

Post-Operative Vision Loss (POVL) following Surgical Procedures

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Abstract

Background: Postoperative vision loss (POVL), with a prevalence of 0.1% of cardiopulmonary bypass cases and 0.02% - 0.2% of spine surgery cases, is a rare but devastating complication that can occur in patients undergoing surgery in the prone position. Although the primary cause of this complication is unknown, POVL has been associated with anemia, hypotension (induced or due to hemorrhage), duration of surgery and over hydration. This author reviews the available evidence on the guidelines and management of these patients.

Methods: A database search of MEDLINE, Academic Search Complete, Google Scholar, the Cochrane library, PubMed Central, and Embase was done using the key terms and phrases; postoperative vision loss, vision, ischemic optic neuropathy, prone position, perfusion, intraocular pressure, surgery, spinal surgery, scoliosis, blood flow and visual evoked potentials. Non-English language articles were excluded. The majority of the evidence retrieved included case studies, retrospective cohort studies and other literature reviews from dates ranging from 1995-2011.

Results: There are no definitive guidelines for the management of patients undergoing spine surgery in the prone position.

Conclusion: A synthesis of the literature revealed there is an increased risk of POVL in the presence of both preoperative and intraoperative risk factors. A medical history of diabetes, smoking and vascular disease can all contribute to the development of POVL. Intraoperative risk factors include, but are not limited to, pressure on the orbit, anemia, length of surgery, patient position and amount of volume infused.

Keywords: Postoperative vision loss; Ischemic optic neuropathy; Prone position; Intraocular pressure; Spinal surgery; Scoliosis; Visual evoked potentials

Introduction

The rare occurrence of POVL, with a prevalence of 0.1% in cardiopulmonary bypass cases and 0.02%- 0.2% in spine surgery cases, may appear inconsequential; however, considering the consequences of this complication result in permanent vision loss, prevention takes on more importance. Surgeries on the spine requiring prone positioning are usually elective; thus, the majority of patients presenting for this type of surgery range in age from 18 to 85 [1,2], often having no or only few comorbidities [3]. Considering this demographic, vision loss as a complication of non-ocular surgery is extremely costly. Due to the increasing number of spine surgeries being performed nationwide [1,2], anesthesia providers must be aware of the risk factors for POVL and the recommended practices for prevention and treatment (Figure 1, Appendix A).

Post-operative vision loss (POVL) refers to the partial or complete loss of vision upon postoperative assessment. Retrospective case studies have shown the rare occurrence of POVL to be most prominent in surgical cases involving the heart (0.113%) or the spine (0.028%-0.2%), with the latter becoming increasingly more prevalent; however, the etiology of the complication is poorly understood [1,4,5]. Possible causes of POVL identified from cohort studies include increased pressure on the globe leading to Central Retinal Artery Occlusion (CRAO), or decreased blood flow and oxygen delivery to the optic nerve, leading to Ischemic Optic Neuropathy (ION) [4]. In both cases, the blood flow to the optic nerve is compromised, causing ischemia and subsequent vision loss. This loss of vision can be temporary in some cases, but often the results are permanent and, therefore, severely debilitating to the patient.

Ischemic Optic Neuropathy (ION) has been identified as the most common cause of POVL cases, with a reported incidence ranging from

0.01% – 1%, depending on the type of surgery [3]. A retrospective study over a 12 year period involving the Mayo Clinic surgical population showed prevalence as low as 0.0008%; however, this did not include cardiac cases [6]. Ischemic Optic Neuropathy is reported in 0.113% of cardiac cases involving cardiopulmonary bypass and in 0.028% – 0.2% of spinal surgery cases [1,5]. Ischemic Optic Neuropathy is characterized by decreased blood flow and perfusion pressure to the optic nerve. The perfusion pressure of the eye is defined as the difference between the systemic mean arterial pressure (MAP) and the intraocular pressure (IOP). Thus, in conditions of increased IOP or decreased MAP, or a combination of both, there is resultant decrease in the perfusion pressure of the eye, possibly resulting in ischemia [7,8]. There are two categories of ION based on the affected region of the optic nerve and the blood flow corresponding with that region: anterior and posterior ischemic optic neuropathy.

Anterior Ischemic Optic Neuropathy (AION) is characterized by an ischemic lesion on the anterior portion of the optic nerve. This region of the optic nerve is supplied by the short posterior ciliary arteries in the choriocapillaris. Ischemia in this region can cause varying degrees of vision loss, ranging from that which is initially reversible, associated with moderate ischemia, to irreversible damage, associated with severe ischemia [4]. Anterior ischemic optic neuropathy is subdivided into two categories including arteritic AION and nonarteritic AION. The

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latter is the most common and often associated with POVL after cardiac surgery. Kalyani et al. [5]. reported in their retrospective case control study that seven of the eight POVL cases following cardiac surgery involved the anterior portion of the optic nerve. The cause is associated with decreased oxygen availability in the blood supply to the optic disk. This can be a result of decreased perfusion pressure, increased vascular resistance, or decreased oxygen carrying capacity. Patients with a medical history of diseases involved with such circumstances such as smoking, peripheral vascular disease, diabetes, cardiovascular disease or atherosclerosis are at increased risk for developing AION postoperatively [4]. In addition, an increase in blood viscosity may play a role in the risk for developing AION in patients with sickle cell disease and polycythemia, as well as patients undergoing CABG with induced hypothermia, leading to increased blood viscosity and decreased blood flow to the optic nerve [5,9]. Diagnosis of AION is made from a fundoscopic exam showing swelling of the optic disk. If irreversible damage to the optic nerve has occurred, over time, pallor will be noted [10]. Intraoperatively, Visual Evoked Potential monitoring can be useful in the diagnosis of ION. ION will result in a reduction in the amplitude and a slight increase in the latency of the monitored waveform [11]. In addition, the blood flow to the optic nerve head may also be measured intraoperatively through the use of invasive or noninvasive flowmeters [12,13].

Posterior Ischemic Optic Neuropathy (PION) is the most common reported cause of vision loss in spinal surgery cases [1], and is often associated with hemorrhage, anemia, and hypotension. The posterior optic nerve is nourished only by the centripetal pial vessels arising from the internal carotid [4]; thus, the posterior portion of the optic nerve may be more susceptible to damage in the above conditions due to the smaller amount of blood supply in comparison to the anterior portion of the nerve. The centripetal pial vessels are small, compressible arterial end vessels that are specifically susceptible to increased venous pressure due to positioning, edema, or overhydration [1]. Diagnosis of PION is difficult due to the lack of evidence of edema around the optic disk on the fundoscopic exam. Like AION findings, over time, pallor will be noted on the optic disk with irreversible damage. It is possible that these diagnoses of PION may actually be a combination of both AION and PION in which the AION is delayed [1] (Figure 2, Appendix A).

Central Retinal Artery Occlusion (CRAO) is the second most prevalent cause of POVL following spinal surgeries performed with the patient in the prone position. This condition presents with a pale retina with a cherry red spot at the macula and a reduced pupillary light reflex. It is manifested by thrombosis, direct pressure to the exterior of the eye, or increased intraocular pressure (IOP) [1,3]. The latter two are evident in some prone spinal surgical patients. In previous years, authors have attributed ill fitting headrests used in prone spinal surgery cases as a cause of POVL through CRAO by causing direct pressure on the globe. However, more recent studies have identified cases where external compression was not a factor [14]. For example, a case report in 2003 presents a 64-yr-old male patient who suffered from temporary vision loss following arthroscopic shoulder surgery. There was no data suggesting prolonged periods of hypotension, hemorrhage or external pressure on the orbit. Possible explanations for the vision loss in this patient include decreased perfusion to the eye as a result of the sitting position or a fat or air embolism, complications not uncommon to both orthopedic surgeries and surgeries performed in the sitting position [14]. As of 2006, of the 93 cases of POVL associated with spine surgery reported by the ASA POVL registry, 10 were attributed to CRAO with the remaining 83 due to ischemic optic neuropathy [3]. These findings lead to the assumption that POVL is more frequently related

to ischemia than pressure on the eye exteriorly. Ischemia can result from CRAO if the IOP exceeds systemic blood pressure, resulting in a decrease in the blood flow through the retinal artery; however, the ischemia present in ION is more often the cause of POVL.

In cases of POVL where ION is the indicative diagnosis, increased intraocular pressure (IOP) has been suspected as one of the culprits contributing to ION, specifically those cases reported following spinal surgery. The etiology of the increased IOP is due to the patient sustaining the prone and possibly prone trendelenburg position throughout the duration of the surgery. Walick et al. [15]. measured the IOPs of awake subjects without history of glaucoma, eye trauma or eye surgery. The researchers found significant differences between the measurements of IOP while sitting (19.3 ± 2.9 mmHg) and lying prone (25.6 ± 4.4 mmHg) and between sitting and lying prone trendelenburg (31.1 ± 2.8 mmHg). The IOP increased in both groups with increased time (0 to 60 min) A similar study by Ozcan et al. [16]. measured IOP in relationship to body position as well as the type of operating table used (Jackson table or an operating table with a Wilson frame and a horseshoe headrest) Ozcan et al. [16]. found similar results to Walick et al. [15] in their study with significant differences related to body position and inclination, but found no significant difference in the type of surgical set up used. The mean IOP in the sitting position was 15.0 mmHg and 16.8 mmHg in the supine position. IOPs in the prone horizontal position and the prone trendelenburg position were 46% and 56% higher, respectively [15]. Mean arterial pressure was also measured in the latter study in relation to the operating table with no clinically significant findings [16]. Due to these results, it is recommended that if possible, the prone trendelenburg position be avoided. According to the surgery being performed, a knee elbow position is favorable due to the smaller changes in IOP, as found by Tiefenthaler et al. [17] in a study of anesthetized patients undergoing lumbar disk surgery in this position. This position involves the patient in a kneeling position with their head turned to the side, resting on a cushion. This study found no change in the IOP from an awake sitting position to an anesthetized knee-elbow position. In addition, results showed an unexpected decrease in the IOP of the dependent eye (17.0 mmHg sitting, 8.1 mmHg knee-elbow; both eyes had similar IOPs initially) [17]. There are multiple relevant findings of these studies involving changes in IOP. First, the increase in IOP when a patient is turned prone may explain the higher incidence of POVL in spine surgery as opposed to other non-ocular and non-cardiac surgeries. However, a drawback is that the subjects in the first two studies mentioned were not anesthetized [9,16]. General anesthesia has been found to produce a decrease in IOP after induction, as well as during intentional hypotension, often utilized in spinal procedures [17]. Further studies involving anesthetized prone subjects have been attempted; however, they were terminated prior to completion [18]. In the latter study [17], the knee elbow position produces less pressure to the chest and abdomen, thus decreasing CVP, which can be increased in the prone position due to abdominal and thoracic pressure. It is important to note that measures are normally taken to prevent an increase in abdominal and thoracic pressure and thus CVP. These measures include supporting the patient on a Wilson frame or Jackson table to allow the abdomen to hang free [19,20]. This is especially important when patients are undergoing surgeries that are not possible in any position other than prone, such as surgeries for scoliosis. Such a decrease in CVP could explain the lack of change in IOP when turning the patient prone to kneeling, as opposed to turning the patient prone [17].

Other intraoperative factors associated with POVL include, but are not limited to, anemia, hypotension (induced or due to hemorrhage),

duration of surgery and over hydration [10,21-23]. Chang et al. [10] reviewed 14,102 spine surgeries over 20 years at Johns Hopkins Hospital finding 4 cases of POVL with a diagnosis of PION. Three of the four cases involved the prone position and the remaining case involved a lateral decubitus position. All cases included a decrease in the hematocrit by 18% - 48%, estimated blood loss ranging from 1050 mL - 8000 mL, large amounts of fluid transfusion ranging from 4224 mL - 24,500 mL, and a duration of surgery ranging 235 min - 630 min [10]. A period of hypotension (MAP 43-68) in comparison to baseline was reported in three of the four cases; however, data regarding blood pressure was not available for the fourth case. It can be assumed that this patient experienced hypotension due to the data for estimated blood loss (7000 mL) and amount of fluid input (24,500 mL) [10]. A similar retrospective cohort study was performed on a larger scale using the National Inpatient Sample (NIS) database [21]. Of the 4,728,815 patients undergoing spinal procedures between 1993 and 2002, 4134 (0.087%) experienced vision impairment, with an additional 271 patients diagnosed specifically with ION and 47 patients diagnosed with CRAO. The total incidence of vision loss among this population was 0.094%. This study found age <18 to be a risk factor for POVL; however, this statistic is related to non-ION related vision loss, an aspect of POVL that has had little attention in past studies [21]. Most recently, Shen et al. [22] reports the majority of pediatric cases are due to cortical blindness, often caused by stroke or embolus. Although the origin of the increased risk for POVL in children is unclear, it is most likely related to the type of surgery performed in the pediatric population. Instrumentation and fusion to surgically manage scoliosis in the pediatric population involves surgeries with long durations, and a higher risk for hemorrhage and hypotension. A major complication of monocular blindness was reported in a study assessing the complications associated scoliosis correction surgery. In the 16 patients followed, the mean operative time was 301.5 minutes with an average blood loss of 861.9 ml [24]. In comparison, lumbar discectomy and fusion surgeries performed in the prone position on the adult population are most often associated with a shorter surgical duration and less blood loss. One study reported surgery times associated with such procedures of 56 ± 33 minutes for an open procedure and 84 ± 36 minutes for a microendoscopic procedure. The open procedures were associated with greater blood loss (306 ± 120 ml) compared to the microendoscopic procedures (41 ± 12 ml), however; both techniques are associated with far less blood loss and surgical time than the scoliosis correction procedures mentioned previously [25]. More attention needs to be paid to the pediatric population and POVL due to these findings [22].

Chirag et al. reported similar results to Chang et al. [10] in respect to intraoperative risk factors associated with ION. The study reported odds ratios for anemia, blood transfusion and hypotension of 6.3, 5.5, and 20.8 respectively [21], and the percent of patients reporting ION postoperatively with these complications were respectively 0.028%, 0.027% and 0.111%, making these characteristics most associated to ION compared to others reported. Results of these two large retrospective studies implicate the common intraoperative risk factors of anemia, hypotension and blood loss as a contributory aspect in the development of POVL. Although there are also cases in which these instances are not apparent, minimizing these intraoperative risks should be the goal of the anesthesia provider [14,21,22,24].

A retrospective review of cases identified numerous risk factors and co-morbidities related to POVL. Patients with a medical history including atherosclerosis, diabetes, hypertension, smoking and obesity are at an increased risk for the complication [16]. In

addition, intraoperative risk factors include situations that increase the intraocular pressure (such as the prone trendelenberg position) or decrease the flow of oxygen to the optic nerve. Surgeries in the prone position lasting longer than 6 hours, anemia (resulting from blood loss or other preexisting disease processes), and hypotension have all been identified as intraoperative risks. Overhydration with crystalloids has also recently been implicated in contributing to orbital edema and increased intraocular pressure [1].

Although POVL is a rare complication, the results are extremely devastating. Therefore, patients undergoing surgeries with increased risk for POVL should be adequately informed. Surgeons should include POVL as a possible complication when obtaining consent, especially when a surgery of long duration in the prone position is anticipated. Research and development should be focused on aspects that can help decrease the prevalence of POVL. Future studies involving the effects of the risk factors on the perfusion to the optic nerve may supply more data pointing to which factor, or combination of factors, requires the most attention in preventing POVL occurrence.

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