

Ischemic Optic Neuropathy following Spine Surgery: The Largest Institutional Case Series and Systematic **Review of the Literature**

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Introduction

Ischemic optic neuropathy (ION) is the most common pathological diagnosis underlying postoperative vision loss. It comes in two primary forms—anterior (AION) - affecting the optic disc or posterior (PION) affecting the optic nerve proximal to the disc (i.e. retrobulbar). Spine surgery remains one of the largest sources of acute perioperative visual loss. Most literature on ION following spine surgery has been in the form of case reports and small case series. Herein, we present an updated systematic review of the literature supplemented with the largest institutional case series reported so far to comprehensively explore clinical presentation, prognosis and perioperative risk factors.

Methods

We retrospectively retrieved all cases of ION diagnosed in the setting of spine surgery at our institution diagnosed between 2000 and 2017. We also conducted a systematic search of Medline, Embase, Scopus databases and identified all cases of perioperative ION following spine surgery reported in the literature from inception to September 2017. Following this, we pooled our results to descriptively analyze demographic, perioperative and follow up data and evaluated risk factors for perioperative ION and visual prognosis. WHO grading was used to assess severity of visual deficit. Matched case-control analysis for the cases of ION at our institution was also performed using institutionally diagnosed cases to further evaluate these potential risk factors.

Results

Amongst 12 cases occurring at our institution diagnosed between 2004 and 2017, a 1:4 matched case control analysis (for age and year of surgery) revealed fusion procedures, higher number of operative levels, blood loss, and change in hemoglobin and hematocrit to be significantly associated with ION. Majority (75%, 9/12) of our cases had bilateral presentation. In addition to the 12 patients from our institution, 182 patients were identified from the literature from 42 studies. Mean age of all cases was 49+/-14 years with 60% males (109/194). Posterior ischemic optic neuropathy (PION) was found in 58.7% (114/194) of cases, anterior ischemic optic neuropathy (AION) in 17% (33/19) and unspecified ION in 24% (47/194). In our own series, 83% (10/12) were diagnosed with PION. Fusions were the most common surgical intervention 86.5%(168/194) with the majority of cases arising in the setting of prone lumbar or thoracolumbar spine surgery 68.5%(36/53). Mean operative time was 561+/-219 minutes. Overall vision outcome remained poor with only 34.5% (67/194) patients undergoing improvement from baseline in either their visual acuity, visual field or color vision. PION was associated with higher odds of severe visual deficit at immediate presentation (OR-6.45, CI-1.04-54.3, p=0.04) and last follow up. Age, sex, presence of a vascular risk factor, type of ION were not significantly associated with odds of improvement.

Summary of perioperative variables Variable	Literature review (n=182)	Institutional case series(n=12)	Total(n=194
Type of procedure', n (%) Posterior decompression alone	6(3.5)	1(8.3)	7(3.6)
Fusion	160(94.6)	8(66.6)	168(86.5)
Vertebrectomy	3(1.8)	3(25)	4(2)
No of operated levels ⁵ , n (%)			
1	23(19)	1(8.3)	24(17.6)
2	37(30)	0(0) 4(33.3)	37(27.2) 25(18.4)
3 >4	21(17) 43(35)	4(33.3) 7(58.3)	50(36.4)
			1131113
Level of procedure ¹ , n (%) Cervical	9(7)	0(0)	9(6.25)
Cervicothoracic	2(1)	1(8.3)	3(2)
Thoracic Thoracolumbar	16(12) 13(10)	1(8.3) 5(33.3)	17(11.8) 18(12.5)
Lumbar	92(70)	4(33.3)	96(66.6)
Sacral	0(0)	1(8.3)	1/144
Positioning*, n(%) supine	2(1)	1(8.3)	3(1.7)
prone	156(95)	10(83.3)	166(93.8)
circumferential† lateral	5(3)	1(8.3)	6(3.3)
	2(1)		2(1.1)
Change in Hematocrit**, mean(SD)	25(5)	9.87(4.2)	23.9(4.9)
Change in Hemoglobin ⁵ , mean(SD)	5±2	3.3(1.5)	4.3(1.8)
(n=17) Lowest intraoperative SBP n=116			
<80	36(31)	5(41.6)	41(32)
81-100 >100	68(59)	7(58.3)	75(58.5)
>100	12(10)	0(0)	12(9.3)
EBL(mL), Median(Range)			
Case reports (n=62) Lee et al, 2006 (n=83)	2000(250-16000) 2000(100-25000)	1500(100-10025)	-
Myers et al. 1996 (n=37)	3500(400-18000)		
Operative time*, Mean(SD)	493(177)	561(219)	497(180)
Facial edema, n (%) *Type of positioning was unavailable for †Type of procedure and operative time v **Change in Hematocrit was unavailable	18/29(62) 17 patients in the literature revi	6/12(50) ew.	24/41(58.5)
§Number of levels operated could not be ¶Level of procedure was unavailable for Circumferential refers to positioning wh Abbreviations: EBL-estimated blood los Summary of post-operative and follo	50 patients from the literature refer the patient spends some tirs, SBP-systolic blood pressure. w up ophthalmic examinatio	eview. ne supine and some time prone durin	
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Variables	Cases (n=12)	Controls [∏] (n=48)	p-values*	OR	95% C.I.
Age, years (mean, SD)	66.4(11.5)	66.4(11)	0.98	1.002	0.91-1.106
Males, n(%)	9(75)	30(62.5)	0.42	1.79 ^{co}	0.43-7.52
Comorbidities, n (%)					
HTN	9(75)	23(47.9)	0.08	4.3	0.82-22.9
Smoking	2(16.7)	16(33.3)	0.21	0.25	0.03-2.24
Hyperlipidemia	8(66.7)	20(41.7)	0.14	2.7	0.73-9.69
Malignancy	2(16.7)	5(10.4)	0.57	1.6	0.31-8.25
Coronary artery disease	4(33.3)	12(25)	0.55	1.55	0.37-6.53
Obesity	5(41.7)	26(54)	0.46	0.63	0.18-2.15
Number of vascular risk factors**. (mean. SD)	2.5(1.4)	2.2(1.6)	0.53	1.14	0.76-1.72
Non-fusion Fusion	2(16.7) 10(83.3)	39(81.25 9(18.75)	0.003	Refer 23.8	
Fusion Positioning	10(83.3)	9(18.75)	0.003	23.8	2.94-192.40
Fusion Positioning Non-prone	10(83.3) 2(16.7)	9(18.75)		23.8 Refer	2.94-192.40 ence
Fusion Positioning Non-prone Prone Number of vertebral levels operated	10(83.3)	9(18.75)	0.003 0.77 0.004	23.8	2.94-192.40
Fusion Positioning Non-prone	10(83.3) 2(16.7) 10(83.3)	9(18.75) 10(20.8) 38(79.2)	0.77	23.8 Refer	2.94-192.40 ence 0.27-6.02
Fusion Positioning Non-prone Prone Prone Number of vertebral levels operated (mean, SD) **	10(83.3) 2(16.7) 10(83.3) 4.75(2.38) 1500(325-	9(18.75) 10(20.8) 38(79.2) 1.58(1.23)	0.77	23.8 Refer 1.27 2.99	2.94-192.40 ence 0.27-6.02 1.42-6.324
Positioning Non-prone Prone Number of vertebral levels operated (mean, SD) ** Blood loss, mL (median, IQR) Intra-op crystalloids (median,	10(83.3) 2(16.7) 10(83.3) 4.75(2.38) 1500(325-5231.25) 6169	9(18.75) 10(20.8) 38(79.2) 1.58(1.23) 100(50-150)	0.77	23.8 Refer 1.27 2.99	2.94-192.40 ence 0.27-6.02 1.42-6.324 1-1.005

Conclusions

Within our institutional experience and the published literature, PION is the most common cause of vision loss following spine surgery and causes more severe visual deficits compared to AION. Prone spine surgery especially multiple level instrumented fusions characterized by longer operative times, higher blood loss and intraoperative hypotension are most associated with the development of this rare but devastating complication.