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Anemia and Hypotension as Contributors to Perioperative Loss of Vision

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INJURIES to the eye during nonophthalmologic surgery such as corneal abrasions usually are traumatic. More serious complications of neurovascular-ophthalmologic origin are rare and have not been reported in the anesthesia literature. Nevertheless, there are several reports in the ophthalmologic and surgical literature of acute loss of vision from optic nerve infarction associated with spontaneous and iatrogenic hemorrhage with anemia,¹⁻¹⁰ severe hypotension,¹¹⁻¹³ or both. These cases are important when one considers recent guidelines recommending transfusions at lower hemoglobin concentrations than previously commonly practiced.^{14,15} This relative anemia associated with acute blood loss and/or hypotension may predispose the patient to optic injury.¹⁶ We present six cases of ischemic optic neuropathy (ION) causing postoperative vision loss after general anesthesia associated with relative risk factors of perioperative anemia, blood loss, and hypotension.

Methods

This study was approved by the Joint Committee on Clinical Investigation. We reviewed all patient charts from our institution over 10 yr who underwent a surgical procedure and had a concurrent discharge diag-

nosis of ION (ICD 37741, 37749, 3499, and 36900). Patients with previous eye disease, direct eye injury, or other explainable causes of ION were excluded from this series. None of the patients presented here had known visual field defects nor significantly decreased visual acuity preoperatively.

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Case 1

C. B. was a 68-yr-old man scheduled for coronary artery bypass grafting. His medical history was significant for systemic hypertension, cigarette smoking, chronic obstructive pulmonary disease, asbestosis, hypercholesterolemia, and angina. His medications included albuterol, theophylline, nicardipine, and furosemide. His preoperative blood pressure was 138/78 mmHg and pulse was 88 beats/min. His preoperative hemoglobin concentration was 14.0 g/dL. The patient underwent an apparently uneventful five-vessel coronary artery bypass grafting. The surgical time was 4 h, 13 min with a cross clamp time of 82 min and a bypass time of 132 min (table 1). The patient's lowest recorded hemoglobin concentration was 6.0 g/dL and lowest recorded mean blood pressure was 60 mmHg (table 2). The postoperative course was complicated by a complaint of blurred vision on postoperative day 2.

When examined 5 days after surgery, the patient had visual acuity of 20/200 in both eyes. The right visual field showed only an inferior island of vision. The left visual field showed generalized constriction associated with a dense central scotoma. There was no relative afferent pupillary defect. Both optic discs were pale and swollen.

Eight days after initial examination, visual acuity had improved somewhat to 20/100 the right eye and 20/80 in the left eye. The right visual field had enlarged, but both fields were constricted. Both optic discs were pale with no significant cupping.

Case 2

T. P. was a 74-yr-old man scheduled for emergency coronary artery bypass grafting for unstable angina. The patient had undergone a coronary artery bypass grafting 3 yr earlier. His medications included lidocaine, heparin, intravenous nitroglycerin, diltiazem, propranolol, and aspirin. On admission, the patient's blood pressure was 130/80 mmHg and hemoglobin concentration was 14.0 g/dL. Over the next

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several hours, he became hypotensive with systolic blood pressures recorded as low as 65 mmHg. The patient was treated with dopamine, dobutamine, and epinephrine, and subsequently an intraaortic balloon was inserted to stabilize his vital signs. Six days after admission, the patient underwent a three-vessel coronary artery bypass grafting (table 1). The surgical time was 7 h, 25 min with a cross clamp time of 90 min and a bypass time of 148 min. The lowest recorded hemoglobin concentration was 6.8 g/dL and the lowest blood pressure was 75/52 mmHg (table 2). The patient was transferred to the intensive care unit, where his vital signs stabilized. The patient complained of visual problems on postoperative day 4.

When examined 5 days after surgery, visual acuity was 20/25 in the right eye and 20/20 in the left eye. There was a dense superior altitudinal defect in the visual field of the right eye. The left visual field was normal. There was a right relative afferent pupillary defect, and the right optic disc was swollen and hyperemic. The left optic disc was normal, although it had a very small central cup.

Eight days after the first examination, the patient's visual acuity and visual fields were unchanged. There was a right afferent pupillary defect; however, the right optic disc swelling had largely resolved, and the disc appeared pale, particularly inferiorly, and showed no central cupping.

Case 3

M. R. was a 62-yr-old woman scheduled for peripheral vascular surgery. Her medical history was significant for coronary artery disease, congestive heart failure, two previous coronary artery bypass grafting procedures, placement of automatic implantable cardioverter defibrillators for ventricular dysrhythmia, myocardial infarction, a transient ischemic attack, hypertension, and vascular surgery consisting of a right iliofemoral and a femoral-popliteal bypass graft. Her medications included pentoxifylline, dipyridamole, digoxin, and aspirin. Her preoperative blood pressure was 160/110 mmHg and pulse was 96 beats/min. Her preoperative hemoglobin concentration was 15.4 g/dL. The patient underwent an aorta-bifemoral bypass procedure lasting 7 h, 35 min (table 1). Her estimated blood loss was 2,500 ml. She received 4 units of packed erythrocytes, 1 unit of hydroxy methyl starch solution, and 11,000 ml crystalloid. The patient was transferred to the intensive care unit postoperatively. In the perioperative period, the lowest hemoglobin concentration was 8.0 g/dL, and the lowest recorded blood pressure was 95/55 mmHg

(table 2). On postoperative day 1, the patient complained of cloudy vision.

When examined 3 days after surgery, her visual acuity was no light perception in the right eye, but 20/20 in the left eye. The left visual field showed a dense superior altitudinal-arcuate defect. There was a marked right relative afferent pupillary defect. Both optic discs were hyperemic and swollen.

Two and a half years later, the patient was unable to perceive light with the right eye. Left eye vision was 20/20, and the superior visual field defect was present, although somewhat smaller. There was a marked right relative afferent pupillary defect, and both optic discs were pale, right more than left, with no significant cupping.

Case 4

E. O. was a 13-yr-old boy with severe scoliosis scheduled for instrumentation and fusion of his spine. His medical history was significant for congenital myopathy. The patient was taking no medications. His preoperative blood pressure was 110/55 mmHg and hemoglobin concentration was 9.9 g/dL. The patient underwent the spine surgery while in the prone position under general anesthesia using deliberate hypotension (table 1). The patient's eyes were examined repeatedly during the surgery to confirm that there was no direct pressure on them. His estimated blood loss was 8 l. He received 2 units of cell-saver blood, 7 units of packed erythrocytes, and 10,300 ml of crystalloid. He also received 6 units of platelets and 7 units of fresh-frozen plasma. The lowest recorded intraoperative hemoglobin concentration was 7.1 g/dL, and the lowest recorded mean blood pressure was 52 mmHg (table 2). On postoperative day 1, the patient complained of visual blurring.

When examined 24 h after surgery, the patient's visual acuity was 20/30 in the right eye and 20/400 in the left eye. The right visual field was normal. The left visual field was limited to a superior island of vision. There was a marked left afferent pupillary defect. Both optic discs appeared normal. Over the next several weeks, visual acuity improved in the left eye, and the visual field defect improved somewhat.

Four years after surgery, the patient's visual acuity was 20/20 in the right eye and 20/60 in the left eye. There was a left afferent pupillary defect, and the left optic disc was pale.

Case 5

K. H. was an 81-yr-old woman scheduled for coronary artery bypass grafting. Her medical history was significant for angina, systemic hypertension, hypothyroidism, and glaucoma. Her medications included nitroglycerin paste 1", diltiazem, propranolol, furosemide, Synthroid, and estrogen. Her preoperative blood pressure was 120/60 mmHg and preoperative hemoglobin concentration was 11.8 g/dL. The patient underwent a four-vessel coronary artery bypass grafting (table 1). The surgery lasted 4 h, 50 min with a cross clamp time of 77 min and a bypass time of 112 min. The patient received 2 units of packed erythrocytes during cardiopulmonary bypass. The intraoperative course was uneventful. The lowest recorded hemoglobin concentration was 5.8 g/dL, and the lowest recorded blood pressure was 60/40 mmHg (table 2). On postoperative day 3, the patient complained of blurred vision.

Table 1. Patient Demographics

Case	Age (yr)	Type of Surgery	Preoperative Hemoglobin (g/dl)	Preoperative Systolic/Diastolic Blood Pressure (Mean) (mmHg)
1	68	CAB × 5	14.0	138/78 (98)
2	74	CAB × 3	11.4	130/80 (97)
3	62	Aortobifemoral bypass	15.4	160/110 (127)
4	13	Spine instrumentation	9.9	110/55 (73)
5	81	CAB × 4	11.8	120/60 (80)
6	51	Abdominal exploration	8.2	90/48 (62)

CAB = coronary artery bypass.

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Table 2. Intraoperative and Postoperative Hemoglobin and Blood Pressure

Case	Lowest Hgb with Concurrent BP			Lowest BP with Concurrent Hgb			Time of Diagnosis of Ischemic Optic Neuropathy (postoperative days)
	Lowest Hgb (% change) (g/dl)	Concurrent Systolic/Diastolic BP, mean (% change mean) (mmHg)	Duration of Anemia (h)	Lowest Systolic/Diastolic BP, mean (% change mean) (mmHg)	Concurrent Hgb (g/dl)	Duration of Hypotension (h)	
1	6.0 (57)	95/45, 62 (37)	0.5	NA, 60 (39)	9.0	2.0	5
2	6.8 (40)	NA, 55 (43)	1.5	75/52, 60 (38)	9.2	2.0	5
3	8.0 (48)	128/70, 89 (29)	72	95/55, 68 (46)	11.0	0.5	3
4	7.1 (28)	NA, 60 (18)	1.75	NA, 52 (29)	7.6	1.75	1
5	5.8 (51)	NA, 79 (1.2)	0.5	80/50, 55 (31)	6.7	1.0	3
6	6.0 (27)	90/60, 70 (-13)	1.0	60/40, 47 (25)	7.5	0.25	5

Hgb = hemoglobin; BP = blood pressure; NA = not available.

When examined 3 days after surgery, the patient's visual acuity was 20/40 in the right eye and "hand motion at 6 inches" in the left eye. The right visual field was normal. The left visual field showed mild peripheral constriction associated with a dense central scotoma. There was a left relative afferent pupillary defect. Both optic discs appeared normal.

Six months later, the patient's right eye was normal. Left eye vision had improved to 20/200. There was a nasal visual field defect. The relative afferent pupillary defect was present on the left, and the left optic disc was pale.

Case 6

L. M. was a 51-yr-old woman with a history of Crohn's disease complicated by multiple gastrointestinal fistulas who underwent abdominal exploration. Her preoperative blood pressure was 90/48 mmHg and preoperative hemoglobin concentration was 8.2 g/dL (table 1). Intraoperatively, the patient received 7 units of packed erythrocytes, 2 units of fresh-frozen plasma, 6 units of platelets, and 16 l of crystalloid. Her lowest recorded hemoglobin concentration was 6.0 g/dL, and her lowest recorded blood pressure was 60/40 mmHg (table 2). Her postoperative course was uneventful except for a complaint of changes in her vision.

When examined 5 days after surgery, the patient's visual acuity was only light perception in both eyes. Both pupils were barely reactive to light, although they reacted normally to proprioceptive stimuli. Both optic discs were normal in appearance.

Eight days later, the patient had bare light perception in both eyes. The pupils were poorly reactive to light stimulation, and both optic discs were normal. The patient was not seen again at our hospital, but her ophthalmologist reported that she never regained visual acuity and that her optic discs eventually became pale.

Discussion

These six cases illustrate a potentially devastating adverse outcome during anesthesia and surgery not previously reported in the anesthesia literature. Ischemic optic neuropathy may have multifactorial risk factors; however, anemia and associated hypotension seem to be the most significant contributors to this form of

postoperative vision loss. Whereas defined lower limits of either hemoglobin concentration or blood pressure levels cannot unequivocally account for the ION observed in our patients, several inferences can be made from this case series. All the patients who developed ION had a period of significant anemia (hemoglobin < 8.0 g/dL) ranging from 30 min to 72 h (table 2). In addition, all the patients experienced hypotension with a decrease in their mean blood pressure from preoperative levels ranging from 24% to 46% for 15 min up to 2 h (table 2). These cases suggest that, although severe anemia alone may not cause ION, even a short episode of hypotension in an already anemic patient may predispose the patient to ION-induced vision loss.

The recent changes in transfusion practice may lead to an increase in the incidence of postoperative ION. Although the risks and concern for the hematologic spread of disease has been well established in the medical community, the anxiety surrounding the spread of acquired immunodeficiency syndrome has forced the medical profession to reevaluate transfusion criteria. Transfusion practice has changed greatly over the last decade. Transfusion of whole blood and erythrocytes reached a peak of 12.2 million units in the United States in 1986 and has declined since that time.¹⁷ Several guidelines have been proposed. The American College of Physicians recommends "in asymptomatic, normovolemic patients with anemia who are at risk, transfusion is not indicated unless a deterioration in vital signs is seen or unless the patients develops symptoms."¹⁸ Other proposed guidelines for erythrocyte practice have incorporated transfusion triggers into appropriateness criteria. A threshold of 8 g/dL of hemoglobin concentration was suggested by the Transfusion Practice Committee of the American Association of

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Blood Banks,¹⁵ whereas a threshold of 7 g/dL was suggested by the National Institutes of Health Consensus Conference on Perioperative Blood Transfusion.¹⁴ The range of anemia in our case series was 5.8–8.0 g/dL. Therefore, at their nadir, the hemoglobin concentrations in two of our subjects (4 and 5) were greater than the trigger level, in one (2) the hemoglobin concentration was only slightly less than the recommended trigger level, and in three (1, 3, and 6) the hemoglobin concentration went 1–1.2 g/dL less than the trigger level for erythrocyte transfusion. Therefore, two patients, and possibly a third patient, would not have been transfused if the Consensus Conference recommendations were followed. Also, in the perioperative period, changes in hemoglobin concentration can occur rapidly and without warning.

If the decision to transfuse is made according to a specific level, the anemia may worsen rapidly before the blood has arrived and is given. Therefore, the duration of the anemia also will be a risk factor in the possible morbidity associated with anemia. While Levine *et al.* showed no effect of prolonged anemia in baboons, the number of subjects was small, and no other perturbations such as hypotension occurred.¹⁹

Hypotension, both relative and absolute, is a major hemodynamic disturbance that can lead to blindness. Several individual cases of vision loss after an acute hypotensive event have been reported. Such diverse causes of the hypotension have included hemodialysis¹² and spontaneous gastrointestinal hemorrhage.^{1,3,4,6–10} Blood loss leading to loss of vision also has been reported after various types of surgeries, including oral surgery,^{20,21} orthopedic procedures,²² and coronary artery bypass grafting.^{23,24}

Most patients who have experienced postoperative ION have been older than 40 yr and have been suffering from a variety of systemic illnesses, including systemic hypertension, cardiac disease, and renal failure. This was true in four of these cases (1, 2, 3, and 5). On the other hand, not all patients in whom postoperative ION developed have these risk factors, as illustrated by two of these cases (4 and 6), suggesting that acute anemia, systemic hypotension, or both are sufficient to induce the condition by themselves.

The patient may complain of visual loss immediately upon awakening from surgery or several days later but almost always within 1 week of surgery. In some cases, patients noted blurred vision immediately after surgery but did not complain about it because they thought it was a normal postoperative phenomenon. In other

cases, patients were confused and lethargic immediately after surgery and complained of visual blurring only when they had begun to recover. In other cases, patients complained of visual loss immediately after surgery, but several days elapsed before an ophthalmologic consultation was obtained. Three of our patients (1, 3, and 6) complained of blurred vision in the immediate postoperative period. The visual complaints prompted an immediate ophthalmologic evaluation in only one of these patients (4). An ophthalmologic consultation was not obtained until postoperative day 3 for one patient (3) and postoperative day 5 for the other (6). Of the other three patients, one (1) complained of blurred vision on postoperative day 2, but a consultation was not requested until day 5; one (5) complained of blurred vision on day 3 and was evaluated the same day; and one (2) complained of blurred vision on day 4 and was examined the next day. It is clear, therefore, that the significance of visual complaints referable to postoperative ION is not always apparent.

Postoperative ION may occur in one eye or both eyes. Among our six patients, three (1, 3, and 6) experienced loss of visual function in both eyes, and the other three (2, 4, and 5) lost vision in one eye. The range of visual loss, as exemplified by our patients, is broad, ranging from no light perception in one case (patient 3) to 20/20. Visual field defects also are variable and include nonspecific constriction, quadrantic defects, and altitudinal defects. Patients who experience unilateral or markedly asymmetric bilateral ION invariably have a relative afferent pupillary defect on the side of the more affected eye. Ophthalmoscopic examination of patients with postoperative ION may reveal swelling of the optic disc (anterior ION) as noted in three of our patients (1, 2, and 3) or a normal appearing optic disc (posterior or retrobulbar ION) as noted in the other three patients (4, 5, and 6). In all cases, however, the optic disc eventually becomes pale. All three of the patients who suffered anterior ION had somewhat small optic discs with little or no cupping, consistent with the type of disc at risk for anterior ION.²⁵ It may be that the configuration of the optic disc in patients who develop postoperative ION determines whether the optic neuropathy is of the anterior or posterior variety.

Histopathologic studies of affected optic nerves have been performed in only a few cases of postoperative ION. The principal pathologic changes are interstitial edema, loss of myelin and astrocytes, and diapedesis of the erythrocytes.⁴ These changes are consistent with

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the hypothesis that most cases of postoperative ION are caused by a combination of anemia and concurrent systemic hypotension, producing infarction of one or both optic nerves.⁴

Although this case series of six patients is from retrospective chart review, which has inherent drawbacks, it suggests the potential risk of postoperative visual loss in patients who experience intraoperative hypotension, anemia, or both. Although the episodes described in these patients of lowest blood pressure and lowest hemoglobin concentration were not necessarily concurrent events, each risk factor was associated with an abnormal value of the other factor (table 2).

Current practice of lower acceptable hemoglobin concentrations associated with more extensive surgeries, and therefore greater potential for blood loss and hypotension, may be predisposing a larger portion of the anesthetic patient population to temporary or permanent vision loss than appreciated previously.

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