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Visual Loss as a Complication of Spine Surgery: A Review of 37 Cases

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≫ The Treatment of Progressive Kyphoscoliosis in Camptomelic Dysplasia.

Abstract

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Study Design. Thirty-seven patients who experienced visual loss after spine surgery were identified through a survey of the members of the Scoliosis Research Society and a review of the recent literature.

Objectives. Records were reviewed in an attempt to identify preoperative and intraoperative risk factors and to assess the likelihood of recovery.

Summary of Background Data. Postoperative blindness after spine surgery has been documented in case reports or small series. The authors report the largest group of such cases to date and the first to allow conclusions regarding risk and prognosis.

Methods. Letters were sent to members of the Scoliosis Research Society requesting copies of medical records concerning patients who experienced postoperative visual deficits after spine surgery. An additional 10 well-documented recent cases were identified from published reports.

Results. Patients with visual loss had a mean age of 46.5 years. Surgery included instrumented posterior fusion in 92% of the cases, with an average operative time of 410 minutes and blood loss of 3500 mL. Most cases had significant intraoperative hypotension, with a mean drop in systolic blood pressure from 130 to 77 mm Hg. However, comparison with a matched group of patients with no visual symptoms showed no differences in the hematocrit or blood pressure values. Visual loss occurred because of ischemic optic neuropathy, retinal artery occlusion, or cerebral ischemia. Eleven cases were bilateral, and 15 patients had complete blindness in at least one eye. Most deficits were permanent.

Conclusions. The authors conclude that blindness after spine surgery is more common than has been recognized previously. Most cases are associated with complex instrumented fusions.

Although visual loss has been recognized as a complication of spine surgery since the 1950s,[11] it has always been considered a rare event and has received little attention. However, during the past few years, there have been several cases reported in the spine literature.[8,12,14,16,21] Although these reports have suggested possible causes, including patient positioning, blood loss, and intraoperative hypotension, direct causal relationships have rarely been demonstrated, and the cause of this unusual but devastating complication remains unclear.

In addition to speculation regarding the intraoperative causes of these problems, several patient risk factors have been suggested. These include chronic hypertension,[3,13,20] diabetes,[13,20] smoking,[13,20] vascular disease,[3,13,20] and disorders that result in increased blood viscosity.[20] In other settings, diabetes,[1] hypertension,[1,2] and structural factors related to optic nerve anatomy [6] also have been associated with ischemic optic neuropathy. Because the evidence for the role of these risk factors in the pathogenesis of visual loss is derived from studies in diverse clinical settings, their influence in patients who undergo spine surgery remains unknown.

The authors report the largest series to date of patients with postoperative visual loss after spine surgery. The authors analyzed the records of 37 such cases and have examined preoperative and intraoperative risk factors, ophthalmologic findings, and the extent of improvement at follow-up.

Methods

Twenty-seven cases in the current series are previously unreported complications that the authors identified through a survey of the members of the Scoliosis Research Society. A letter was sent to more than 400 surgeons throughout the English-speaking world requesting information about any patients they may be aware of who had experienced visual loss after spine surgery. The specific documents requested included the preoperative history and physical examination notes, operative report, anesthesia record, ophthalmology notes, and follow-up vision evaluation. Because of concerns about active or potential litigation, anonymous replies with identifying information deleted were encouraged.

Ten additional cases were chosen for the series from the medical literature. The current authors included cases from articles published in English within the past 10 years whose descriptions of risk factors, operative conditions, and ophthalmologic findings were sufficiently detailed to allow evaluation. For several of these cases whose descriptions were incomplete, additional information was obtained directly from the original authors.

Despite efforts to include as many cases as possible, not all records are complete. For example, a few cases were included for which anesthesia records were incomplete or for which the most recent follow-up was at hospital discharge. However, the current study does not include an additional 14 recent cases for which records are either inadequate or unavailable.

After all of the records were obtained, the authors selected a subgroup of 28 cases for which documentation was complete. This subgroup was compared with a control group derived from 1736 spine fusions performed at the authors' institution. Control subjects were individually matched to members of the blindness group for age, type of surgery, approach, number of levels, instrumentation, and primary *versus* revision surgery (Table 1). Statistical comparison of these groups was performed using computer-assisted analysis of variance. Differences were taken to be significant at $P <= 0.05$.

	Blindness Group	Controls
N	28	28
Age (yr)	45.4	45.6
Surgery		
No. of fusions	28	28
No. of revisions	11	11
Mean no. of levels	3.4	3.3
Operative time (min)	430	250*
Intraoperative blood loss (mL)	3600	880*
Hematocrit (%)		
Preoperative	41	40
Lowest recorded	28	29
Systolic blood pressure (mm Hg)		
Preoperative	129	124
Lowest recorded	77	79
Lowest (ION only)	78	80

* $P \leq 0.05$.
ION = ischemic optic neuropathy.

Table 1. Matched Group Comparison

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Results

The authors received replies from 28 surgeons who had knowledge of one or more patients with this complication. Twenty-four respondents supplied sufficient materials for their cases to be included in the study. In addition, the authors received 41 replies from surgeons who had never seen this complication in more than 500 collective years of practice.

The characteristics of our study population are summarized in Table 2. Where the denominator in a proportion is less than 37, it reflects the number of subjects for whom those data were available. Patient ages were randomly distributed. No patient was known to have significant preoperative eye disease, and only one patient was known to have had a carotid bruit. Other than previous spine surgery and the risk factors listed in Table 2, there were no unusual features in the medical histories of the patients who experienced visual problems. The only medications that were common among them were analgesics, which related to their presenting symptoms. The preoperative diagnoses are summarized in Table 3.

Age at surgery (yr) (range)	46.5	(12–68)
Risk factors (no. (%))		
Hypertension	13/31	(42)
Smoking	11/26	(42)
Diabetes	6/31	(19)
Vascular disease	5/29	(17)
No known risk factors	13/31	(42)

Table 2. Patient Characteristics

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Diagnosis	No. of Cases
Spinal stenosis	9
Scoliosis	7
Spondylolisthesis	6
Disc disease	4
Fracture	2
Tumor	1
Previous spine surgery	13

Table 3. Preoperative Diagnoses

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Features of the surgical procedures that preceded the vision loss are shown in Table 4. Most of these cases were instrumented posterior fusions performed on healthy patients. For the 15 patients for whom the American Society of Anesthesiologists score was available, it averaged 2.3.

Prone positioning [no. (%)]	36/37	(97)
Fusion [no. (%)]	36/37	(97)
Instrumentation [no. (%)]	34/37	(92)
Operative time (min) (range)	410	(120–750)
Intraoperative blood loss (mL) (range)	3500	(400–18,000)
Hematocrit (%) (range)		
Preoperative	40	(28–49)
Lowest recorded	28	(18–36)
Systolic blood pressure (mm Hg) (range)		
Preoperative	130	(90–170)
Lowest recorded	77	(0–98)

Table 4. Surgical Factors

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Although the long operative times, large amounts of blood loss, and degree of hypotension appear striking, it is difficult to know whether they are excessive for these cases of major spine reconstruction. To place these numbers in context, Table 1 compares 28 patients who experienced visual symptoms (blindness group) with a group of individually matched control subjects. It is clear that the patients who experienced vision loss had longer surgery times with much greater blood loss. However, the hematocrit and blood pressure values were nearly identical. Even comparing a still narrower subgroup consisting of patients who had ischemic optic neuropathy to their matched controls showed no significant pressure difference. This reflects the vast majority of cases in which hypotensive anesthesia is used without complication.

Visual changes were first noted by 15 patients in the recovery room. The remaining patients reported symptoms between the first and 12th postoperative days, with 81% of cases noted by postoperative day 2. Most delays in diagnosis were caused by patients thinking that visual problems were part of normal recovery or that their eyes had been bandaged. However, a few patients initially had normal vision and experienced symptoms after delays of 1 to 12 days.

Visual symptoms are summarized in Table 5. Visual field deficits included central scotomas (three eyes), peripheral narrowing (six eyes), and either quadrant (four eyes) or altitudinal (five eyes) defects. Incomplete acuity loss with full visual fields occurred in five patients. Complete absence of light perception occurred in 15 patients, three of whom were blind in both eyes. Diagnoses were based on the initial ophthalmologic assessment and the description of the ocular findings. Ischemic optic neuropathy accounted for most of these cases, with a significant number of central retinal artery occlusions also reported. Three cases were attributed to cortical ischemia documented by magnetic resonance imaging. In the remaining three cases, the available information was insufficient to allow a definite diagnosis.

Unilateral [no. (%)]	28	(76)
Bilateral [no. (%)]	11	(30)
Partial deficits [patients (eyes)]		
Visual field loss	18	(22)
Acuity loss only	5	(6)
Complete blindness [patients (eyes)]	15	(18)
Diagnoses (cases)		
Central retinal artery occlusion	5	
Ischemic optic neuropathy		
Posterior	14	
Anterior	6	
Cortical ischemia	3	
Other or unspecified	3	

Table 5. Visual Symptoms

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Most cases had no attempt at treatment, but various methods were occasionally used, including steroid therapy, massage, ice, rebreathing, paracentesis, and anticoagulation. The results of follow-up evaluation are shown in Table 6. There was no relationship between either the diagnosis or any treatment modality and resolution of symptoms. The amount of improvement in the few patients in whom it occurred usually was small. The most significant increase was from hand movement perception to 20/200 acuity in one patient. No patient who initially presented with complete absence of light perception had significant vision at follow-up.

Time to follow-up	10.0 mo	(range, 7 days–8 yr)
Vision at follow-up [patients (%)]		
Visual acuity improved	8	(22)
Visual field improved	5	(14)
No change	25	(68)
Worse	1	(3)

Table 6. Follow-up

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Discussion

The difficulty in understanding postoperative blindness after spine surgery stems from its rarity and its inhomogeneity. There are several suspected patient risk factors, several possible intraoperative causes, and several distinct syndromes that produce the visual loss. It is impossible in most cases to know the relative influence of each of the possibilities.

Direct pressure on the eye, especially as a result of patient malposition in a horseshoe-type headrest, has been cited as a factor contributing to visual loss in several published reports.[7,8,11,12,18,19,21] There are several types of evidence that support this relationship. One case [18] occurred after a headrest was noted to have slipped and compressed the eye. A similar event was suspected in other reports. This relationship also is supported by the finding of local ecchymosis about the affected eye,[8] or periorbital numbness,[11] both of which were noted in some of the patients in our series. In one remarkable case,[7] the patient's last comment before going to sleep was to tell the anesthesiologist that he was pressing on the eye that later became blind. In addition to these observations, there is experimental evidence that increased intraocular pressure may lead to optic nerve ischemia by inhibiting blood flow to the eye.[20]

Despite this evidence for pressure on the globe in some of these cases, it is equally apparent that postoperative blindness can occur in its absence. Reviews of postoperative blindness after general surgical procedures [13,20] include many procedures in the supine position, some of which were performed on the lower extremity. It is unlikely that there was orbital pressure during all of these cases. In addition, many of the reported cases are bilateral, which makes pressure from positioning less likely. In the current series, many of the patients had no evidence of periorbital trauma or local edema. In fact, some patients had visual loss despite the documented careful use of foam headrests with ocular cutouts or Gardner-Wells tongs. It seems clear that other factors also are involved.

Anemia also has been cited as a causative factor in previous reports of blindness after spine surgery.[3,13,14,16] This is consistent with reports of blindness after blood loss from other causes, such as postpartum bleeding,[5] gastrointestinal hemorrhage,[5,9,15] or various types of surgery.[17] In fact, some surgical series report an incidence of visual loss in as many as 1% of patients,[20] most commonly after cardiopulmonary bypass. However, it is difficult to evaluate blood loss as a risk factor in isolation. Patients with significant bleeding generally also have marked hypotension, long operative times, and other potential risk factors. However, blood loss appears to have some influence apart from hypotension, as is seen in the literature [9] and in the current series. The authors reviewed the cases of five patients who experienced ischemic optic neuropathy despite systolic blood pressures that never fell below 90 mm Hg. These five patients lost an average of 5 L of blood during surgery. One of these patients experienced bilateral deficits, which makes pressure on the eye an unlikely cause.

Although a few of the patients in this series experienced visual loss without severe hypotension, there is strong evidence that hypotension can play a part in these disorders. There are reports of ischemic optic neuropathy after syncopal attacks 5 or rapid correction of malignant hypertension,4 both of which are characterized by relative hypotension without bleeding or other surgery-associated factors such as positioning. In addition, nearly all of the reports of postoperative blindness in the literature note moderate to severe intraoperative hypotension as a contributing risk factor. However, the case for hypotension as a cause of visual loss is clouded by induced intraoperative hypotension having been used for years with no complications in the overwhelming majority of patients. This is reflected in the current study in there being no difference in the mean blood pressure values between the blindness and control subgroups. It appears that intraoperative hypotension can increase the risk of postoperative visual loss but that moderate hypotension alone is rarely the cause of those symptoms. Hypotension-related retinal changes may be time dependent,10 thus making a critical hypotension threshold even more difficult to define.

Based on the data from this study and previously published discussions of blindness after spine surgery, the authors conclude:

1. The incidence of significant visual complications after spine surgery is on the order of one case per 100 spine surgeons per year. This is a crude estimate based on incomplete reporting from a specific group of surgeons.
2. Many cases occur in patients who have no identified preoperative risk factors, although hypertension, smoking, diabetes, and vascular disease appear to lead to increased risk.
3. Most cases occur after instrumented posterior fusions with long operative times and substantial intraoperative blood loss.
4. Most cases occur after significant intraoperative hypotension, with prolonged drops in systolic pressure to below 90 mm Hg, although such hypotension usually is safely tolerated.
5. Visual changes usually begin within the first 2 days after surgery, although rarely symptoms may be delayed as long as 2 weeks.
6. Most postoperative visual deficits will show no significant improvement with time.
7. Patients who experience complete absence of light perception will not have significant improvement in their vision with time.

Despite a better understanding of this complication, the best means of its prevention remain unclear. Although cases have been seen in a variety of settings and in patients without known risk factors, clinicians should be especially cautious with the hypertensive smoker undergoing a three-level revision decompression and instrumented osteotomy. On the basis of the available information, the authors recommend the following considerations for selected high-risk patients:

1. Vigilance regarding eye protection during positioning by both the surgeon and the anesthesiologist and special attention to the eyes by the anesthesiologist during the case. Although direct pressure appears to play a role in only a few of these cases, those few are most likely preventable.
2. Careful use of hypotensive anesthesia, balancing its benefits with the possibility that it may contribute to complications in some cases. The authors recommend establishing a minimum systolic pressure for each patient preoperatively and not allowing the pressure to "drift" below that value.
3. Aggressive intraoperative blood replacement using the cell saver or predonated autologous blood.
4. Staging when appropriate for especially long cases that require multiple approaches.
5. Monitoring for visual deficits in the recovery room.
6. Early ophthalmology consultation when visual changes are identified.

The authors will continue to gather information about such cases. It is hoped that spine surgeons and anesthesiologists together can learn how to better prevent these rare, but often devastating, complications.

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