Original Research Article

Duration after Macular Hole Surgery for Stabilisation of Visual Acuity: A Long-term Retrospective Review

Zakaria NA[1,2], Wangdi L[1,2,3], Ho NWW[1,2], Cheng TC[1,2], Nasaruddin RA[1,2], Che Hamzah J[1,2], Bastion MLC[1,2] (🖂)

[1]Department of Ophthalmology, Faculty of Medicine, Universiti Kebangsaan Malaysia, Jalan Yaacob Latif, Bandar Tun Razak, 56000 Cheras, Kuala Lumpur, Malaysia
[2]Hospital Canselor Tuanku Muhriz, Jalan Yaacob Latif, Bandar Tun Razak, 56000 Cheras, Kuala Lumpur, Malaysia
[3]Jingme Dorji Wangchuk National Referral Hospital (JDWNRH), 11001, Thimphu, Bhutan

Abstract

The purpose of the study is to determine the median duration for visual recovery to achieve visual stability and visual acuity gain after macular hole surgery in our local population. This was a retrospective study. Patients with full-thickness macular holes (FTMH) from surgical logs were included between January 2009 and December 2019. The patients' medical records were reviewed for pre-, intra-, and post-operative data collection. Patients who fulfilled the inclusion and exclusion criteria were recruited and analysed. Data collected from the medical record pre-operatively, which included baseline best corrected visual acuity (BCVA), interval of symptoms development to surgery, any ocular co-morbidities, optical coherence tomography (OCT) for size and stage of macular hole and central subfield thickness (CST). Intra-operative notes included whether vitrectomy with or without phacoemulsification and with the internal limiting membrane (ILM) peel or ILM flaps, types of dye, and tamponade agent used. Post-operative data included BCVA and CST on each visit, types of macular hole closure, or any complications. Data were analysed using SPSS.Thirty-one patients were diagnosed with FTMH. Sixteen patients who underwent pars plana vitrectomy (PPV) were included and analysed. Fifteen patients (93.75%) achieved successful macular hole closure after the primary operation. The median duration BCVA reached at stability was 19.5 months (IQR 9 – 26.25), and visual acuity gained by 0.44 LogMAR (IQR 0.165 – 0.565). Ten patients (62.5%) underwent combined PPV with phacoemulsification. CST showed improvement from baseline, 444 (IQR 347.5 – 519.75) to 273 (IQR 232 -285.5), 230 (IQR 221.5-255), and 270 (IQR 254-322) at the period interval of 0 to 3 months, 3 to 6 months, and 6 to 12 months respectively. Gas C3F8 and membrane blue were commonly used as tamponade agents and dyes, and PPV with ILM peel was the common surgery performed. Six patients (40%) achieved type 1 macular hole closure within 12 months of follow-up. Despite the small sample size, our study provided practical information regarding patient's expectations of when their vision can become stable after macula hole surgery in our local population.

Keywords: Full-thickness macular hole; vision stability; visual acuity gain.

Correspondence:

Prof. Dr. Mae-Lynn Catherine Bastion. Department of Ophthalmology, Faculty of Medicine, Universiti Kebangsaan Malaysia, Jalan Yaacob Latif, Bandar Tun Razak, 56000 Cheras, Kuala Lumpur, Malaysia. Tel: +6019-3200763 E-mail: maelynnbdr@gmail.com

Introduction

A macular hole (MH) is a vitreomacular interface disorder that typically causes a reduction of visual acuity (VA), metamorphopsia, and central scotoma. It is characterised by a full-thickness defect of the foveal retina. It is more commonly seen in women, and the reported incidence is 7.8/100,000 per year (1). Pathogenesis of MH is idiopathic or secondary to myopia, trauma, or other causes (2, 3).

There was no specific treatment for MH before 1991 (4). In 1991, pars plana vitrectomy (PPV) with gas tamponade was first introduced by Kelly and Wendel (1991) as an effective treatment with successful closure for idiopathic macular hole. With surgical procedures, it was reported that 58% of the macula could reattach successfully and 42% of the overall success rate for improved visual acuity postoperatively (5). Since then, PPV and gas tamponade have been used as the mainstay treatment for macular hole.

Later, newer techniques, such as internal limiting membrane (ILM) peeling, were introduced. With the improvement in the surgical technique, more than 90% of the macular holes achieved anatomical closure after surgery (6-9). Despite successful anatomical closure, the functional recovery may take a year to reach its maximum (6,10). This could be due to a delay in functional recovery of the photoreceptors and a slower resolution of sub-foveal fluid (10-13).

Despite many studies conducted to analyse visual recovery after MH surgery, none were conducted in patients with an ethnicity other than Southeast Asian, and there was no analysis of the mean duration after surgery for stabilisation of visual acuity. This paper aimed to determine the mean or median duration for visual recovery to achieve visual stability after MH surgery in our local population. This information is useful for proper management and counselling of the patient, which includes an evidence-based expectation of when their vision will recover to its final level.

Materials and Methods

Study population

The study protocol was approved by the ethics committee of the Faculty of Medicine, Hospital Canselor Tuanku Muhriz (Ethics number: UKM PPI/111/8/JEP-2022-434), and the data collection procedure adhered to the tenets of the Declaration of Helsinki.

Patient data were collected retrospectively by reviewing the medical records of 31 patients flagged as having MH in the surgical log at Hospital Canselor Tuanku Muhriz, Universiti Kebangsaan Malaysia (UKM) from January 2009 until December 2019. The search term "macular hole" was used to find the cases from a log record kept by two vitreoretinal surgeons who had been operating at the hospital since 2009. Subsequently, the medical and operation records were traced to confirm the diagnosis and intervention.

The inclusion criteria for this study were patients with full-thickness MH who underwent pars plana vitrectomy for treatment of macula hole and had a minimum of 18 months follow-up after MH surgery. The exclusion criteria for this study were patients with missing or incomplete medical records.

Definition of terms.

The term "visual stability" is defined as similar Snellen visual acuity for two consecutive measurements at least 6 months apart.

General examination

All patients underwent comprehensive pre-operative ophthalmological examinations, including uncorrected and best-corrected visual acuity (BCVA), and was documented using Snellen's chart. Optical coherence tomography (OCT) of the macula was performed using spectral-domain OCT, Spectralis OCT (Heidelberg Engineering, Heidelberg, Germany), and we measured the central subfield thickness (CST) and determined the type of full-thickness macula hole (FTMH) following the Modified Gass classification and International Vitreomacular Traction Study Group classification (IVTS).

The pre-operative data included the patient's age, gender, ethnicity, aetiology of macular hole, the timing of surgery from the onset of visual disturbances, lens status, baseline visual acuity at presentation, OCT macula for baseline CST and type of FTMH.

Surgical procedures

Standard small incision three-port PPV (23-gauge or 25-gauge) was performed by two trained and experienced vitreoretinal surgeons working in the same centre using Constellation Vision System (Alcon Laboratories, USA). All eyes underwent PPV either the PPV was combined with cataract or not, ILM peeling was performed within a 2 -disc diameter centred on the fovea using trypan blue (Dorc Inc., Zuidland, the Netherland) or Brilliant Blue G dyes (Ocublue Plus, Aurolab, India) under fluid or air, followed by fluid-air exchange, then gas tamponade either semi-expansile sulphur hexaflouride (SF6) or perfluoropropane (C3F8) gases, or air tamponade. The surgical technique was PPV with ILM peeled to the macula holes or an inverted ILM flap. Patients were instructed to keep their head in a prone position for a minimum of 2 weeks after surgery, as much as 50 minutes per hour with a 10-minute rest break.

The postoperative data obtained from the medical records included visual acuity at day one, 1 month, 3 months, then subsequently 3 monthly until 36 months, any cataract development post-PPV, any cataract surgery performed post-PPV and OCT macula for CST measurement and type of macula hole closure either type 1 (closed without foveal neurosensory retinal defect) or type 2 (closed with foveal neurosensory defect) were also collected.

Statistical analysis

Data were entered and analysed with Statistical Package for the Social Sciences (SPSS) (Version 22, SPSS, IBM, Chicago, USA). The visual acuity was measured using the Snellen chart and then converted to the logarithm of the minimal angle of resolution (LogMAR) units for statistical analysis. Parametric data were described as mean ± standard deviation (SD), whereas nonparametric data were described as median with [interquartile range (IQR)]. All the descriptive data were presented using appropriate tables and graphical summaries.

Result

A total of 31 eyes of 31 patients diagnosed with FTMHs were included in this study. However, 15 of the 31 patients then were excluded due to missing data from medical records (n=6), patients refusing surgical intervention (n=1), follow-up being less than 18 months (n=5), and missing pre-operative notes (n=3). Sixteen patients were eventually included in the study (Figure 1).

The sociodemographic and pre-operative data were shown in Table 1, in which the majority were female (75.0%) and patients were elderly. Half were Chinese in ethnicity. The median baseline BCVA was 1.0 LogMAR (IQR 0.65 – 1.36 LogMAR), approximately 6/60 with Snellen (IQR 6/24 – 6/120). The main aetiology of the MH in this study was idiopathic (n=13, 81.3%), followed by a secondary cause, myopia (n=2, 12.5%). The majority of the macular holes were at stages 3 and 4. The median interval of symptoms development to surgery was 14 weeks (IQR 5-24 weeks). More were phakic at the time of surgery (n=14, 87.5%). The operative data were shown in Table 2. Ten patients underwent combined PPV and cataract surgery. Two out of 3 remaining phakic patients underwent cataract surgery at 8 months after PPV, while the remaining one after 60 months of follow-up. Trypan blue dye and ILM peeled were the most commonly used, and surgical techniques were performed intra-operatively. C3F8 was the most common gas used (62.5%).

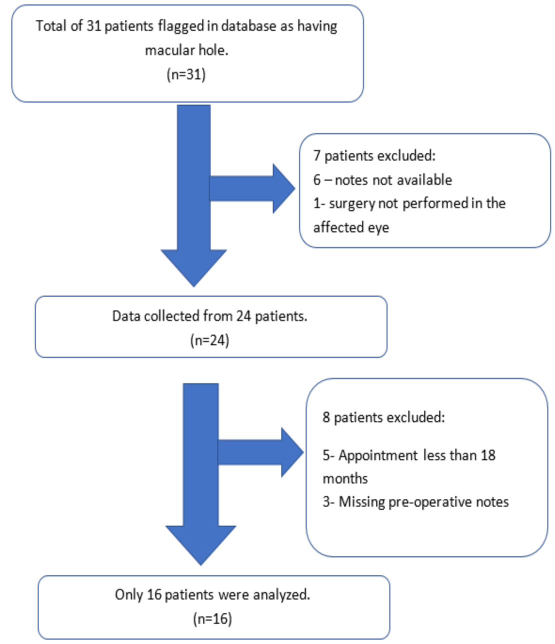

FIGURE 1: Study workflow

TABLE 1: Sociodemographic and pre-operative data

Variables (N = 16)	**Total** [a]
Age, median in IQR (years)	68 (65.25 – 72.25)
Gender	
- Male	4 (25.0%)
- Female	12 (75.0%)
Ethnicity	
- Malay	7 (43.8%)
- Chinese	8 (50.0%)
- Others	1 (6.3%)
Baseline BCVA (LogMAR)	1.00 (0.65 – 1.36)
Interval of visual disturbances to surgery (weeks)	14 (5 – 24)
Aetiology of macular hole	
- Idiopathic	13 (81.3%)
- Myopia	2 (12.5%)
- Post-retinal detachment repair	1 (6.3%)
Stage of macular hole (Modified Gass classification)	
- Stage 2	2 (12.5%)
- Stage 3	7 (43.8%)
- Stage 4	7 (43.8%)
Baseline CST (um)	444.5 (347.5 – 519.8
Lens status	
- Phakic	14 (87.5%)
- Pseudophakic	2 (12.5%)

[a]Value shown in n (%) for categorical data, while for continuous data shown in median (Interquartile range, IQR)

TABLE 2: Operative data

PPV combined with cataract surgery	
- Yes	10 (62.5%)
- No	6 (37.5%)
Type of dye used	
- Tryphan blue	12 (75.0%)
- Brilliant Blue G	4 (25.0%)
Type of surgical technique performed	
- PPV with ILM peel	14 (87.5%)
- PPV with inverted flap	2 (12.5%)
Tamponade agents	
- C_3F_8	10 (62.5%)
- SF_6	5 (31.3%)
- Air	1 (6.3%)

[a] Value shown in n (%) for categorical data, while for continuous data shown in median (range) or median (Interquartile range)

Table 3 showed the patients' pre- and postoperative data included in the study. The median follow-up period post-operatively was 52.5 months (IQR 29 - 60), while the median duration at which visual acuity reached stability was at 19.5 months (IQR 9 – 26.25), and the median visual acuity improvement was 0.44 (22 letters) [IQR 0.165 (8 letters) – 0.565 (28.25 letters) in LogMAR].

A total of 14 patients (87.5%) improved their final visual acuity from the median baseline. There were gains in visual acuity (in logMAR) at 12, 24, 36, 48, and 60 months were 0.30(IQR 0.27 – 0.49), 0.45(IQR 0.165 -0.565), 0.41(IQR 0.165-0.625), 0.35(IQR 0.255-0.625) and 0.30(IQR 0.09 -0.54) respectively. Most patients had achieved an anatomical closure by 3 months (n=7, 43.75%) (Table 4).

There were no documented intra-operative complications. Fifteen patients (93.75%) achieved anatomical closure before the visual acuity reached stability. Six patients (40%) of the 15 patients achieved type 1 closure, while 9 patients (60%) achieved type 2 closure (Table 4). Six patients (37.5%) of 16 patients recorded post-operative complications, which were transient gas bubbles that caused diplopia which eventually resolved (n=1), optic atrophy secondary to raised intra-ocular pressure (n=1), worsening vision due to macular ischaemia (n=1), failed MH closure (n=1) and development of postoperative cataract (n=2). Significant differences in visual acuity at baseline reached stability in the group with postoperative complications with a p-value of 0.036 and 0.035, respectively. However, the duration of the visual acuity reached stability, which was not significant, with a p-value of 0.302 compared with those without complications (Table 5). Nevertheless, there was no re-opening of the MH throughout the follow-up period after the successful primary surgery. In six patients, visual acuity stabilisation occurred as early as 9 months, while only one stabilised at 42 months.

Discussion

Limited data exists in the long-term follow-up of BCVA after MH surgery. To determine whether the visual acuity has reached its stability, the subject must be followed up for a long period after the surgery. Other ocular comorbidities that may affect the vision need to be identified. Chawla et al. showed a continuation of improvement and stability of BCVA over a mean follow-up of 36 months. The median visual acuity at 4 months to 6 months post MH surgery was 20/63 with a median gain of 20 letters (0.40 LogMAR), while the median visual acuity at a mean follow-up of 36 months was 20/46 with a median gain of 28 letters (0.53 LogMAR) (14). A study by Leonard et al. showed a visual acuity gain from 20/50 [6/15] (0.4 logMAR) at 12 months to 20/30 [6/9] (0.18 LogMAR) at 3 years (10).

In the present study, the median duration of visual acuity reached stability at 19.5 months (IQR 9 – 26.25 months) with a median gain of 22 letters (0.44 LogMAR) [IQR of 8 letters (0.165 LogMAR) - 28.25 letters (0.565 LogMAR)] which was similar with a study by Chawla et al. for number of letter gain, however incomparable with the median duration. Purtskhvanidze et al. demonstrated that visual acuity of 20/44 Snellen (0.34 LogMAR) at 3 months to 6 months improved to 20/28 Snellen (0.15 LogMAR) at 4 years post MH surgery (15). Our results showed visual improvement at 12 months of follow-up, with 20/50 in Snellen (0.39 in logMAR) to 20/40 in Snellen (0.30 in logMAR) at 60 months of follow-up. It showed stability in visual improvement at a longer visit. To date, no study has reported the duration of when the visual acuity reached stability, to our definition of a minimum of 6 months of consecutive similar visual acuity.

We had included cases of MH secondary to myopia in the study because these patients had no visual impairment before the occurrence of the MH during their annual ophthalmology visit. They were follow-up for myopia before the occurrence of the macular hole.

TABLE 3: Pre- and post-operative data of patients included in the study

Case	Age	Gender	Aetiology of MH	MH stage	Baseline VA (LogMAR)	VA reached at stability (LogMAR)	Duration VA reached at stability (months)	Type of MH Closure	Improvement of letters from baseline to stabilised VA (LogMAR)	Complication(s)
1	57	Female	Idiopathic	3	0.78	0.60	21 months	1	0.12	Transient gas bubble causing diplopia which eventually resolved
2	67	Male	Idiopathic	3	0.78	0.30	24 months	2	0.48	-
3	74	Female	Myopia	4	0.30	0.18	12 months	1	0.12	-
4	62	Female	Idiopathic	3	0.60	0.30	27 months	1	0.30	-
5	72	Female	Idiopathic	3	1.00	0.18	18 months	1	0.82	-
6	72	Male	Idiopathic	4	1.78	0.78	27 months	2	1.00	Optic atrophy secondary to raised IOP
7	67	Female	Idiopathic	4	1.00	0.30	42 months	2	0.70	-
8	75	Female	Myopia	2	1.48	0.48	36 months	1	1.00	Cataract post PPV
9	53	Female	Idiopathic	3	0.78	0.60	9 months	2	0.18	Cataract post PPV
10	69	Female	Idiopathic	4	1.78	1.48 1.98	12 months, 24 months	2	-	Worsening due to macula ischaemia
11	66	Female	Idiopathic	4	1.00	0.48	9 months	2	0.52	-
12	73	Female	Idiopathic	4	1.48	1.08 1.78	9 months, 45 months	-	-	Persistent MH
13	70	Female	Idiopathic	4	1.00	0.48	9 months	2	0.52	-
14	65	Male	Post scleral buckle	3	1.78	1.30	9 months	2	0.48	-
15	66	Female	Idiopathic	3	1.00	0.60	9 months	2	0.40	-
16	76	Male	Idiopathic	2	0.48	0.30	21 months	1	0.18	-

TABLE 4: Types of macular hole closure and CST at months of macula hole closed

Duration post PPV (months)	Anatomical closure after MH surgery N=15		*CST (µm)	
				Median (IQR)
0-3	7	Type 1: 3 Type 2: 4	n=7	273 (232.0 – 285.5)
> 3-6	3	Type 1: 1 Type 2: 2	n=3	230 (221.5 – 255.0)
>6-12	5	Type 1: 2 Type 2: 3	n=5	270 (254.0 – 322.0)

*Value shown in n (%) for categorical data, while for continuous data shown in median (range) or median (Interquartile range)

TABLE 5: Univariate analysis of variables in the study outcomes

Variables	Baseline VA (LogMAR)	p-value	VA reached at stability (LogMAR)	p-value	Duration VA reached at stability, LogMAR (months)	p-value	Improvement of letters from baseline to stabilised VA (LogMAR)	p-value
Postoperative complication								
Yes (N = 6)	1.48 (1.00)	**0.036***	0.69 (1.26)	**0.035***	25.5 (20.25)	0.302	0.15 (1.00)	0.608
No (N= 10)	1.00 (0.43)		0.30 (0.24)		15.0 (15.75)		0.48 (0.29)	
Gender								
Male (N = 4)	1.28 (1.23)		0.54 (0.87)		22.5 (14.25)		0.48 (0.62)	
Female (N = 12)	1.00 (0.58)		0.48 (0.30)		19.5 (24.75)		0.35 (0.54)	
Age	1.00 (1.48)	0.533	0.48 (0.48)	0.937	21.0 (36.00)	0.225	1.00 (0.44)	0.285

*Statistically significant; p value < 0.05 with two-tailed significant
Data were presented in Median (Interquartile range), and significant differences between the two groups were checked using the Independent-Sample Median Test. At the same time, age was checked for any significant correlation using Pearson's correlation.

One patient with post-retinal detachment repair was also included as he developed MH 20 years later after the scleral buckle performed with BCVA of 6/18. Post-operative visual recovery after the MH surgery varies between these 3 patients due to variations in visual acuity at presentation, interval of symptoms development to surgery, and the stages of the macular hole. OCT macula of case 3, showed elongation of the posterior pole with foveaschisis, with her initial BCVA being 20/30 (0.18 logMAR) and then dropping to 20/40 (0.30 logMAR) when she was diagnosed with a MH with myopic foveoschisis. However, she regained initial visual acuity at 12 months following MH surgery.

One of the parameters measured in our study was the central subfield thickness (CST). There was an improvement in the CST, which was analysed in the pre-and post-operative periods. However, it does not represent the median overall CST improvement as it was analysed in groups of months at times when the MH was closed and not at the duration when visual acuity reached stability, which was slightly later, within 9 to 24 months after MH surgery. Improving the CST may become one of the prognostic factors of the degree of visual recovery. The limitation of this study included its retrospective nature. Hence, we encountered missing data. Other limitations included inadequate data on the size of macula holes pre-operatively. Only 16 of 31 patients who were operated on could be included and analysed due to a high dropout rate, leading to a small sample size. It can be assumed, however, that these individuals recovered and did not need to be represented during the follow-up time.

The present study is the first in Malaysia to analyse the duration of visual acuity stability after MH surgery defined by 2 consecutive visual acuity assessments 6 months apart. It can provide a baseline for future study. The small sample size can be overcome by collecting multi-centre data, focusing on holes of similar stages, and excluding other types of MH for more meaningful results.

Conclusion

In conclusion, our study provides practical information regarding patient's expectations of when their vision can become stable after MH surgery. This information can guide the surgeon to counsel patients appropriately.

References

1. Jackson TL, Donachie PHJ, Sparrow JM, Johnston RL. United Kingdom National Ophthalmology Database study of vitreoretinal surgery: Report 2, macula hole. Ophthalmology 2013; 120(3): 629-34.

2. M. Landolfi, M. A. Zarbin, and N. Bhagat, “Macular holes,” Ophthalmology Clinics of North America, Vol. 15, No. 4, 2002, pp. 565–572.

3. Cour ML, Friis J. Macular holes: Classification, epidemiology, natural history, and treatment. Acta Ophthalmologica 2003; 80(6): 579-87.

4. Margherio AR. Macular hole surgery in 2000. Curr Opin Ophthalmol 2000; 11(3): 186-90.

5. Kelly NE, Wendel RT. Vitreous surgery for idiopathic macular holes. Results of a pilot study, Arch Ophthalmol 1991; 109(5): 654-9.

6. Christensen UC, Krøyer K, Sander B et al. Value of internal limiting membrane peeling in surgery for idiopathic macular hole stage 2 and 3. A randomized clinical trial. Br J Ophthalmol 2009; 93(8): 1005-20.

7. Kwok AK, Lai TY, Wong VW. Idiopathic macular hole surgery in Chinese patients: A randomized study to compare indocyanine green-assisted internal limiting membrane peeling with no internal limiting membrane peeling. Hong Kong Med J 2005; 11(4): 259-66.

8. Mester V, Kuhn F. Internal limiting membrane removal in the management of full-thickness macular holes. Am J Ophthalmol 2000; 129(6): 769-77.

9. Tognetto D, Grandin R, Sanguinetti G et al. Internal limiting membrane removal during macular hole surgery: Results of a multicenter retrospective study. Ophthalmology 2006; 113(8): 1401-11.

10. Leonard RE, Smiddy WE, Flynn HW, Feuer W. Long-term visual outcomes in patients with successful macular hole surgery. Ophthalmology 1997; 104(10): 1648-52.

11. Hasler PW, Prünte C. Early foveal recovery after macular hole surgery. Br J Ophthalmol 2008; 92(5): 645-54.

12. Takahashi H, Kishi S. Tomographic features of early macular hole closure after vitreous surgery. Am J Ophthalmol 2000; 130(2): 192-8.

13. Lee JE, Lee SU, Jea SY. Reorganization of photoreceptor layer on optical coherence tomography concurrent with visual improvement after macular hole surgery. Korean J Ophthalmol 2008; 22(2): 137-79.

14. Chawla A, Barua A, Patton N. Long-term structural and functional outcomes after macula hole surgery. Retina. 2016; 36(2): 321-4.

15. Purtskhvanidze K, Treumer F, Junge O. The long-term course of functional and anatomical recovery after macular hole surgery. Invest Ophthalmol Vis Sci,2013; 54(7): 4882-91.