Suprachoroidal Hemorrhage in Penetrating Keratoplasty

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ABSTRACT
Nine cases of intraoperative expulsive suprachoroidal hemorrhage occurred in a series of 2011 consecutive penetrating keratoplasties (an incidence of 0.45%). In four cases, the complication was directly related to the anesthesia technique. The incidence of hemorrhage was 1.0% in the eyes with preoperative anterior chamber intraocular lenses (IOLs), an incidence significantly higher than for any other associated condition ($P < .02$). Four of the nine patients recovered a postoperative visual acuity of 20/70 or better. We discuss reasons for the relatively high incidence of hemorrhage during penetrating keratoplasty; its occurrence in relation to the type of anesthesia used, prior intraocular surgery, types of surgery performed together with the penetrating keratoplasty, and the presence of an anterior chamber IOL; and the risks introduced by hemorrhage in a fellow eye and by a previous hemorrhage in the same eye.

Intraoperative expulsive suprachoroidal hemorrhage has been reported to have occurred during surgery for cataracts, glaucoma, retinal detachment, and penetrating keratoplasty, and after suture removal following penetrating keratoplasty. In a review of the world literature, Pau found that approximately one third of all suprachoroidal hemorrhages occurred during surgery, one third from 3 to 6 hours after surgery, and one third at some later point. Taylor reported a 0.17% incidence for all intraocular surgeries, while Purcell et al reported 14 cases with penetrating keratoplasty procedures. In a review of over 35,000 intraocular surgical procedures at New York Eye and Ear Infirmary, Speaker et al found an overall incidence of 0.19%, and an incidence during penetrating keratoplasty of 0.56%.

We analyzed the incidence and possible predisposing causes of suprachoroidal hemorrhages occurring in a series of 2011 consecutive penetrating keratoplasties.

MATERIALS AND METHODS
We reviewed all of the penetrating keratoplasty procedures performed between July 1982 and February 1991 for the occurrence of intraoperative expulsive suprachoroidal hemorrhage. All of the surgeries were performed by one of two corneal surgeons (F.W.P. or W.E.W.), or by fellows-in-training, under the direct supervision of these surgeons. The data collection methods have been previously reported.

For purposes of this study, an intraoperative expulsive suprachoroidal hemorrhage was defined as a sudden movement forward towards the pupil during surgery of a dark retinal/choroidal detachment, with threatened or actual expulsion of intraocular contents. All such instances were diagnosed intraoperatively and documented in the operative report. Cases in which positive vitreous pressure was not accompanied by a definitive hemorrhagic choroidal bulging, or in which
postoperative funduscopic examination failed to show any evidence of choroidal hemorrhage were excluded.

The various diagnostic groups uncovered were further classified in terms of preoperative lens status—phakic, aphakic, or pseudophakic. The diagnostic and intraocular lens (IOL) groups then were compared using the chi-square test.

RESULTS

A consecutive series of 2011 penetrating keratoplasty procedures in 1668 patients were performed between July 1982 and February 1991. The mean age of the patients was 68.8 years (range, 3 to 97 years). Of the 2011 procedures, 708 were in males and 1303 in females; 1033 in right eyes and 978 in left eyes. Table 1 shows the preoperative diagnoses and the type of anesthesia used.

Suprachoroidal hemorrhage occurred in nine of the procedures.

Among all of the groups analyzed, the only one with a significantly higher incidence of suprachoroidal hemorrhage than any other group was the one comprised of eyes with anterior chamber IOLs ($P < .02$). For all of the other groups analyzed, differences in terms of the incidence of hemorrhage either were not significant, or the incidence was too low to derive statistical significance.

The incidence was similar in general and local anesthesia cases. However, it is important to note that local anesthesia was primarily used for short and simple cases, while general anesthesia was used for more complicated ones. There was no significant correlation between developing a hemorrhage and preoperative high blood pressure, diabetes mellitus, heart disease or intraoperative tachycardia, and arrhythmia or blood-pressure fluctuations.

Table 2 summarizes the preoperative, operative, and postoperative data of the nine keratoplasties complicated by suprachoroidal hemorrhage. The ages of the patients (two men and seven women) ranged from 33 to 86 years (mean, 66.3 years). Seven cases occurred under general anesthesia; two under local anesthesia. Of the seven cases under general anesthesia, two had received an additional preoperative retrobulbar block. Before July 1986, retrobulbar blocks were used along with general anesthesia to minimize postoperative pain and the chance of suprachoroidal hemorrhage. This practice was abandoned in cases with no appreciable change in postoperative pain. Hemorrhages directly related to complications from general anesthesia developed in three patients (patients 1, 2, and 4; Table 2). At least one case, and possibly two, were related to the use of local anesthesia. A coughing attack while under local anesthesia caused an immediate suprachoroidal hemorrhage in patient 9.

A total of 13 previous intraocular surgeries had been performed in eight of the nine eyes with suprachoroidal hemorrhage. Subsequent intraocular procedures were completed in five eyes without complications, including two eyes that required repeat penetrating keratoplasty (Table 2).

Final visual acuities for the 9 eyes were: light perception to counts fingers in 4; 20/400 in 1; 20/70 in 1; and 20/40 or better in 3. The final intraocular pressure (IOP) in all but two patients (6 and 9) was less than 20 mm Hg on no antiglaucoma therapy. Patient 6 was on antiglaucoma medication before and after penetrating keratoplasty.

DISCUSSION

The incidence of intraoperative expulsive suprachoroidal hemorrhage during penetrating keratoplasty is reported to be higher than for other intraocular procedures. The incidence we found, 0.45%, is similar
to that previously reported. Various reasons for this higher incidence with penetrating keratoplasty have been suggested. Some have pointed out that intra-arteriolar pressure in the suprachoroidal space is unopposed by IOP for a relatively longer period of time during penetrating keratoplasty, especially when additional procedures such as vitrectomy, intraocular lens removal/exchange, etc, are performed. Additionally, eyes for which the latter are indicated often are inflamed, congested, and presumably at higher risk for hemorrhage. In the present series, all but one eye had undergone prior intraocular surgery, and three had glaucoma, a known risk factor. To reduce the probability of choroidal hemorrhage, Taylor has recommended that local anesthesia be used in all intraocular procedures. The incidence of suprachoroidal hemorrhage under general anesthesia in our series was 0.45%, nearly identical to that among eyes under local anesthesia (0.46%). Straight penetrating keratoplasties were performed under both local and general anesthesia, with no instance of intraoperative hemorrhage in either group. During the period in which the surgeries we reviewed were performed, general anesthesia was preferred in cases which were generally longer and more complicated because penetrating keratoplasty was to be combined with additional procedures. An anesthesiologist cognizant of the risk of intraoperative hemorrhage is crucial if general anesthesia is to be used in such surgery.

Of the seven hemorrhages that occurred in our series under general anesthesia, three were directly related to the patient’s “bucking” on the endotracheal tube or movement caused by the anesthesiologist. Similar findings have been reported. The other four cases were unrelated to anesthetic complications or resulted from tachycardia. If general anesthesia is used, we believe complete paralysis of the patient throughout the procedure is required. Also, the anesthesiologist should be warned that, when a running suture closure is used, the eye will not be firm until the end of surgery.

Nerve simulators are used by some anesthesiologists to gauge the degree of paralysis. However, the use of these simulators on skeletal muscles, especially the diaphragm, is not fool-proof. A nerve stimulator showed complete paralysis just prior to “bucking” and subsequent suprachoroidal hemorrhage in patient 1 in our series. Four other patients “bucked” on the endotracheal tube within a very short time after nerve simulators had shown no response. In one of these cases, vitreous was lost before the patient could be paralyzed again. Fortunately, no hemorrhages occurred in any of these cases.

The difficulty of doing long cases under local anesthesia is demonstrated by patient 9. This patient was lying comfortably and quietly under local anesthesia. The corneal button was removed and an anterior vitrectomy was being performed when the patient suddenly began a protracted cough. In trying to suppress the cough, a tremendous valsalva maneuver was created, which immediately caused an exsanguineous choroidal hemorrhage. An adequate general anesthesia probably would have prevented this hemorrhage.

The case of patient 7 is also noteworthy. This patient was phakic, with no suspected risk factors such as high blood pressure, glaucoma, or prior intraocular surgery. Surgery was performed under local anesthesia without  

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age</th>
<th>IOP</th>
<th>Diagnosis</th>
<th>Anesthesia</th>
<th>IOL Removed</th>
<th>Factors Contributing to Hemorrhage</th>
<th>Subsequent Surgery</th>
<th>Final Vision</th>
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<tr>
<td>1</td>
<td>86</td>
<td>15</td>
<td>PBK</td>
<td>General</td>
<td>Stableflex</td>
<td>“Bucked” on tube</td>
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<td>20/400</td>
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<td>22</td>
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<td>Stableflex</td>
<td>Movement caused by insertion of arterial line</td>
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<tr>
<td>3</td>
<td>79</td>
<td>14</td>
<td>PBK</td>
<td>General</td>
<td>Stableflex</td>
<td>Total hyphema</td>
<td>PPV, buckle</td>
<td>LP</td>
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<tr>
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<td>12</td>
<td>PBK</td>
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<td>“Bucked” on tube</td>
<td>PKP</td>
<td>20/40</td>
</tr>
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<td>33</td>
<td>20</td>
<td>Failed graft, aphakia</td>
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<td>None</td>
<td>Coughing attack</td>
<td>PPV, IOL, Molteno</td>
<td>20/70</td>
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</tbody>
</table>

IOP = intraocular pressure, IOL = intraocular lens, PBK = pseudophakic bullous keratopathy, CF = counts fingers, ABK = aphakic bullous keratopathy, HM = hand movements, PAS = peripheral anterior synechiae, LP = light perception, PPV = pars plana vitrectomy, PKP = penetrating keratoplasty, AV = anterior vitrectomy.
complications, and no movement or valsalva-type maneuver occurred. Positive vitreous pressure was present after removal of the corneal button, pushing the lens-iris diaphragm forward. A vitreous tap was performed and liquid vitreous was aspirated. The lens-iris diaphragm dropped back. However, the lens began to protrude forward again, before the capsulotomy was completed. There was immediate vitreous loss through a zonular dehiscence. A dark hemorrhagic mass could be seen in the fundus. Two sclerotomies were performed. Lens material and vitreous were removed as completely as possible and the donor button was sutured in place. The sclerotomy sites were opened repeatedly to allow continual drainage. Whether the initial positive vitreous pressure was due to an undetected hemorrhage or whether the vitreous tap caused the hemorrhage is unknown.

This study underscores the difficulties of statistically analyzing a complication with an inherently low incidence such as intraoperative expulsive suprachoroidal hemorrhage. Eight of the nine patients who had hemorrhages had had a total of 13 previous ocular surgeries. However, when the entire study population was considered, there was no significant difference between the incidence of hemorrhage among those with prior intraocular surgery and those without.

The types of surgery performed also made no significant difference. No hemorrhages occurred during any of the 544 straight penetrating keratoplasty procedures performed. Clinically, it would seem that a simple penetrating keratoplasty would be less likely to be complicated by a suprachoroidal hemorrhage than a keratoplasty combined with other procedures. However, we found no significant difference in the incidence of hemorrhages in these two groups.

Table 2 shows that six of the nine eyes with hemorrhages had an anterior chamber IOL. There were no indications that the initial cataract surgeries was complicated. However, the very presence of an anterior chamber IOL seems to predispose an eye to hemorrhage ($P < .02$). This may be due to chronic low-grade inflammation caused by the IOL, or to the additional manipulations required to remove it during an exchange procedure.

Verhoeff reported bilateral choroidal hemorrhage in two cases, and others have concluded that the fellow eye of an eye with a choroidal hemorrhage is at higher risk. Bilateral suprachoroidal hemorrhage occurred in 2 of 25 cases in Davison's two series. Our findings were consistent with these. Patient 8 was referred due to a previous choroidal hemorrhage that resulted in the loss of her eye. The patient had severe cardiovascular disease, systemic hypertension, and severe glaucoma. When initially evaluated, the patient already had undergone a number of glaucoma procedures to the remaining eye and was on maximum topical antiglaucoma therapy. The hemorrhage occurred while an anterior vitrectomy was being performed under uncomplicated general anesthesia. There were no fluctuations in blood pressure or heart rate during the procedure.

Because the incidence of suprachoroidal hemorrhages is low, no definitive statement can be made with regard to whether or not an eye in which a suprachoroidal hemorrhage occurred during a previous penetrating keratoplasty is at higher risk for hemorrhage during subsequent surgery. However, we conclude, as others have, that when clearly indicated, further surgery can be performed safely in these eyes, with good results. Subsequent surgery was performed without complications in five of our nine hemorrhage cases. Nevertheless, we prefer to wait 6 months or more before attempting further surgery, unless retinal complications such as detachment occur.

Indications for subsequent surgery were retinal detachment (patient 3), failed graft (patients 4 and 5), and uncontrolled glaucoma and aphakia requiring secondary IOL (patient 9). At the time of regraft, patient 5 also required anterior chamber reconstruction for extensive peripheral anterior synechiae. The following day, the retained anterior chamber IOL was found touching the corneal graft and, accordingly, was exchanged for an iris-sutured posterior chamber lens. Both surgeries were performed under general anesthesia without complications.

Clearly, a suprachoroidal hemorrhage does not necessarily doom an eye. Since Verhoeff and Vail initial reports of success in salvaging eyes suffering from suprachoroidal hemorrhages, several authors have reported good results achieved by prompt recognition and early intervention. The cases in our series were managed according to the principles outlined by Gerard et al and Bair. All were treated with sclerotomies, prompt wound closure, and reformation of the anterior chamber. Vitreous was cleaned from the wound and anterior chamber as meticulously as possible. All patients received high-dose systemic corticosteroids (80 to 120 mg/day) postoperatively. Lambrou et al have reported that the use of systemic corticosteroids in the initial management of these patients improves their prognosis. IOPs were monitored closely and treated with systemic carbonic anhydrase inhibitors and topical beta blockers as needed. A predominant feature in some patients is postoperative pain, often out of proportion to clinical findings (patients 1 and 9). However, five of our nine hemorrhage patients had minimal postoperative pain. Samuels has suggested that the intense pain is caused by the stretching of the long posterior ciliary nerve. This may be minimized by maintaining patent sclerotomy sites, allowing for continual drainage of the suprachoroidal space.
REFERENCES