Comparison of Different Procedures in a Combination of ab Interno Microhook Trabeculotomy and Cataract Surgery

Yusaku Miura (✉ miurasaku@gmail.com)

Kochi University

Ken Fukuda

Kochi University

Research Article

Keywords: cataract surgery, intraocular pressure (IOP), interno microhook trabeculotomy

Posted Date: August 4th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-778022/v1>

License: This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Version of Record: A version of this preprint was published at Journal of Clinical Medicine on January 29th, 2022. See the published version at <https://doi.org/10.3390/jcm11030738>.

Abstract

Purpose. To compare the clinical outcomes of ab interno microhook trabeculotomy (μ LOT) before and after cataract surgery for the combination of μ LOT and cataract surgery.

Methods. This retrospective case series included 24 eyes that underwent μ LOT combined with cataract surgery at Kochi University Hospital. Groups 1 and 2 included eyes that underwent μ LOT before and after cataract surgery (12 eyes each), respectively. The patient characteristics and clinical outcomes were also analyzed.

Results. The mean preoperative intraocular pressure (IOP) in Groups 1 and 2 (25.3 ± 11.0 mmHg and 22.4 ± 10.5 mmHg) were reduced significantly to 14.5 ± 3.6 mmHg and 12.3 ± 3.0 mmHg, respectively, at 5–7 months postoperatively. The mean preoperative number of antiglaucoma medications in Groups 1 and 2 (4.3 ± 1.4 and 3.7 ± 1.5) had also decreased significantly to 2.7 ± 0.9 and 1.7 ± 1.6 at 5–7 months postoperatively. Postoperative hyphema with niveau formation was observed in five eyes in Group 2 (41.7%) but not in Group 1.

Conclusion. For the combination of μ LOT and cataract surgery, performing μ LOT before cataract surgery may be less likely to result in postoperative hyphema with niveau.

Introduction

Trabeculotomy (LOT) is performed in patients with mild to moderate glaucoma to reduce the intraocular pressure (IOP) by reducing the resistance to aqueous flow by incising the trabecular meshwork and the inner wall of the Schlemm canal [1–4]. Generally, LOT is less likely to induce postoperative vision-threatening complications such as hypotony maculopathy, choroidal hemorrhage, bleb infections, and endophthalmitis that can occur after trabeculectomy [1, 5].

Recently, minimally invasive glaucoma surgery (MIGS) has been reported as a safer and less traumatic ab-interno surgical procedure. [6–9]. Unlike conventional ab externo LOT using metal trabeculotomy, MIGS tends to involve minimal trauma with very little or no scleral dissection, minimal or no conjunctival manipulation, good safety, and rapid recovery [10]. Among MIGS, the microhook LOT (μ LOT) reported by Tanito is especially easy and less time-consuming to perform because the tip of the hook is much smaller than that in the other gonio-surgery devices and the intracameral manipulation of the hook is easier than in the other devices. Another advantage of μ LOT is it does not require expensive devices [11]. However, a study of combined cataract surgery and μ LOT reported postoperative hyphema with niveau formation in 41% of cases [12] while another study of combined cataract surgery and kahook dual blade categorized as MIGS reported no postoperative hyphema with niveau formation [13]. These studies utilized different surgical procedures and instruments. Hirabayashi et al. performed ab-interno LOT using a kahook dual blade before cataract surgery [13]. In contrast, Tanito et al. performed μ LOT after cataract surgery; however, the reason for performing μ LOT after and not before cataract surgery was not described [12]. Thus, it is not clear whether μ LOT should be performed before or after cataract surgery. Therefore, the

present study compared μ LOT before and after cataract surgery to determine if there were differences in clinical outcomes according to the timing of the cataract procedure.

Results

This retrospective study included a total of 24 eyes from 20 patients who underwent surgery. Groups 1 and 2 comprised 12 eyes of 10 patients, respectively. The patient characteristics are shown in Table 1. The two groups were well-matched for demographic characteristics.

The mean IOP in Group 1 decreased significantly, from 25.3 ± 11.0 mmHg at baseline to 14.5 ± 3.6 mmHg at 5–7 months postoperatively ($p = 0.002$) (Table 2). Similarly, the mean IOP in Group 2 decreased significantly, from 22.4 ± 10.5 mmHg at baseline to 12.3 ± 3.0 mmHg at 5–7 months postoperatively ($p = 0.0047$). The mean IOPs did not differ significantly between the two groups at baseline and 5–7 months postoperatively ($p = 0.42$ and 0.16 , respectively).

The mean number of antiglaucoma medications in Group 1 decreased significantly from 4.3 ± 1.4 at baseline to 2.7 ± 0.89 at 5–7 months postoperatively ($p = 0.015$). Similarly, the mean number of antiglaucoma medications in Group 2 also decreased significantly, from 3.7 ± 1.5 to 1.7 ± 1.6 ($p = 0.0093$). The mean number of antiglaucoma medications did not differ significantly different between the two groups at baseline and 5–7 months postoperatively ($p = 0.36$ and 0.13 , respectively).

The mean best corrected visual acuity (BCVA) in Group 1 improved significantly from 0.22 ± 0.26 at baseline to -0.018 ± 0.19 at 5–7 months postoperatively ($p = 0.0067$). Similarly, the mean BCVA improved significantly from 0.14 ± 0.19 to -0.013 ± 0.075 in Group 2 ($p = 0.022$). The mean BCVA did not differ significantly between the two groups at baseline and 5–7 months postoperatively ($p = 0.58$ and 0.40 , respectively). The mean surgical times for Groups 1 and 2 were 16.0 ± 5.4 minutes and 20.3 ± 7.6 minutes, respectively ($p = 0.11$).

Table 3 lists the complications and subsequent interventions. All cases (100%) showed intraoperative blood reflux into the anterior chamber from the incised angle. Postoperative hyphema with niveau formation was observed in five eyes (41.7%) in Group 2 but not in Group 1 ($p = 0.019$). In three of these eyes, the hyphema resolved spontaneously within 1 week postoperatively without any intervention. However, we performed hyphema washout in two eyes (16.7%) that showed no tendency to improve. Postoperative transient IOP elevation was observed in two eyes (16.7%) in Group 1 and three eyes (25.0%) in Group 2, all of which normalized within 1 week following the administration of glaucoma medications. Postoperative blood accumulation in the lens bag was observed in one eye (8.3%) in Group 2, which was treated with Nd:YAG laser capsulotomy to spread the accumulated blood.

Discussion

The results of our study showed that when performing μ LOT and cataract surgery combined, μ LOT should be performed before rather than after cataract surgery to avoid postoperative hyphema with

niveau formation.

In our study, all cases showed intraoperative blood reflux from the incised angle into the anterior chamber. This intraoperative hemorrhage is common in μ LOT and other MIGS procedures [12, 14, 15]. Blood reflux occurs when unroofing Schlemm's canal in the setting of intraoperative hypotony and should be considered an expected event in these surgical procedures. The incidence of postoperative hyphema with niveau formation in Group 2 was 41.7%, which is similar to that reported in a previous study of combined cataract surgery and μ LOT [12]. In a previous study of μ LOT only [14], postoperative hyphema with niveau formation occurred in 38% of cases, a rate similar to those in a previous study [12] and Group 2 in the present study. However, postoperative hyphema with niveau formation did not occur in Group 1 and the incidence of this complication was significantly lower in Group 1 than in Group 2. Perfusion pressure during cataract surgery may help prevent postoperative hyphema. In Group 1, perfusion pressure during cataract surgery after μ LOT increased the intraoperative IOP and compressed the incised wound. As a result, intraoperative blood reflux was reduced and postoperative hyphema was less likely to occur. In contrast, in Group 2 and previous studies [12, 14], μ LOT was performed after or without cataract surgery. Therefore, a reduction in intraoperative blood reflux due to perfusion pressure cannot be expected.

The procedures in Groups 1 and 2 have advantages. The advantages of performing μ LOT before cataract surgery include obtaining a good gonioscopic view through a clear cornea and avoiding anterior chamber instability from the large keratome incision used in cataract surgery. In contrast, the advantages of performing μ LOT after cataract surgery include obtaining good visibility of the trabecular meshwork in the open angle due to cataract removal. However, regardless of the procedure used, μ LOT combined with cataract surgery was completed successfully in our study because the ease of performing this surgery was not affected. We observed no significant difference in surgical times between Groups 1 and 2 ($P=0.11$). The IOP and number of antiglaucoma medications preoperatively and 5–7 months postoperatively did not differ significantly difference between Groups 1 and 2. Tanito et al. reported that μ LOT combined with cataract surgery decreased the mean IOP and number of antiglaucoma medications from 16.4 mmHg and 2.4 preoperatively to 11.8 mmHg and 2.1 at the final 9.5-month evaluation [12], similar to the outcomes in Groups 1 and 2 in the present study.

The limitations of our study are the small sample size, the non-randomized nature of the study, and the short follow-up period. To clarify the difference in clinical outcomes of μ LOT before and after cataract surgery, a larger number of cases and longer follow-up periods are needed. Furthermore, randomized studies should be performed to eliminate biases such as patient backgrounds.

In conclusion, the results of our study showed that both μ LOT before and after cataract surgery effectively reduced the IOP and number of antiglaucoma medications. However, the incidence of postoperative hyphema with niveau formation was lower for μ LOT before rather than after cataract surgery. Thus, μ LOT should be performed before cataract surgery when performing combined μ LOT and cataract surgery.

Methods

This retrospective study adhered to the tenets of the Declaration of Helsinki and was approved by the institutional ethics committee, which waived the requirement for informed consent as the data analyzed were de-identified. Our study included patients with glaucoma who underwent μ LOT before (Group 1) or after (Group 2) cataract surgery.

Most surgeries were performed by a single surgeon (Y.M.). Some surgeries were performed by three doctors supervised by Y.M. between April 2019 and June 2020 at Kochi University Hospital, Japan. We excluded patients with a postoperative follow-up of < 5 months. Data including age, sex, glaucoma type, IOP based on Goldmann applanation tonometry, number of antiglaucoma medications, best-corrected visual acuity (BCVA), surgical time, intraoperative and postoperative complications, and interventions for complications were collected from the medical charts.

First, peribulbar anesthesia was performed in all eyes using a sub-Tenon injection of 2% lidocaine. In Group 1, μ LOT was performed using the following procedure: viscoelastic material (1% sodium hyaluronate, Opegan Hi, Santen Pharmaceutical, Osaka, Japan) was injected into the anterior chamber (AC) through two corneal ports on the temporal side created using a 20-gauge microvitrectomy (MVR) knife (Mani, Utsunomiya, Japan). Using a Hill surgical gonioscope (Ocular Instruments, Bellevue, WA, USA) to observe the angle opposite the corneal port, a microhook was inserted into the AC through the corneal port. The tip of the microhook was then inserted into the Schlemm's canal and moved circumferentially to incise the inner wall of the Schlemm's canal and trabecular meshwork over 2 clock hours. Using the same procedure, LOT was performed using a microhook inserted through another corneal port. That is, a trabecular meshwork totaling 120 degrees or more was incised. In Group 1, standard phacoemulsification with IOL implantation was performed through an additional temporal corneal 2.8 mm incision. In Group 2, μ LOT was performed using the same procedure as described above after standard phacoemulsification with IOL implantation.

Statistical analysis BCVA was converted to the logarithm of the minimum angle of resolution (logMAR) for statistical analysis. Wilcoxon signed-rank tests were used to compare IOP, number of antiglaucoma medications, and BCVA values preoperatively and 5–7 months postoperatively. Wilcoxon rank-sum tests were used to evaluate the group differences between continuous variables. The incidence of complications was compared between the groups using Fisher exact tests. Statistical significance was set at $p < 0.05$. All data were entered into an Excel spreadsheet (Microsoft Corp., Redmond, WA, USA) and analyzed using Excel 2016 with the add-in software Statcel 4.

Declarations

Author contributions

All authors contributed to the study conception and design. Yusaku Miura performed data collection and analysis. Yusaku Miura wrote the first draft of the manuscript and all authors commented on the previous

versions of the manuscript. All authors read and approved the final manuscript.

Additional Information

Competing interests The authors declare no competing interests.

Correspondence and requests for materials should be addressed to Y.M.

Reprints and permissions information are available at www.nature.com/reprints.

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

References

1. Chihara, E. *et al.* Trabeculotomy ab externo: an alternative treatment in adult patients with primary open-angle glaucoma. *Ophthalmic Surg*, **24**, 735–739 (1993).
2. Tanihara, H. *et al.* Surgical effects of trabeculotomy ab externo on adult eyes with primary open angle glaucoma and pseudoexfoliation syndrome. *Arch Ophthalmol*, **111**, 1653–1661 (1993).
3. Tanito, M., Ohira, A. & Chihara, E. Surgical outcome of combined trabeculotomy and cataract surgery. *J Glaucoma*, **10**, 302–308 (2001).
4. Tanito, M., Ohira, A. & Chihara, E. Factors leading to reduced intraocular pressure after combined trabeculotomy and cataract surgery. *J Glaucoma*, **11**, 3–9 (2002).
5. Kashiwagi, K. *et al.* Change in visual acuity and associated risk factors after trabeculectomy with adjunctive mitomycin C. *Acta Ophthalmol*, **94**, e561–70 (2016).
6. Francis, B. A. *et al.* Novel glaucoma procedures: a report by the American Academy of Ophthalmology. *Ophthalmology*, **118**, 1466–1480 (2011).
7. Grover, D. S. *et al.* Gonioscopy-assisted transluminal trabeculotomy, ab interno trabeculotomy: technique report and preliminary results. *Ophthalmology*, **121**, 855–861 (2014).
8. Sato, T., Hirata, A. & Mizoguchi, T. Outcomes of 360 degrees suture trabeculotomy with deep sclerectomy combined with cataract surgery for primary open angle glaucoma and coexisting cataract. *Clin Ophthalmol*, **8**, 1301–1310 (2014).
9. Sato, T., Hirata, A. & Mizoguchi, T. Prospective, noncomparative, nonrandomized case study of short-term outcomes of 360 degrees suture trabeculotomy ab interno in patients with open-angle glaucoma. *Clin Ophthalmol*, **9**, 63–68 (2015).
10. Saheb, H. & Ahmed, I. I. Micro-invasive glaucoma surgery: current perspectives and future directions. *Curr Opin Ophthalmol*, **23**, 96–104 (2012).
11. Tanito, M. Microhook ab interno trabeculotomy, a novel minimally invasive glaucoma surgery. *Clin Ophthalmol*, **12**, 43–48 (2018).

12. Tanito, M., Ikeda, Y. & Fujihara, E. Effectiveness and safety of combined cataract surgery and microhook ab interno trabeculotomy in Japanese eyes with glaucoma: report of an initial case series. *Jpn J Ophthalmol*, **61**, 457–464 (2017).
13. Hirabayashi, M. T., King, J. T., Lee, D. & An, J. A. Outcome of phacoemulsification combined with excisional goniotomy using the Kahook Dual Blade in severe glaucoma patients at 6 months. *Clin Ophthalmol*, **13**, 715–721 (2019).
14. Tanito, M., Sano, I., Ikeda, Y. & Fujihara, E. Short-term results of microhook ab interno trabeculotomy, a novel minimally invasive glaucoma surgery in Japanese eyes: initial case series. *Acta Ophthalmol*, **95**, e354–e360 (2017).
15. Richter, G. M. & Coleman, A. L. Minimally invasive glaucoma surgery: current status and future prospects. *Clin Ophthalmol*, **10**, 189–206 (2016).

Tables

Table 1 Patient characteristics

	Group 1	Group 2	p
No. of eyes	12	12	
Mean age (range), years	70.4 ± 11.1	73.9 ± 8.0	0.47
	(51–85)	(60–82)	
Sex			
Male	5 (41.7%)	10 (83.3%)	
Female	7 (58.3%)	2 (16.7%)	
Eye			
Right	4 (33.3%)	7 (58.3%)	
Left	8 (66.7%)	5 (41.7%)	
Glaucoma Type			
POAG	7 (58.3%)	5 (41.7%)	
EXG	2 (16.7%)	5 (41.7%)	
Secondary	3 (25.0%)	2 (16.7%)	
Follow-up (months)	6.1 ± 0.28	6.0 ± 0.71	0.79

Table 2 Surgical results

	Group 1	Group 2	p
IOP (mmHg)			
Preoperative	25.3 ± 11.0	22.4 ± 10.5	0.42
Postoperative	14.5 ± 3.6	12.3 ± 3.0	0.16
Medication			
Preoperative	4.3 ± 1.4	3.7 ± 1.5	0.36
Postoperative	2.7 ± 0.9	1.7 ± 1.6	0.13
BCVA (logMAR)			
Preoperative	0.22 ± 0.26	0.14 ± 0.19	0.58
Postoperative	-0.018 ± 0.19	-0.013 ± 0.075	0.40
Surgical time	16.0 ± 5.4	20.3 ± 7.6	0.11

Table 3 Complications and interventions

	Group 1	Group 2	p
Intraoperative complications			
Blood reflux	12 (100%)	12 (100%)	
Postoperative complications			
Hyphema with niveau formation	0	5 (41.7%)	0.019
Transient IOP elevation > 30mmHg	2 (16.7%)	3 (25.0%)	0.50
Blood accumulation in the lens bag	0	1 (8.3%)	0.50
Postoperative intervention			
Hyphema washout	0	2 (16.7%)	0.24
Nd:YAG laser capsulotomy	0	1 (8.3%)	0.50