Delayed Suprachoroidal Hemorrhage after Glaucoma Filtration Procedures

Sonal S. Tuli, MD, Darrell WuDunn, MD, PhD, Thomas A. Ciulla, MD, Louis B. Cantor, MD

Objectives: To determine the incidence of, risk factors for, and outcomes of delayed suprachoroidal hemorrhage (DSCH) after glaucoma filtration surgery.

Design: Retrospective case-control study.

Participants: All patients undergoing glaucoma filtration procedures between 1986 and 2000 at Indiana University who were diagnosed postoperatively with suprachoroidal hemorrhage. A total of 66 patients with DSCH were identified. These were compared with a randomly selected group of patients who underwent similar procedures but did not have suprachoroidal hemorrhage.

Methods: Total cases of DSCH were initially compared with the total number of glaucoma surgeries to determine the overall incidence and the incidence in the different procedures. Subsequently, a case-control study was performed comparing the group with hemorrhage to the control group to identify risk factors. Finally, outcomes and prognostic factors were determined by comparing vision preoperatively and postoperatively and parameters of patients with good and poor outcomes.

Main Outcome Measures: Incidence of DSCH, risk factors associated with its occurrence, visual outcomes, and factors important for prognosis.

Results: Of a total of 2285 glaucoma filtration procedures, 66 (2.9%) cases of DSCH were identified. It developed in 9 of 615 (1.5%) trabeculectomies without antimetabolite, 30 of 1248 (2.4%) trabeculectomies with antimetabolite, 2 of 72 (2.8%) valved tube shunt implantations, and 25 of 350 (7.1%) nonvalved tube shunt implantations. The increased incidence of DSCH after tube shunts compared with trabeculectomy-associated DSCH was significant ($P < 0.0001$) with an odds ratio of 3.2. The risk factors for DSCH after glaucoma surgery include white race ($P = 0.012$), anticoagulation ($P = 0.034$), severe postoperative hypotony ($P = 0.033$), and aphakia/anterior chamber intraocular lens ($P = 0.002$). The visual outcomes of patients with hemorrhage were poor, with a decrease in logarithm of the minimum angle of resolution visual acuity from 0.72 to 1.36, which was statistically significant compared with the controls ($P < 0.009$).

Conclusions: Delayed suprachoroidal hemorrhage occurs more frequently after tube shunt implantation than after trabeculectomy. Caution should be exercised when operating on patients with known risk factors, because the visual outcomes after DSCH are poor. *Ophthalmology 2001;108:1808–1811 © 2001 by the American Academy of Ophthalmology.*

Suprachoroidal hemorrhage associated with intraocular surgery has been recognized for centuries. Baron de Wenzel, Jr first described it in 1786 after cataract surgery performed by his famous father in 1760.[1] The term "expulsive hemorrhage" was coined by Terson[2] who also described its gross pathology. In 1915, Verhoeff[3] made the first successful attempt at treatment by performing a scleral puncture. Despite this long history, suprachoroidal hemorrhage remains one of the most feared complications of ophthalmic surgery.

Originally received: February 8, 2001.
Accepted: May 15, 2001. Manuscript no. 210089.

From the Department of Ophthalmology, Indiana University, Indianapolis, Indiana.

Supported in part by an unrestricted grant from Research to Prevent Blindness, Inc., New York, New York. Dr. Ciulla is a recipient of a career development grant from Research to Prevent Blindness, Inc.

The authors have no financial or proprietary interest in any aspect of this study.

Reprint requests to Darrell WuDunn, MD, PhD, Department of Ophthalmology, Indiana University, 702 Rotary Circle, Indianapolis, IN 46202.

Expulsive hemorrhage differs from delayed suprachoroidal hemorrhage (DSCH) in its incidence, pathophysiology, and management.[4] Expulsive hemorrhage is rare and consists of sudden and massive hemorrhage under the choroid during surgery that may result in extrusion of intraocular contents. DSCH after surgery varies considerably in severity but is generally characterized by the sudden onset of severe pain, decreased vision, and a shallow anterior chamber usually associated with raised intraocular pressure (IOP).

The incidence of DSCH after glaucoma filtration procedures varies from 1.6% to 6.2%, depending on the type of surgery performed and the criteria used for diagnosis.[5–14] In aphakic patients, the incidence has been as high as 13%.[5] The risk factors have also varied considerably between studies and have included myopia, aphakia, hypertension, high preoperative IOP, drop in IOP, postoperative hypotony, and many other anecdotal factors.[5–14]

Of the numerous reports on DSCH, there are no large single surgeon series or studies comparing the different glaucoma procedures and their incidence, risk factors, and

ISSN 0161-6420/01/$–see front matter
PII S0161-6420(01)00763-1

outcomes. We attempted to perform a comprehensive study of patients undergoing different types of glaucoma surgery, with and without suprachoroidal hemorrhage, to determine the incidence, risk factors, and outcomes of DSCH.

Materials and Methods

The charts of all patients who underwent glaucoma filtration procedures by one glaucoma surgeon (LBC) who were diagnosed with postoperative suprachoroidal hemorrhage between 1986 and 2000 were reviewed. Patients were identified by searching through a database of patient records in the Glaucoma Department at Indiana University. Only those patients with confirmation of their diagnosis by echography or by ophthalmoscopic visualization of the hemorrhage were included in the study. Patients who had intraoperative expulsive hemorrhage were not included in the study. The data that were collected included age, gender, race, medical history, whether the patient used any anticoagulants or antiplatelet agents, ocular history (including number of prior surgeries, phakic status, number of ocular medications, and type of glaucoma), IOP just before surgery, type of surgery performed, immediate postoperative IOP, interval between surgery and onset of suprachoroidal hemorrhage, size of the hemorrhage, associated findings (hyphema, vitreous hemorrhage, retinal detachment), whether the hemorrhage was drained, final IOP, and final best-corrected visual acuity.

The total number of glaucoma filtration procedures performed by the same ophthalmologist (LBC) during the same time period was identified, and the overall incidence of delayed suprachoroidal hemorrhage was calculated. The surgeries were then stratified by procedure (trabeculectomy without antimetabolite, trabeculectomy with antimetabolite, valved tube shunts, and nonvalved tube shunts), and the incidence of hemorrhage in each type of procedure was calculated.

A control group was then randomly selected from the group that had undergone similar filtration procedures but had not had suprachoroidal hemorrhage develop.[15] Because there was a statistically significant difference in the incidence of hemorrhage between the different procedures, the control group was matched by procedure.

All statistical procedures were performed in SPSS for Windows (SPSS Inc. Chicago IL) (version 10.07). Logistic regression analysis was performed for all cases and for trabeculectomy and tube shunt implantation separately. Because of the small number of cases of DSCH for logistic regression, the analysis of the trabeculectomies included both antimetabolite and nonantimetabolite cases, whereas the analysis of tube shunt implantations included both valved and nonvalved implants. The following factors were included as covariates in the logistic regression analysis: age, gender, hypertension, anticoagulation (including aspirin, Coumadin, dipyridamole, heparin, pentoxifylline, ticlopidine), white race, number of prior intraocular surgeries, disrupted posterior capsule/anterior hyaloid face (aphakia or anterior chamber intraocular lens), severe hypotony during the first week postoperatively (intraocular pressure $\leq$ 3 mmHg), preoperative IOP, and drop in IOP from preoperative level to postoperative level within the first week.

For other comparisons between DSCH and control groups, Student's *t* test was used for parametric data (age, IOP), Mann–Whitney *U* test for nonparametric data (number of prior surgeries, number of preoperative medications), and Fisher's exact test or chi-square test for proportions (gender, race, hypertension, anticoagulation). Visual acuities were converted into logarithm of the minimum angle of resolution (logMAR) units, and the difference between pre- and post-DSCH logMAR units was calculated.[16] These were averaged and compared (Mann–Whitney *U* test) between the two groups to study the visual outcome of DSCH.

Table 1. Total Cases of Glaucoma Surgery and Delayed Suprachoroidal Hemorrhage

Procedure	Total Number	Number of Delayed Suprachoroidal Hemorrhages	Percent (%)
Trabeculectomy without antimetabolite	615	9	1.5
Trabeculectomy with antimetabolite	1248	30	2.4
Valved tube shunts	72	2	2.8
Nonvalved tube shunts	350	25	7.1
Total	2285	66	2.9

Results

Of 2285 glaucoma filtration procedures, 66 (2.9%) DSCHs were identified. With regard to the type of filtration procedure, DSCH developed in 9 of 615 (1.5%) cases of trabeculectomy without antimetabolite, 30 of 1248 (2.4%) cases of trabeculectomy with antimetabolite, 2 of 72 (2.8%) valved tube shunt implantations, and 25 of 350 (7.1%) nonvalved tube shunt implantations (Table 1). The increased incidence of DSCH after tube shunts compared with trabeculectomy-associated DSCH was statistically significant ($P < 0.0001$, chi-square test) with an odds ratio of 3.2 (Table 2). The incidence of DSCH did not vary significantly over the 14-year period covered by the study.

Given this difference in risk of DSCH based on type of surgery, a case-control study was then performed comparing the groups with hemorrhage to a randomly selected, procedure-matched group without hemorrhage to identify risk factors of DSCH (Table 3). As summarized in Table 4, the risk factors for DSCH after trabeculectomy include preoperative anticoagulation ($P = 0.034$; odds ratio: 3.62) and aphakic or anterior chamber intraocular lens status ($P = 0.013$; odds ratio: 5.76). For tube shunts, the only risk factor found is postoperative hypotony (IOP $\leq$ 3 mmHg; $P = 0.019$; odds ratio: 4.40). Combining all cases of trabeculectomies and tube shunt implantations, the risk factors for DSCH after glaucoma surgery are aphakia/anterior chamber intraocular lens pseudophakia ($P = 0.002$; odds ratio: 4.81), severe postoperative hypotony ($P = 0.033$; odds ratio: 2.37), anticoagulation ($P = 0.034$; odds ratio: 2.70), and white race ($P = 0.012$; odds ratio: 5.99).

The visual outcomes of patients with hemorrhage were poor, with a decrease in logMAR visual acuity from 0.72 (20/105) preoperatively to 1.36 (20/460) at last follow-up ($P < 0.0001$, Wilcoxon signed-rank test). In the control group the mean logMAR decreased slightly from 0.61 (20/81) preoperatively to 0.84

Table 2. Risk of Delayed Suprachoroidal Hemorrhage among Glaucoma-filtering Procedures

Procedure	Incidence of Delayed Suprachoroidal Hemorrhage (%)	P Value	Odds Ratio
Tube shunt:trabeculectomy*	6.4:2.1	<0.0001	3.2
Trabeculectomy with:without antimetabolite†	2.4:1.5	0.23	NS
Tube shunt valved:nonvalved†	7.1:2.8	0.29	NS

NS = not significant.

*Chi-square test.

†Fisher's exact test.

Table 3. Characteristics of Delayed Suprachoroidal Hemorrhage Cases and Controls

	Delayed Suprachoroidal Hemorrhage Cases	Controls	*P* Value
Age (yrs ± SD)			
Trabeculectomy	69.9 ± 17.4	67.3 ± 16.0	0.49*
Tube shunt implant	71.7 ± 15.1	64.7 ± 14.2	0.09*
Male:female			
Trabeculectomy	15:24	19:22	0.51†
Tube shunt implant	12:15	11:16	1.0†
White:African American			
Trabeculectomy	37:2	34:6	0.26†
Tube shunt implant	26:1	22:4	0.35†
Hypertension (%)			
Trabeculectomy	53.8	51.2	0.83†
Tube shunt implant	48.1	48.1	1.0†
Anticoagulation (%)			
Trabeculectomy	35.9	12.2	0.018†
Tube shunt implant	22.2	29.6	0.76†
Prior surgeries (no. ± SD)			
Trabeculectomy	1.0 ± 0.8	0.7 ± 1.0	0.016‡
Tube shunt implant	2.4 ± 1.1	2.0 ± 1.6	0.15‡

*Student's *t* test.

†Fisher's exact test.

‡Mann–Whitney *U* test.

SD = standard deviation.

(20/138) postoperatively ($P = 0.0002$, Wilcoxon signed-rank test). The overall drop in logMAR from preoperative to final follow-up was significantly greater in the DSCH group compared with the control group ($P = 0.004$, Mann–Whitney *U* test). None of the risk factors tested were predictive of final visual outcome.

Discussion

The literature describing DSCH after glaucoma filtration surgery is limited. There is a scarcity of large single-surgeon case series comparing the incidence of DSCH after various types of glaucoma filtration procedures. The largest study to our knowledge involves a consecutive series of 500 glaucoma operations in which DSCH developed in 10 eyes (2%).[6] In another prior study of 432 consecutive cases of trabeculectomy or tube shunt, DSCH developed in 13 cases (3.0%),[7] similar to the incidence reported in other smaller studies[8,9] and this study. There are some reports, however, that describe an incidence of delayed DSCH after glaucoma filtration surgery as high as 6% after trabeculectomy and 5-fluorouracil injections[10] and as high as 8% after Molteno tube placement.[11]

In this series, DSCH occurred more frequently after tube shunt implantation than after trabeculectomy. Although surgical indications and techniques may have evolved over the past decade, particularly with the advent of antimetabolites and newer tube shunt devices and techniques, the incidence of DSCH did not vary appreciably over the 14-year span of this series. Increased risk of DSCH after tube shunt has been reported,[7] and the incidence of DSCH after Molteno tube shunt placement may be as high as 8%.[11] The Ahmed tube shunt, designed to limit postoperative hypotony, is thought to limit the risk of postoperative DSCH; one recent study reported DSCH in 4 of 85 cases (4.7%),[17] and another study noted DSCH in one eye of 60 cases (2%),[18] but it is unclear whether this represents a statistically significant difference from the study involving Molteno tube placement. It is possible that eyes undergoing tube shunt placement have more severe glaucoma with a higher preoperative IOP and a subsequent larger drop in pressure after placement of the tube shunt. In our series, the number of previous intraocular surgeries was not a significant risk factor for DSCH in the trabeculectomy group, the tube shunt group, or overall.

In this series, risk factors for DSCH differed, depending on the type of procedure performed. As noted previously, the risk factors for DSCH after trabeculectomy included preoperative anticoagulation and aphakic or anterior chamber intraocular lens status, whereas those for tube shunts included postoperative hypotony. Age, hypertension, and high preoperative IOP were not found to be risk factors. Of these risk factors, postoperative hypotony would be expected to increase the likelihood of DSCH, given the proposed mechanism for this complication.[19] In particular, one prior histologic study in rabbits described four sequential stages in the development of DSCH: (1) engorgement of the choriocapillaris, (2) followed by suprachoroidal effusion near the posterior pole, (3) stretching and tearing of choroidal and ciliary body vessels, (4) followed by extravasation of blood from the torn vessels at the ciliary body base to

Table 4. Logistic Regression Models–Risk Factors for Delayed Suprachoroidal Hemorrhage

Variables	Delayed Suprachoroidal Hemorrhage Cases	Controls	*P* Value	Odds Ratio
White race—overall (in %)	95.5	82.4	0.012	5.99
Anticoagulation—overall (in %)	33.3	19.1	0.034	2.70
Anticoagulation—trabeculectomy (in %)	35.9	12.2	0.034	3.62
Hypotony (≤3 mmHg)—overall (in %)	40.9	25.0	0.033	2.37
Hypotony (≤3 mmHg)—tube shunt (in %)	37.0	7.4	0.019	4.40
Aphakia/ACIOL—overall (in %)	34.9	11.8	0.002	4.81
Aphakia/ACIOL—trabeculectomy (in %)	33.3	7.3	0.013	5.76

ACIOL = anterior chamber intraocular lens.

result in DSCH.[20] Ocular hypotension can lead to engorgement of the choroid, the first step in the development of DSCH.[19]

Some of previously reported risk factors of DSCH after filtering surgery include old age, aphakia, postoperative hypotony, vitrectomy, general anesthesia, increased venous pressure, use of fluorouracil, and high myopia.[5–7,11–13] As in this study, several prior studies suggest that aphakia is a statistically significant risk factor for DSCH.[5,6,7,13,21,22] One prior study of 500 cases noted an incidence of DSCH of 6.6% in eyes that were aphakic.[6] In contrast, in the Fluorouracil Filtering Surgery Study, 10 of 162 eyes (6.2%) that had undergone previous cataract extraction developed a nonexpulsive suprachoroidal hemorrhage after filtering surgery, and high preoperative IOP represented the only statistically significant risk factor for DSCH.[12] The reason for this discrepancy in risk factors among these studies is unclear, although the number of cases of DSCH in many of these series is relatively small.

In this series, the visual outcomes of patients with DSCH were poor, with a decrease in logMAR visual acuity from 0.72 to 1.36, which was statistically significant compared with the controls ($P < 0.009$). Prior studies have also documented poor visual outcomes in these cases.[5,6,11,22–24] This decline in visual function is not unexpected, because DSCH can lead to vitreous hemorrhage, retinal detachment, hypotony, and other sight-threatening complications. Several studies have previously suggested that the visual outcome correlates with increasing DSCH extent and complexity.[23,24]

In summary, this study has several limitations related to its retrospective design. However, to our knowledge, this study represents the largest case series of DSCH reported to date, and all the procedures were performed by a single surgeon. The results from this study amplify and corroborate some findings from other smaller studies, suggesting that DSCHs occur more frequently after tube shunts compared with trabeculectomies, but also suggesting that risk factors for DSCH may differ based on the type of procedure performed. Caution should be exercised when operating on patients with known risk factors, because the outcomes after DSCH are generally poor.

References

1. Ware, J. A Treatise on the Cataract (M. de Wenzel, Jun. Traité de la cataracte. Paris, 1786). Birmingham: Gryphon Editions, 1791;176–80.
2. Terson A. Remarques sur les hémorrhagies sous-choroïdiennes traumatiques et sur les hémorrhagies expulsives. Arch d'Ophtalmol 1893;13:446–53.
3. Verhoeff FH. Scleral puncture for expulsive sub-choroidal hemorrhage following sclerostomy, scleral puncture for post-operative separation of the choroid. Ophthalmic Record 1915;24:55–9.
4. Speaker MG, Guerriero PN, Met JA, et al. A case-control study of risk factors for intraoperative suprachoroidal expulsive hemorrhage. Ophthalmology 1991;98:202–10.
5. Givens K, Shields MB. Suprachoroidal hemorrhage after glaucoma filtering surgery. Am J Ophthalmol 1987;103:689–94.
6. Ruderman JM, Harbin TS Jr, Campbell DG. Postoperative suprachoroidal hemorrhage following filtration procedures. Arch Ophthalmol 1986;104:201–5.
7. Canning CR, Lavin M, McCartney ACE, et al. Delayed suprachoroidal haemorrhage after glaucoma operations. Eye 1989;3:327–31.
8. Levkovitch-verbin H, Goldenfeld M, Melamed S. Fornix-based trabeculectomy with mitomycin-C. Ophthalmic Surg Lasers 1997;28:818–22.
9. Nguyen QH, Budenz DL, Parrish RK II. Complications of Baerveldt glaucoma drainage implants. Arch Ophthalmol 1998;116:571–5.
10. Rockwood EJ, Parrish RK II, Heuer DK, et al. Glaucoma filtering surgery with 5-fluorouracil. Ophthalmology 1987;94:1071–8.
11. Paysse E, Lee PP, Lloyd MA, et al. Suprachoroidal hemorrhage after Molteno implantation. J Glaucoma 1996;5:170–5.
12. Risk factors for suprachoroidal hemorrhage after filtering surgery. The Fluorouracil Filtering Surgery Study Group. Am J Ophthalmol 1992;113:501–7.
13. Chu TG, Green RL. Suprachoroidal hemorrhage. Surv Ophthalmol 1999;43:471–86.
14. Frenkel REP, Shin DH, Prevention and management of delayed suprachoroidal hemorrhage after filtration surgery. Arch Ophthalmol 1986;104:1459–63.
15. Gail M, Williams R, Byar DP, Brown C. How many controls? J Chron Dis 1976;29:723–31.
16. Bailey IL, Lovie JE. New design principles for visual acuity letter charts. Am J Optom Physiol Optics 1976;53:740–5.
17. Ayyala RS, Zurakowski D, Smith JA, et al. A clinical study of the Ahmed glaucoma valve implant in advanced glaucoma. Ophthalmology 1998;105:1968–76.
18. Coleman AL, Hill R, Wilson MR, et al. Initial clinical experience with the Ahmed glaucoma valve implant. Am J Ophthalmol 1995;120:23–31.
19. Wolter JR, Garfinkel RA. Ciliochoroidal effusion as precursor of suprachoroidal hemorrhage: a pathologic study. Ophthalmic Surg 1988;19:344–9.
20. Beyer CF, Peyman GA, Hill JM. Expulsive choroidal hemorrhage in rabbits. A histopathologic study. Arch Ophthalmol 1989;107:1648–53.
21. Ariano ML, Ball SF. Delayed nonexpulsive suprachoroidal hemorrhage after trabeculectomy. Ophthalmic Surg 1987;18:661–6.
22. Gressel MG, Parrish RK II, Heuer DK. Delayed nonexpulsive suprachoroidal hemorrhage. Arch Ophthalmol 1984;102:1757–60.
23. Scott IU, Flynn HW Jr, Schiffman J, et al. Visual acuity outcomes among patients with appositional suprachoroidal hemorrhage. Ophthalmology 1997;104:2039–46.
24. Wirostko WJ, Han DP, Mieler WF, et al. Suprachoroidal hemorrhage. Outcome of surgical management according to hemorrhage severity. Ophthalmology 1998;105:2271–5.