Title: Surgical approaches for optic nerve sheath fenestration for Idiopathic Intracranial Hypertension and review of the literature

Veranis S 1

1. 251 General Air Force and Reserve Hospital

Correspondence, Veranis Sotiris 251 General Air Force and Reserve Hospital, Kanellopoulou Katehaki 3-5, 11525, Athens, Greece, email: veranissotiris@gmail.com

Abstract

Idiopathic Intracranial Hypertension is one of the causes of blindness in the modern world. It affects usually overweight female patients in their childbearing age. Unfortunately, there are no clear quidelines in respect of the best possible approach to treat this rare condition. Conservative treatment which means weight loss, acetazolamide prescription and close follow up and on the other hand surgical treatments are the main options. Ventriculoperitoneal shunt to relieve intracranial pressure and Optic Sheath Fenestration are both surgical options that can be also combined treat patients and save their vision decline 1,4. In this study, we retrospectively reviewed different techniques of optic sheath fenestration and measured the outcome and the complication rate of each one.

Keywords IIH, optic nerve sheath fenestration, papilledema

Introduction

Idiopathic intracranial hypertension (IIH) has been increasing in prevalence during the past decade37. When medical treatment is inadequate to control vision decline, surgical treatment options must be considered. Optic nerve sheath fenestration (ONSF) is a well-established surgical technique to stabilise or improve vision decline and numerous surgical approaches have been described.

Purpose

The aim of this study is to is to retrospectively review which are the preferred surgical approaches for optic nerve sheath fenestration, in which surgical approach results are better and assess the safety of its approach in terms of complication rate. Furthermore, we searched for evidence regarding the pathophysiology of the therapeutic effect and the effect on internal cranial pressure (ICP).

Materials and Methods

We used the following keywords and phrases: optic sheath fenestration for pseudotumor cerebri, optic sheath fenestration for idiopathic intracranial hypertension, optic sheath fenestration and surgical techniques to perform web based search in PubMed and Google Scholar.

Inclusion and exclusion criteria have been defined before performing the search.

Inclusion criteria: Optic nerve sheath fenestration for IIH, report of complication rate, follow up of vision postoperatively, report of surgical method used, English language.

Exclusion criteria cerebral vein thrombosis, trauma, ischemic optic neuropathy, optic nerve glioma, animal studies, CNS infection cases, experimental studies

Prisma 2009 flow diagram was used to identify screen and include the eligible studies for further qualitative synthesis. A total of sixty-two (62) articles retrieved from the database search and after removing 5 duplicates fifty-seven (57) articles screened. Seventeen (17) articles excluded by title or abstract 26,27,29,30,34,35,36and forty (40) full-text articles assessed for eligibility. Twenty-three (23) 22,25,28,31,32,33, articles were excluded with reasons and seventeen (17) articles finally included for qualitative synthesis.

Results

A total of 17 studies included for qualitative synthesis of the results. (Table 1) 13 studies reported results of medial approaches, 2 studies reported results of lateral approaches and 2 studies results of transnasal endoscopic ONSF. Studies using medial approaches reported 238 patients and 398 eyes, female were 200 and male patients were 38, studies using lateral approaches reported 90 patients, 71 eyes and female were 72 and male 18, studies referring to endoscopic ONSF reported 24 patients ,28 eyes, female were 19 and male 5. Different rates of complications were reported between the studies. We summarized the total number of reported complications in studies utilizing medial approaches in 46 of 238 patients (19%), in studies that described lateral approaches there were 23 complications of 90 patients (25%) and at last there were no complications reported in the 24 patients were endoscopic approach was used (0%). Vision was improved in 189 (80%) patients and decreased in 11 (4%) regarding medial approaches, improved in 74(82%) regarding lateral approaches and in 24 (100%) regarding endoscopic approaches.

In conclusion, optic nerve sheath fenestration is a vision saving technique. The duration of the procedure in experienced hands is short, usually less than an hour and it has reasonable rate of complications. There is evidence that even unilateral approach affects both eyes. There is no clear data about the effect of ONSF on ICP control and patients need ICP follow up. There is no clear data about the pathophysiology of the therapeutic effect of ONSF.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Author** | **Patients** | **Male** | **Female** | **Eyes** | **Method** | **Results** | **Complications** | **Effect on ICP** |
| 1 | Wilkes 2 | 1 | 0 | 1 | 2 | Medial | VA further declined | Not procedural | ICP remained high |
| 2 | Vaidya3 | 102 | 4 | 98 | 205 | Medial | VA improved VF improved Papiledema n=121 eyes showed resolution n=84 improved | Include transient diplopia post-operatively in 7 patients (6.7%) 17 patients (16.3%) developed some degree of efferent pupillary dysfunction, either unilaterally or bilaterally | Not reported |
| 3 | Rizzo5 | 2 | 0 | 2 | 4 | Medial | Initially improved | Choroidal infraction decreased VA | Not reported |
| 4 | Prabhakaran VC6 | 1 | 0 | 1 | 1 | Vertical lid split approach | VA improved VF improved Papiledema improved | No complications reported | Not reported |
| 5 | Pineles SL7 | 42 | 5 | 37 | 50 | Medial | VA improved n=8 stable n=20 deteriorated n=9 | abscess n =1 transient diplopia n=1 tonic pupil n=1 | Not reported |
| 6 | Malik AI8 | 12 | N/A | N/A | 24 | Superomedial eyelid crease approach | VA improved | Ptosis, pupillary deficit, acute orbital inflammation | Not reported |
| 7 | Kaur N9 | 1 | 0 | 1 | 1 | Endoscopic Optic Nerve Decompression EOND 2 fenestrations  | VA improved | No complications reported | Not reported |
| 8 | Hagen SM10 | 10 | 0 | 10 | 11 | Medial superonasal transconjunctival | VA improved | Chemosis periorbital oedema n=2 minor subconjunctival bleeding n=5 lacrimation n=1 periorbital oedema n=2 | Not reported |
| 9 | Fonseca PL12 | 14 | 3 | 11 | 16 | Medial | VA improved VF improved  | 3 patients required shunt procedure | Not reported |
| 10 | Chandrasekaran S13 | 32 | 3 | 29 | 51 | Medial | VA improved VF improved | No complications reported | Not reported |
| 11 | Alsuhaibani AH16 | 62 | 10 | 52 | 31 | Lateral canthotomy95%Lateral orbitotomy 5% | Papilledema reduction VA improved VF improved | No complications reported | Not reported |
| 12 | Al Othman B17 | 1 | 0 | 1 | 1 | Medial upper Eyelid | VA declined | Retrobulbar oedema requiring IV steroids | Not reported |
| 13 | Tarrats L18 | 23 | 4 | 19 | 27 | EOND | VA improved VF improved | No complications reported | Not reported |
| 14 | Shuaib MM19 | 1 | 0 | 1 | 1 | Medial | VA improved | No complications reported | Not reported |
| 15 | Pelton RW21 | 12 | 6 | 6 | 12 | Superomedial lid crease incision | VA improved VF improved | tonic pupil n=1vertical diplopia n=2transient medial ptosis n=1 | Not reported |
| 16 | Agarwal MR23 | 8 | 5 | 3 | 20 | Medial | VA improved VF improved | No complications reported | Not reported |
| 17 | James J Corbett24 | 28 | 8 | 20 | 40 | Lateral | Papiledema improved 24/8VA improved 12/40Stabilized 22/406/40 decreasedVF improved 21/40Stabilized 10/40 | Tonic pupil n=16Loss of vision one month post op n=5Retrobulbar haemorrhage n=1VI nerve palsy n=1 | Not reported |

Figure Rough estimation of complication rate for its approach

Figure Diagram depicting the relative percentage of its approach in our cohort

Discussion

Our results depicted that Optic nerve sheath fenestration is rather a safe technique with zero morbidity and mortality. Complications regarding the orbit could happen in a reasonable rate11,14. The workhorse of these approaches seems to be medial techniques in respect to lateral techniques. It is very interesting the fact that endoscopic optic nerve sheath fenestration utilizing the transnasal approach has very good results with no complications reported18. We have to mention though that the population studied in the endoscopic cohort was much smaller that the medial and lateral groups and as a result we cannot make definite conclusions. Further studies are needed to elucidate more the value of transnasal endoscopic optic sheath fenestration.

 References

1. Yaqub MA, Mehboob MA, Islam QU. Efficacy and safety of optic nerve sheath fenestration in patients with raised intracranial pressure. *Pak J Med Sci*. 2017;33(2):471-475. doi:[10.12669/pjms.332.11937](https://doi.org/10.12669/pjms.332.11937)

2. Wilkes BN, Siatkowski RM. Progressive Optic Neuropathy in Idiopathic Intracranial Hypertension After Optic Nerve Sheath Fenestration. *Journal of Neuro-Ophthalmology*. 2009;29(4).

3. Vaidya NS, Mahmoud AM, Buzzacco D, Katz SE. Visual outcomes following optic nerve sheath fenestration via the medial Transconjunctival approach. *null*. 2016;35(5):271-277. doi:[10.1080/01676830.2016.1193530](https://doi.org/10.1080/01676830.2016.1193530)

4. Spitze A, Lam P, Al-Zubidi N, Yalamanchili S, Lee AG. Controversies: Optic nerve sheath fenestration versus shunt placement for the treatment of idiopathic intracranial hypertension. *Indian J Ophthalmol*. 2014;62(10):1015-1021. doi:[10.4103/0301-4738.146012](https://doi.org/10.4103/0301-4738.146012)

5. Rizzo JF, Lessell S. Choroidal Infarction after Optic Nerve Sheath Fenestration. *Ophthalmology*. 1994;101(9):1622-1626. doi:[10.1016/S0161-6420(94)31128-6](https://doi.org/10.1016/S0161-6420%2894%2931128-6)

6. Prabhakaran VC, Selva D. Vertical lid split approach for optic nerve sheath decompression. *Indian J Ophthalmol*. 2009;57(4):305-306. doi:[10.4103/0301-4738.53057](https://doi.org/10.4103/0301-4738.53057)

7. Pineles SL, Volpe NJ. Long-Term Results of Optic Nerve Sheath Fenestration for Idiopathic Intracranial Hypertension: Earlier Intervention Favours Improved Outcomes. *null*. 2013;37(1):12-19. doi:[10.3109/01658107.2012.757787](https://doi.org/10.3109/01658107.2012.757787)

8. Malik AI, Xu J, Lee AG. Outcomes of optic nerve sheath fenestration from superomedial eyelid crease approach. *null*. Published online February 15, 2021:1-9. doi:[10.1080/01676830.2021.1880444](https://doi.org/10.1080/01676830.2021.1880444)

9. Kaur N, Patro SK, Gupta AK, Chauhan N. Idiopathic Intracranial Hypertension and Endoscopic Optic Nerve Sheath Fenestration. *Indian Journal of Otolaryngology and Head & Neck Surgery*. Published online August 13, 2020. doi:[10.1007/s12070-020-02004-7](https://doi.org/10.1007/s12070-020-02004-7)

10. Hagen SM, Wegener M, Toft PB, Fugleholm K, Jensen RH, Hamann S. Unilateral Optic Nerve Sheath Fenestration in Idiopathic Intracranial Hypertension: A 6-Month Follow-Up Study on Visual Outcome and Prognostic Markers. *Life*. 2021;11(8). doi:[10.3390/life11080778](https://doi.org/10.3390/life11080778)

11. Intracranial Hypertension. *null*. 2018;33(1):36-41. doi:[10.1080/08820538.2017.1353810](https://doi.org/10.1080/08820538.2017.1353810)

12. Fonseca PL, Rigamonti D, Miller NR, Subramanian PS. Visual outcomes of surgical intervention for pseudotumour cerebri: optic nerve sheath fenestration versus cerebrospinal fluid diversion. *Br J Ophthalmol*. 2014;98(10):1360. doi:[10.1136/bjophthalmol-2014-304953](https://doi.org/10.1136/bjophthalmol-2014-304953)

13. Chandrasekaran S, McCuskey P, Minassian D, Assaad N. Visual outcomes for optic nerve sheath fenestration in pseudotumor cerebri and related conditions. *Clinical & Experimental Ophthalmology*. 2006;34(7):661-665. doi:[10.1111/j.1442-9071.2006.01301.x](https://doi.org/10.1111/j.1442-9071.2006.01301.x)

14. Brodsky MC, Rettele GA. Protracted Postsurgical Blindness With Visual Recovery Following Optic Nerve Sheath Fenestration. *Archives of Ophthalmology*. 1997;115(11):1473-1474. doi:[10.1001/archopht.1997.01100160643025](https://doi.org/10.1001/archopht.1997.01100160643025)

15. Blessing NW, Tse DT. Optic nerve sheath fenestration: a revised lateral approach for nerve access. *null*. 2019;38(2):137-143. doi:[10.1080/01676830.2018.1452949](https://doi.org/10.1080/01676830.2018.1452949)

16. Alsuhaibani AH, Carter KD, Nerad JA, Lee AG. Effect of Optic Nerve Sheath Fenestration on Papilledema of the Operated and the Contralateral Nonoperated Eyes in Idiopathic Intracranial Hypertension. *Ophthalmology*. 2011;118(2):412-414. doi:[10.1016/j.ophtha.2010.06.025](https://doi.org/10.1016/j.ophtha.2010.06.025)

17. Al Othman B, Raabe J, Malik A, Li H, Kini A, Lee AG. Transient vision loss after optic nerve sheath fenestration. *null*. 2020;39(3):217-220. doi:[10.1080/01676830.2019.1668433](https://doi.org/10.1080/01676830.2019.1668433)

18. Tarrats L, Hernández G, Busquets JM, et al. Outcomes of endoscopic optic nerve decompression in patients with idiopathic intracranial hypertension: Optic decompression hypertension. *Int Forum Allergy Rhinol*. 2017;7(6):615-623. doi:[10.1002/alr.21927](https://doi.org/10.1002/alr.21927)

19. Shuaib MM, Helmy GM, Badr Eldin N, Elnahry AG, Elnahry GA. Optical coherence tomography of the optic nerve head before and after optic nerve sheath fenestration for idiopathic intracranial hypertension. *Acta Neurologica Belgica*. 2020;120(3):775-777. doi:[10.1007/s13760-020-01331-4](https://doi.org/10.1007/s13760-020-01331-4)

20. Pircher A, Montali M, Pircher J, Berberat J, Remonda L, Killer HE. Perioptic Cerebrospinal Fluid Dynamics in Idiopathic Intracranial Hypertension. *Front Neurol*. 2018; 9:506. doi:[10.3389/fneur.2018.00506](https://doi.org/10.3389/fneur.2018.00506)

21. Pelton RW. Superomedial Lid Crease Approach to the Medial Intraconal Space. 2001;17(4):13.

22. Blessing NW, Tse DT. Optic nerve sheath fenestration: a revised lateral approach for nerve access. *Orbit*. 2019;38(2):137-143. doi:[10.1080/01676830.2018.1452949](https://doi.org/10.1080/01676830.2018.1452949)

23. Agarwal MR, Yoo JH. Optic nerve sheath fenestration for vision preservation in idiopathic intracranial hypertension. *FOC*. 2007;23(5): E7. doi:[10.3171/FOC-07/11/E7](https://doi.org/10.3171/FOC-07/11/E7)

24. Corbett JJ, Nerad JA, Tse DT, Anderson RL. Results of Optic Nerve Sheath Fenestration for Pseudotumor Cerebri: The Lateral Orbitotomy Approach. *Archives of Ophthalmology*. 1988;106(10):1391-1397. doi:[10.1001/archopht.1988.01060140555022](https://doi.org/10.1001/archopht.1988.01060140555022)

25.Z. Mitros, S. Sadati, C. Seneci, et al. Optic Nerve Sheath Fenestration With a Multi-Arm Continuum Robot. *IEEE Robotics and Automation Letters*. 2020;5(3):4874-4881. doi:[10.1109/LRA.2020.3005129](https://doi.org/10.1109/LRA.2020.3005129)

26.VanderVeen DK, Nihalani BR, Barron P, Anderson RL. Optic nerve sheath fenestration for an isolated optic nerve glioma. *Journal of American Association for Pediatric Ophthalmology and Strabismus*. 2009;13(1):88-90. doi:[10.1016/j.jaapos.2008.07.009](https://doi.org/10.1016/j.jaapos.2008.07.009)

27.Thomas S, Tan J, Lawden M, Sampath R. Optic Nerve Sheath Fenestration for Intracranial Hypertension Associated With Chronic Inflammatory Demyelinating Polyneuropathy. *Ophthalmic Plastic & Reconstructive Surgery*. 2004;20(4). <https://journals.lww.com/op-rs/Fulltext/2004/07000/Optic_Nerve_Sheath_Fenestration_for_Intracranial.17.aspx>

28. Shah RJ, Shen JH, Joos KM. Endoscopic free electron laser technique development for minimally invasive optic nerve sheath fenestration. *Lasers in Surgery and Medicine*. 2007;39(7):589-569. doi:[10.1002/lsm.20531](https://doi.org/10.1002/lsm.20531)

29. Mohamed IG, Roa W, Fulton D, et al. Optic Nerve Sheath Fenestration for a Reversible Optic Neuropathy in Radiation Oncology. *American Journal of Clinical Oncology*. 2000;23(4). <https://journals.lww.com/amjclinicaloncology/Fulltext/2000/08000/Optic_Nerve_Sheath_Fenestration_for_a_Reversible.18.aspx>

30. McHenry JG, Spoor TC. Optic Nerve Sheath Fenestration for Treatment of Progressive Ischemic Optic Neuropathy. *Archives of Ophthalmology*. 1993;111(12):1601-1601. doi:[10.1001/archopht.1993.01090120015001](https://doi.org/10.1001/archopht.1993.01090120015001)

31. Joos KM, Shah RJ, Robinson RD, Shen JH. Optic nerve sheath fenestration with endoscopic accessory instruments versus the free electron laser (FEL). *Lasers in Surgery and Medicine*. 2006;38(9):846-851. doi:[10.1002/lsm.20397](https://doi.org/10.1002/lsm.20397)

32. Joos KM, Mawn LA, Shen JH, Casagrande VA. Chronic and acute analysis of optic nerve sheath fenestration with the free electron laser in monkeys. *Lasers in Surgery and Medicine*. 2003;32(1):32-41. doi:[10.1002/lsm.10146](https://doi.org/10.1002/lsm.10146)

33. Jin-Hui Shen, Vivien A. Casagrande, Karen Margaret Joos M.D., et al. Acute optic nerve sheath fenestration with the free-electron laser. In: Vol 3591.; 1999. doi:[10.1117/12.350585](https://doi.org/10.1117/12.350585)

34. Jefferis JM, Raoof N, Carroll T, Salvi SM. Optic nerve sheath fenestration in patients with visual failure associated with vestibular schwannoma. *null*. 2019;33(4):402-408. doi:[10.1080/02688697.2018.1538482](https://doi.org/10.1080/02688697.2018.1538482)

35. Glaser JS, Teimory M, Schatz NJ. Optic Nerve Sheath Fenestration for Progressive Ischemic Optic Neuropathy: Results in Second Series Consisting of 21 Eyes. *Archives of Ophthalmology*. 1994;112(8):1047-1050. doi:[10.1001/archopht.1994.01090200053021](https://doi.org/10.1001/archopht.1994.01090200053021)

36. Gasperini J, Black E, Van Stavern G. Perineural Metastasis of Breast Cancer Treated with Optic Nerve Sheath Fenestration. *Ophthalmic Plastic & Reconstructive Surgery*. 2007;23(4). <https://journals.lww.com/op-rs/Fulltext/2007/07000/Perineural_Metastasis_of_Breast_Cancer_Treated.25.aspx>

37. Kalyvas A, Neromyliotis E, Koutsarnakis C, et al. A systematic review of surgical treatments of idiopathic intracranial hypertension (IIH). *Neurosurg Rev*. 2021;44(2):773-792. doi:[10.1007/s10143-020-01288-1](https://doi.org/10.1007/s10143-020-01288-1)