Good News

But Why Is the Incidence of Postoperative Ischemic Optic Neuropathy Falling?

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THE first description of postoperative visual loss (POVL) in Medline is from 1950.[1] Cases appeared sporadically over the next 30 to 40 yr (fig. 1), mostly related to opthalmalogic procedures, cardiac surgery, and a miscellany of other operations. Some were due to direct eye injuries, but some were due to ischemic optic neuropathy (ION), most commonly reported in association with massive intraoperative hemorrhage and hypotension or radical head and neck surgery. Then, in the early 1990s, cases of ION began to appear after prone spine surgeries. Along with the rapid growth in instrumented spine procedures, the yearly number of publications accelerated dramatically (fig. 1). Some of these publications advanced unsupported theories as to cause and equally unsupported recommendations regarding prevention. In response, the American Society of Anesthesiologists (ASA) made a concerted effort to gather objective information by establishing the POVL Registry in 1999. Over the next few years, information was accumulated that began to shed some light on the problem. For example, case data in the registry effectively eliminated "pressure on the globe" as a major cause of POVL, established the important role of case duration, and raised questions about the specific roles of blood loss, transfusion, hypotension, anemia, *etc.*, strongly supporting a belief in a complex multivariate etiology.[2] Based on this, the ASA published its first Practice Advisory regarding POVL in 2006.[3] Working with data in the registry, the POVL Study Group conducted a multicenter case-matching study intended to better examine risk factors for ION.[4] As expected, multiple factors were found to differ between patients with and without ION, but only six could be identified as independent risk factors in a multivariate model: male sex, obesity, the use of a Wilson frame for positioning, case duration, estimated blood loss (EBL), and the fraction of colloids given as part of non–blood fluid management. Many of these items were incorporated into an updated ASA Practice Advisory in 2012.[5]

"...since 1998 to 2000, the incidence of postoperative ION [ischemic optic neuropathy following prone spine surgery] has fallen by almost 60%.... But why has this occurred?"

In this issue of the JOURNAL, Rubin *et al.*[6] looked at long-term trends in the incidence of ION after spine fusion surgery. Using data from the Nationwide Inpatient Sample (NIS), they provide two key pieces of new information. First, they confirmed that male sex, obesity, and transfusion (which *may be* a surrogate for blood loss) are risk factors, and they added age to the list. Second—and certainly of far greater importance—they showed that, since 1998 to 2000, the incidence of postoperative ION has fallen by almost 60%, from approximately 1.63/10,000 to 0.6/10,000 in 2010 to 2012.

Since this is a new finding, rigorous confirmatory data are lacking, but there are other consistent observations. For example, the number of cases reported yearly to the ASA POVL registry has been decreasing progressively from a peak in 2000 to 2002 (Karen Posner, Ph.D., University of Washington, Seattle, Washington, personal communication, February 2016). Yearly malpractice claims for POVL for one

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Corresponding article on page 457.

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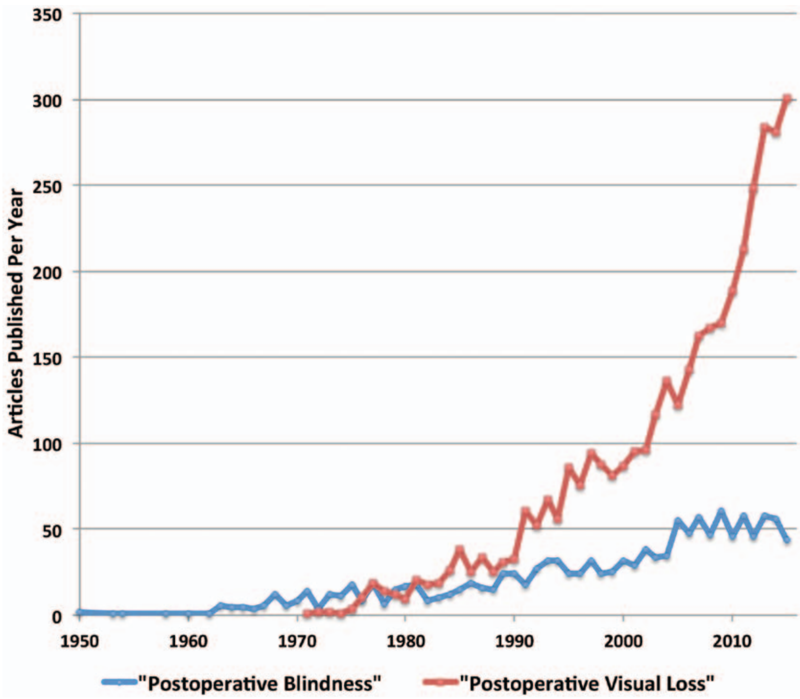

Fig. 1. Publications per year retrieved from Medline using the search terms "postoperative blindness" and "postoperative visual loss."

large national insurer (Preferred Physicians Medical, USA) peaked between 1997 and 2004 and have been dropping since (with only one case filed since 2008; Steven Sanford, personal communication, April 2016).

This is great news for us and our patients! But why has this occurred? Is it due to the conscious efforts of anesthesiologists and surgeons to prevent ION or is it an unintended consequence of changes in either our patients or in the conduct of anesthesia and surgery? While we would all like to believe that it was due to our well-focused efforts, a careful consideration of many factors suggest that it is more likely to be due to the latter (or at least a combination of the two).

A better understanding of WHY the incidence has decreased can help us understand WHY the event occurs at all. In other words, further considerations of known risks (*e.g.*, age, sex, and obesity)—and their changes over time—may provide mechanistic insights and/or allow us to better focus on a narrower range of factors. I'd therefore like to look at these risks individually.

Patient Characteristics: Age, Sex, and Obesity

It is reasonable to conclude that *patient* risk factors are *not* improving; our patients are not getting younger or smaller, and there is nothing to suggest a major change in the sex of spine surgery patients. The aging of our surgical population is well known. For example, the average age of patients undergoing major spine surgery at The University of Iowa, Iowa City, Iowa, has *increased* by over 8 yr since 1996. Data from NIS show that over the data range evaluated by Rubin *et al.* and in the same spinal fusion population, age increased by 5 yr, the incidence of obesity increased substantially, and there was only a tiny change in sex ratio (a 3% drop in the fraction of males).* Supplementary information from the American College of Surgeons National Surgical Quality Improvement Program database for spine fusion surgery—albeit over a shorter time period—also supports these findings (information provided by Dr. Y. Gao, Department of Orthopedics, University of Iowa).

Surgical Factors: Positioning, Case Duration, Blood Loss, and Fluid Management

The POVL group demonstrated that the use of a Wilson frame was associated with the highest "risk ratio" of any of the six factors, presumably due to higher intraabdominal and venous pressures secondary to abdominal compression and perhaps a tendency toward a more head-down posture. While no objective data are available, an informal e-mail survey of more than a dozen senior members of the U.S. neuroanesthesia community strongly indicates that the use of the Wilson frame, at least for major spine fusions, has nearly disappeared in the last decade, having largely been replaced by OSI/Jackson tables. Positioning on the OSI/Jackson table results in less abdominal compression and, frequently, a more neutral head (or even head-up) position.

*As part of this assessment, this author contacted the senior author of Rubin *et al.* (Dr. Roth) and asked him to provide additional data from Nationwide Inpatient Sample, specifically related to the changes over time in patient ages and the incidence of obesity and transfusions.

If, as suggested,[4] venous pressure plays an important role in ION, this change alone may be playing a major role.

The NIS database does not contain case duration data and, to the best of my knowledge, no other national source of case duration information exists. I was able to retrieve deidentified duration information from our Departmental billing database for adult patients back to 1996, focusing on the same current procedural terminology–coded procedures as studied by Rubin *et al.* As expected—and as reported by Rubin *et al.*—case numbers for 2013 to 2015 were three times greater than those for 1996 to 1998 (1042 *vs.* 347). Average case duration for these two 3-yr periods decreased by 18 min (P = 0.031), and the fraction of cases lasting greater than or equal to 6 h decreased from 54% in 1996 to 1998 to 43% in 2013 to 2015 (P = 0.0003)—although surprisingly, the fraction of cases lasting more than 8 h did not change (18%). If these data are representative of national practice, it is possible that some changes in operative times may be an important factor, but also suggest that the relationship between case duration and the incidence of ION is both complex and highly nonlinear.

The POVL group identified EBL as a risk factor, while Rubin *et al.* showed an association between transfusion and ION. Neither NIS nor the National Surgical Quality Improvement Program tracks operative EBL over time, but the progressive adoption of minimally invasive techniques[7,8] and the growing use of antifibrinolytics such as tranexamic acid might be expected to decrease EBL[9,10]—we just don't know. At our institution, overall incidence and volume of blood transfused has fallen over time—but surprisingly NIS data (see footnote 1) show that the fraction of patients transfused has actually increased (although volume data are not available). Whether "transfusion" is a surrogate for EBL (as suggested by Rubin *et al.*) and whether other (unrecorded) changes in transfusion practice are playing a role are unknown. The data do suggest that transfusion *per se* cannot explain the changes in ION.

One last factor shown by the POVL group to be relevant is the colloid fraction of total nonblood fluids. Again, like EBL, no longitudinal data exist to determine if changes have occurred. However, colloid use was quantitatively the smallest risk factor identified by the POVL group, so even a huge change in practice would be expected to have a minimal impact.

Conclusions

As noted, the observed reductions in the incidence of ION are unlikely to be due to changes in our patients (age, sex, or body mass index) and hence must be related to how we are practicing. The largest changes are *probably* due to changes in surgical positioning along with a possible reduction in operative times. Did these changes occur specifically in response to our recognition of ION? Probably not. For example, the onset of the decrease in ION incidence appears to have predated the appearance of objective information and practice advisories, although general awareness of the problem, driven by the rapidly expanding literature, may have played some role. In addition, other unrecognized factors may be operating. The risk factors defined by the POVL Study Group are limited by the relatively small sample size (and the huge sample used by Rubin *et al.* probably explains why they—but not the POVL Study Group—were able to identify age as a risk factor). For example, hypotension could not be identified by the POVL group as a factor—and yet ischemic injury to any organ is influenced by perfusion pressure. Given the large number of published articles anecdotally suggesting a link between blood pressure and ION, it is possible that anesthesiologists have become more compulsive about blood pressure management in these patients.

Caveat

It would be a mistake to assume that "this problem has been beaten." Cases of devastating postoperative blindness after prone spine surgery continue to appear, if for no other reason than that the number of surgeries performed has increased, and, as noted by the authors, the incidence of retinal artery occlusion has not changed. Further progress will depend on continuing research—both clinical and laboratory—into causative mechanisms. For example, we still do not understand why ION occurs in only a small fraction of patients, even when they are matched for known risks; the POVL Study Group showed that even in patients at highest risk (obese males undergoing very long operations on a Wilson frame with large EBLs), the predicted incidence of ION is only on the order of 2 to 3%. What is different about these patients *versus* the 97 to 98% of similar patients having similar operations who do not develop ION? Only by solving this dilemma can we completely eliminate this problem, and hopefully, the observations of Rubin *et al.* will aid us in focusing our efforts.

Competing Interests

The author is not supported by, nor maintains any financial interest in, any commercial activity that may be associated with the topic of this article.

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References

1. Curtillet E, Portier P: Un cas d'amaurose post-operatoire [Postoperative amaurosis]. Afr. Fr. Chir 1950; 1:51–3
2. Lee LA, Roth S, Posner KL, Cheney FW, Caplan RA, Newman NJ, Domino KB; The American Society of Anesthesiologists: Postoperative Visual Loss Registry: Analysis of 93 spine surgery cases with postoperative visual loss. Anesthesiology 2006; 105:652–9
3. American Society of Anesthesiologists: Practice advisory for perioperative visual loss associated with spine surgery: A report by the American Society of Anesthesiologists Task

Force on perioperative blindness. ANESTHESIOLOGY 2006; 104:1319–28

4. The Postoperative Visual Loss Study Group: Risk factors associated with ischemic optic neuropathy after spinal fusion surgery. ANESTHESIOLOGY 2012; 116:15–24
5. American Society of Anesthesiologists: Practice Advisory for perioperative visual loss associated with spine surgery: An updated report by the American Society of Anesthesiologists Task Force on perioperative visual loss. ANESTHESIOLOGY 2012; 116:274–85
6. Rubin DS, Parakati I, Lee LA, Moss HE, Joslin CE, Roth S: Perioperative visual loss in spine fusion surgery: Ischemic optic neuropathy in the United States from 1999 to 2011 in the Nationwide Inpatient Sample. ANESTHESIOLOGY 2016; 125:457–64
7. Banczerowski P, Czigléczki G, Papp Z, Veres R, Rappaport HZ, Vajda J: Minimally invasive spine surgery: Systematic review. Neurosurg Rev 2015; 38:11–26; discussion 26
8. Phan K, Rao PJ, Kam AC, Mobbs RJ: Minimally invasive *versus* open transforaminal lumbar interbody fusion for treatment of degenerative lumbar disease: Systematic review and meta-analysis. Eur Spine J 2015; 24:1017–30
9. Wang M, Zheng XF, Jiang LS: Efficacy and safety of antifibrinolytic agents in reducing perioperative blood loss and transfusion requirements in scoliosis surgery: A systematic review and meta-analysis. PLoS One 2015; 10:e0137886
10. Cheriyan T, Maier SP II, Bianco K, Slobodyanyuk K, Rattenni RN, Lafage V, Schwab FJ, Lonner BS, Errico TJ: Efficacy of tranexamic acid on surgical bleeding in spine surgery: A meta-analysis. Spine J 2015; 15:752–61

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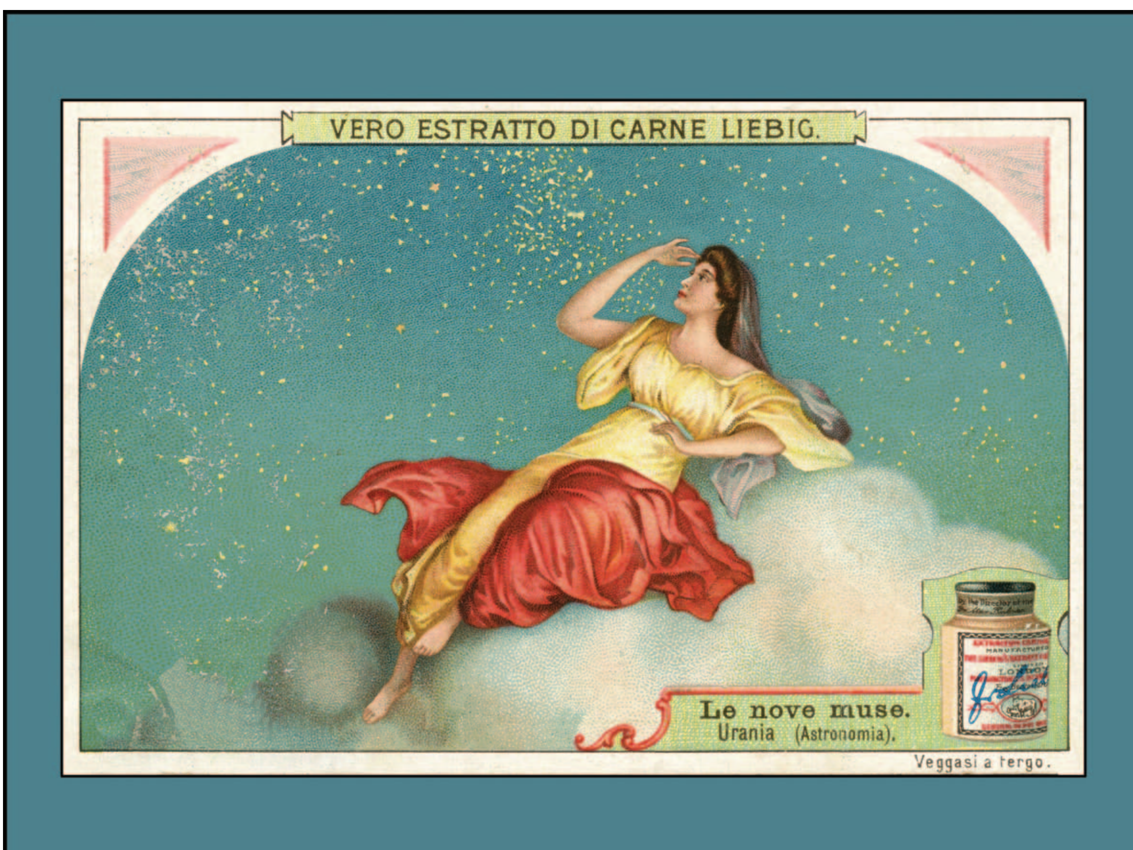
From Chloroform to Urania, Liebig's Muse of Astronomy



In Greek mythology, Zeus bedded the Titaness of Memory (Mnemosyne), and she conceived nine daughters, the Muses. Each Muse advanced her respective art by (1) prompting humans' memorization of her art and (2) inspiring memorable, original art for future generations. Memory, the daughter of Sky (Ouranos or Uranus), gave birth to Urania, the Muse of Astronomy (*above*), who graces this Italian card advertising a company cofounded by chloroform pioneer Justus von Liebig (1803 to 1873). Astronomy ("star arranging") for many ancients reflected or foretold efforts by divinities. For example, Homer's account of Odysseus' rescue from Calypso's island by Hermes, the speediest god, might have been reflected in the *Odyssey* by the astronomical path of Mercury, the speediest planet. (Copyright © the American Society of Anesthesiologists' Wood Library-Museum of Anesthesiology.)

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