



Prospective cohort study of risk factors for choroidal detachment after trabeculectomy

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Abstract

Purpose To investigate risk factors for choroidal detachment after trabeculectomy.

Methods We prospectively evaluated 97 patients with open-angle glaucoma who underwent primary trabeculectomy to investigate risk factors for choroidal detachment after trabeculectomy. The primary outcome measure was risk factors for the occurrence and severity of choroidal detachment after trabeculectomy. Choroidal detachment severity was quantified as the number of fundus quadrants with choroidal detachment.

Results Sixteen patients (16.5%) had choroidal detachment. Mean period between surgery and occurrence of choroidal detachment was 7.9 ± 5.7 days. Mean intraocular pressure (IOP) on the first day of choroidal detachment was 6.1 ± 3.0 mm Hg. Multivariable analyses revealed that the exfoliation glaucoma, greater Δ IOP between preoperative and lowest postoperative IOPs, and thicker cornea were associated with choroidal detachment ($P = 0.022$, $P = 0.002$, and $P = 0.013$, respectively). These factors were also associated with the severity of choroidal detachment (exfoliation glaucoma; $P = 0.013$, greater Δ IOP; $P < 0.001$, and thicker cornea; $P = 0.006$).

Conclusions Exfoliation glaucoma, more IOP reduction, and thicker cornea are associated with the occurrence and severity of choroidal detachment after trabeculectomy.

Keywords Glaucoma · Trabeculectomy · Choroidal detachment · Risk factor

Introduction

Choroidal detachment is a common early complication after trabeculectomy [1], and most cases are temporary and occur in the early postoperative period. The frequency of choroidal detachment after trabeculectomy is approximately 5–44% [1–6]. Hypotony after trabeculectomy causes fluid accumulation in the suprachoroidal space, which can induce choroidal detachment. According to some reports, early postoperative hypotony and choroidal detachment are responsible for inflammation in the anterior chamber and surgical failure after trabeculectomy [3, 7]. Moreover, some studies suggest that older age is associated with choroidal detachment [6, 8]. Although risk factors for choroidal detachment after trabeculectomy have been evaluated, those for the severity of choroidal detachment remain unknown. Therefore, we aimed to evaluate risk factors for the occurrence and severity of choroidal detachment after trabeculectomy.

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Materials and methods

Patient selection

This study was approved by the Institutional Review Board of Fukui University Hospital, Fukui, Japan. This study was registered with the University Hospital Medical Information Network Clinical Trials Registry of Japan (Identifier University Hospital Medical Information Network: UMIN 000007813; date of access and registration: April 24, 2012). The protocol was in accordance with the Declaration of Helsinki. Written informed consent was obtained from all patients after providing a detailed explanation of the procedures involved.

We performed a prospective, clinical cohort study to evaluate risk factors for choroidal detachment after trabeculectomy. Patients were recruited between April 1, 2012, and March 31, 2016, at Fukui University Hospital and were included if they met the following criteria: age ≥ 20 years; having open-angle glaucoma including primary open-angle glaucoma or exfoliation glaucoma; and no history of intraocular surgery other than phacoemulsification. Exclusion criteria were aphakic eyes, eyes with previous vitrectomy, eyes with a history of glaucoma surgery before trabeculectomy, or pseudophakic eyes previously treated with cataract extraction other than phacoemulsification.

Surgical procedures

For the present study, all of the surgeries were performed by one surgeon (MI). The surgical procedure was performed as follows: A 5-mm conjunctival incision was made along the limbus to create a fornix-based conjunctival flap, or an 8-mm conjunctival incision was made parallel to the limbus at 7 to 9 mm posterior to the limbus to create a limbus-based conjunctival flap. In addition, we created a 4-mm wide half-layer scleral flap. Mitomycin C (0.4 mg/ml) was applied on and under the scleral flap and under the Tenon's capsule for 4 min, and the eye was irrigated with physiological saline (100 ml). Following excision of a deep limbal block to create a fistula in the anterior chamber, peripheral iridectomy was performed. Both the scleral and conjunctival flaps were sutured with 10–0 monofilament nylon. Postoperatively, all patients received similar topical medication with 1.5% levofloxacin 3 times a day for 1 month and

0.1% betamethasone sodium phosphate 3 times a day for 6 months.

Data collection

We gathered patient data, including sex, age, type of glaucoma, lens status, preoperative intraocular pressure (IOP), postoperative IOP, number of glaucoma medications, corneal thickness, axial length, anterior chamber opening duration, and postoperative laser suture lysis. Patients were hospitalized for 7 to 10 days after surgery, and then the study-related visit was scheduled for 2 and 4 weeks after surgery. IOP and number of glaucoma medications were evaluated before surgery and, along with complications, assessed at all postoperative visits. The anterior chamber opening duration during surgery was defined as the time between making the incision for fistula creation in the anterior chamber and suturing the scleral flap.

Outcome measures

Risk factors for the occurrence and severity of choroidal detachment as an early postoperative complication after trabeculectomy were the primary outcome measures. Postoperative choroidal detachment was described as a solid-appearing elevation of the retina and choroid on funduscopic examination. The severity of choroidal detachment was based on the number of fundus quadrants occupied by choroidal detachment.

Statistical analysis

The Chi-squared test, Fisher exact test, the Mann–Whitney U nonparametric test, and paired t test with Bonferroni correction were used to perform univariate comparisons between subgroups. Multivariate analysis was performed to determine the variables associated with choroidal detachment using a logistic regression and multiple linear regression models. A P value < 0.05 was considered statistically significant.

Results

Patient characteristics

In total, 97 patients (97 eyes) were enrolled in the present study. All patients were completely followed for 4 weeks after surgery. Table 1 summarizes the patients' characteristics.

Outcome measure

The preoperative IOP was 23.7 ± 9.2 mm Hg and decreased significantly to 13.6 ± 7.6 mm Hg at 1 day after surgery ($P < 0.001$), 8.8 ± 4.0 mm Hg at 7 days after surgery ($P < 0.001$), 11.5 ± 4.5 mm Hg at 2 weeks after surgery ($P < 0.001$), and 12.9 ± 4.4 mm Hg at 4 weeks after surgery ($P < 0.001$).

Of 97 patients, 16 (16.5%) experienced choroidal detachment after trabeculectomy. Patients were divided into groups of those with ($n = 16$) and without ($n = 81$) choroidal detachment, and subgroup analyses were conducted. Table 2 shows a comparison between the groups with and without choroidal detachments.

The significant difference was found in the type of glaucoma between the groups with and without choroidal detachments ($P = 0.031$). In 12 out of 16 choroidal detachment patients (75%), the type of glaucoma was exfoliation glaucoma. Cornea was significantly thicker in patients with choroidal detachment than in those without choroidal detachment ($P = 0.0033$). The preoperative IOP in choroidal detachment patients was significantly higher than in those patients without choroidal detachment ($P = 0.0038$). The mean period between surgery and choroidal detachment was 7.9 ± 5.7 days. Thus, the lowest postoperative IOP within 7 days after surgery was considered as the lowest postoperative IOP. Mean IOP on the first day of choroidal detachment was 6.1 ± 3.0 mm Hg. The lowest postoperative IOP in patients with choroidal detachment was 5.1 ± 2.9 mm Hg versus 6.5 ± 3.2 mm Hg in those without choroidal detachment, and there was no significant difference between the two groups ($P = 0.093$). The Δ IOP, defined as the formula "preoperative IOP—the lowest postoperative IOP," was significantly higher in those with choroidal detachment than in those without choroidal

Table 1 Patient characteristics

Characteristics	Total ($n = 97$)
Age, mean (SD), years	69.9 (13.2)
Sex, n (%)	
Men	44 (45)
Women	53 (55)
Type of glaucoma, n (%)	
Primary open-angle glaucoma	49 (51)
Exfoliation glaucoma	48 (49)
Lens status, n (%)	
Phakic	59 (61)
Pseudophakic	38 (39)
Conjunctival incision, n (%)	
Fornix-based	60 (62)
Limbus-based	37 (38)
Preoperative IOP, mean (SD), mm Hg	23.7 (9.2)
Number of preoperative glaucoma medications, mean (SD)	2.7 (0.7)
Anterior chamber opening duration, mean (SD), min	5.0 (1.3)
Axial length, mean (SD), mm	24.5 (2.3)
Corneal thickness, mean (SD), μ m	507.9 (33.1)
Postoperative laser suture lysis, n (%)	
Yes	63 (65)
No	34 (35)

IOP intraocular pressure,
SD standard deviation

Table 2 Comparison of patient characteristics between those with and without choroidal detachment

Characteristics	CD (+) (<i>n</i> = 16)	CD (–) (<i>n</i> = 81)	<i>P</i> value
Age, mean (SD), years	74.6 (14.0)	69.0 (12.9)	0.19
Sex, <i>n</i> (%)			0.41
Men	9 (56)	35 (43)	
Women	7 (44)	46 (57)	
Type of glaucoma, <i>n</i> (%)			0.031
Primary open-angle glaucoma	4 (25)	45 (56)	
Exfoliation glaucoma	12 (75)	36 (44)	
Lens status, <i>n</i> (%)			0.40
Phakic	8 (50)	51 (63)	
Pseudophakic	8 (50)	30 (37)	
Conjunctival incision, <i>n</i> (%)			0.59
Fornix-based	11 (69)	49 (60)	
Limbus-based	5 (31)	32 (40)	
Preoperative IOP, mean (SD), mm Hg	30.7 (13.1)	22.3 (7.5)	0.0038
Number of preoperative glaucoma medications, mean (SD)	2.8 (0.8)	2.7 (0.7)	0.83
Axial length, mean (SD), mm	23.8 (1.5)	24.6 (2.4)	0.46
Corneal thickness, μ m	526.2 (28.6)	504.2 (32.9)	0.0033
Period between surgery and CD, mean (SD), days	7.9 (5.7)		
IOP on the first day of CD, mean (SD), mm Hg	6.1 (3.0)		
The lowest postoperative IOP (within 7 days), mean (SD), mm Hg	5.1 (2.9)	6.5 (3.2)	0.093
Δ IOP (pre-lowest post)	25.6 (13.7)	15.8 (7.7)	0.0025
Anterior chamber opening duration, mean (SD), min	5.4 (1.4)	4.9 (1.3)	0.063
Postoperative laser suture lysis, <i>n</i> (%)			0.57
Yes	9 (56)	54 (67)	
No	7 (44)	27 (33)	

Data are shown in mean \pm standard deviation

CD choroidal detachment, IOP intraocular pressure

detachment ($P = 0.0025$). No other statistically significant differences were found between the groups.

Patient characteristics including type of glaucoma, corneal thickness, preoperative IOP, and Δ IOP were assessed as possible determinants of postoperative choroidal detachment. Multivariate analyses using logistic regression models (stepwise selection) demonstrated exfoliation glaucoma, higher Δ IOP, and thicker cornea were significantly associated with choroidal detachment ($P = 0.022$, $P = 0.002$, and $P = 0.013$, respectively; Table 3). In the three factors, type of glaucoma had the highest relative risk (RR = 5.43). Exfoliation glaucoma was the strongest factor for the occurrence of choroidal detachment. No

other statistically significant determinants were observed in this analysis.

Severity of choroidal detachment was categorized as one quadrant (three eyes), two quadrants (seven eyes), three quadrants (five eyes), and four quadrants (one eye). Patient characteristics, type of glaucoma, corneal thickness, preoperative IOP, and Δ IOP were evaluated as possible determinants of the severity of choroidal detachment. Multivariate analyses using multiple regression models (stepwise selection) demonstrated that exfoliation glaucoma, higher Δ IOP, and thicker cornea were significantly associated with the severity of choroidal detachment ($P = 0.013$, $P < 0.001$, and $P = 0.006$, respectively; Table 4). In the three factors, Δ IOP had the highest standardized

Table 3 Multivariate analysis for determining variables associated with choroidal detachment after trabeculectomy using a logistic regression model

Variable	Unstandardized coefficients, <i>B</i>	RR (95% CI)	<i>P</i> value
(Constant)	– 19.3		0.002
Type of glaucoma (exfoliation glaucoma/primary open-angle glaucoma)	1.69	5.43 (1.27–23.2)	0.022
Δ IOP (pre-lowest post 7 days) (mm Hg)	0.091	1.10 (1.04–1.16)	0.002
Corneal thickness (μ m)	0.029	1.03 (1.01–1.05)	0.013

95% CI = 95% confidence interval

IOP intraocular pressure, *RR* relative risk**Table 4** Multivariate analysis for determining variables associated with the severity of choroidal detachment after trabeculectomy using a multiple regression model

Variable	Unstandardized coefficients <i>B</i>	Standardized coefficients Beta	<i>T</i>	<i>P</i> value
(Constant)	– 3.92		– 3.11	0.003
Type of glaucoma (exfoliation glaucoma/primary open-angle glaucoma)	0.42	0.23	2.55	0.013
Δ IOP (pre-lowest post 7 days) (mm Hg)	0.032	0.33	3.68	< 0.001
Corneal thickness (μ m)	0.007	0.26	2.82	0.006

IOP intraocular pressure

coefficients (Beta = 0.33). No other statistically significant determinants were observed in this analysis.

Discussion

The objective of our study was to evaluate risk factors for the occurrence and severity of choroidal detachment after trabeculectomy. We evaluated 16 patients (16.5%) who experienced choroidal detachment in our study. Our multivariable analyses revealed that the exfoliation glaucoma, greater Δ IOP, and thicker cornea were significant risk factor for choroidal detachment ($P = 0.022$, $P = 0.002$, and $P = 0.013$, respectively). More severe choroidal detachment was also associated with the exfoliation glaucoma, greater Δ IOP, and thicker cornea ($P = 0.013$, $P < 0.001$, and $P = 0.006$, respectively).

Previous reports have evaluated risk factors for the occurrence of choroidal detachment after

trabeculectomy. Jampel et al. prospectively reported on 300 glaucomatous patients who had undergone trabeculectomy and found that choroidal detachment was significantly associated with older age [8]. Haga et al. retrospectively reported that choroidal detachment was significantly associated with older age and lower postoperative IOP among 420 glaucomatous patients who had recently undergone trabeculectomy [6]. However, those reports did not evaluate the severity of choroidal detachment. Thus, our prospective study is unique as we report on the relationship between patient data and severity of choroidal detachment.

Choroidal detachment occurs in hypotonic eyes after intraocular surgeries including trabeculectomy [9, 10]. A previous study also reported that the lowest postoperative IOPs were significantly lower in patients with choroidal detachment [6]. Although there were no significant differences in the lowest postoperative IOP between those with and without choroidal

detachment in the present study, the postoperative IOPs also tended to be lower in those with versus without choroidal detachment (5.1 mm Hg vs 6.5 mm Hg, respectively), suggesting that lower postoperative IOPs may have contributed to the occurrence of choroidal detachment. By contrast, the present study demonstrated that preoperative IOP and Δ IOP, rather than the lowest postoperative IOP, were significantly greater in patients with versus without choroidal detachment, which means that if the patient underwent greater IOP reduction from a higher preoperative IOP, they would more frequently encounter choroidal detachment. In fact, multivariate analysis has shown that greater Δ IOP rather than lower postoperative IOP is a significant prognostic factor for choroidal detachment, suggesting that the gap between pre- and postoperative IOPs increases the occurrence of choroidal detachment rather than postoperative hypotony, which may be explained by the change in ocular shape. Several reports have shown that IOP reduction causes axial length shortening after trabeculectomy [11–15]. The structural change in eyeball shape due to greater Δ IOP might have increased fluid inflow into the suprachoroidal space.

Our present study shows that eyes with exfoliation glaucoma are associated with choroidal detachment. Breakdown of the aqueous humor barrier is more extensive in eyes with exfoliation syndrome following intraocular surgery [16, 17]. In addition, intraocular surgery causes ocular inflammation and breakdown of the aqueous humor barrier, which may cause bleb failure after trabeculectomy [18]. The elevated cytokine concentration in aqueous humor in eyes with exfoliation syndrome might induce the breakdown of the blood-aqueous barrier, enhancing vascular permeability of the choriocapillaris and inflow into the suprachoroidal space. Optical coherence tomography angiography provides more information regarding vascular change in eyes with choroidal detachment.

Corneal thickness is associated with IOP. As for IOP measurement, thicker cornea results in higher IOP than thinner cornea [19, 20]. In eyes with thicker cornea, postoperative IOP after trabeculectomy might be overestimated compared to the actual IOP. Therefore, the difference between measured IOPs and actual IOP in eyes with thick cornea might lead to choroidal detachment.

We are aware of the limitations of this study. First, we used funduscopic examination only to evaluate

postoperative choroidal detachment. The ultrasound observations, including ultrasound biomicroscopy and B-mode scanning, would have provided a more objective approach to evaluate choroidal detachment. Second, we could not collect clinical data on preoperative and postoperative inflammation. Postoperative intraocular inflammation increases the vascular permeability of the choriocapillaris [21] and may cause choroidal detachment. Therefore, we should have included the measurement of flare value by flare-cell meter in our analyses.

Conclusions

Exfoliation glaucoma, greater IOP reduction, and thicker cornea are associated with the occurrence and severity of choroidal detachment after trabeculectomy.

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Data availability All data generated or analyzed during this study are included in this published article.

Compliance with ethical standards

Conflicts of interest There is no conflict of interest regarding the publication of this paper.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee (Institutional Review Board of Fukui University Hospital) and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

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