

# Transient Intraocular Pressure Elevation after Trabeculotomy and its Occurrence with Phacoemulsification and Intraocular Lens Implantation

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**Purpose:** To elucidate the characterization of intraocular pressure (IOP) spike after trabeculotomy, and after the combined procedure of phacoemulsification and aspiration (PEA) and intraocular lens (IOL) implantation.

**Methods:** Included in this study were 39 patients (53 eyes) with primary open-angle glaucoma with IOPs uncontrolled even with anti-glaucoma medication. We conducted a retrospective study for the following two groups: Patients who underwent trabeculotomy alone (25 eyes) and patients undergoing trabeculotomy combined with PEA and implantation of an IOL (28 eyes).

**Results:** In 7 (28%) of the 25 eyes after trabeculotomy alone and 7 (25%) of the 28 eyes after the combined procedure, transient IOP elevation was found postoperatively. The incidence of hyphema-related IOP spike was significantly higher in eyes after trabeculotomy alone (16%) than after the combined procedure (0%). After removal of the blood present in the anterior chamber in eyes with hyphema-related IOP spikes, the IOP levels were well controlled.

**Conclusions:** Hyphema-related IOP spike is one of the common complications in eyes after trabeculotomy alone, and the combined procedure decreases the incidence of this complication. It is thought that removal of prolonged massive hyphema is effective as treatment for hyphema-related IOP spike. **Jpn J Ophthalmol 2001;45:288–292** © 2001 Japanese Ophthalmological Society

**Key Words:** Hyphema, intraocular lens implantation, IOP spike, phacoemulsification, trabeculotomy.

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## Introduction

Trabeculotomy has been reported<sup>1–8</sup> to effectively reduce aqueous outflow resistance. We have previously reported that this procedure is effective in controlling intraocular pressure (IOP) in eyes with certain forms of glaucoma, such as primary open-angle glaucoma (POAG),<sup>6</sup> pseudoexfoliation syndrome,<sup>6</sup>

developmental glaucoma,<sup>7</sup> or primary angle-closure glaucoma.<sup>8</sup> In addition, we have already reported our modification and its benefits to the surgical outcome of combined trabeculotomy, cataract extraction and intraocular lens (IOL) implantation for treatment of open-angle glaucoma and coexisting cataract<sup>9–11</sup> or pseudoexfoliation syndrome and coexisting cataract.<sup>12</sup> Postoperative transient IOP elevation (IOP spike) and hyphema were common complications after these procedures. Additionally, we have reported a patient in whom massive and prolonged hyphema after trabeculotomy caused

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marked IOP elevation.<sup>13</sup> Herein, we will describe the characterization of the IOP spike associated with prolonged massive hyphema (hyphema-related IOP spike), and the decreased incidence of this complication after our combined procedure of trabeculotomy, phacoemulsification and aspiration (PEA) and implantation of an IOL.

### Materials and Methods

Included in this retrospective study were 53 eyes of 39 patients (23 men and 16 women; mean age:  $65.2 \pm 14.8$  years SD) with POAG with uncontrolled IOP (more than 20 mm Hg) even with anti-glaucoma medication. No previous surgery for glaucoma had been performed in these eyes. In 25 (47%) of the 53 eyes, trabeculotomy (the single procedure) was performed, and in 28 (53%) of the 53 eyes, the trabeculotomy procedure combined with PEA and IOL was performed because of co-existing cataract. Characteristics of each study group are shown in Table 1. The mean follow-up periods for the eyes that underwent the single procedure and the combined procedure were  $28.9 \pm 15.5$  and  $27.4 \pm 10.9$  months, respectively.

To explain the IOP spike after trabeculotomy, we defined IOP spike as when the IOP levels were over 30 mm Hg even after surgery or had increased by over 5 mm Hg compared with the IOP level on the previous day. We also defined hyphema-related IOP spike as when prolonged massive hyphema in the anterior chamber was accompanied by the above-mentioned IOP spike. Prolonged massive hyphema was defined as when the meniscus of the hyphema existed around the pupil and lasted for at least 7 days after surgery.

The technique of trabeculotomy performed in this study was modified somewhat from that described in our previous paper,<sup>6</sup> based on the procedure developed by Harms and Dannheim.<sup>3</sup> Briefly, after a conjunctival incision, a scleral flap was created at the limbus. After identifying Schlemm's canal, the exter-

nal wall of Schlemm's canal was opened over the full width of the scleral flap. U-shaped probes (Trabeculotome; Handaya, Tokyo) were inserted and rotated into the anterior chamber. After the rotation of the probes, the scleral flap was closed with 10-0 nylon sutures. In combination with PEA and IOL, the procedure was modified as described in our reports.<sup>9-12</sup> Briefly, a secondary flap of 4/5 thickness inside an initial scleral flap of 1/2 thickness was created at the upper or temporal upper limbus for identification of Schlemm's canal, and a continuous curvilinear capsulorrhexis was done through the paracentesis. Next, insertion and rotation of the U-shaped probes were completed, and then the secondary flap for trabeculotomy was closed with 10-0 nylon sutures. Routine PEA and IOL were done using the initial flap followed by closing the initial scleral flap with 10-0 nylon sutures.

### Results

In 14 (26%) of the 53 eyes in this study, IOP spikes as defined above occurred after the surgery. The IOP spikes of these 14 eyes started on the  $2.0 \pm 1.7$  postoperative day (mean  $\pm$  SD), and lasted for  $2.6 \pm 2.6$  days (mean  $\pm$  SD). The mean peak level of IOPs was  $42.0 \pm 10.2$  mm Hg. IOP spikes occurred in 7 (28%) of the 25 eyes with the single procedure and in 7 (25%) of the 28 eyes with the combined procedure. In 4 eyes of the 7 eyes with IOP spikes after the single procedure, a prolonged massive hyphema in the anterior chamber accompanied the IOP spike. The IOP spikes in these eyes were categorized as hyphema-related IOP spikes. When the mean ( $\pm$  SD) peak level of IOPs in eyes with hyphema-related IOP spikes reached  $46.5 \pm 12.8$  mm Hg, we resorted to surgery to remove the blood present in the anterior chamber. Surgery to remove the hyphema was performed in all the eyes with hyphema-related IOP spike between 7 to 10 days after the first surgery. We removed blood (hyphema) by using aspiration and infusion devices and/or a vitreous cutter. In all of the eyes treated by removal of the blood in the anterior chamber, IOP decreased to below 20 mm Hg immediately after the surgery, as the blood in the anterior chamber disappeared.

Although the mean peak level of IOPs in eyes with non-hyphema-related IOP spikes was  $40.2 \pm 9.2$  mm Hg, which was lower than in eyes with hyphema-related IOP spikes, the statistical difference was not significant ( $P = .285$ ; Mann-Whitney *U*-test). Hyphema after surgery was observed in 17 (68%) of the 25 eyes undergoing the single procedure and in 14

**Table 1.** Characteristics of 39 Patients (53 Eyes)

	Single Procedure	Combined Procedure
No. of eyes/patients	25/18	28/21
Sex (M/F)	12/6	11/10
Age in years (mean $\pm$ SD)	$56.6 \pm 15.0$	$73.3 \pm 9.5$
Range	32 to 82	54 to 88
Follow-up in months (mean $\pm$ SD)	$28.9 \pm 15.5$	$27.4 \pm 10.9$

SD: standard deviation.

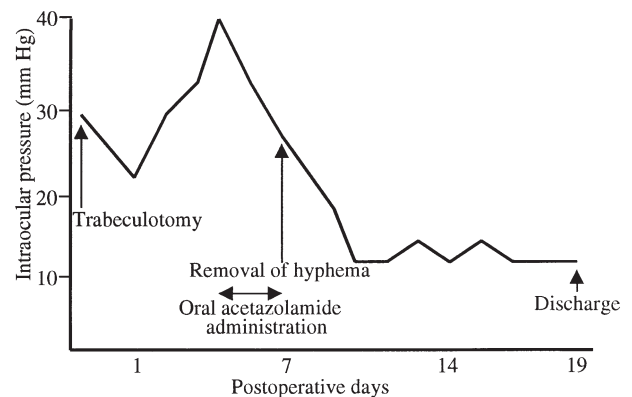
(50%) of 28 eyes undergoing the combined procedure. The prolonged massive hyphema defined above was observed in only 4 of the 7 eyes with IOP spikes after the single procedure. Hyphema-related IOP spikes were not seen in eyes treated by the combined procedure (Table 2).

### Case Report

A 43-year-old man with POAG had IOP levels between 26 and 32 mm Hg in his right eye, despite treatment with anti-glaucoma medication. Because of the lack of response to medical treatment, we performed trabeculotomy on his right eye. The intraoperative reflux of blood from the operated region was observed routinely as occurs during many such procedures. On the first postoperative day, the IOP decreased from 30 mm Hg on the day of surgery to 22 mm Hg (Figure 1) even though a massive hyphema existed in the anterior chamber. The meniscus of the accumulated hyphema in the anterior chamber was around the pupil. On the second postoperative day, the IOP increased to 29 mm Hg. The peak level of the IOP was observed on the 4th postoperative day and the massive hemorrhage still existed in the anterior chamber. Although the IOP level decreased to 26 mm Hg after treatment with oral acetazolamide tablets, large amounts of partially coagulated blood in addition to the massive hyphema continued to exist in the anterior chamber. To remove the blood, we washed out the hemorrhage by using an infusion cannula from the site of paracentesis in the limbus, and removed the remaining coagulated blood by using a vitreous cutter from another paracentesis site. On the following day, the hyphema in the anterior chamber had disappeared and the IOP was 18 mm Hg. The IOP level was subsequently maintained below 21 mm Hg. At the final examination 27 months after surgery, the IOP was 11 mm Hg with topical  $\beta$ -blocker medication.

### Analysis of IOP Levels

The mean IOP at the preoperative examinations in this study was  $26.8 \pm 7.4$  mm Hg with  $2.5 \pm 1.1$



**Figure 1.** Change in intraocular pressure (IOP) levels in eye of 43-year-old man with hyphema-related IOP spike.

anti-glaucoma medications. Anti-glaucoma medications used in this study were classified into four kinds of eyedrops;  $\beta$ -blockers, pilocarpine, dipivefrin, and isopropyl unoprostone. When one type of drug was administered, it was counted as 1 anti-glaucoma medication. The mean preoperative IOPs in eyes with the single procedure and with the combined procedure were  $28.0 \pm 9.1$  mm Hg with  $2.7 \pm 1.1$  medications and  $25.7 \pm 5.4$  mm Hg with  $2.4 \pm 1.1$  medications, respectively. The difference in preoperative IOP levels between the single procedure and the combined procedure groups was not significant ( $P = .247$ , Mann-Whitney  $U$ -test). At the final examination (the mean follow-up period,  $28.1 \pm 13.2$  months), the mean IOP in this study was  $18.3 \pm 5.0$  mm Hg with  $0.9 \pm 1.2$  medications. The mean IOPs in the eyes with the single procedure and with the combined procedure were  $19.3 \pm 6.7$  mm Hg with  $1.1 \pm 1.2$  medications and  $17.4 \pm 2.5$  mmHg with  $0.8 \pm 1.1$  medications, respectively. The difference in the IOP levels between the single procedure and the combined procedure groups was not significant ( $P = .615$ , Mann-Whitney  $U$ -test). Interestingly, the IOP levels at the final examination in eyes that had hyphema-related IOP spikes were well controlled (mean IOP =  $13.0 \pm 2.7$  mm Hg) although the mean preoperative IOP ( $36.0 \pm 20.3$  mm Hg) was higher than the mean level of the preoperative IOP in eyes with the single procedure. Moreover, the mean IOP in the eyes that underwent non-hyphema-related IOP spikes after the single procedure and after the combined procedure were  $21.3 \pm 10.1$  mm Hg and  $17.0 \pm 2.7$  mm Hg, respectively, which shows that the mean IOP level in eyes with hyphema-related IOP spikes was the lowest among the eyes with IOP spikes (Table 3). All the eyes that underwent IOP spikes had been examined for at least 1 year after surgery.

**Table 2.** Occurrence of Intraocular Pressure Spikes\*

	Single Procedure	Combined Procedure
Hyphema-related	4 (16.0) <sup>†</sup>	0 (0) <sup>†</sup>
Non-hyphema-related	3 (12.0)	7 (25.0)
Total	7 (28.0)	7 (25.0)

\*Values in parentheses are percentages.

<sup>†</sup> $P < .043$  (Fisher's exact method).

**Table 3.** Intraocular Pressure (IOP) (mm Hg) over Time in Eyes with IOP Spikes

Time of Examination	Hyphema-related IOP Spike After Single Procedure			Non-hyphema-related IOP Spike After Single Procedure			Non-hyphema-related IOP Spike After Combined Procedure		
	No. of Eyes	IOP	No. of Medications*	No. of Eyes	IOP	No. of Medications*	No. of Eyes	IOP	No. of Medications*
Preoperative	4	36.0 ± 20.3	2.5 ± 0.6	3	28.3 ± 8.4	3.7 ± 0.6	7	26.1 ± 2.3	2.6 ± 0.5
Postoperative									
1 month	4	12.0 ± 3.8	0.8 ± 1.0	3	15.0 ± 7.6	1.0 ± 1.0	7	19.1 ± 4.6	1.1 ± 1.5
3 months	4	13.3 ± 4.6	1.0 ± 1.2	3	16.3 ± 8.7	0.6 ± 1.2	7	17.1 ± 0.9	1.0 ± 1.3
6 months	4	13.5 ± 3.7	0.8 ± 1.0	3	17.3 ± 3.2	0.7 ± 1.2	7	17.3 ± 1.3	1.0 ± 1.3
9 months	4	13.5 ± 3.0	0.5 ± 0.6	3	19.0 ± 4.6	0.7 ± 1.2	7	18.1 ± 1.8	0.6 ± 1.0
1 year	4	13.8 ± 2.1	0.5 ± 0.6	3	25.7 ± 7.5	1.3 ± 1.2	7	18.1 ± 2.1	0.6 ± 1.0
2 years	3	12.7 ± 7.6	1.0 ± 1.0	1	15	0	6	17.5 ± 3.2	0.3 ± 0.8
3 years	2	13.5	1.0	0			3	19.3 ± 0.6	0.0 ± 0.0
4 years	2	16.0	1.0	0			1	16	0
5 years	1	17	2	0			0		
Last visit	4	13.0 ± 2.7	0.8 ± 1.0	3	21.3 ± 10.1	1.3 ± 1.2	7	17.0 ± 2.7	0.3 ± 0.8

\*Four kinds of eyedrops were used in this study. When one type of drug was administered, it was counted as 1 anti-glaucoma medication.

One year after surgery, the IOP levels in the eyes with hyphema-related IOP spikes after the single procedure were significantly lower than those with non-hyphema-related IOP spikes after the single procedure ( $P = .032$ ; Mann-Whitney  $U$ -test) and after the combined procedure ( $P = .022$ ; Mann-Whitney  $U$ -test).

### Discussion

Our present studies showed that hyphema-related IOP spikes occurred only in POAG eyes treated by the single procedure of trabeculotomy, and not in POAG eyes treated by the combined procedure of PEA and IOL. Hyphema-related IOP spike was well controlled by the additional operation to remove the massive hyphema in the anterior chamber. Moreover, the IOP levels were lower in eyes that had hyphema-related IOP spikes, than in eyes that had non-hyphema-related IOP spikes.

Chihara et al<sup>4</sup> reported that the occurrence of sharp elevations in IOP (>10 mm Hg) was 7% after trabeculotomy for POAG although their definition of IOP spike is different from that in our present study. In our previous report, the occurrence was 29% and 22% in trabeculotomy combined with PEA and IOL for the treatment with POAG and coexisting cataract,<sup>11</sup> and pseudoexfoliation syndrome and coexisting cataract,<sup>12</sup> respectively. After trabeculotomy for POAG or pseudoexfoliation syndrome, prolonged hyphema was encountered in 18% of the cases treated by trabeculotomy alone<sup>6</sup> and in 6% treated by trabeculotomy combined with PEA and IOL implantation.<sup>11,12</sup> It seems that prolonged hy-

phema is a more common complication in the single procedure than in the combined procedure. The hemorrhage is thought to be a consequence of the rupture of the trabecular meshwork, after which Schlemm's canal is filled with blood by a reflux from episcleral vessels.<sup>3</sup> In the cases with hyphema-related IOP spikes, it seems probable that the delayed absorption and coagulation of the hemorrhage resulted in disturbance of the aqueous outflow, which led to the drastic increase in IOP. We have already reported<sup>13</sup> a case with postoperative elevated IOP levels caused by massive and prolonged hemorrhage after trabeculotomy only, indicating that hyphema needs to be removed using aspiration and infusion devices. The point we should emphasize is why no cases with hyphema-related IOP spikes occurred after the combined procedure. Because the blood reflux from episcleral vessels after trabeculotomy is washed out during PEA and IOL, the occurrence of massive hyphema may be thereby decreased. Moreover, because the combined procedure of PEA and IOL is performed in high IOP levels, it is thought that the high pressure in the anterior chamber prevents the blood reflux from episcleral vessels.

Interestingly, the IOP levels in eyes with hyphema-related IOP spikes were well controlled after the removal of hyphema. Because the blood reflux from episcleral vessels occurs when the pressure in the anterior chamber decreases, the procedure of cleavage on the inner wall of Schlemm's canal may decrease the IOP levels effectively in eyes with hyphema-related IOP spikes. However, because of partially coagulated blood in the anterior chamber, it is

thought that the IOP spike continues until the blood has diminished. Therefore, the removal of hyphema is thought to be effective as treatment for hyphema-related IOP spike.

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