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Original Article

Efficacy of Optic Nerve Sheath Fenestration in Patients with Increased Intracranial Pressure

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Abstract

Objectives: To evaluate the effectiveness of optic nerve sheath fenestration (ONSF) on visual functions in patients with increased intracranial pressure (ICP).

Materials and Methods: The medical records of 24 eyes of 17 patients who had ICP due to idiopathic intracranial hypertension, cerebral venous sinus thrombosis, or intracranial cyst and underwent ONSF surgery to prevent visual loss were evaluated. Pre- and postoperative visual acuity, optic disc images, and visual field findings were reviewed.

Results: The mean age of the patients was 30.4±8.5 years, and 88.2% were female. The patients' mean body mass index was 28.67±6.1 kg/m^2. The mean follow-up time was 24±12.1 months (range: 3-44). At postoperative 3 months, the mean best-corrected distance visual acuity had improved in 20 eyes (83.3%) and stabilized in 4 eyes (16.7%) compared to preoperative values. In visual field mean deviation, an improvement was observed in 10 eyes (90.9%), while 1 eye (9.1%) eye remained stable. Optic disc edema decreased in all patients.

Conclusion: This study indicates that ONSF has beneficial effects on visual function in patients with rapidly progressive visual loss caused by increased intracranial pressure.

Keywords: Idiopathic intracranial hypertension, optic nerve sheath fenestration, pseudotumor cerebri, visual field

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Introduction

Papilledema is an optic nerve swelling caused by increased intracranial pressure (ICP) and characterized by irreversible vision loss and visual field defects if left untreated.[1] Idiopathic intracranial hypertension (IIH), intracranial space-occupying lesions, and cerebral venous sinus thrombosis (CVST) are well-known causes of papilledema.[2,3] Treatment modalities including medical and surgical options aim to prevent vision loss and reduce the clinical findings of increased ICP. Medical management includes dietary modification, weight loss, carbonic anhydrase inhibitors, and diuretics.[4] Optic nerve sheath fenestration (ONSF), neurosurgical shunting procedures (lumboperitoneal or ventriculoperitoneal shunt), and venous sinus stenting are performed in patients who have persistent headaches and rapidly progressive visual loss refractory to maximum medical treatment.[5,6,7]

ONSF was first described by DeWecker[8] in 1872 and was reported to be a possible therapeutic procedure for papilledema by Hayreh[9] in 1964. It is a surgical procedure that lowers the cerebrospinal fluid pressure through an incision in the dural-arachnoid sheath on the retrobulbar optic nerve region. Major advantages of ONSF surgery are the low complication rate, short anesthesia and hospitalization times, and bilateral resolution of papilledema after unilateral decompression.

In the present study, we share our experience and aim to evaluate the efficacy of the ONSF procedure in patients with increased ICP.

Materials and Methods

Patients who underwent ONSF for increased ICP in our clinic were included this retrospective study. Medical records from January 2011 to June 2014 were reviewed to identify eligible patients. The study was conducted in accordance with the Declaration of Helsinki and informed consent forms were obtained from all participants. Approval to conduct the study was received from the local ethics committee.

All patients were referred to our tertiary center for consideration of an ONSF with a diagnosis of IIH and CVST, and intracranial cyst. The diagnoses were confirmed by neurology consultation including a neurological exam, neuroimaging, and lumbar puncture. Indications for ONSF included persistent headache and/or rapidly progressive loss of visual function associated with increased ICP despite maximal medical treatment or neurosurgical shunting procedures. All patients were operated by the same surgeon under general anesthesia using the standard medial transconjunctival orbitotomy technique (Figure 1).

The results of ophthalmologic examinations including best-corrected distance visual acuity (BDVA), optic disc photographs, and standard 30-2 visual field with automated Humphrey perimetry conducted preoperatively and at 3 and 6 months postoperatively were analyzed. Reliable visual field was defined as having less than 33% false positives and negatives and fewer than 3 fixation losses. Additionally, age, sex, body mass index (BMI), operated side, and history of neurosurgical shunting procedures were documented for all patients.

Statistical Analysis

Statistical analyses were performed using SPSS version 21 software package (IBM Corp., Armonk, NY, USA).

In this study, a postoperative increase in BDVA of two or more Snellen lines was defined as improvement, a decrease in BDVA of two or more Snellen lines was defined as vision loss, and a change in BDVA up to two Snellen lines was defined as stabilization. In visual field mean deviation, an increase greater than 5 dB was considered improvement, a decrease greater than 5 dB was considered deterioration, and a change up to 5 dB was considered stabilization. An improvement or stabilization in BDVA and/or visual field at postoperative 3 months compared to preoperative values was accepted as surgical success.

Results

Twenty-four eyes of 17 patients were included in the study. The demographic data and clinical characteristics of the patients are shown in Table 1. The mean age of the patients was 30.4±8.5 years (range: 13-47). Most (88.2%) of the patients was female. Etiologically, ICP developed as a result of IIH in 11 patients (64.7%), CVST in 4 patients (23.5%), and both CVST and intracranial cyst in 2 patients (11.7%). ONSF was performed unilaterally in 10 (58.9%) patients and bilaterally in 7 patients (41.1%). The mean body mass index of the patients was 28.67±6.1 kg/m^2. Seven patients had normal weight, 4 patients were overweight, 5 were obese, and 1 patient was morbidly obese. Five patients had a history of shunt procedure. The time from diagnosis to surgery ranged from 2-12 weeks, with a mean of 6±3 weeks.

The preoperative ophthalmologic findings of the patients are presented in Table 2. BDVA was worse than 20/200 in 11 eyes (54.1%). Visual field data were not be available in 13 eyes

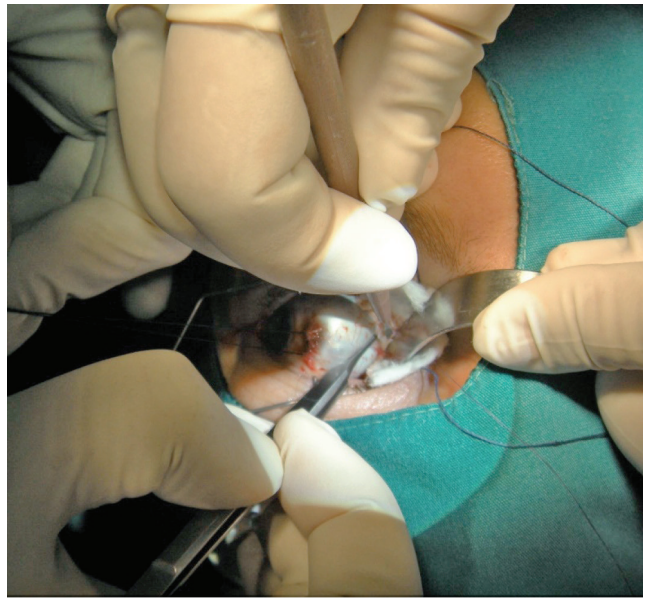

Figure 1. Intraoperative photograph of a patient who underwent optic nerve sheath fenestration

because of adaptation problems and poor vision. Papilledema was observed in 13 eyes (54.1%) and 11 eyes (45.9%) had an optic atrophy. The mean follow-up time was 24±12.1 months (range: 3-44).

At postoperative 3 months, improvement in BDVA was observed in all 13 (100%) of the eyes with papilledema (Table 3). In eyes with optic atrophy, there was an improvement in BDVA in 7 eyes (63.6%) and stabilization in 4 eyes (36.4%) at 3 months postoperatively (Table 3). No patient had vision loss after the surgery. There was a statistically significant improvement in the mean visual field mean deviation at 3 months postoperatively (p=0.003). Figure 2 shows an example of improvement in visual field after ONSF. The visual field mean deviation improved in 10 eyes (90.9%) and stabilized in 1 eye (9.1%) postoperatively. Papilledema regressed after the surgery in all eyes (Figure 3). Surgical success was achieved in 100% of the patients. None of the patients required a secondary ONSF surgery during the follow-up period.

Discussion

Early diagnosis and treatment of papilledema is important, as it may cause progressive and permanent loss of vision. The degree of increase and duration of ICP are the most important factors affecting the time of transition from papilledema to optic atrophy. This study focused on the clinical outcomes of surgical treatment with ONSF for elevated ICP in patients with progressive visual loss. We investigated the efficacy of ONSF using the measurements of BDVA and visual field mean deviation. Compared to preoperative data, 83.3% of the eyes had improved BDVA and 90.9% had better visual field mean deviation at 3 months postoperatively.

Table 1. Baseline demographics and clinical characteristics of the patients (n=17)

Age (years) (mean ± SD, min-max)	30.4±8.5 (13-47)
Gender (n, %)	
Female	15 (88.2%)
Male	2 (11.8%)
BMI (kg/m^2) (mean ± SD, min-max)	28.67±6.1 (20.9-42.2)
History of a shunt procedure (n, %)	5 (29.4%)
Primary ICP elevation (IIH) (n, %)	11 (64.7%)
Secondary ICP elevation (n, %)	
CVST	4 (23.5%)
CVST + intracranial cyst	2 (11.7%)

BMI: Body mass index, ICP: Intracranial pressure, IIH: Idiopathic intracranial hypertension, CVST: Cerebral venous sinus thrombosis, min: Minimum, max: Maximum, SD: Standard deviation

Table 2. Preoperative ophthalmologic examination results of the eyes (n=24)

BDVA (n, %)	
20/20-20/40	4 (16.6%)
20/40-20/200	9 (37.5%)
<20/200	11 (45.9%)
Visual field mean deviation (n, %)	
<20 dB	2 (8.3%)
≥20 dB	9 (37.5%)
Unreliable	13 (54.1%)
Optic disc findings (n, %)	
Papilledema	13 (54.1%)
Optic atrophy	11 (45.9%)

BDVA: Best-corrected distance visual acuity

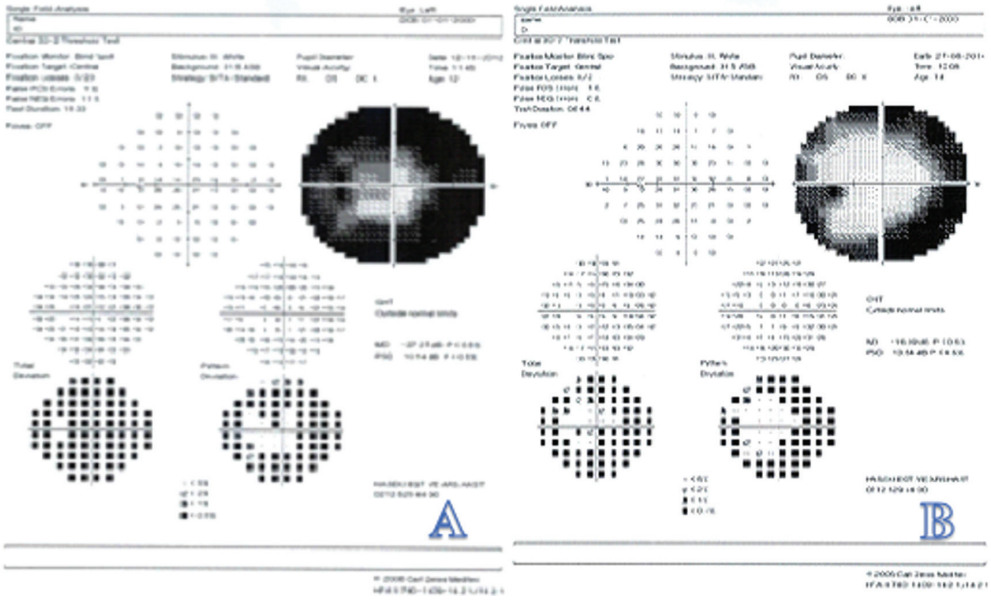

Figure 2. Visual fields of a patient with idiopathic intracranial hypertension before (A) and after (B) optic nerve sheath fenestration

Table 3. Distribution of improvement, stabilization, and deterioration after ONSF

	Eyes with papilledema (n=13)	Eyes with optic atrophy (n=11)
BDVA (n, %)		
Improvement	13 (100%)	7 (63.6%)
Stabilization	0	4 (36.4%)
Deterioration	0	0
Visual field mean deviation (n, %)		
Improvement	10 (90.9%)	-
Stabilization	1 (9.1%)	-
Deterioration	0	-

ONSF: Optic nerve sheath fenestration, BDVA: Best-corrected distance visual acuity

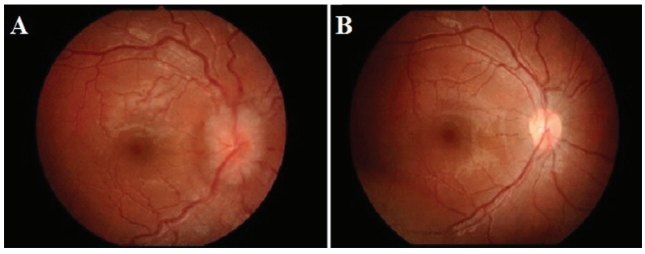

Figure 3. Fundus photographs of a patient with idiopathic intracranial hypertension before (A) and after (B) optic nerve sheath fenestration

A local filtering effect is one of the possible mechanisms by which ONSF provides improvement in the retrobulbar circulation.[10] Fluid collection in the operated area consistent with a cerebrospinal fluid filtration mechanism was observed using magnetic resonance imaging in the early postoperative period of ONSF.[11] A second possibility is that a fibrous scar in the subarachnoid space blocks the flow of increased cerebrospinal fluid to optic nerve head.[10] A generalized decrease of ICP after ONSF is another possible mechanism.[12] However, the main mechanism of the effect of ONSF remains unclear.

The effectiveness and safety of ONSF in elevated ICP has been proven in many clinical trials, and studies have even shown significant improvements in visual function.[6,13,14,1516,17] The largest study conducted to date evaluated the efficacy of ONSF performed by a single surgeon at the same institution in 578 eyes and reported improvement or stabilization of visual acuity in 94.4% and visual field in 96.9% of the eyes, similar to our study.[15] Moreover, a previous study suggested that ONSF has superior outcomes to other surgical techniques for the treatment of IIH.[14] Revision surgery is often required after shunt procedures. Rosenberg et al.[18] reported a high reoperation rate in the treatment of IIH and a shunt failure rate of 64%. Better visual acuity outcomes were reported following ONSF in patients with a decline in visual function after lumboperitoneal shunting.[13,19] In the present study, 29.4% of the patients had a history of shunt procedures. BDVA and visual field mean deviation improved or stabilized in all patients. Surgical treatment decisions may depend on the local preferences and availability of experienced surgeons.[6] However, this study suggests that ONSF may be an effective treatment option to improve visual function in patients who have progressive visual loss following shunt surgery.

Preoperative optic disc pallor and visual acuity do not predict the outcomes of ONSF surgery.[19,20] Therefore, optic disc pallor is not a contrandication to ONSF. However, a study by Spoor et al.[21] demonstrated statistically better visual outcomes in patients with acute papilledema compared to chronic atrophic papilledema. In the present study, 11 eyes (45.9%) had an optic disc atrophy preoperatively, but all of these eyes showed stabilization or improvement after ONSF surgery.

IIH is an elevated ICP syndrome of unknown etiology, frequently seen in young, overweight women.[2,3] In this study, IIH was the etiological factor in 88.2% of the patients undergoing ONSF. The IIH patients in our study were consistent with the literature in terms of age, sex, and weight. Our results indicated that ONSF was beneficial in patients with increased ICP secondary to pathologies such as IIH and CVST.

Study Limitations

Potential limitations of the present study include its single-center, retrospective design, small sample size, lack of papilledema grading, and relatively short follow-up period.

Conclusion

In conclusion, this study demonstrated improved or stabilized visual outcomes after ONSF surgery in patients with elevated ICP and rapidly progressive visual loss. However, further prospective, randomized controlled studies with larger patient series and longer follow-up are needed to obtain stronger evidence.

Ethics

Ethics Committee Approval: University of Health Sciences Türkiye Haseki Training and Research Hospital Clinical Research Ethics Committee (date: 25.11.2020/decision no: 2020-220).

Peer-review: Externally peer reviewed.

Authorship Contributions

Surgical and Medical Practices: N.D., Concept: F.Ö., Design: F.Ö., Data Collection or Processing: S.C.Ö., Analysis or Interpretation: S.C.Ö., N.D., Literature Search: D.Ö.Ö., Writing: S.C.Ö.

Conflict of Interest: No conflict of interest was declared by the authors.

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References

1. Zamecki KJ, Frohman LP, Turbin RE. Severe visual loss associated with idiopathic intracranial hypertension (IIH) in pregnancy. Clin Ophthalmol. 2007;1:99-103.
2. Raoof N, Sharrack B, Pepper IM, Hickman SJ. The incidence and prevalence of idiopathic intracranial hypertension in Sheffield, UK. Eur J Neurol. 2011;18:1266-1268.
3. Dağdelen S, Aykan Ü. Dural ectasia of the optic nerve and unilateral proptosis-two rare comorbidities associated with idiopathic intracranial hypertension. Turk J Ophthalmol. 2013;43:297-300.

4. Friedman DI, Jacobson DM. Idiopathic intracranial hypertension. J Neuroophthalmol. 2004;24:138-145.
5. Biousse V, Bruce BB, Newman NJ. Update on the pathophysiology and management of idiopathic intracranial hypertension. J Neurol Neurosurg Psychiatry. 2012;83:488-494.
6. Spitze A, Malik A, Al-Zubidi N, Golnik K, Lee AG. Optic nerve sheath fenestration vs cerebrospinal diversion procedures: what is the preferred surgical procedure for the treatment of idiopathic intracranial hypertension failing maximum medical therapy? J Neuroophthalmol. 2013;33:183-188.
7. Kulhari A, He M, Fourcand F, Singh A, Zacharatos H, Mehta S, Kirmani JF. Safety and Clinical Outcomes after Transverse Venous Sinus Stenting for Treatment of Refractory Idiopathic Intracranial Hypertension: Single Center Experience. J Vasc Interv Neurol. 2020;11:6-12.
8. DeWecker L. On incision of the optic nerve in cases of neuroretinitis. In: Power H, ed. Report of the Fourth International Ophthalmological Congress. London: Savill, Edwards and Co; 1873:11-14.
9. Hayreh SS. Pathogenesis of oedema of the optic disc (papilloedema). A Preliminary Report. Br J Ophthalmol. 1964;48:522-543.
10. Keltner JL. Optic nerve sheath decompression. How does it work? Has its time come? Arch Ophthalmol. 1988;106:1365-1369.
11. Yazıcı Z, Yazıcı B, Tuncel E. Findings of magnetic resonance imaging after optic nerve sheath decompression in patients with idiopathic intracranial hypertension. Am J Ophthalmol. 2007;144:429-435.
12. Mittra RA, Sergott RC, Flaharty PM, Lieb WE, Savino PJ, Bosley TM, Hedges TR Jr. Optic nerve decompression improves hemodynamic parameters in papilledema. Ophthalmology. 1993;100:987-997.
13. Guy J, Johnston PK, Corbett JJ, Day AL, Glaser JS. Treatment of visual loss in pseudotumor cerebri associated with uremia. Neurology. 1990;40:28-32.
14. Feldon SE. Visual outcomes comparing surgical techniques for management of severe idiopathic intracranial hypertension. Neurosurg Focus. 2007;23:e6.
15. Moreau A, Lao KC, Farris BK. Optic nerve sheath decompression: a surgical technique with minimal operative complications. J Neuroophthalmol. 2014;34:34-38.
16. Nithyanandam S, Manayath GJ, Battu RR. Optic nerve sheath decompression for visual loss in intracranial hypertension: report from a tertiary care center in South India. Indian J Ophthalmol. 2008;56:115-120.
17. Anzeljc AJ, Frias P, Hayek BR, Canter Weiner N, Wojno TH, Kim HJ. A 15-year review of secondary and tertiary optic nerve sheath fenestration for idiopathic intracranial hypertension. Orbit. 2018;37:266-272.
18. Rosenberg ML, Corbett JJ, Smith C, Goodwin J, Sergott R, Savino P, Schatz N. Cerebrospinal fluid diversion procedures in pseudotumor cerebri. Neurology. 1993;43:1071-1072.
19. Sergott RC, Savino PJ, Bosley TM. Modified optic nerve sheath decompression provides long-term visual improvement for pseudotumor cerebri. Arch Ophthalmol. 1988;106:1384-1390.
20. Kelman SE, Heaps R, Wolf A, Elman MJ. Optic nerve decompression surgery improves visual function in patients with pseudotumor cerebri. Neurosurgery. 1992;30:391-395.
21. Spoor TC, Ramocki JM, Madion MP, Wilkinson MJ. Treatment of pseudotumor cerebri by primary and secondary optic nerve sheath decompression. Am J Ophthalmol. 1991;112:177-185.