of 24 letters ($P < 0.001$). Smaller holes and U-shaped closure morphology were associated with superior outcomes. Complications were minimal, with no retinal detachments reported.

Conclusion: Vitrectomy with internal limiting membrane (ILM) peeling achieved high closure rates, with smaller holes and U-shaped closures predicting superior visual outcomes, underscoring the value of early intervention and optical coherence tomography-based prognostication.

Contribution: This study provided region-specific outcome data to support surgical decision-making and patient counselling in sub-Saharan Africa.

Keywords: full-thickness macular hole; ILM peel; vitrectomy; visual acuity outcomes; anatomical closure; retinal surgery; surgical outcomes; South Africa.

Introduction

A full-thickness macular hole (FTMH) is a defect in the fovea that causes central vision loss and most commonly arises from abnormal vitreomacular traction.[1,2,3,4] While idiopathic cases are the most frequent, secondary holes can occur in association with high myopia, trauma or other retinal pathology.[1,2,5] The incidence of FTMH is estimated at 4–8 per 100 000 individuals, predominantly affecting women in the sixth to seventh decades of life.[2,6,7]

Surgical management has advanced significantly since Kelly and Wendel's landmark report describing successful closure with pars plana vitrectomy (PPV).[1,8] Contemporary techniques, including internal limiting membrane (ILM) peeling, improved intra-operative dyes and modern gas tamponades, achieve closure in 90% – 100% of cases.[1,9,10,11,12] Functional outcomes, however, vary widely and depend on several anatomical factors, particularly pre-operative macular hole size and restoration of the outer retinal layers.[6,8,9] The primary goal of FTMH surgery remains to restore visual acuity (VA) through anatomical closure.[6,13]

Optical coherence tomography (OCT) has revolutionised the classification and prognostication of macular hole surgery.[4,5,14] In 2013, the International Vitreomacular Traction Study (IVTS) classification provided ophthalmologists with a reproducible framework based on OCT features to standardise FTMH measurements.[5] Quantitative assessment of FTMH is typically based on the minimum linear diameter (MLD), which measures the narrowest distance between the hole edges

at the mid-retina on the maximum hole aperture scan, with a line drawn approximately parallel to the retinal pigment epithelium (RPE).[5] Macular hole size is shown to strongly correlate with surgical outcomes.[1,9,15] Large macular holes, highly myopic eyes and chronic cases remain challenging, with closure rates and functional recovery significantly lower than those of small, acute idiopathic holes.[1,5,6,11,12]

Postoperative closure configuration is typically categorised as U-shaped, V-shaped, irregular and open.[1,15] U-shaped closures, with a normal foveal contour, are observed in about 45% of cases and result in the best visual outcomes.[1,15] V-shaped closures, with steep foveal contours, occur in 26% of cases and are associated with less favourable outcomes.[1,15] Irregular closures, seen in 8.8% of cases, often evolve into U- or V-shaped patterns over time.[1,15] Open closures show limited visual recovery because of foveal defects and fluid accumulation around the hole.[1,15]

Research on FTMH surgical outcomes in sub-Saharan Africa remains limited. Many patients travel from neighbouring countries to South Africa for vitreoretinal surgical services, often presenting with a longer duration of symptoms before intervention. This study evaluates the anatomical and functional outcomes of FTMH surgeries performed at a single retinal centre in Johannesburg.

Aims

This study aimed to describe the surgical outcomes of FTMH repair in patients treated at a retinal centre in Johannesburg, South Africa.

Research methods and design

This study was a retrospective case series that evaluated the anatomical and visual outcomes of patients who underwent FTMH repair at Northcliff Eye Centre, Johannesburg, between 01 January 2014 and 30 August 2024. Patients with FTMH were selected from the Heidelberg Spectralis OCT database. Each patient was allocated a subject number in chronological order of collection. The patients' file numbers were used to retrieve files for data collection.

Inclusion criteria included all patients whose idiopathic FTMH was treated at Northcliff Eye Centre within the given time frame, with available pre-operative and 3-month post-operative OCT images, as well as VA records. In cases where both eyes were operated on, the right eye was selected for the study, provided that it was followed up for at least 3 months post-operatively. Patients who had FTMH secondary to trauma, including iatrogenic trauma, macular hole formation following retinal detachment repair and macular holes secondary to cystoid macular oedema were excluded from the study.

The patients' demographics, pre-existing systemic and ophthalmic chronic conditions, likely aetiology, FTMH laterality, associated symptoms and duration thereof were captured. Symptom duration was self-reported and thus subject to recall bias. Macular hole chronicity (less than 6 months versus 6 months or more) was recorded where possible. Axial length was not routinely captured in patient files and therefore could not be used to identify high myopia. The pre-operative VA, intraocular pressure (IOP), OCT-based FTMH size (μm) based on the measured MLD, stage of vitreous detachment, and lens state were captured. Captured surgical details included anaesthesia type, staining medium, tamponade agent, posturing and duration, whether the ILM was peeled, and intra-operative complications. Combined procedures such as cataract surgery, retinal detachment repair (RDR) or epiretinal membrane (ERM) peel were also recorded. Post-operative information on day 1, 1 month, and 3 month time points was captured. This included VA, IOP, lens status, OCT findings, hole closure, and post-operative complications. In the 1-month and 3-month post-operative review, closure patterns on OCT imaging were also captured. Closure patterns were classified into U-shaped, V-shaped, irregular and open holes.[1,15] The macular hole closure pattern has been shown to be associated with VA outcomes.

At Northcliff Eye Centre, VA was tested using the Snellen chart and recorded in decimal format. For this study, all VAs were converted to logMAR format. The MLD of macular holes was measured on the SD-OCT image using the calliper function. Standardised anatomical landmarks were used to measure FTMHs, defined as the narrowest horizontal distance between the edges of the neurosensory retina, parallel to the RPE, at the hole's widest aperture. The IVTS classification system was used to classify FTMHs into small (< 250 μm), medium (250 μm – 400 μm) or large (> 400 μm) holes.[5]

Cataract was recognised as a confounder because it can affect both baseline VA and post-operative best-corrected visual acuity (BCVA). However, lens-related variables were not incorporated into the statistical analysis, as the study was not powered for multivariable regression. Visual acuity outcomes were therefore analysed using univariate methods and interpreted with appropriate caution. As cataract does not affect anatomical closure, no adjustments were required for the primary anatomical endpoint.

Statistical considerations

Analyses were performed in R version 4.1.1. Demographic and clinical characteristics were summarised as counts and proportions for categorical variables, and medians with interquartile ranges (IQR) for continuous variables. Associations between logMAR VA and demographic or clinical factors were assessed using linear regression. Pre- and post-operative VA were compared using a paired Student's *t*-test. For comparisons across groups, non-parametric methods were applied for continuous variables (Kruskal–Wallis rank-sum test), while categorical variables were analysed using Pearson's chi-squared test or Fisher's exact test, depending on expected cell counts. Statistical significance was set at $P < 0.05$.

Ethical considerations

Ethical clearance was obtained prior to commencement of the study. Ethics approval was granted by the Human Research Ethics Committee (Medical) at the University of the Witwatersrand (reference number: M250334) on 03 April 2025. Given the retrospective nature of the study and the use of anonymised data, informed consent was waived in accordance with local ethical guidelines. The study data were sourced from patient records available at Northcliff Eye Centre, with permission from the Chief Executive Officer. Subject numbers were assigned to ensure anonymity and file numbers were used to trace patients to OCT images for data collection. Names, surnames and birthdates were excluded to maintain confidentiality.

Results

Between 01 January 2014 and 30 August 2024, a total of 338 eyes from 316 patients presented with FTMH. Following application of the inclusion and exclusion criteria, 157 eyes from 157 patients were eligible and included in the final analysis. The patient demographics, pre-operative details and intra-operative characteristics are listed in Table 1 and Table 2. The median age of patients was 67 years, with an IQR of 62–71 years and a female predominance of 72.0%. The median duration of symptoms was 10 weeks (IQR: 4–24 weeks), most commonly presenting with blurred vision (35.7%) or metamorphopsia (29.9%). Full-thickness macular holes were bilateral in 13.4% of cases, with surgery performed in 55.4% of right eyes and 44.6% of left eyes. Median pre-operative VA was 0.7 logMAR (IQR: 0.53–0.80 logMAR). Over half the eyes were phakic with cataract changes (58.0%), while 33.1% were pseudophakic on presentation. The median FTMH size was 422 μm (IQR: 273–624 μm), with the majority classified as large FTMHs (54.1%). All surgeries were performed under peribulbar anaesthesia, supporting procedural consistency and demonstrating the safety of local anaesthesia, with ILM peeling carried out in 93% of cases. The most used staining medium was Trypan Blue (43.3%), followed by combined Trypan Blue and Brilliant Blue G (36.3%). The predominant tamponade agent was SF6 gas (96.8%), while air (1.3%) and silicone oil (1.9%) were rarely used. Most patients were instructed to posture for 3 days (73.2%). Combined procedures included cataract surgery in 16.6% and ERM peeling in 24.8% of cases. Intra-operative complications were infrequent, with incidental retinal breaks occurring in 10.8% and no complications were reported in 89.2% of cases.

TABLE 1: Demographics and characteristics of the study population (N = 157).

Characteristic	Median	IQR	*n*	%
Age (years)	67	62–71	-	-
Sex				
Female	-	-	113	72.0
Male	-	-	44	28.0
Duration of symptoms (weeks)	10	4–24	-	-
Unknown duration	-	-	28	-
Symptoms experienced				
Blurring	-	-	56	35.7
Metamorphopsia	-	-	47	29.9
Central vision loss	-	-	39	24.8
Asymptomatic	-	-	1	0.6
FTMH laterality				
Bilateral	-	-	21	13.4
Left only	-	-	63	40.1
Right only	-	-	73	46.5
Eye undergone surgery				
Right eye	-	-	87	55.4
Left eye	-	-	70	44.6
Pre-operative best corrected visual acuity (LogMAR)	0.70	0.52–0.80	-	-
Pre-operative lens status				
Phakic, with cataract	-	-	91	58.0
Phakic, clear lens	-	-	14	8.9
Pseudophakic	-	-	52	33.1
Pre-operative intraocular pressure	14.0	11.0–16.0	-	-
Vitreous state				
Clear	-	-	154	98
Haemorrhage or Haze	-	-	3	1.9
FTMH size (μm)	422	273–624	-	-
Small FTMH (< 200 μm)	-	-	34	21.7
Medium FTMH (200 μm – 400 μm)	-	-	38	24.2
Large FTMH (> 400 μm)	-	-	85	54.1
OCT quality	32.0	28.0–35.0	-	-

IQR, interquartile range; FTMH, full-thickness macular hole; OCT, optical coherence tomography; LogMAR, logarithm of the minimum angle of resolution.

TABLE 2: Intra-operative characteristics of the study population (N = 157).

Characteristic	*n*	%
Anaesthetics used		
Local, peribulbar	157	100.0
Staining medium		
Trypan Blue and Brilliant Blue G	57	36.3
Trypan Blue	68	43.3
Unknown	32	20.4
ILM peel	146	93.0
Tamponade agent used		
Air	2	1.3
Oil	3	1.9
SF6	152	96.8
Days of post-operative posturing		
1	3	1.9
2	4	2.5
3	115	73.2
4	9	5.7
5	19	12.1
7	3	1.9
Unknown	4	2.5
Autologous transplant		
Inverted ILM flap	2	1.3
No transplant	155	98.7
Combined cataract surgery	26	16.6
Combined ERM peel	39	24.8
Combined RDR	4	2.5
Intra-operative adjuvants		
Intravitreal Vitreal S	1	0.6
Intravitreal bevacizumab	1	0.6
OptiStim	34	21.7
No adjuvant	121	77.1
Intra-operative complications		
None	140	89.2
Retinal break	17	10.8

ILM, internal limiting membrane; RDR, retinal detachment repair; ERM, epiretinal membrane.

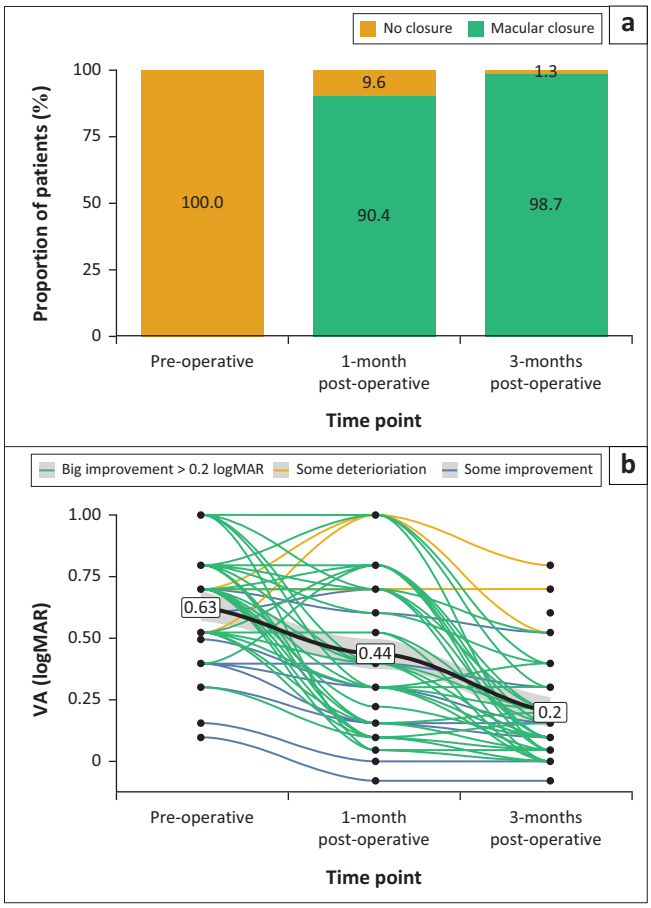

FIGURE 1: Primary outcomes of the study. (a) Stacked bar chart showing macular hole closure increased from 90.4% at 1 month to 98.7% at 3 months post-operatively. (b) Spaghetti plot showing that visual acuity (VA) (logMAR) improved steadily, with mean VA improving from 0.7 pre-operatively to 0.22 at 3 months.

Figure 1 and Table 3 represent the primary outcomes: VA and the key anatomical endpoints based on OCT closure. Visual acuity outcomes were summarised using median values with IQR (Table 3) to account for the skewed distribution of the data, while mean values were displayed graphically (Figure 1) to illustrate overall trends. The median pre-operative BCVA was 0.7 logMAR (IQR: 0.52–0.80), equivalent to approximately 35 Early Treatment Diabetic Retinopathy Study (ETDRS) letters. Vision declined transiently on day 1 to 0.8 logMAR but improved significantly to 0.40 logMAR (IQR: 0.30–0.70), representing a gain of 15 letters at 1 month. There was further improvement to 0.22 logMAR (IQR: 0.10–0.49), a gain of 24 letters at 3 months ($P < 0.001$). Anatomical closure was achieved in 90.4% at 1 month and 98.7% at 3 months ($P < 0.001$). A total of 12 (7.6%) eyes required re-operation for a persistent FTMH during the follow-up period. The median macular hole size of the holes that failed to close was larger; however, this difference was not statistically significant ($P = 0.080$). The IOP remained stable throughout all the follow-up time points ($P = 0.85$). Lens status shifted substantially during the post-operative course, with a reduction in phakic eyes because of cataract progression and extraction. While 66.8% of eyes were phakic pre-operatively, this declined to 17.2% by 3 months, with pseudophakia increasing from 33.1% to 50.3%. These outcome measures are demonstrated in Table 4.

Complications on day 1 after surgery were minimal, with 95.5% of eyes showing no adverse events and only 4.5% experiencing transient high IOP, all managed successfully with medical treatment. By 1 month, the complication profile had changed, with cataract progression observed in 33.8% of phakic eyes, persistent FTMH on OCT in 9.6% and high IOP in 1.3% of cases. At 3 months, the rate of complications decreased overall. Cataract progression declined to 14% as many patients underwent cataract surgery between these time points. Persistent FTMH was seen in only 1.2% after 12 eyes (7.6%) required re-operation, and elevated IOP was seen in 1.9%. Notably, no cases of retinal detachment occurred at any post-operative time points.

Outcomes stratified by baseline macular hole size are presented in Table 5. Smaller macular holes achieved significantly better post-operative visual outcomes and earlier anatomical closure. At 1 month, median VA was superior in small holes (logMAR 0.22) compared with medium (logMAR 0.40) and large (logMAR 0.52) holes ($P = 0.002$). This difference persisted at 3 months (logMAR 0.1 vs logMAR 0.22 and logMAR 0.40; $P < 0.001$). Closure

TABLE 3: Primary outcomes of the study (N = 157).

Characteristic	Pre-operative					One-month outcome					Three-month outcome					*P*-value†
	Median	IQR	*n*	%	95% CI	Median	IQR	95% CI	*n*	%	Median	IQR	95% CI	*n*	%	
LogMAR visual acuity	0.70	0.52–0.80	-	-	0.62, 0.69	0.40	0.30–0.70	0.41, 0.52	-	-	0.22	0.10–0.49	0.25, 0.35	-	-	< 0.001
OCT macular closure	-	-	0	0.0	0.0, 3.0	-	-	84.0, 94.0	142	90.4	-	-	95.0, 100	155	98.7	< 0.001

CI, confidence interval; IQR, interquartile range; OCT, optical coherence tomography; LogMAR, logarithm of the minimum angle of resolution.
†, Kruskal–Wallis rank sum test; Pearson's chi-squared test.

TABLE 4: Outcome measures comparing pre-operative data with post-operative time points at day 1, 1 month and 3 months (N = 157).

Characteristic	Pre-operative				Day 1 Post-operative				One-month post-operative				Three-month post-operative				*P*-value†
	Median	IQR	*n*	%	Median	IQR	*n*	%	Median	IQR	*n*	%	Median	IQR	*n*	%	
LogMAR visual acuity	0.70	0.52–0.80	-	-	0.80	0.80–0.80	-	-	0.40	0.30–0.70	-	-	0.22	0.10–0.49	-	-	< 0.001
Intraocular pressure	14.0	11.0–16.0	-	-	14.0	10.0–18.0	-	-	13.0	11.0–16.0	-	-	13.0	11.0–16.0	-	-	0.85
Lens status																	
Phakic, clear lens	-	-	14	8.9	-	-	11	7.0	-	-	9	5.7	-	-	2	1.3	-
Phakic, cataract	-	-	91	57.9	-	-	67	42.7	-	-	64	40.8	-	-	25	15.9	-
Pseudophakic	-	-	52	33.1	-	-	79	50.3	-	-	71	45.2	-	-	79	50.3	-
No follow-up	-	-	0	0.0	-	-	0	0.0	-	-	13	8.3	-	-	51	32.5	-
OCT macular closure	-	-	0	0.0	-	-	N/A	N/A	-	-	142	90.4	-	-	155	98.7	< 0.001
FTMH size (μm)	422	273–624	-	-	N/A	N/A	-	-	647	437–816	-	-	754	435–1073	-	-	0.080

OCT, optical coherence tomography; FTMH, full-thickness macular hole; IQR, interquartile range; LogMAR, logarithm of the minimum angle of resolution.
†, Kruskal–Wallis rank sum test; Pearson's chi-squared test.

TABLE 5: Outcomes stratified by full-thickness macular hole size.

Variable	Small (< 250 μm)				Medium (250 μm – 400 μm)				Large (> 400 μm)				*P*-value
	Median	IQR	*n*	%	Median	IQR	*n*	%	Median	IQR	*n*	%	
Total	-	-	34	22.0	-	-	38	24.0	-	-	85	54.0	
Visual acuity													
Pre-operative	0.70	0.40–0.80	-	-	0.70	0.52–0.80	-	-	0.70	0.52–0.80	-	-	0.13†
One-month outcome	0.22	0.10–0.46	-	-	0.40	0.22–0.70	-	-	0.52	0.30–0.70	-	-	0.002†
Three-month outcome	0.10	0.00–0.15	-	-	0.22	0.15–0.30	-	-	0.40	0.22–0.52	-	-	< 0.001†
OCT macular closure													
One-month outcome	-	-	33	97.0	-	-	38	100.0	-	-	71	84.0	0.003‡
Three-month outcome	-	-	34	100.0	-	-	38	100.0	-	-	83	98.0	> 0.99‡
Change in VA (logMAR)	0.54	0.70–0.35	-	-	0.30	0.61–0.15	-	-	0.40	0.50–0.12	-	-	0.041†
Line improvement on ETDRS chart	27	35.0–17.5	-	-	15	30.5–7.5	-	-	20	25.0–6.0	-	-	-
Macular closure shape at 3 months	-	-	-	-	-	-	-	-	-	-	-	-	0.088§
U-shaped	-	-	16	47.1	-	-	19	50.0	-	-	25	29.4	-
Irregular shaped	-	-	12	35.3	-	-	10	26.3	-	-	27	31.8	-
V-shaped	-	-	6	17.6	-	-	9	23.7	-	-	31	36.5	-
No closure	-	-	0	0.0	-	-	0	0.0	-	-	2	2.4	-

VA, visual acuity; OCT, optical coherence tomography; IQR, interquartile range; LogMAR, logarithm of the minimum angle of resolution.
†, Kruskal–Wallis rank sum test; ‡, Fisher's exact test; §, Pearson's chi-squared test.

rates based on OCT scans at 1 month were higher in small and medium holes (97.0% and 100.0%) than in large holes (83.5%; P = 0.003). By 3 months, rates exceeded 97.6% across all groups. Visual improvement was greatest in the small hole cohort, with a median gain of 27 ETDRS letters (P= 0.041). At 3 months, macular hole closure configuration differed by baseline size, with U-shaped closure predominating in small and medium holes (47.1% and 50%). In contrast, V-shaped closure was more frequent in large holes (36.5%), although this did not reach statistical significance (P = 0.088).

Visual outcomes at both 1 and 3 months post-operatively varied significantly according to the macular hole closure shape (Table 6). At 1 month, eyes with U-shaped closure (median logMAR 0.30, IQR: 0.15–0.56) and irregular-shaped closure (median logMAR 0.30, IQR: 0.30–0.52) achieved better vision compared to V-shaped closure (median logMAR 0.52, IQR: 0.30–0.80; P = 0.02). This trend was more pronounced at 3 months, where U-shaped closures demonstrated the best VA (median logMAR 0.15, IQR: 0.05–0.30), followed by irregular-shaped (median logMAR 0.22, IQR: 0.10–0.49) and V-shaped closures (median logMAR 0.40, IQR: 0.20–0.70; P = 0.006). These findings suggest that U-shaped closure morphology is associated with superior post-operative functional recovery compared to V- or irregular-shaped closures. The distribution of closure shapes shifted between 1 and 3 months, with a relative increase in irregular patterns and fewer U- and V-shaped closures, although this trend was not statistically significant (P = 0.055).

TABLE 6: Closure shape compared with visual acuity logarithm of the minimum angle of resolution (logMAR) outcomes.

Visual acuity (logMAR)	Irregular shaped		V-shaped		U-shaped		*P*-value
	Median	IQR	Median	IQR	Median	IQR	
One-month post-operative	0.30	0.30–0.52	0.52	0.30–0.80	0.30	0.15–0.56	0.020†
Three-month post-operative	0.22	0.10–0.49	0.40	0.20–0.70	0.15	0.05–0.30	0.006†

†, Kruskal–Wallis rank sum test.

TABLE 7: Multinomial regression model results for the association between closure shape and full-thickness macular hole size at 3 months.

Characteristic	Medium (250 μm – 400 μm)			Large (> 400 μm)		
	OR	95% CI	*P*-value	OR	95% CI	*P*-value
Macular closure shape						
Irregular shaped	-	-		-	-	
U-shaped	1.25	0.35–4.40	0.73	0.44	0.15–1.30	0.14
V-shaped	5.00	0.42–59.7	0.20	12.4	1.43–106	0.022

CI, confidence interval; OR, odds ratio.

Post-operative BCVA did not differ significantly by macular closure shape at either 1 month or 3 months. In contrast, hole size was strongly associated with visual outcomes. Eyes with large FTMHs had significantly worse BCVA than eyes with small holes at both 1 month ($\beta = 0.21$; $P < 0.001$) and 3 months ($\beta = 0.26$; $P < 0.001$), while medium holes showed a smaller but significant decrease at 3 months ($\beta = 0.16$; $P = 0.023$). Logistic regression (Table 7) revealed no significant relationship between closure shape and medium-sized holes; however, large holes were more likely to demonstrate V-shaped closure at 3 months (OR 12.4; $P = 0.022$).

Discussion

This study evaluated functional and anatomical outcomes following surgery for FTMH over 10 years at a single retinal centre. Overall, high anatomical closure rates and substantial improvements in VA were observed, which is consistent with published outcomes from large series of macular hole surgery. The median VA improved by 24 ETDRS letters by 3 months, with closure achieved in 98.7% of eyes, underscoring the effectiveness of PPV with ILM peeling and gas tamponade.

The number of persistent macular holes at 3 months was very low ($n = 2$), and several surgical variables showed minimal variability across the cohort (ILM peeling in 93.0% and SF6 tamponade in 96.8%). Multivariable regression was not statistically appropriate, as it would have produced unstable and unreliable estimates. For this reason, univariate analyses were performed. Baseline macular hole size was the strongest predictor of visual outcome and speed of anatomical recovery. Small and medium holes closed more rapidly and achieved superior VA gains compared with larger holes, which is consistent with prior reports. Large holes not only demonstrated slower visual recovery but were also more likely to result in V-shaped closure configurations, which were independently associated with poorer functional outcomes. These findings suggest that both baseline size and closure morphology provide complementary prognostic information in the post-operative period.

Cataract represents an important source of confounding in macular hole surgery studies because lens opacity affects post-operative VA and may progress following vitrectomy. A formal statistical adjustment was not feasible because of limited variability in several key surgical variables and the small number of non-closure events. Although lens status and post-operative cataract surgery were documented, these variables were not incorporated into the statistical analysis. As a result, VA outcomes should be interpreted with awareness of possible confounding from cataract.

Our analysis of closure shape adds to the growing body of evidence that not all anatomical closures confer equal functional benefit. U-shaped closures were associated with the best visual recovery, while V-shaped closures yielded significantly worse outcomes at both 1 and 3 months. These results were consistent with Michalowski et al.'s study outcomes.[15] Although the distribution of closure morphology shifted between time points, with an increase in irregular configurations, these patterns did not significantly impact closure rates. Similar associations between U-shaped closure and superior visual function have been described previously, suggesting that OCT-based assessment of closure morphology should be integrated into routine prognostic evaluation.[15]

Post-operative complications were infrequent, with no retinal detachments and only transient elevations in IOP in a small proportion of cases. Cataract progression was the most common sequela in one-third of the study population, which is well recognised following vitrectomy and gas tamponade.[6,13] A relevant consideration is that the majority of patients in this study presented at a median age of 67 years, by which stage some degree of cataract was commonly present. This contributed to the marked shift towards pseudophakia over the follow-up period. The FTMH re-operation rate of 7.6% was within expected ranges and persistent holes were predominantly larger at baseline size, highlighting the need for careful counselling and possible adjunctive surgical strategies in this subgroup.

Strengths and limitations

The strengths of this study include a relatively large cohort of patients, detailed OCT-based classification of closure patterns and stratified analysis by macular hole size. A key strength of this study is that all surgeries were performed by only two surgeons, ensuring procedural consistency and reducing variability in surgical techniques. However, several

limitations should be observed. The retrospective design may introduce selection bias and follow-up was limited to 3 months. This constraint reflects the centre's large national and international referral base, as many patients return to their home regions after surgery, making longer-term follow-up unavailable. It was more cost-efficient for patients to follow up long-term with their local ophthalmologist after successful FTMH closure. These circumstances precluded assessment of long-term visual stability or recurrence. In addition, OCT morphology was evaluated at fixed time points; more granular longitudinal imaging may have yielded further insight into closure dynamics. An additional limitation is the lack of detailed functional assessment beyond VA, such as residual metamorphopsia or other subjective measures of visual function, which may have provided a more comprehensive understanding of post-operative recovery.

Conclusion

Pars plana vitrectomy with ILM peeling and gas tamponade achieved high closure rates and significant visual improvement in this series of 157 patients with FTMHs. Baseline macular hole size remains the most important predictor of surgical success, with small and medium holes demonstrating faster and greater gains in BCVA. Closure configuration on OCT also provides prognostic value, with U-shaped morphology associated with the most favourable outcomes and V-shaped closures linked to poorer vision. These findings reinforce the importance of early surgical intervention before FTMH enlargement and careful post-operative OCT monitoring to guide patient counselling and expectations. Future prospective studies with longer follow-up are warranted to refine the role of closure morphology as a prognostic biomarker and to optimise management strategies for large macular holes.

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Competing interests

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

CRediT authorship contribution

Ting-Ying M. Liu: Conceptualisation, Methodology, Investigation, Writing – Original Draft, Project Administration, Data curation, Resources and Writing – Review & Editing. Mokokomadi A. Makgotloe: Writing – Review & Editing, Supervision. All authors reviewed the article, contributed to the discussion of results, approved the final version for submission and publication and take responsibility for the integrity of its findings.

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Data availability

The data that support the findings of this study are not openly available in accordance with the agreement with the CEO of Northcliff Eye Centre to protect their patient privacy. The data are available from the corresponding author, Ting-Ying M. Liu, upon request.

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