

# Incidence of short-term complications and associated factors after primary trabeculectomy in Chiang Mai University Hospital

Thidarat Leeungurasatien, Preeyanuch Khunsongkiet, Kassara Pathanapitoon, Damrong Wiwatwongwana

**Background:** To determine the incidence of early postoperative complications and associated factors after primary trabeculectomy in Thai glaucoma patients. **Design:** This was a retrospective observational study performed in Chiang Mai University Hospital. **Participants:** One hundred and eighteen glaucoma patients participated in the study. **Methods:** All glaucoma patients underwent primary trabeculectomy with mitomycin C (MMC) using fornix-based conjunctival flap technique between December 2011 and May 2013. Surgical complications during the first 3 months of follow-up were recorded, and associated risk factors were analyzed. **Main Outcome Measures:** The incidence of posttrabeculectomy complications was the main outcome measure. **Results:** One hundred and eighteen eyes of 118 patients were included. Early postoperative complications developed in 55 eyes (56.7%). Complications included hypotony (25 eyes, 27.2%), serous choroidal detachment (CD) (14 eyes, 15.6%), subconjunctival hemorrhage (12 eyes, 13.0%), hyphema (11 eyes, 12.4%), bleb leak (8 eyes, 8.8%), encapsulated bleb (2 eyes, 2.2%), aqueous misdirection (1 eye, 1.1%), corneal epithelial defect (1 eye, 1.1%), and overfiltration (1 eye, 1.1%). There were no reported cases of endophthalmitis or blebitis. Hypotony was associated with serous CD ( $P = 0.006$ ), and hyphema was associated with neovascular glaucoma (NVG) patients ( $P = 0.009$ ). NVG was not associated with the increased rate of surgical failure ( $P = 0.083$ ). **Conclusions:** The incidence of early complications after first-time trabeculectomy with MMC was high (56.7%) in this Thai clinic setting, but most were transient and self-limited conditions. The correlations between hypotony and CD as well as hyphema and NVG were compatible with the previous studies.

**Key words:** Early complications, primary trabeculectomy, trabeculectomy

Glaucoma is a leading cause of blindness and low vision worldwide. Most patients are asymptomatic, and late presentation of the disease can lead to a permanent visual loss. The prevalence of glaucoma is increasing. According to Quigley and Broman, the estimated number of the world population with glaucoma will increase from 60.5 million in 2010 to 79.6 million in 2020<sup>[1]</sup> and will reach 111.8 million in 2040.<sup>[2]</sup> In an urban population-based survey in Thailand, the prevalence of glaucoma in people aged 50 years or older was 3.8% and this increased with age.<sup>[3]</sup>

Trabeculectomy is a primary surgical procedure used to relieve intraocular pressure (IOP) when pressure reduction is unsuccessfully controlled with medications or lasers. However, there are many complications after the surgery, including subconjunctival hemorrhage, hyphema, hypotony, blebitis, endophthalmitis, and loss of vision.

The previous studies reported various rates<sup>[4-9]</sup> and types of complications after trabeculectomy. Risk factors which were relevant for the development of complications and surgical failure were also different among studies.<sup>[5,10-13]</sup> There are only a few recent reports of surgical outcomes after trabeculectomy in Thailand. The present study aimed to determine the incidence of early postoperative complications and associated risk factors

after trabeculectomy in Thai glaucoma patients at Chiang Mai University Hospital.

## Methods

This retrospective study included all consecutive glaucoma patients >18 years old who underwent primary trabeculectomy or combined phacotrabeculectomy at Chiang Mai University Hospital from December 2011 to May 2013. The medical records were reviewed from December 2011 to December 2012, and prospective data were collected from January 2013 to May 2013. The study included only the first-operated eye of each subject. None of the eyes underwent intraocular surgery, other than cataract extraction by phacoemulsification and none underwent laser, other than iridotomy before the surgery. Patients who had a postoperative follow-up period of <12 weeks were excluded. This study was approved by the Ethics Committee, Faculty of Medicine, Chiang Mai University in accordance with the Declaration of Helsinki.

## Preoperative evaluation

Patient information including age, gender, underlying diseases, anticoagulant or antiplatelet use, and number of

This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as the author is credited and the new creations are licensed under the identical terms.

**For reprints contact:** reprints@medknow.com

**Cite this article as:** Leeungurasatien T, Khunsongkiet P, Pathanapitoon K, Wiwatwongwana D. Incidence of short-term complications and associated factors after primary trabeculectomy in Chiang Mai University Hospital. Indian J Ophthalmol 2016;64:737-42.

## Access this article online

### Website:

www.ijo.in

### DOI:

10.4103/0301-4738.195011

## Quick Response Code:



Department of Ophthalmology, Faculty of Medicine, Chiang Mai University, Chiang Mai, Thailand

**Correspondence to:** Dr. Thidarat Leeungurasatien, Department of Ophthalmology, Faculty of Medicine, Chiang Mai University, 110 Intavarorot Road, Tambon Sripoom Amphur Muang, 50200 Chiang Mai, Thailand. E-mail: tleeungu@gmail.com

**Manuscript received:** 24.05.16; **Revision accepted:** 17.09.16

glaucoma drugs used (a fixed combination drug was counted to one bottle) were obtained from medical records. The Snellen chart was used to collect patient's vision. Best-corrected visual acuity (BCVA) was then transformed to the logarithm of the minimum angle of resolution (logMAR) unit.<sup>[14]</sup> Optic disc evaluation, applanation tonometry, and gonioscopy were performed using slit-lamp biomicroscopy.

Primary glaucoma was defined as typical glaucomatous optic cupping associated with raised IOP ( $\geq 21$  mmHg without treatment) and glaucomatous visual field loss without any other ocular disease or congenital anomaly. Primary angle-closure glaucoma (PACG) was defined as primary glaucoma with a closed angle (Grade 0–1  $\geq 180^\circ$  by the modified Shaffer grading system).

### Surgical procedure

The operations were performed by three experienced glaucoma specialists and supervised trainees with close observation and the techniques used were quite standard. For trabeculectomy, a fornix-based conjunctival peritomy was created at a superior location. A partial thickness 2–4 mm in width and length rectangular scleral flap was dissected forward into clear cornea. After the scleral flap creation, mitomycin C (MMC) (0.2–0.3 mg/ml) was applied beneath the conjunctiva and onto the scleral surgical site for 3 min and then washed out with copious balanced salt solution (BSS). Viscoelastic was injected through a temporal paracentesis site to maintain the anterior chamber (AC) depth. A 1.5–2.0 mm wide sclerostomy was created using Kelly Descemet's membrane punch 1.0 mm diameter tip just anterior to the scleral spur and peripheral iridectomy was performed. The scleral flap was sutured with 10-0 nylon in an interrupted manner. The suture tension and suture numbers were adjusted until a slow flow of aqueous could be seen through the scleral flap and then the conjunctiva was closed with 10-0 nylon. For phacotrabeculectomy, we performed the two-site technique. Superior conjunctival peritomy, scleral flap dissection, and MMC application were done before making a temporal clear corneal incision. Then, phacoemulsification and intraocular lens insertion were performed after irrigation of MMC. The temporal wound was closed with a single 10-0 nylon suture and then trabeculectomy was carried out. The operative procedure and intraoperative complications were recorded.

### Postoperative management

All participants were treated with topical prednisolone acetate 1% four times daily for about 6–8 weeks and a topical antibiotic. The frequency of topical steroid was adjusted for the degree of inflammation and tapered over several weeks. Postoperative information including visual acuity, IOP, postoperative complications, and additional glaucoma medications or interventions was recorded at 1-day, 1-, 3-, 6-, and 12-week follow-ups and as frequently as the patient's condition requires.

The primary outcome was the incidence of posttrabeculectomy complications. Secondary outcomes included risk factors associated with postoperative complications, surgical failure, and clinical course after trabeculectomy in our hospital.

Surgical success was defined as complete when the last follow-up IOP was  $< 21$  mmHg and  $\geq 5$  mmHg with no additional antiglaucoma medication and as qualified when IOP was controlled with medication.

Hypotony was defined as a postoperative IOP of  $< 5$  mmHg and persistent hypotony was defined as sustained hypotony on the last two consecutive follow-ups.

Surgical failure was defined as a postoperative IOP  $\geq 21$  mmHg or  $< 20\%$  reduction below baseline on the last two consecutive follow-up visits, persistent hypotony, additional glaucoma surgery including bleb revision or repeat trabeculectomy, and loss of light perception vision or a  $> 2$  lines loss of best-corrected vision after the surgery.

### Statistical analysis

Statistical analysis was performed using SPSS statistics software (version 16.0, SPSS, Inc., Chicago, IL). Descriptive statistics was used to describe the characteristic of study participants. The complication was defined as present or absent regardless of time of follow-up and number of event.

Univariate analyses were used to delineate the relationship between individual risk factors and complications. The  $\chi^2$  test and Mann-Whitney U-test were done to analyze the effects of categorical and quantitative variables. Wilcoxon signed-ranks test was used to compare preoperative and postoperative BCVA and amount of topical antiglaucoma drug use. A final multivariate logistic model including all statistically significant and previously known risk factors was then performed to assess their independent association. Statistical significance was identified as  $P < 0.05$ . Odds ratio (OR) was reported with the corresponding 95% confidence interval.

### Results

A total of 188 eyes of 188 glaucoma patients underwent trabeculectomy or combined phacotrabeculectomy in Chiang Mai University Hospital between December 2011 and May 2013. Seventy subjects were excluded from the study due to previous ocular surgery other than phacoemulsification, age of 18 or younger, or the follow-up period of  $< 12$  weeks. The remaining eligible 118 cases were included in our study. Table 1 shows demographic features and clinical characteristics of the patients. There were 55 males (46.6%) and 63 females (53.4%). The mean age was  $57.7 \pm 16.1$  years (range: 19–86 years). The majority of the patients had hypertension as an underlying disease. Neovascular glaucoma (NVG) was diagnosed in 33 cases (28%), followed by primary open-angle glaucoma (POAG) with 32 cases (27.1%) and PACG 29 cases (24.6%).

There were 104 patients who underwent trabeculectomy and 14 who underwent phacotrabeculectomy. In 95 eyes (80.5%), surgery was performed under local anesthesia using subconjunctival xylocaine with adrenaline injection, and in the remaining 23 eyes (19.5%), surgery was performed under general anesthesia. The surgeons made the conjunctival flap superonasally in 51 eyes (43.2%), directly superior in 39 eyes (33.1%), and superotemporally in 27 eyes (22.9%). The mean scleral flap size was  $7.7 \pm 2.7$  mm<sup>2</sup> (range: 2–16 mm<sup>2</sup>), and the mean number of scleral flap sutures was  $2.4 \pm 1.6$  (range: 1–12 sutures). The mean operative time was  $40.2 \pm 16.7$  min (range: 15–90 min) for the trabeculectomy group and  $40.4 \pm 13.1$  min (range: 20–70 min) for the phacotrabeculectomy group. Intraoperative complications were found in 28 eyes (23.8%), which included 15 (12.7%) subconjunctival hemorrhages, 7 (5.9%) AC bleeds, 4 (3.4%) conjunctival buttonholes, 1 (0.8%) scleral flap tear, and 1 (0.8%) epithelial defect.

Postoperative complications are shown in Table 2. Complications were found in 55 eyes (56.7%). The most common complication was hypotony, which was present in 25 eyes (27.2%). Fourteen cases (15.6%) experienced hypotony with serous choroidal detachment (CD). During the 3-month follow-up period, encapsulated bleb caused increased IOP in two subjects (2.2%). Both of them developed early encapsulated

bleb at postoperative 6 and 12 weeks, respectively. Needling revision with 5-fluorouracil (5-FU) subconjunctival injection was performed in these two subjects and the final IOP was under control with 2–3 topical anti-glaucoma medications. This study found a 50-year-old female with PACG developing aqueous misdirection at 1 week after the surgery. The AC was completely flat with an IOP of 40 mmHg. After performing yttrium-aluminum-garnet laser hyaloidotomy, the eye pressure decreased to 14 mmHg. Aqueous misdirection recurred at 3 weeks postoperatively and the eye pressure rose to 35 mmHg with posterior synechia formation. She then subsequently underwent trans pars plana vitrectomy, AC reformation, and posterior synechialysis. After the operation, the AC depth was well formed, and the IOP was 11 mmHg without antiglaucoma medication. Neither endophthalmitis nor blebitis was found in this study. During postoperative follow-up, the rate of each complication tended to decrease overtime [Fig. 1].

There was no statistical difference when comparing preoperative BCVA (mean: 1.113 ± 0.9 logMAR, range: 0–2.8 logMAR) with BCVA at the last visit (mean: 1.119 ± 0.9 logMAR, range: 0–2.9 logMAR) (*P* = 0.451). The mean BCVA was temporarily decreased during the first 3 weeks. The mild decrease of mean BCVA was observed at 1 week. However, the patients' vision returned to the baseline visual acuity at the last follow-up visit.

Fig. 2 shows the mean postoperative IOP reduction from the baseline of all patients and also the three most common types of glaucoma in this study. The mean IOP reduction decreased overtime throughout the follow-up period. The maximal reduction of IOP after the surgery was at 1 week. The mean IOP reduction in NVG group was higher than in POAG and PACG groups at every follow-up time point but was statistically significant only at postoperative week 3 (*P* = 0.016) and week 6 (*P* = 0.019) when comparing with the POAG group. At postoperative week 12, the pressure of 101 eyes (85.6%) was successfully controlled. Of these patients, eighty subjects (67.8%) were in complete success group and 21 subjects (17.8%) were in qualified success group.

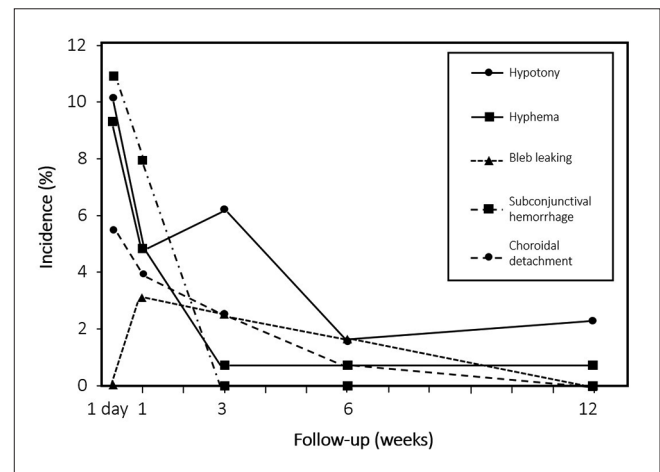
**Table 1: Demographic features and clinical characteristics of study patients**

Baseline characteristics	n (%)
Gender (%)	
Male	55 (46.6)
Female	63 (53.4)
Age (mean±SD) (years)	57.7±16.1
Range	19-86
Underlying diseases (%)	
None	50 (42.4)
Hypertension	45 (38.1)
Diabetes mellitus	31 (26.3)
Dyslipidemia	16 (13.6)
Heart disease	2 (1.7)
Others	18 (15.3)
IOP-lowering medications (bottles)	3.1±0.6
Range	1-4
BCVA (logMAR)	1.1±0.9
Range	0-2.8
IOP (mmHg)	27.0±11.1
Range	8-52
Diagnosis (%)	
POAG	32 (27.1)
PACG	29 (24.6)
NVG	33 (28.0)
Uveitic glaucoma	13 (11.0)
Other*	11 (9.3)

\*Pseudoexfoliation glaucoma, angle recession glaucoma, Axenfeld-Rieger syndrome, and lens-induced glaucoma. BCVA: Best-corrected visual acuity, IOP: Intraocular pressure, POAG: Primary open-angle glaucoma, PACG: Primary angle-closure glaucoma, NVG: Neovascular glaucoma, SD: Standard deviation

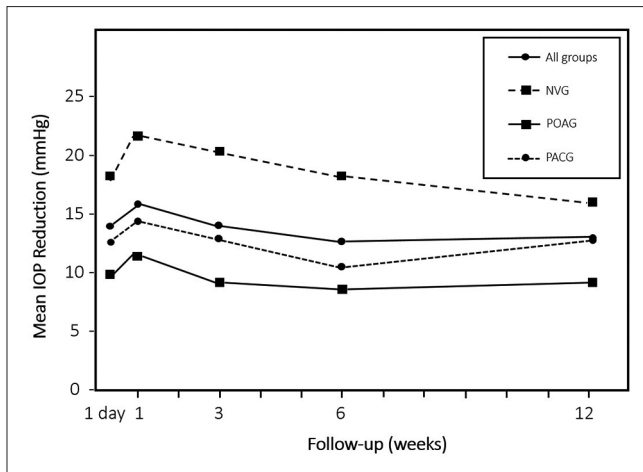
**Table 2: Early postoperative complications after trabeculectomy and combined phacotrabeculectomy with mitomycin C**

Complications	Number of eye (%)
Hypotony	25 (27.2)
Hypotony with serous choroidal detachment	14 (15.6)
Subconjunctival hemorrhage	12 (13.0)
Hyphema	11 (12.4)
Bleb leak	8 (8.8)
Encapsulated bleb	2 (2.2)
Aqueous misdirection	1 (1.1)
Corneal epithelial defect	1 (1.1)
Overfiltration with a shallow anterior chamber	1 (1.1)



**Figure 1: Incidence of hypotony, serous choroidal detachment, subconjunctival hemorrhage, hyphema, and bleb leaking (the five most common postoperative complications in this study) after trabeculectomy or combined phacotrabeculectomy with mitomycin C presented as percentage at each follow-up time point**





**Figure 2:** Reduction of intraocular pressure after trabeculectomy or combined phacotrabeculectomy with mitomycin C. Data are presented as mean intraocular pressure reduction of all groups of patients, primary open-angle glaucoma, primary angle closure glaucoma, and neovascular glaucoma subgroups

Failed trabeculectomy was found in 16 eyes (13.5%). Causes of the failure were inadequate IOP reduction for 10 eyes (8.5%), reoperation for 5 eyes (4.2%), and persistent hypotony for 1 eye (0.8%). No cases developed loss of light perception vision after the surgery.

The mean number of topical medication use was decreased from  $3.1 \pm 0.6$  to  $0.5 \pm 1.0$  bottles ( $P < 0.001$ ) at 12 weeks after the surgery. However, the percentage of additional glaucoma medications increased over time during the follow-up period (4.2%, 5.1%, 3.4%, 6.8%, and 10.2% at postoperative 1 day, 1, 3, 6, and 12 weeks, respectively).

Additional procedures were performed in sixty eyes (46.9%). Laser suture lysis was the most common procedure and was performed in 51 eyes (43.3%), generally at 3 weeks after the surgery. Bleb needling with subconjunctival 5-FU injection was performed in 2 eyes (1.7%). The subconjunctival 5-FU injection was done in 1 eye (0.8%). Trabeculectomy revision was performed in one patient (0.8%) whose IOP remained over 40 mmHg after performing laser suture lysis. Trans pars plana vitrectomy was done in one patient (0.8%) with aqueous misdirection. One eye (0.8%) needed reformation procedure and bleb compression suture to manage overfiltration with consequent shallow AC.

Table 3 shows risk factors for developing complications and surgical failure after trabeculectomy or combined phacotrabeculectomy with MMC during first 12 weeks. Hypotony was a risk factor for serous CD (OR = 6.180,  $P = 0.006$ ) and NVG was a risk factor for hyphema (OR = 6.366,  $P = 0.009$ ).

## Discussion

In this study, the incidence of complications in the first 3 months after primary trabeculectomy or combined phacotrabeculectomy using a fornix-based technique with MMC in Thai patients was 56.7%. From previous literature, there were varying rates of short-term complications (from 2 weeks to 1 year after trabeculectomy) ranging from 5.2% to 50%.<sup>[4-9]</sup> Our result is quite similar to the collaborative initial glaucoma treatment study (CIGTS)<sup>[5]</sup> which found early

postoperative complications in 232 eyes (50%) during the first month after initial trabeculectomy even though most of the participants in the CIGTS were Caucasian or of African descent. Unlike our population, all the participants were never exposed to topical medications before trabeculectomy, and a limbus-based conjunctival flap technique without MMC use was used. A large national survey of primary trabeculectomy for POAG in the United Kingdom (UK)<sup>[4]</sup> also found early postoperative complications (within 2 weeks after the surgery) in 578 eyes (46.6%). However, in the largest Asian study which was conducted in Singapore<sup>[8]</sup> and had a higher proportion of PACG patients, found surprisingly a low overall incidence of postoperative complications of only 65 eyes out of 1262 eyes (5.2%).

In a previous retrospective review in Thai glaucoma patients,<sup>[6]</sup> which is comparable to our study by study design and surgical technique, complications were found in 24 of 69 eyes (34.8%). The incidence was lower than in our study even though their study had a longer duration of follow-up (1 year). This result may be due to their highly standardized surgical technique and use of only one ophthalmologist as the surgeon.

The rate of complications was highly variable among different studies. This is possibly secondary to variability in patient demographics such as race and type of glaucoma, surgical technique including conjunctival incision and closure and the presence of antimetabolite use, type and duration of preoperative glaucoma medication use, varying definitions of complications, surgeons' experience, and duration of follow-up.

The most common complication in our study was hypotony (27.2%), followed by CD (15.6%), subconjunctival hemorrhage (13%), hyphema (12.4%), and bleb leak (8.8%).

Hypotony was a major complication in several studies including our study (27.2%), the UK study<sup>[4]</sup> (24.3%), and the Singapore study<sup>[8]</sup> (prolonged hypotony = 1.8%). The incidence of hypotony was low in CIGTS (0.9%), in which there was no use of MMC. In one study in Nigeria,<sup>[7]</sup> only one-third of the patients with glaucoma underwent trabeculectomy with intraoperative 5-FU use, and no cases of hypotony during the 1-year postoperation. This result is compatible with studies in African descent,<sup>[15,16]</sup> which reported lower rates of hypotony and presumed that the thicker sclera in this population could be involved.

Hypotony in our study was quite high compared with other studies. This is possible because we reported all the patients who had at least one-time hypotony at any follow-up visit. Some studies excluded hypotony at day 1 after trabeculectomy, or hypotony was counted when a patient had hypotony in at least three consecutive follow-up visits.<sup>[4,7]</sup> Surgeon factor also plays an important role in determining the early postoperative IOP, which includes the tension of sutures, number of sutures, immediate IOP at the end of surgery, and timing of suture lysis. Even though most transient early postoperative hypotony could be safely managed conservatively if the AC is not flat and hypotony is not prolonged, the previous studies<sup>[17-21]</sup> have shown that occurrence of early postoperative hypotony was associated with higher risk of trabeculectomy failure and complications that could involve an adverse vision outcome such as flat AC, cataract, serous and hemorrhagic choroidal effusion, macular edema, and optic nerve edema. To prevent

**Table 3: Statistical analysis of relationship between early postoperative complications included surgical failure and presumed risk factors**

Complications	Variables	Univariate analysis ( <i>P</i> )	Multivariate analysis		
			OR	95% CI	<i>P</i>
Hypotony	DM	0.102	1.038	0.094-1.338	0.126
	Number of stitches	0.008	0.206	0.559-1.185	0.283
	Staff/resident	0.162	0.774	0.121-1.759	0.257
Choroidal detachment	Hypotony	0.007	6.180	1.705-22.403	0.006*
	Age	0.418	0.991	0.953-1.031	0.659
Hyphema	NVG	0.010	6.366	1.595-25.413	0.009*
	Operation	0.133	0.253	0.048-1.327	0.104
Bleb leak	Age	0.822			
Failure	IOP-lowering medications (bottles)	0.103	2.003	0.818-4.906	0.128
	NVG	0.064	0.159	0.020-1.270	0.083

\**P*<0.05. OR: Odds ratio, CI: Confidence interval, DM: Diabetes mellitus, NVG: Neovascular glaucoma, IOP: Intraocular pressure

early hypotony, a trabeculectomy should be meticulously performed at every step<sup>[22-24]</sup> including: making a thicker scleral flap and avoiding dissecting the side cuts too anterior into the clear cornea, maintaining the AC with viscoelastic or BSS or using continuous intraoperative infusion to avoid intraoperative hypotony, creating a small sclerostomy with more overlap with the flap, and suturing the flap until minimal flow can be seen before suturing the conjunctival wound in watertight closure.

As in several studies, hypotony in our study was transient; there were no cases of hypotony maculopathy, and persistent hypotony was only 0.8%. We found that hypotony was associated with CD in 14 eyes (15.6%); however, all CDs reported in our study resolved spontaneously without any surgical intervention. Hypotony in our study was not associated with age, angle closure, surgeon factor, bleb leak, and overfiltration with a flat AC.

Our study found subconjunctival hemorrhage in 12 eyes (13%), but the details of size and location of the hemorrhage were not included in the notes.

Hyphema was the most common early-onset complication in the UK study (24.6%) as well as in the report of the population-based study in Minnesota (38%).<sup>[9]</sup> Hyphema in our study was lower (11 eyes, 12.4%) than in the largely Caucasian populations of these two studies, and most of our cases were microscopic hyphemas. As in many previous reports, we found that the hyphema resolved spontaneously within several weeks of the operation. A recent report by Nakatake *et al.*<sup>[25]</sup> showed that gross hyphema was statistically significantly associated with trabeculectomy failure in NVG patients.

The incidences of bleb leak among studies<sup>[6,8,26]</sup> that used a fornix-based conjunctival flap technique ranged between 0.9% and 30%. This disparity of early bleb leak rate is most likely because of differences in surgical techniques, especially with conjunctival closures and surgical skill. Bleb leak was the most common postoperative complication in a previous Thai study (23.2%).<sup>[6]</sup> In our study, the rate of bleb leak was lower (8.8%), and all cases were treated conservatively without surgical revision. Even though Kohl and Walton<sup>[26]</sup> reported multivariate analyses from studies that early bleb leaks were not independent risks for bleb failure, long-term results of this complication should be studied in the Thai population.

The mean IOP reduction was the highest 1 week after trabeculectomy (15.9 mmHg) and gradually decreased to 13 mmHg at the last follow-up visit. During the 3-month follow-up period, successful eye pressure control was 85.6%. The mean number of topical medication use significantly decreased from 3 to 0.5 medications. The final BCVA after the surgery did not change from the baseline BCVA (*P* = 0.451).

Despite the high rate of early posttrabeculectomy complications in our study, they were transient and self-limited conditions. In addition, further management, including both medications and minor procedures, improved the postoperative outcomes. There was only one patient (0.8%) who underwent trabeculectomy revision for inadequate IOP control.

There are factors proposed as risks for trabeculectomy complications. The present study identified postoperative hypotony as a risk factor for serous CD (OR = 6.180, *P* = 0.006) while CIGTS concluded that older patients were more likely to experience serous CD (OR = 1.34, *P* = 0.03). The CIGTS proposed that aging was also the risk for new anterior or posterior synechiae (OR = 1.48, *P* = 0.03) and of wound leak (OR = 1.76, *P* = 0.004), whereas it was not found to increase the occurrence of serous CD or of wound leak in our study (*P* = 0.418, 0.822).

NVG has been reported to be the most substantial risk factor for postoperative hyphema and surgical failure.<sup>[10,11,13]</sup> In our study, one-third (11 of 33 cases) of NVG patients had active neovascularization of the iris during trabeculectomy, and the diagnosis of NVG was found significantly related to postoperative hyphema (OR = 6.336, *P* = 0.009). Kojima *et al.*<sup>[13]</sup> indicated that the risk factors for hyphema were not only independently associated with NVG (OR = 2.404, *P* = 0.0017) but also involved with anticoagulant or antiplatelet medication use (OR = 2.143, *P* = 0.0274). Neovascularization in the AC and anticoagulant or antiplatelet medication use enhanced the risk of postoperative hyphema in NVG patients (OR = 5.7886, *P* = 0.0163, OR = 3.3325, *P* = 0.0450), whereas preoperative injection of intravitreal bevacizumab reduced the likelihood (OR = 0.3568, *P* = 0.0275). In our study, postoperative hyphema was not found to be involved with preoperative anticoagulant or antiplatelet medication use (*P* = 0.635).

NVG was not a risk factor for failure in this study (OR = 0.064, *P* = 0.083). Moreover, uveitic glaucoma and higher preoperative

IOP did not increase the failure rate ( $P=0.369, 0.174$ , respectively). Inoue *et al.*<sup>[10]</sup> reported that NVG (relative risk [RR] =1.88,  $P = 0.049$ ) and higher preoperative IOP (RR = 1.05/mmHg,  $P = 0.0077$ ) were prognostic factors for surgical failure among 116 vitrectomized eyes who underwent trabeculectomy. The disparity of the results might be because of the difference in failure definition and the duration of the follow-up period.

In addition, we found no statistical difference in the failure rate between trabeculectomy performed by staff physicians and residents ( $P = 0.689$ ). This result may be explained by the consistency of the surgery in which all surgeries performed by residents must be supervised by an attending.

There were some limitations in our study. First, retrospective data could have selection and information bias. Second, we used multiple surgeons, so there were some degrees of difference in their surgical techniques. And third, we included several types of glaucoma which could increase confounding factors between the groups. Because of the short follow-up period, the association between early complications and long-term success could not be assessed. A prospective long-term investigation should be conducted to further validate our findings related to risk factors for trabeculectomy failure.

## Conclusions

The incidence of early postoperative complications in our study was 56.7%. Hypotony was the most common complication. The occurrence of hyphema was related to NVG and hypotony was a risk for serous CD.

## Acknowledgments

We are thankful to Dr. Jenny Chen, a resident in training in ophthalmology at the University of California, Los Angeles (UCLA) and Prof. Shan C. Lin, director at glaucoma service, University of California, San Francisco (UCSF), who kindly corrected the text.

## Financial support and sponsorship

Our study was approved and supported by the Faculty of Medicine Endowment Fund, Faculty of Medicine, Chiang Mai University.

## Conflicts of interest

There are no conflicts of interest.

## References

1. Quigley HA, Broman AT. The number of people with glaucoma worldwide in 2010 and 2020. *Br J Ophthalmol* 2006;90:262-7.
2. Tham YC, Li X, Wong TY, Quigley HA, Aung T, Cheng CY. Global prevalence of glaucoma and projections of glaucoma burden through 2040: A systematic review and meta-analysis. *Ophthalmology* 2014;121:2081-90.
3. Bourne RR, Sukudom P, Foster PJ, Tantisevi V, Jitapunkul S, Lee PS, *et al.* Prevalence of glaucoma in Thailand: A population based survey in Rom Klao District, Bangkok. *Br J Ophthalmol* 2003;87:1069-74.
4. Edmunds B, Thompson JR, Salmon JF, Wormald RP. The National Survey of Trabeculectomy. III. Early and late complications. *Eye (Lond)* 2002;16:297-303.
5. Jampel HD, Musch DC, Gillespie BW, Lichter PR, Wright MM, Guire KE; Collaborative Initial Glaucoma Treatment Study Group. Perioperative complications of trabeculectomy in the collaborative initial glaucoma treatment study (CIGTS). *Am J Ophthalmol* 2005;140:16-22.
6. Lim LA, Chindasub P, Kitnarong N. The surgical outcome of primary trabeculectomy with mitomycin C and A fornix-based conjunctival flap technique in Thailand. *J Med Assoc Thai* 2008;91:1551-7.
7. Ashaye AO, Komolafe OO. Post-operative complication of trabeculectomy in Ibadan, Nigeria: Outcome of 1-year follow-up. *Eye (Lond)* 2009;23:448-52.
8. Tan YL, Tsou PF, Tan GS, Perera SA, Ho CL, Wong TT, *et al.* Postoperative complications after glaucoma surgery for primary angle-closure glaucoma vs primary open-angle glaucoma. *Arch Ophthalmol* 2011;129:987-92.
9. Olayanju JA, Hassan MB, Hodge DO, Khanna CL. Trabeculectomy-related complications in Olmsted County, Minnesota, 1985 through 2010. *JAMA Ophthalmol* 2015;133:574-80.
10. Inoue T, Inatani M, Takihara Y, Awai-Kasaoka N, Ogata-Iwao M, Tanihara H. Prognostic risk factors for failure of trabeculectomy with mitomycin C after vitrectomy. *Jpn J Ophthalmol* 2012;56:464-9.
11. Boimer C, Birt CM. Preservative exposure and surgical outcomes in glaucoma patients: The PESO study. *J Glaucoma* 2013;22:730-5.
12. Haga A, Inatani M, Shobayashi K, Kojima S, Inoue T, Tanihara H. Risk factors for choroidal detachment after trabeculectomy with mitomycin C. *Clin Ophthalmol* 2013;7:1417-21.
13. Kojima S, Inatani M, Shobayashi K, Haga A, Inoue T, Tanihara H. Risk factors for hyphema after trabeculectomy with mitomycin C. *J Glaucoma* 2014;23:307-11.
14. Schulze-Bonsel K, Feltgen N, Burau H, Hansen L, Bach M. Visual acuities "hand motion" and "counting fingers" can be quantified with the freiburg visual acuity test. *Invest Ophthalmol Vis Sci* 2006;47:1236-40.
15. Singh K, Byrd S, Egbert PR, Budenz D. Risk of hypotony after primary trabeculectomy with antifibrotic agents in a black west African population. *J Glaucoma* 1998;7:82-5.
16. Stamper RL, McMenemy MG, Lieberman MF. Hypotonous maculopathy after trabeculectomy with subconjunctival 5-fluorouracil. *Am J Ophthalmol* 1992;114:544-53.
17. Wu G, Hildreth T, Phelan PS, Fraser SG. The relation of volume and outcome in trabeculectomy. *Eye (Lond)* 2007;21:921-4.
18. Bindlish R, Condon GP, Schlosser JD, D'Antonio J, Lauer KB, Lehrer R. Efficacy and safety of mitomycin-C in primary trabeculectomy: Five-year follow-up. *Ophthalmology* 2002;109:1336-41.
19. Gedde SJ, Schiffman JC, Feuer WJ, Herndon LW, Brandt JD, Budenz DL; Tube versus Trabeculectomy Study Group. Treatment outcomes in the Tube Versus Trabeculectomy (TVT) study after five years of follow-up. *Am J Ophthalmol* 2012;153:789-803.e2.
20. Higashide T, Ohkubo S, Sugimoto Y, Kiuchi Y, Sugiyama K. Persistent hypotony after trabeculectomy: Incidence and associated factors in the Collaborative Bleb-Related Infection Incidence and Treatment Study. *Jpn J Ophthalmol* 2016;60:309-18.
21. Stiles M. Filtration surgery: Indications and improvements. *Glaucoma Today* 2014:48-9.
22. Saeedi OJ, Jefferys JL, Solus JF, Jampel HD, Quigley HA. Risk factors for adverse consequences of low intraocular pressure after trabeculectomy. *J Glaucoma* 2014;23:e60-8.
23. Jones E, Clarke J, Khaw PT. Recent advances in trabeculectomy technique. *Curr Opin Ophthalmol* 2005;16:107-13.
24. Khaw PT, Dahlmann A, Mireskandari K. Trabeculectomy technique: The Moorfields Safe Surgery System with new adjustable sutures. *Glaucoma Today* 2005;12:22-9.
25. Nakatake S, Yoshida S, Nakao S, Arita R, Yasuda M, Kita T, *et al.* Hyphema is a risk factor for failure of trabeculectomy in neovascular glaucoma: A retrospective analysis. *BMC Ophthalmol* 2014;14:55.
26. Kohl DA, Walton DS. Limbus-based versus fornix-based conjunctival flaps in trabeculectomy: 2005 update. *Int Ophthalmol Clin* 2005;45:107-13.