

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 the12 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)
Vertebral resection	3(1.8)	3(25)	4(2)
No of operated levels [‡] , n (%)			
1	23(19)	1(8.3)	24(17.6)
2	37(30)	0(0)	37(27.2)
3	21(17)	4(33.3)	25(18.4)
>4	43(35)	7(58.3)	50(36.4)
Level of procedure*, n (%)			
Cervical	9(7)	0(0)	9(6.25)
Cervicothoracic	2(1)	1(8.3)	3(2)
Thoracic	16(12)	1(8.3)	17(11.8)
Thoracolumbar	13(10)	5(33.3)	18(12.5)
Lumbar	92(70)	4(33.3)	96(66.6)
Sacral	0(0)	1(8.3)	1(14)
Positioning*, n(%)			
supine	2(1)	1(8.3)	3(1.7)
prone	156(95)	10(83.3)	166(93.8)
circumferential [†]	5(3)	1(8.3)	6(3.3)
lateral	2(1)	0(0)	2(1.1)
Change in Hematocrit**, mean(SD)			
25(5)	9.87(4.2)	23.9(4.9)	
Change in Hemoglobin [‡] , mean(SD)			
5(2)	3.3(1.5)	4.3(1.8)	
Lowest intraoperative SBP - n=116			
<80	36(31)	5(41.6)	41(32)
81-100	68(59)	7(58.3)	75(58.5)
>100	12(10)	0(0)	12(9.3)
EBL(ml), Median(Range)			
Case reports (n=62)	2000(250-16000)	1500(100-10025)	-
Lee et al. 2006 (n=83)	2000(100-25000)		
Myers et al. 1996 (n=37)	3500(400-18000)		
Operative time [‡] , Mean(SD)			
563(179)	563(219)	497(180)	
facial edema, n (%)			
18(29(62)	6(12(50)	24(41(58.5)	
*Type of positioning was unavailable for 17 patients in the literature review.			
†Type of procedure and operative time was unavailable for 13 patients in the literature review.			
‡Change in Hematocrit was unavailable for 45 patients in the literature review and 2 patients in the case series.			
§Change in Hemoglobin was available for 17 patients in the literature review and 10 patients in the case series.			
¶Intraoperative blood pressures were unavailable for 66 patients in the literature review.			
‡Number of levels operated could not be ascertained in 58 patients from the literature review.			
§Level of procedure was unavailable for 50 patients from the literature review.			
†Circumferential refers to positioning where the patient spends some time supine and some time prone during the procedure			
Abbreviations: EBL-estimated blood loss, SBP-systolic blood pressure.			
Summary of post-operative and follow up ophthalmic examination			
Variable	Literature review (n=182)	Institutional case series (n=12)	Total (n=194)
Initial post-op presentation			
Diagnosis, n (%)			
ION, unspecified	47(26)	0(0)	47(24.2)
PION	104(57)	10(83.3)	114(58.7)
AION	31(17)	2(16.6)	33(17)
Onset, n/N (%)			
Up to 24h	36/50(72)	9/12(75)	45/62(72.5)
24h to 48h	8/50(16)	1/12(8.3)	9/62(14.1)
3-5 days	3/50(6)	2/12(16.6)	5/62(8)
6-9 days	2/50(4)	0/12(0)	2/62(3.2)
≥9 days	1/50(2)	0/12(0)	1/62(1.6)
Disk edema, n/N (%)			
10/48(21)	2/12(16)	12/60(20)	
Disk pallor, n/N (%)			
7/49(14)	0/12(0)	7/61(11.47)	
Laterality, n (%)			
OU (Bilateral)	93(51)	9(75)	102(52.8)
OS or OD (Unilateral)	88(49)	3(25)	91(47.2)
Pupillary defect, n/N (%)			
40/47(85)	5/12(45.5)	45/59(76.2)	
Visual Field Deficit (VFD) [†] , n (%)			
89(100)	12 (100)	101(100)	
Acuity			
No visual impairment or mild	3/56(5)	5/12(41.6)	8/68(11.7)
Moderate	6/56(11)	0/12(0)	6/68(8.82)
Severe	4/56(7)	2/12(16.6)	6/68(8.82)
Blindness	105/176(60)	5/12(41.6)	110/188(58.5)
Color vision deficit, n/N (%)			
22/24(92)	10/12(83.3)	32/36(88.8)	
Last follow up [‡]			
Visual Field Defect (VFD), n/N (%) [‡]			
Improved	19/52(27)	3/10(30)	27/62(43.5)
Unchanged	32/52(62)	5/10(50)	37/62(59.7)
Worsened	1/52(2)	2/10(20)	3/62(4.8)
Visual Acuity (VA), n/N (%)			
Improved	25/52(37)	3/10(30)	36/62(58)
Unchanged	25/52(48)	4/10(40)	29/62(46.8)
Worsened	2/52(4)	3/10(40)	5/62(8)
Color vision, n/N (%)			
Improved	8/26(31)	2/10(20)	10/36(27.8)
Unchanged	15/26(58)	7/10(70)	22/36(61.1)
Worsened	3/26(12)	1/10(10)	4/36(11.1)
Disk pallor			
36/43(84)	10/10(100)	46/53(86.8)	
Outcome [‡]			
Improved	64(35)	3(30)	67(34.5)
Unchanged	101(55)	4(40)	105(54.1)
Worsened	2(1)	3(30)	5(2.5)
†Information about field deficit at onset was missing for 83 patients which were from the registry(ref)			
‡Follow up ophthalmic examination was missing for 2 patients in our series.			
§Overall outcome was unavailable for 15 patients in the literature review and 2 patients in the series.			
Abbreviations: ION- Ischemic optic neuropathy, AION- anterior ischemic optic neuropathy, PION- posterior ischemic optic neuropathy, OS (oculus sinister) left eye, OD (oculus dextrus) right eye, OU (oculus uterque) both eyes			

All ION patients and controls. OR, Odds Ratio; HTN, Hypertension; CI, confidence interval					
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 [‡]	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
Type of spine surgery, n (%)					
Non-fusion	2(16.7)	39(81.25)		Reference	
Fusion	10(83.3)	9(18.75)	0.003	23.8	2.94-192.40
Positioning					
Non-prone	2(16.7)	10(20.8)		Reference	
Prone	10(83.3)	38(79.2)	0.77	1.27	0.27-6.02
Number of vertebral levels operated (mean, SD) **					
4.75(2.38)	1.58(1.23)	0.004	2.99	1.42-6.324	
Blood loss, mL (median, IQR)					
1500(225-5231.25)	100(50-150)	0.02	1.003	1-1.005	
Intra-op crystalloids (median, IQR)					
6169 (4385-9658)	2161(1585-3002)	0.008	1.001	1-1.002	
Net change in Hgb, mg/dl (median, IQR)					
3.15 (1.825-5.05)	1.1(0.4-2)	0.01	2.28	1.20-4.34	
Net change in Hct (%) (median, IQR)					
9.45 (4.95-14.575)	3.8(1.8-6)	0.01	1.32	1.07-1.65	

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.