

# Delayed-Onset Symptomatic Hyphema After Ab Interno Trabeculotomy Surgery

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- **PURPOSE:** To describe patients who have experienced delayed-onset hyphema after ab interno trabeculotomy surgery with the Trabectome (Neomedix Corp) for open-angle glaucoma.
- **DESIGN:** Retrospective case series.
- **METHODS:** STUDY POPULATION: Patients at Mayo Clinic, Rochester, Minnesota, who underwent Trabectome surgery between September 1, 2006, and December 31, 2010, and who had symptomatic hyphema at least 2 months after surgery. OBSERVATION PROCEDURE: Patients with blurred vision at least 2 months after Trabectome surgery were examined for the presence of hyphema using a slit lamp and gonioscopy. MAIN OUTCOME MEASURES: Proportion of patients experiencing delayed-onset symptomatic hyphema after Trabectome surgery. Associated factors and clinical course for these patients.
- **RESULTS:** Of 262 cases of Trabectome surgery, there were 12 cases of delayed-onset symptomatic hyphema (4.6%). The average age was 74.3 years (range, 66 to 82 years). Median time to onset of hyphema was 8.6 months (range, 2 to 31 months) after surgery. Symptom onset commonly occurred on awakening. The most common characteristic was maintaining a sleep position on the surgical side. Most hyphemas resolved within 1 to 2 weeks, except in 1 patient, who required trabeculectomy for a refractory intraocular pressure spike.
- **CONCLUSIONS:** This is a series of patients with symptomatic delayed-onset hyphema after Trabectome surgery in the absence of further surgeries or trauma. Likely mechanisms are exertion-related increase in episcleral venous pressure or ocular compression from sleeping on the surgical side, followed by sudden decompression and blood reflux. Symptomatic patients should identify and avoid associated triggers because delayed-onset hyphema may be associated with intermittent intraocular pressure spikes that may require medical or surgical treatment. (Am J Ophthalmol 2012;154:476–480. © 2012 by Elsevier Inc. All rights reserved.)

**T**HE TRABECTOME IS A NOVEL SURGICAL DEVICE USED for ab interno trabeculotomy in open-angle glaucoma (Neomedix Corp, Tustin, California, USA). It uses electro-surgical ablation of the trabecular meshwork and the inner wall of the Schlemm canal to increase conventional outflow facility. Removal of this tissue also is presumed to result in an open communication between the episcleral venous system and the anterior chamber.

The main reported side effect of Trabectome surgery is perioperative anterior chamber blood reflux. This occurs during or immediately after instrument removal in most cases and usually resolves within 1 week after surgery.<sup>1–3</sup> This is a case series of 12 patients at our center who have experienced single or multiple episodes of hyphema more than 2 months after Trabectome surgery. These delayed-onset episodes of hyphema occurred in the absence of further surgeries or trauma after Trabectome surgery. We identified patient or surgical risk factors for this complication, with the goal of providing information for future Trabectome surgery patients.

## METHODS

- **SUBJECTS:** Cases of symptomatic delayed-onset hyphema after Trabectome surgery were identified from a pool of 262 patients who underwent Trabectome surgery between September 1, 2006, and December 31, 2010, by 1 surgeon (A.J.S.) at the Mayo Clinic in Rochester, Minnesota. The diagnosis of hyphema or microhyphema was made on the basis of slit-lamp examination and gonioscopy results. The intraocular pressures (IOPs) at the visit before, during, and after diagnosis of hyphema were recorded and compared using paired t tests. The patient and surgical characteristics that could be related to this complication also were recorded.

Patients who underwent Trabectome surgery at our center typically had open-angle glaucoma that was refractory to medical treatment. Some patients underwent Trabectome surgery in combination with cataract extraction and intraocular lens placement. Patients who had undergone other treatments for open-angle glaucoma before Trabectome surgery, such as trabeculectomy or laser trabeculoplasty, also were included.

- **SURGICAL PROCEDURE:** The surgical procedure has been described elsewhere.<sup>1–4</sup> In brief, the surgery was

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**TABLE 1.** Patient and Surgical Characteristics of Patients Who Experienced Symptomatic Delayed-Onset Hyphema after Trabectome Surgery

Case No.	Age (y)	Sex	Glaucoma Type	Operated Eye	Prior Surgery	Combination Surgery
1	66	F	POAG	Right	—	No
2	77	F	PEX	Right	—	Phaco, pciOL, pupilloplasty
3	82	F	PEX	Left	Laser PI	Phaco, pciOL
4	79	F	PEX	Left	Laser PI	Phaco, pciOL
5	77	F	POAG	Right	—	Phaco, pciOL
6	74	F	Mixed	Left	Laser PI	Phaco, pciOL
7	68	F	POAG	Right	—	Phaco, pciOL
8	77	F	Low tension	Right	ALT	Phaco, pciOL
9	78	F	PEX	Right	—	Phaco, pciOL
10	76	F	POAG	Right	ALT	Phaco, pciOL
11	71	F	POAG	Right	ALT	Phaco, pciOL
12	66	M	PD	Left	Trab, tube	Phaco, pciOL, pupilloplasty

ALT = argon laser trabeculoplasty; F = female; M = male; pciOL = posterior chamber intraocular lens; PD = pigment dispersion; PEX = pseudoexfoliation glaucoma; Phaco = intracapsular lens extraction; PI = peripheral iridotomy; POAG = primary open-angle glaucoma; Trab = trabeculectomy.

performed through a temporal clear corneal incision, and the nasal trabecular meshwork was visualized with a Swan-Jacob lens. The anterior chamber was filled with viscoelastic to facilitate insertion of the Trabectome handpiece. The Trabectome handpiece was used to ablate the trabecular meshwork and inner wall of the Schlemm canal over a 120-degree arc. For Trabectome only cases, viscoelastic then was removed using irrigation and aspiration, and carbachol was injected into the anterior chamber to constrict the pupil. The wound was closed using a single 10-0 nylon suture. For combination cases, cataract extraction and intraocular lens implantation were performed after the Trabectome surgery.

## RESULTS

TWELVE CASES OF DELAYED-ONSET HYPHEMA AFTER Trabectome surgery were identified from among 262 Trabectome cases at our center. Patient and surgical characteristics of these patients are summarized in Tables 1 and 2. The 12 subjects comprised 1 man and 11 women. The average age of these patients at the time of Trabectome surgery was 74.8 years (range, 66 to 82 years). Most patients had primary open-angle glaucoma (5 of 12 cases, 42%) or pseudoexfoliative glaucoma (4 of 12 cases, 33%). Other diagnoses included pigment dispersion (1 case), mixed mechanism (1 case), and normal tension (1 case) glaucoma. Most patients (11 of 12 cases, 92%) underwent cataract extraction in combination with Trabectome surgery.

The time between Trabectome surgery and onset of symptoms related to hyphema ranged between 2 and 31 months, with a median of 5 months. Eight (66%) of the 12

cases involved the right eye. The symptom at presentation in all patients was a transient decrease in vision. When questioned about the recurrence of symptoms, 6 (50%) of the 12 patients reported having 4 or more episodes; most of these patients returned to clinic with a clinically documented repeat episode. Ten patients woke up in the morning or overnight with their symptoms; most of these patients maintained a sleep position that was either on the surgical side or else face down. On examination, 2 patients had blood in the temporal angle, and 7 patients had blood in the nasal angle with a microhyphema of 3 to 4+ red blood cells (30 to 40 cells per  $1 \times 1$ -mm field) in the anterior chamber (Figure 1). Three patients were found to have a layered hyphema of less than 1 mm of heme settled inferiorly without blood in the angle. Patients were initiated on prednisolone acetate 1% drops 4 times daily, and each case of hyphema resolved within 1 to 2 weeks.

The mean IOP of the 12 patients when diagnosed with delayed-onset hyphema was 25 mm Hg and ranged between 13 and 52 mm Hg (Figure 2). This was significantly higher than the mean IOP at the visit before diagnosis of hyphema (mean, 13 mm Hg; range, 7 to 19 mm Hg;  $P = .009$ ) and at the visit after resolution of hyphema (mean, 13 mm Hg; range, 11 to 17 mm Hg;  $P = .01$ ). In 11 of the 12 patients, the IOP spike associated with hyphema resolved by the next visit. Patient 3, who had an IOP spike from 13 to 50 mm Hg when diagnosed with a hyphema, had a large nasal clot that prevented visualization of the surgical cleft. Because her IOP was refractory to multiple topical and oral pressure-lowering medications, she required an urgent same-day trabeculectomy that reduced her IOP to 15 mm Hg within 5 days. Six months later, however, she had another nasal clot in the same eye (Figure 3) that involved an IOP

**TABLE 2.** Summary of Characteristics of Patients Who Experienced Symptomatic Delayed-Onset Hyphema after Trabectome Surgery

Patient Characteristics	No. (Unless Otherwise Indicated)
Age (at time of surgery), y	
Mean	74.3
Range	66 to 82
Median	77
Sex	
Male	1
Female	11
Laterality	
Right eye	8
Left eye	4
Diagnosis	
POAG	5
Pseudoexfoliation	4
Pigment dispersion	1
Mixed mechanism	1
Normal tension	1
Combined surgery	
Trabectome with cataract extraction	11
None (Trabectome only)	1
Prior surgery	
Laser trabeculoplasty	3
Trabeculectomy	1
Laser PI	3
Further surgeries	
Trabeculectomy	1
Systemic medications	
Aspirin/NSAIDs	8
Warfarin/heparin/Plavix	2
Steroids	1
Antihypertensives	7
Medical problems	
Diabetes	1
Hypertension	9

NSAIDs = nonsteroidal anti-inflammatory drugs; PI = peripheral iridotomy; POAG = primary open-angle glaucoma.

spike to 24 mm Hg that resolved within 1 week with prednisolone and brimonidine.

Systemic medications used by patients at the time of onset of hyphema included aspirin (8 of 12 cases) and various antihypertensive medications (7 of 12 cases), including  $\beta$ -blockers and diuretics. Of the 8 patients who were taking aspirin, 6 were taking 81 mg daily and 2 were taking 325 mg daily. Only Patient 5 was taking an anticoagulant (warfarin), the dose of which had been increased just before the time of hyphema formation. In terms of medical history, most patients had hypertension (9 of 12 cases). There were no other common underlying medical diagnoses among the 12 patients.

## DISCUSSION

TRABECTOME SURGERY FOR OPEN-ANGLE GLAUCOMA reduces IOP by ablating a segment of trabecular meshwork and the inner wall of the Schlemm canal. The inner wall of the Schlemm canal and juxtacanalicular trabecular meshwork have been identified as the primary sites of abnormal flow resistance in open-angle glaucoma.<sup>5</sup> Partial removal of these tissues results in a significant increase in outflow facility.<sup>6–8</sup> However, removal of these tissues also is assumed to result in a permanent opening in the blood-aqueous barrier. Although intraoperative blood reflux is common, delayed-onset hyphema in the absence of further ocular surgeries or trauma has not been reported previously. We have described a series of 12 patients who experienced symptomatic hyphema between 2 and 31 months after Trabectome surgery.

Although all Trabectome patients have an open blood-aqueous barrier, only a small proportion of patients experience symptomatic spontaneous delayed-onset symptomatic hyphemas. This series represents 4.6% of a pool of 262 Trabectome surgeries. As demonstrated by the triggers for delayed-onset hyphema in these 12 patients, most hyphemas are related to exertion or sleeping on the surgical side in the presence of an open blood-aqueous barrier created by the Trabectome. Two likely mechanisms seem to explain most of these cases. First, physical exertion in some patients may result in an elevation of episcleral venous pressure to a level greater than IOP and may cause reflux of blood from the venous system into the anterior chamber. Second, ocular compression from sleeping on the surgical side may result in a temporary elevation of IOP with a slow decrease back to baseline as the compressive object (e.g., a pillow) is held in place. When the compressive force is removed, the IOP would decrease suddenly. In some patients, the magnitude of the decrease may result in an IOP less than episcleral venous pressure, and blood may reflux into the anterior chamber.

A recent case report in the literature describes a 63-year old woman who underwent trabeculectomy 11 months after Trabectome surgery and experienced intraoperative reflux of blood into the anterior chamber.<sup>9</sup> The authors hypothesized that this was related to blood in the Schlemm canal during trabeculectomy, which resulted in reflux of blood from the area of the prior Trabectome surgery into the anterior chamber. This case is consistent with our findings that the blood-aqueous barrier continues to be disrupted several months after Trabectome surgery. However, the patients in our case series did not have any surgery or trauma that may have triggered a hyphema.

If the blood-aqueous barrier is open after Trabectome, it is not clear why more patients do not experience late hyphemas. One possibility is that a healing response in most patients results in closure of the blood-aqueous barrier. As well, it is possible that the proportion of

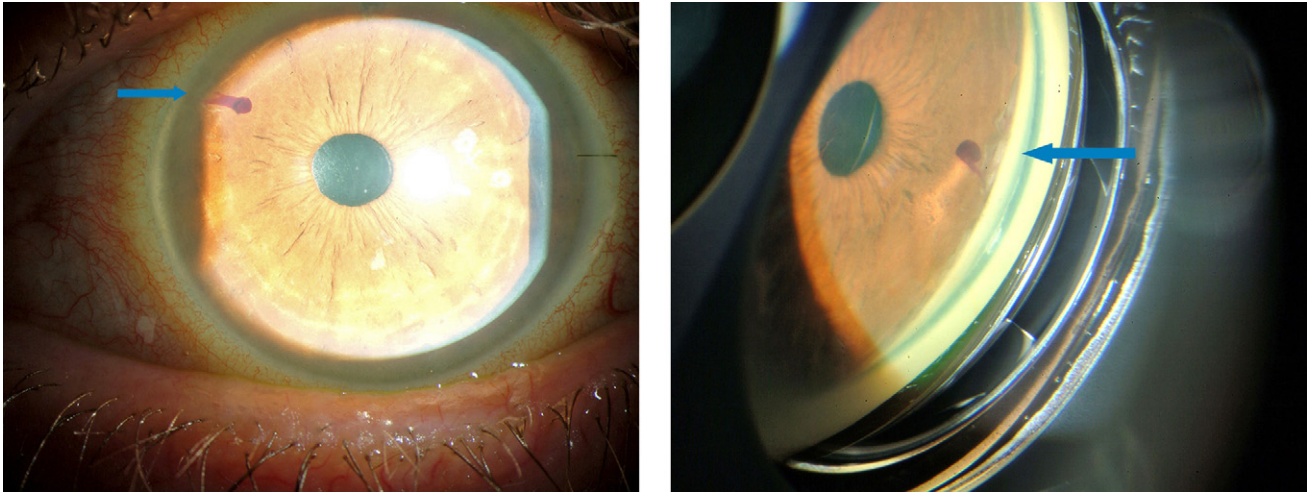


FIGURE 1. Images showing symptomatic delayed-onset hyphema after ab interno trabeculotomy surgery in Patient 6. (Left) Slit-lamp photograph of Patient 6, who had blood in the supranasal angle on waking up 11 months after combined Trabectome (Neomedix Corp., Tustin, California, USA) surgery and cataract extraction, which also was viewed with (Right) gonioscopy. Arrows indicate blood in the angle.

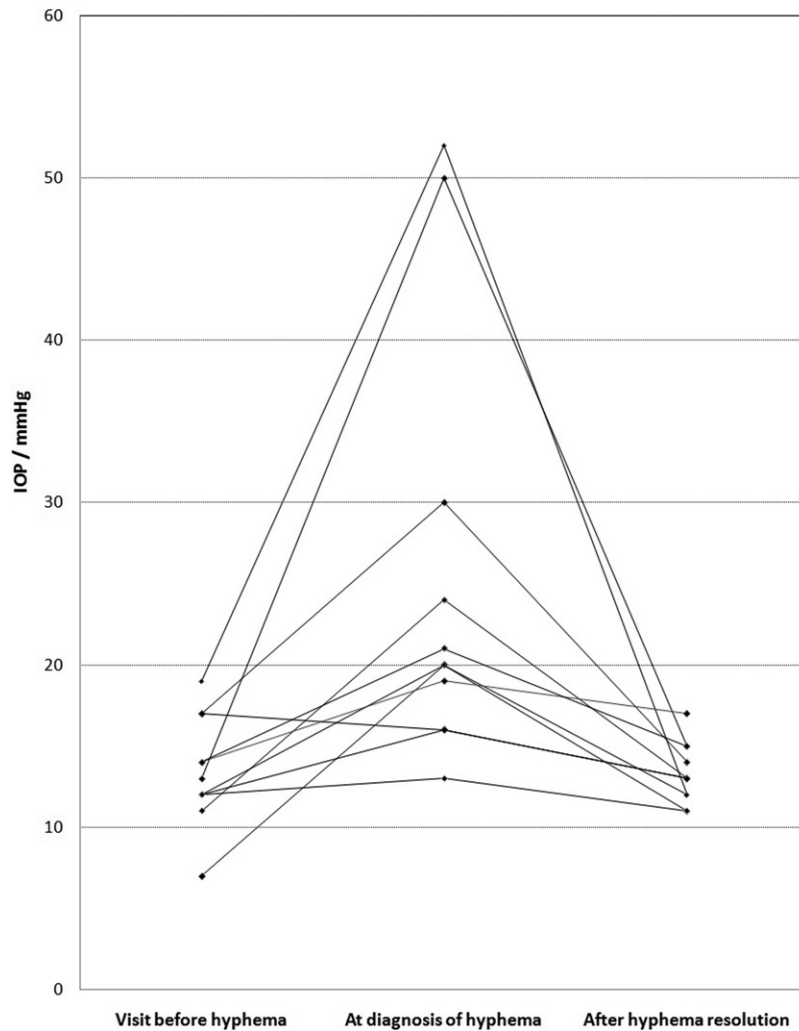
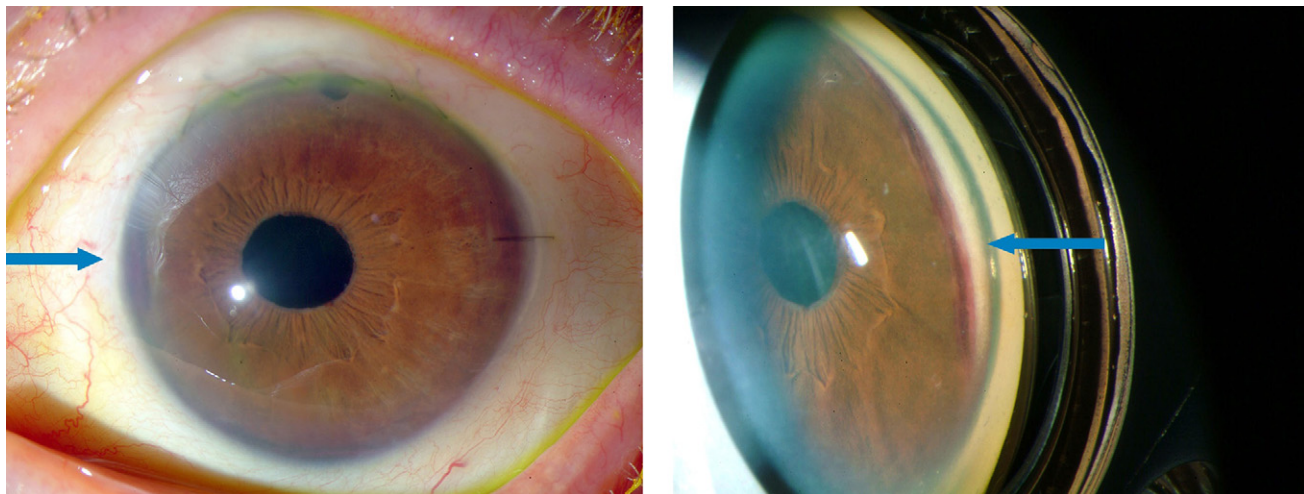


FIGURE 2. Graph showing intraocular pressure (IOP) spikes on diagnosis of delayed-onset hyphema after previous ab interno trabeculotomy surgery. Trend in the IOP of each patient's operated eye at the clinical visit before, during, and after the episode of symptomatic delayed-onset hyphema.



**FIGURE 3.** Images from Patient 3, who demonstrated a second hyphema 6 months after a trabeculectomy for the intraocular pressure spike related to the first delayed hyphema. Five and a half months after combined Trabectome (Neomedix Corp., Tustin, California, USA) surgery and cataract extraction, Patient 3 had blood in the nasal angle and a refractory intraocular pressure spike to 50 mm Hg, for which she underwent urgent trabeculectomy. Six months later, she again had blood in the nasal angle in the same eye, as seen on (Left) slit-lamp examination and (Right) gonioscopy. Arrows indicate blood in the angle.

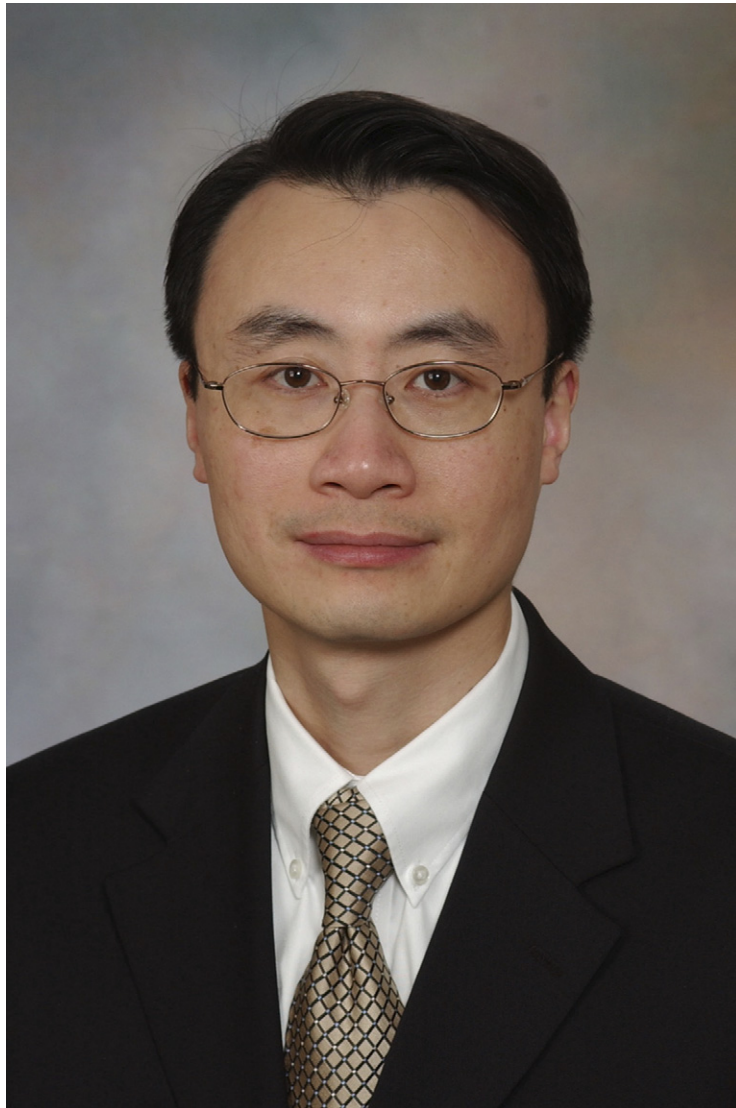
delayed-onset hyphemas is higher than the number reported in this case series. Our case series included only patients with symptomatic hyphemas confirmed with slit-lamp examination. Other patients may describe vague symptoms of intermittent foggy vision or a transient film over the vision on waking up, but do not obtain an eye examination at the time of symptoms. Also, asymptomatic microhyphemas may occur, but also were not identified in this series.

Delayed-onset hyphema after Trabectome surgery can occur months to years later, even in the absence of further ocular surgeries or trauma. Trabectome patients and their care providers should be aware of such symptoms. Trabectome patients who experience symptoms that are suspicious for delayed-onset hyphema should identify and avoid any associated triggers because the hyphema may be associated with significant and recurrent IOP spikes that may require medical or surgical treatment.

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### **Biosketch**

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### **Biosketch**

Yachna Ahuja, MD, received her medical degree at Case Western Reserve University in Cleveland, Ohio as a four-year Amici Merit Scholar. She completed a clinical research training fellowship at the National Cancer Institute in Bethesda, Maryland. She is currently a chief resident in ophthalmology at the Mayo Clinic in Rochester, Minnesota, following which she will pursue a glaucoma fellowship at the Byers Eye Institute at Stanford in Palo Alto, California.