Narrative Review

Post-operative Vision Loss (POVL) Following Non-ocular Surgery

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Abstract

Post-operative vision loss (POVL) following non-ocular surgery is a serious complication whose causes are still unclear, although various postulated factors are considered based on published literature. POVL is a rare complication of non-ocular surgery that can occur as a result of injury to any of the visual pathways' several components. Except for mild corneal abrasions that are uncomplicated, an urgent ophthalmology consult is essential. Except for corneal abrasions, the majority of causes of POVL can result in irreversible vision loss. All patients receiving general anaesthesia should have their eyes covered with bandages that keep their eyelids closed to avoid corneal damage. Patients should be positioned so that there is no pressure on the globe. Following POVL, acute evaluation should include a determination of discomfort, visual impairments, and the pupillary light reflex. Inform patients who are scheduled to undergo protracted spine surgery in the prone position, with or without significant blood loss, about the possibility of POVL. Maintain periodic eye examinations throughout the surgical procedure to avoid putting direct pressure on the globe. In high-risk patients, monitor blood pressure with an intraarterial catheter to allow for beat-to-beat monitoring, volume status evaluation, and frequent laboratory sampling. Maintain mean arterial pressure as close to preoperative baseline as possible to optimise perfusion to the spinal cord, optic nerve, and other visual system structures. As a result of the high number of malpractice lawsuits filed against POVL practitioners, access to case reports is restricted for the general population.

Key Words: ischemic optic neuropathy, non-ocular surgery with vision loss, post-operative vision loss.

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Introduction

Post-operative vision loss (POVL) during non-ocular treatment is a catastrophic consequence following surgery under general anaesthesia. There is a variability in the reported incidence of POVL, which ranges from 0.056 to 1.3 per cent,[1] depending on the available literature. Coronary angioplasty (occurrence 0.09%)[2] and spinal angioplasty (incidence as high as 0.2%)[3] are the surgical procedures that pose the most significant risk for POVL. In addition to ischemic optic neuropathy (ION) and causes like central retinal artery occlusion (CRAO), and cortical blindness, other aetiologies include corneal abrasion. Strong evidence indicates that the incidence of POVL is growing, which may be related in part to an increase in the number of spinal surgeries requiring fusion.[3]

Risk factors

Impairment of vision has been strongly associated with male sex, hypotension, extended duration of procedures/surgeries, a requirement of the prone position, and a decreased use of colloids, among other factors. A few modifiable risk factors are obesity, cardiovascular disease, hyperlipidaemia, diabetes mellitus, and tobacco use. Risk factors for POVL after cardiac surgery include low post-operative haematocrit, presence of clinically significant vascular disease, long duration of cardio pulmonary bypass, red cell transfusion, use of other blood components.

Incidence

POVL is a rare complication of surgery, having a higher incidence following cardiac, spine, head and neck, and some orthopaedic procedures than after other treatments. The majority of the information comes from retrospective investigations and case series. Non-ocular operations result in 5.4 per 10,000 cases of transitory POVL and 0.16 per 10,000 cases of permanent POVL.[4] POVL lasting more than 30 days was seen in 4.3 out of 10,000 patients undergoing noncardiac procedures and in 0.08 out of 10,000 patients undergoing cardiac procedures.[5, 6] Incidence of POVL in various procedures is summarised in Table 1.

Table 1 Incidence of POVL in various procedures [4]

Sno.	Type of procedure /surgery	Incidence
1	Appendectomy	0.12 per 10,000
2	Knee surgery	1.08 out of every 10,000
3	Hip surgery	1.86 out of every 10,000
4	Laminectomy without fusion	0.86 per 10,000
5	Spinal fusions	3.09 per 10,000 of all fusions, 0.66 per 10,000 for anterior approach exclusively, and 5.50 per 10,000 for posterior approach
6	Cardiovascular surgery	8.64 per 10,000

Diagnosis of POVL

When a patient complains of vision loss, they should seek immediate ophthalmologic attention to devise an accurate evaluation, diagnosis, and treatment plan as quickly as possible to preserve as much eyesight as feasible. It has been suggested that patients undergo a gross vision screening for each eye as soon as feasible following emergence from anaesthesia for procedures linked with a high risk of POVL, such as cardiac procedures, prone spine surgery, head and neck surgery, hip/femur surgery and long duration surgeries.[7,8]

Eye Symptoms

a) Pain - Eye pain, particularly when accompanied by a foreign body sensation, is indicative of corneal abrasion. Eye discomfort can also arise as a result of acute glaucoma or retrobulbar hematoma, both of which are considered ophthalmologic emergencies. Pituitary apoplexy, acute angle-closure glaucoma, and posterior reversible encephalopathy syndrome (PRES) usually present with headaches.

b) Red eye- The most common causes of a red eye are acute angle-closure glaucoma and corneal abrasion, but it can occur in other conditions.

c) Unilateral or bilateral loss of vision- In the case of CRAO, anterior and posterior ischemic optic neuropathy, damage to the intracranial visual pathways, and retro bulbar hematoma, can cause complete vision loss (either unilateral or bilateral) or visual field deficiency may ensue.

d) Blurring of vision or presence of halos- Symptoms of acute angle-closure glaucoma can include intermittent blurring of vision and the presence of halos. Transient blurred vision is most commonly associated with glycine-induced visual loss, but it can also occur as a result of corneal abrasion.

Examination findings

Pupillary reflexes-

1. A poor or absent direct pupillary response to light in one pupil with a normal response when light is directed to the other pupil ("indirect" response) is observed in patients with unilateral CRAO, ischemic optic neuropathy, and retro bulbar hematoma and this "relative afferent pupillary defect" is revealed by the swinging flashlight manoeuvre.

2. If these processes are bilateral, there will be poor or absent direct pupillary responses and a normal response when light is flashed.

3. In patients with acute angle-closure glaucoma, mid-dilated and nonreactive pupils are noted, whereas in those who have experienced glycine-induced visual loss, sluggish to fix and dilated pupils are seen.

4. In cases of corneal abrasion, cerebral or cortical vision loss, and in cases of PRES, the presence of pupillary light responses is not abnormal.

Expert opinion

The ophthalmologist's evaluation typically includes a review of the patient's medical history, perioperative events, ocular complaints, and an eye examination that includes testing for visual acuity,

colour vision, pupillary light reflex, visual field, slit-lamp bio microscopy, intraocular pressure measurement, and a dilated funduscopic examination unless acute glaucoma is suspected. Further diagnostic testing may be performed based on the findings, and may include computed tomography (CT) or magnetic resonance imaging (MRI) of the head and orbits, with particular attention paid to the visual pathways to screen for infarctions, haemorrhages, and pituitary apoplexy; visual evoked potentials to evaluate optic nerve and visual pathways function, and electroretinography (ERG) if there is any concern about retinal function (as with glycine toxicity).[1,5,6,7,8]

Table 2- Summary of commonly identified causes of POVL

Sno.	Causes	Pathophysiology/mechanism	Clinical presentation	Prevention
1	Abrasion of the Cornea	Inhibition of corneal reflex decreased tear production	Transient blurry vision, tearing, redness, photophobia, foreign body sensation	Artificial tears, antibiotic ointment, eyelid tape, padding eyes
2	Ischemic Optic Neuropathy	Increased intraocular pressure and ophthalmic vein congestion	painless and progressive deterioration of vision can progress to complete blindness	Early diagnosis and management by an ophthalmic expert
3	Occlusion of the Central Retinal Artery	Emboli and direct pressure on the globe	Unilateral or bilateral loss of vision	Vasodilators, ocular massage, and thrombolytic drugs
4	Cortical Blindness	Ischemia or extreme hypoperfusion of occipital lobes	Deteriorating or complete loss of vision	Maintenance of haemodynamic, staged procedures to avoid long duration
5	Traumatic optic neuropathy	Indirect injury to the optic nerve due to intra-orbital haemorrhage, vascular insufficiency, or a nerve sheath injury	Total loss of vision	Immediate decompression of the optic nerve
6	Glycine induced acute transient POVL	Glycine induced decrease in impulses from the retina to the cerebral cortex	Transient blurring or blindness	Techniques to reduce absorption of irrigation fluid
7	PRES after Eclampsia	Preeclampsia toxaemia or eclampsia	Loss of vision or blurring, headache, seizure, altered mental status	Antihypertensives, antiseizure medications
8	Vision Loss After Spine Surgery	External ocular injury (corneal abrasion or sclera injury), acute glaucoma, cortical blindness, retinal ischemia	Loss of vision	Application of lubricants and covering the patient's eyes over closed lids

Abbreviations POVL- post operative vision loss, PRES-Posterior reversible encephalopathy syndrome

Various aetiologies of POVL

1. Abrasion of the Cornea

Causative mechanism

Corneal abrasion caused by general anaesthesia is a result of decreased corneal protection caused by inhibition of the corneal reflex and decreased tear production. Longer surgical procedures and prone or lateral positions during surgery have all been demonstrated to increase the chance of this complication.

Prevention of corneal abrasion

Administrations of artificial tears and antibiotic ointment are typically used in the treatment of CA. Although no intervention is effective in protecting CA during surgery, eyelid tape is the most widely utilised and most effective protection technique. It has been demonstrated that proper placement of eyelid protection can reduce the incidence of CA. While using Mayfield headrest in prone position, proper padding should be used and head position should be carefully examined to avoid pressure over eyes.

2. Abrasion of the Cornea

ION is the most prevalent cause of permanent POVL after non-ocular surgery, accounting for around half of all cases. According to the American Spine Society's Postoperative Visual Loss Registry, ION is responsible for 89% of perioperative vision loss in spine surgery, with posterior ION (PION) accounting for 60%.[7,8]

Causative mechanism

Intraocular pressure (IOP) is increased by lying prone or in the Trendelenburg position during a long surgery, resulting in ophthalmic vein congestion and, in certain circumstances, ION and permanent POVL. A typical manifestation is a painless loss of eyesight after awakening from anaesthesia in the prone position. The presence of anaemia and hypotension is detected in these patients; nevertheless, the specific mechanism by which the ischemia occurs is still a mystery to researchers. However, despite identifying predisposing factors, no single causative mechanism for ION can explain the genesis of the condition in all surgical situations. A case study reported by Quraishi et al. 8 demonstrated that regulating haemoglobin, haematocrit, and systolic blood pressure to adequately maintain ocular perfusion in a patient diagnosed with PION resulted in improved eyesight after surgery in a PION patient. According to Hassani et al9, providing recombinant human erythropoietin after a 6-hour surgery that resulted in severe blood loss reverses the consequences of PION.

Corrective and preventive action

The patient should have a complete physical examination as soon as they discover even minor changes in their eyesight because the feasibility of POVL treatment options tends to deteriorate with time.

3. Occlusion of the Central Retinal Artery

Although it accounts for a small proportion of POVL patients, CRAO ranks as the second most common cause related to spinal surgery. According to the American Spine Association's POVL registry, CRAO is the aetiology of POVL in 11% of all spine surgery cases.

Causative mechanism

Embolism and direct compression of the globe are two conditions that are typically related to CRAO. CRAO, in contrast to PION, exhibits itself more frequently in a single manifestation. Prone-positioned surgery increases the risk of CRAO because the weight of the head against the headrest causes external ocular compression, which can cause vision loss.

Corrective and preventive action

If CRAO is treated within 6 hours, it is considered reversible. A variety of therapies, including vasodilators, ocular massage, and thrombolytic drugs, are effective in alleviating the visual impairments induced by CRAO, but their effectiveness in ION has been inconsistent.10

4. Cortical Blindness

Cortical blindness has been found as the third most common cause of POVL in non-ocular surgical patients. CB is a vision loss produced by ischemia or significant hypoperfusion of the occipital lobes. It is a rare condition that can present as bilateral vision loss ranging from partial to complete loss of vision on one side of the face.

Stroke (32%), heart surgery (20%), and cerebral angiography (12%) account for the majority of occurrences of cortical blindness.

Causative mechanism

Anaesthesia duration, blood loss, position during surgery, and fluid administration are all crucial considerations to consider during the surgical procedure. According to the American Society of Anaesthesiologists' POVL Registry data between 1999 and 2012, 94 % of ION cases stemmed from operations conducted under general anaesthesia for 6 hours or more.[11]

Corrective and preventive action

According to the American Society of Anaesthesiologists' Practice Advisory, the head of patient should be positioned at the same level or higher than their heart and kept in a neutral forward position whenever possible to lower IOP and avoid POVL from forming. To lessen the impact, it has been suggested that procedures needing long-duration anaesthesia be staged over a period. The patient should be advised of the risks associated with staging when compared to prolonged anaesthesia if this sort of procedure is to be utilised in the first place.

5. Traumatic optic neuropathy

Causative mechanism

Traumatic optic neuropathy commonly occurs due to indirect injury to the optic nerve due to intra-orbital haemorrhage, vascular insufficiency or a nerve sheath injury. Direct damage to the optic nerve during dissection and insertion of implant

materials can also occur. Although rare, post-operative traumatic optic neuropathy is a potentially serious complication. Total loss of vision can occur secondary to optic nerve contusion or compression due to hematoma, ischemia or direct bone fragment penetration of the optic nerve.[12]

Corrective and preventive action

This requires immediate decompression of the optic nerve and but high doses of corticosteroids is controversial.

6. Glycine induced acute transient Post-operative visual loss

Glycine is sometimes used as an irrigating fluid during transurethral resection of prostate surgery. Plasma glycine concentration of 5–8 mmol/L causes visual disturbances.

Causative mechanism

Glycine, an inhibitory neurotransmitter in the retina, slows down the impulses from the retina to the cerebral cortex resulting in prolonged visual evoked potentials and absent oscillatory potentials on the electroretinogram.[13] This causes transient blindness, which usually resolves within 24 hours.

Corrective and preventive action

Volume overload and electrolyte abnormalities should be corrected along with necessary supportive care. Bipolar cautery will allow the use of another irrigant such as normal saline, sorbitol/mannitol. Techniques to reduce absorption of irrigation fluid should be employed i.e. operative time less than 60 minutes, low-pressure irrigation, and limited trendelenburg position. Intraprostatic vasopressin injection can cause vasoconstriction and minimise open dilated vessel fluid absorption. Laser or holmium laser technique may be utilised to minimise bleeding and absorption of irrigant. If ≥1000 mL of irrigant is absorbed, the procedure should be halted.

7. PRES after Eclampsia

Causative mechanism

Preeclampsia toxaemia or eclampsia is one of the leading causes of Posterior reversible encephalopathy syndrome (PRES). In PRES associated with PET/eclampsia, Ophthalmic disorders include cortical blindness, central retinal artery and vein occlusions, serious retinal detachment, retinal or vitreous haemorrhages, and ischemic optic neuropathy Purtscher-like retinopathy. Timely diagnosis and treatment are of great importance for a reasonable prognosis of the disease since any delay in this regard can lead to permanent neurological deficits and other complications.[14]

Corrective and preventive action

Treatment includes antihypertensives, mannitol for reducing cerebral oedema, antiseizure medication and magnesium sulphate for managing preeclampsia or eclampsia.

8. Causes of Vision Loss After Spine Surgery

Causative mechanism

POVL after spine surgery could be due to

external ocular injury (corneal abrasion or sclera injury), acute glaucoma, cortical blindness, retinal ischemia or could be IONs whose subtype, PION is most frequently associated with lumbar operations and hence LION (Lumbar ION).[15]

Corrective and preventive action

Corneal injuries can be prevented by applying lubricants and covering the patient's eyes with gauze over closed lids before positioning.[16] The manoeuvres that decrease the chances of embolisation can prevent cortical damage.[17] CRAO can be prevented by avoiding compression of the globe and avoiding pressure by anaesthetic face masks. In prone position, a foam headrest should be used and eyes should be appropriately placed in the opening of the headrest; the position of the head and the eyes should be checked intermittently by palpation or visualisation. The horseshoe headrest (Mayfield) for the prone-positioned warrants caution. For the patient, positioned prone for cervical spine surgery, this headrest should not be used as the surgeon has a greater chance of head movement, leading to compression of the eye.

ASA practice advisory

Inform patients undergoing long-term spine surgery about the possibility of significant blood loss and the rare but unpredictable risk of POVL. Systemic blood pressures must be monitored, and deliberate hypotension should be avoided.[18] Staging of surgical operations, lengthy procedures (> 4 h), and significant blood loss (> 800 ml) increase the risk. It may be useful to position the head equal to or higher than the heart and to employ antiplatelet medicines, steroids, or intraocular pressure-lowering medications.

Patient evaluation and preparation prior to surgery

1. Thorough review of the patient's preoperative history and examination to identify patients who have preoperative anaemia, vascular risk factors (e.g., hypertension, diabetes, peripheral vascular disease, coronary artery disease, previous stroke, carotid artery stenosis), obesity, or tobacco use should be done.[18]

2. Patients should be advised that certain preoperative factors may enhance their risk of POVL during spine surgery. These individuals include but are not limited to, those who are male, obese, have risk factors for vascular disease such as hypertension or peripheral vascular disease, or have diabetic retinopathy.

3. Inform patients scheduled for extensive operations, significant blood loss, or both, that there may be an elevated risk of POVL.

4. Determine on a case-by-case basis whether or not to advise patients who are not thought to be "high-risk" for visual loss.[18]

Intraoperative conduct of anaesthesia

Intraoperative management includes blood pressure control, fluid and anaemia management, vasopressor use, patient positioning, and surgical process staging.[18]

Blood Pressure Control

Blood pressure control in high-risk patients

is determined by various patient variables, including the existence of persistent hypertension, cardiac dysfunction, and renal and vascular illness before surgery. Additionally, other intraoperative factors affect blood pressure management, including fluid management, rate of blood loss, hypotension, and the administration of vasopressors. In high-risk patients, systemic blood pressure should be monitored continuously. The Task Force believes that there is no evidence linking the use of purposeful hypotensive procedures during spine surgery to the development of perioperative vision loss. As a result, the appropriateness of using purposeful hypotension in these individuals should be decided individually. [18]

Intraoperative Fluid Management.

The available literature is insufficient to determine the link between intravascular volume monitoring and the occurrence of vision loss in spine surgery patients (Category D evidence).[18] Although large amounts of crystalloids have been associated with increased intraoperative ocular pressure, periorbital oedema, and double vision in patients undergoing cardiopulmonary bypass, the research on these concerns in spine surgery patients is inadequate (Category D evidence). In high-risk individuals, central venous pressure monitoring should be explored. Colloids should be administered in conjunction with crystalloids to maintain intravascular volume in patients who have experienced significant blood loss. [18]

Anaemia Management

There is inadequate information to determine the efficacy of intraoperative anaemia control during spine surgery (Category D evidence).18 Haemoglobin or haematocrit levels should be evaluated on a regular basis during surgery in high-risk patients who lose a significant amount of blood.[18]

Utilisation of Vasopressors

There is insufficient literature to evaluate the long-term usage of high dose adrenergic agonists during spine surgery (Category D evidence). As a result, the use of adrenergic agonists should be determined on a case-by-case basis.[18]

Positioning of the Patient

Direct pressure on the eye should be avoided to limit the risk of CRAO and other ocular injuries. Consultants and members of all specialised societies concur that using a horseshoe headrest may increase the risk of ocular compression and perioperative CRAO. They all agree that prone-positioned patients' eyes should be checked and documented frequently. Additionally, they all agree on the prevalence of perioperative facial oedema in high-risk patients.[18]

When possible, the high-risk patient should be positioned so that the head is level with or slightly higher than the heart. When feasible, the head of the high-risk patient should be kept in a neutral forward position (i.e., without substantial neck flexion, extension, lateral flexion, or rotation).

Surgical Procedures Staging

Most patients who develop perioperative ION during spine surgery undergo lengthy operations with significant blood loss while lying prone. The consultants and specialised society members believe that lengthy operations should be staged.

While doing staged spine surgery in high-risk patients may result in higher costs and hazards to the patient (e.g., infection, thrombosis, or neurologic injury), it may also help to reduce these risks and the risk of perioperative vision loss in some patients. As a result, phased spine surgeries should be considered in high-risk individuals.

Post-operative Management

If there is any doubt about the possibility of visual loss, an urgent ophthalmologic consultation should be sought to ascertain the cause. Additionally, haemoglobin or haematocrit readings, hemodynamic state, and arterial oxygenation may be optimised. Consider MRI to rule out intracranial causes of visual loss. In high-risk patients suspected of having ION, haemoglobin or haematocrit levels should be elevated, blood pressure increased, and oxygen supplied. In high-risk patients, utilise purposeful hypotension only when the anaesthesiologist and surgeon concur that it is necessary despite using other methods to limit bleeding.[18]

Medico legal aspect/ Informed consent

Because of the variety of aetiologies of POVL and the limited success of current treatments, it is appropriate to consider disclosing information about POVL before surgery. Informed consent is one means of achieving this level of information disclosure. Salgo v Stanford (1957) was the first case in which the term "informed consent" was used, and the court decided that informed consent should include making patients aware of all potential dangers, advantages, and alternative therapies before undergoing surgical or anaesthetic operations. Based on one survey conducted in 2011 it was discovered that out of 437 patients receiving spine surgery at the Mayo Clinic in Florida, 80 percent wanted a full disclosure of the dangers associated with POVL. Patients may also be advised regarding the occurrence of POVL, risk factors that are both modifiable and non-modifiable, and preventative techniques that do not eliminate the possibility of acquiring POVL during the informed consent procedure.[19]

Conclusion

As a result of the low prevalence of POVL and the accompanying scarcity of published information, little is known about this potentially fatal complication. Acute evaluation should include a determination of discomfort, visual impairment, and the pupillary light reflex. Inform patients who are scheduled to undergo protracted spine surgery in the prone position, with or without significant blood loss, about the possibility of POVL. Maintain periodic eye examination throughout the surgical procedure mainly to avoid any direct pressure over the globe. POVL should be assessed immediately by an ophthalmologist to determine the cause and initiate treatment. Measures such as maintaining normal hemodynamic, elevating the operating table's headrest in high-risk patients reduce IOP and increase eyeball blood circulation, hence assisting in preventing POVL in high-risk surgeries. Preventive treatments include proper posture on soft or Mayfield supports and periodic eye examination during the surgical operation.

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Conflicts of interest

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