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Strategies to prevent ischemic optic neuropathy following major spine surgery: A narrative review☆

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ABSTRACT

Postoperative vision loss following a major spine operation is a rare but life-changing event. Most of reports have been linked to ischemic optic neuropathy, and patients undergoing surgery for scoliosis correction or posterior lumbar fusion seem to be at the highest risk. Despite that some key risk factors have been identified, much of the pathophysiology still remain unknown. In fact, whereas only a minority of patients at high risk will present this complication, others with similar risk factors undergoing different procedures may not develop it at all. On the other hand, even when all preventive measures have been taken, ischemic optic neuropathy may still occur. Therefore, it is appropriate for clinicians involved in these cases to inform their patients about the existence of a small but unpredictable risk of vision loss. Since ischemic optic neuropathy is deemed to be the leading cause of vision loss in the context of major spine surgery in prone position, this review will be focused on its main aspects related to the frequency, diagnosis, predisposing factors, and prevention. Regrettably, no treatment has been proved to be effective for this condition.

Contents

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1. Introduction

Among all possible neurological complications related to general anesthesia (e.g. delirium, postoperative cognitive decline, stroke, spinal cord ischemia) [1], waking up from an elective spine surgery with significant visual impairment is one of the most dreadful experiences one patient can ever have. Postoperative vision loss (POVL) has been described as an uncommon, devastating, and usually irreversible complication associated with major procedures involving heart, blood vessels, and spine, among others [2]. Immediately after or within the first days of a spine operation, there have been reported cases of POVL after cervical laminectomies, thoracic or lumbar fusions, and other complex spinal procedures [2–6]. The main causes for prone procedures include ischemic optic neuropathy (ION), central retinal artery occlusion (CRAO), cortical blindness, and external ocular injury [1,7] (Fig. 1).

External ocular injury and CRAO tend to be mainly related to improper positioning of the patient (the latter may be also explained by embolic phenomena), whereas cortical blindness has been linked to ischemia of the visual cortex [1,7,8]. However, the mechanisms involving ION seem to be more complex. Despite having identified and optimized some risk factors, ION is still the leading cause of POVL, and patients undergoing prone spine surgery are at the greatest risk along with cardiac surgery [9–11]. In this scenario, the role of the anesthesiologist on its prevention is unclear. Therefore, in this narrative review, the epidemiology, pathophysiology, diagnosis, risk factors, prevention and potential legal implications of ION following spine surgery in prone position are discussed.

2. Epidemiology

Visual impairment associated with neurosurgical operations is a well-known complication that has been reported as early as 1954 [12]. Of note, most of POVL cases are unrelated to direct pressure to the eye [13,14]. Over the last few years, case-reports regarding POVL involving ION after major spine surgery have considerably increased [15–19]. It may be due to an increasing awareness of the problem, discrepancies in the inclusion criteria of studies or a true growth in the incidence resulting from the advances in spinal instrumentation, that make it possible to treat more complex cases [1,20]. In the United States, it has been estimated that from all claims related to the injuries to the visual pathways, those associated with optical nerve injury had increased from 5% (1980–1994) to 38% (1995–2011) [21].

Most of POVL reports (77%) have been linked to spine surgery in the prone position [2,22,23]. For these procedures, Epstein recently reported that incidence of POVL ranged from 0.013 to 0.2% [24]. This estimation has been confirmed by other authors [7,17,19,26–30], and the highest risk appears to be in patients undergoing surgery for scoliosis correction, or posterior lumbar fusion [22,26]. For spinal fusion procedures, the POVL incidence was 0.03% in a 10-year dataset analysis [14]. However, in a case-control analysis the incidence has been reported as high as 0.36% [31].

It has been estimated that four in every five cases of POVL are caused by ION [2,8,16], from which more than a half develop bilateral disease [8]. In addition, most patients with perioperative ION are men on average 50 years old, many of which are relatively healthy [22]. ION can be further subdivided in anterior (AION) and posterior (PION) -see below-, depending on the vascular supply (Table 1). Although AION is more common in the general population [32], PION is the cause of the majority of cases related to prone spine surgery (Fig. 1) [30,33,34].

On the other hand, Rubin et al. [35] recently reported that in the United States, the incidence of postoperative ION had diminished by 2.7 times from 1998 to 2012, despite the increase in the number of spine procedures. After examining >2.500.000 posterior thoracic and lower back fusions performed during that period, they found an incidence of 1.02 per 100.000 spinal fusions (95% CI 0.72–1.32). However, they could not differentiate among severity or type of ION. Remarkably, the incidence had consistently decreased along three-year periods, in contrast with retinal artery occlusion, which remained essentially unchanged [35]. It has been speculated that this change in trend may be due to several factors: the use of Wilson frame has dramatically dropped in that country over the last decade, surgeons have optimized the technique (thus diminishing the blood loss and shortening the length of the procedure), minimally invasive spine operations have increased, and anesthesiologists are more concerned about the intraoperative hypotension. Yet, it is possible that many cases have not been coded as ION, thus biasing the sample [35,36]. Additionally, a significant number of POVL cases may remain underreported, thus representing a publication bias [23].

3. Pathophysiology

The optic nerve blood flow relies on optimal ocular perfusion pressure (OPP) [17,18,37] and low resistance to the blood flow [38]. The OPP is defined as the difference between mean arterial blood pressure

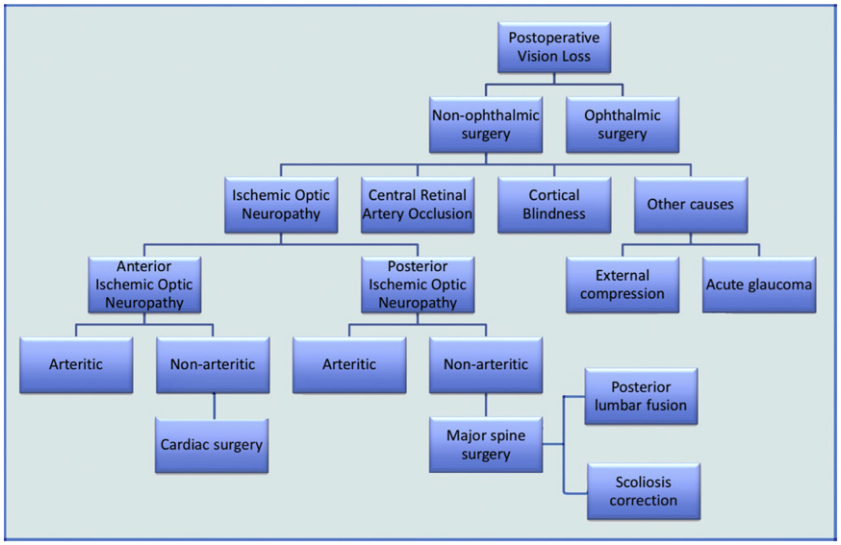

Fig. 1. Main causes of postoperative vision loss in the context of non-ophthalmic surgery [49].