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ORIGINAL ARTICLE

Evaluation of the demographic and neuro-ophthalmologic findings of our patients with non-arteritic ischemic optic neuropathy

Gozde Orman, Gulten Sungur, Ozlem Candan, Kubra Kucukiba, Nurten Unlu, Ayse Burcu

Department of Ophthalmology, Ankara Research and Training Hospital, Ankara, Türkiye

Abstract

Purpose: The purpose of the study was to evaluate the demographic, etiological, and neuro-ophthalmological characteristics of non-arteritic anterior ischemic optic neuropathy (NAION), with particular emphasis on prognostic factors and treatment outcomes.

Methods: In this retrospective cross-sectional study, we analyzed 143 eyes of 72 patients diagnosed with NAION between July 2016 and December 2023. Comprehensive ophthalmic examinations in-cluded best-corrected visual acuity, intraocular pressure measurements, visual field testing, and optical coherence tomography (OCT). Patients were stratified into prognostic groups based on final visual outcomes, and multiple variables were analyzed for their predictive value.

Results: This study analyzed 143 eyes of 72 patients diagnosed with NAION. Bilateral involvement was observed in 19.4% of cases, with a mean interval of 27.9 months between sequential eye in-volvement. The cohort demonstrated a mean age of 62.35 years. Analysis of systemic comorbid-ities revealed that 54.1% of patients presented with multiple conditions, with diabetes mellitus (52.7%) and hypertension (50%) being the predominant systemic diseases. Patients exhibited diverse surgical histories. Ophthalmic examination findings included optic disc edema in acute cases, progressing to disc pallor and atrophy in chronic stages. OCT demonstrated significant alterations in retinal nerve fiber layer (RNFL) thickness from the acute to chronic phases. With regard to visual outcomes, 28.4% of cases presented initially with poor visual acuity.

Conclusion: This study identifies novel prognostic indicators in NAION, particularly the rate of RNFL thin-ning and the timing of intervention. These findings support the implementation of rapid referral protocols and regular OCT monitoring in acute cases. The significant impact of systemic comorbidities emphasizes the importance of comprehensive vascular risk management in these patients.

Keywords: Ischemic optic neuropathy; non-arteritic anterior ischemic optic neuropathy; optical coherence tomography; systemic risk factors; visual acuity.

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Correspondence: Kubra Kucukiba, M.D. Ankara Research and Training Hospital, Ankara, Türkiye
E-mail: kubrakucukiba@gmail.com

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Ischemic optic neuropathy (ION) represents one of the most significant causes of acute vision loss in middle-aged and elderly populations, particularly affecting individuals over 50 years of age.[1] The condition manifests through a sudden, painless decrease in vision, typically noticed by patients upon awakening, suggesting a potential role of nocturnal hypotension in its patho-genesis.[2,3]

The classification of ION is primarily based on the anatomical location of the ischemic event and its underlying etiology. Anatomically, it can affect either the anterior or posterior segments of the optic nerve, with anterior ION accounting for approximately 90% of all cases.[2] Etiologically, both anterior and posterior forms are further subdivided into arteritic and non-arteritic variants, with non-arteritic anterior ION (NAION) being the most prevalent form.[1,3]

The pathophysiology of NAION is complex and multifactorial. The prelaminar portion of the optic nerve head receives its blood supply from the short posterior ciliary arteries, whose compromised perfusion can initiate a cascade of pathological events.[3] Current evidence suggests that the primary mechanism involves hypoperfusion of these vessels and/or thromboembolic events, leading to a compartment syndrome within the confined space of the optic nerve head.[3,4] This hypothesis is supported by the frequent observation of a "disc at risk" – a congenital vari-ant characterized by a crowded optic nerve appearance with minimal to absent physiological cupping – in affected individuals.[4,5]

The development of NAION is closely associated with various systemic risk factors that affect microvascular circulation. These include hypertension (HT), diabetes mellitus (DM), obstructive sleep apnea syndrome, hyperlipidemia (HL), coronary artery disease (CAD), and cerebrovascular disease.[3-6] Recent research has also highlighted the potential role of nocturnal hypotension, particularly in patients taking antihypertensive medications in the evening.[7,8] In addition, emerging evidence suggests that inflammatory markers and prothrombotic states may contribute to the pathogenesis of NAION, though their exact role remains under investigation.[9]

The present study aims to comprehensively examine the demographic, etiological, and neuro-ophthalmological characteristics of NAION in our patient population. By analyzing these aspects, we seek to contribute to the growing body of knowledge about this vision-threatening condition and potentially identify specific risk patterns or presentations that might be unique to our geographic and demographic context.

Materials and Methods

This cross-sectional retrospective study was conducted in accordance with the Declaration of Helsinki principles. Ethical approval was obtained from the Scientific Research Ethics Commit-tee of Ankara Training and Research Hospital (approval number E-24-164, dated July 26, 2024). Informed consent was obtained from all participants or their legal guardians. Patient files diag-nosed with NAION at the Neuro-ophthalmology Clinic of the Department of Ophthalmology, between July 2016 and December 2023, were reviewed. The patients' best-corrected visual acui-ty (BCVA) was measured using the Snellen chart, intraocular pressure (IOP) was assessed with the Goldmann applanation tonometer, and light reflexes were evaluated with a light source. Fundus examination was performed with a 90-diopter lens after biomicroscopic examination and pupil dilation with tropicamide. The patient's symptoms, clinical findings, and medical histories were evaluated. Visual fields were analyzed using the Humphrey Field Analyzer (Humph-rey-Zeiss Instruments, Dublin, California) with the Goldmann size III 30/2 program, and optical coherence tomography (OCT) (Spectralis, Heidelberg, Germany) was used to examine the optic disc retinal nerve fiber layer (RNFL) thickness.

Patients who presented with unilateral sudden painless vision loss and were diagnosed with NAION were included in this study if they exhibited diffuse or segmental hyperemic edema at the optic disc head, retinal hemorrhage at the disc margin, color vision abnormalities, and typical visual field defects, with no ocular, systemic, or neurological diseases to explain these findings. Patients presenting weeks or months after vision loss, who did not show acute optic disc edema at the initial visit but had segmental or total optic disc pallor or atrophy, were evaluated. Patients with microvascular disease findings in the etiology and without other ocular, systemic, and neurological diseases and findings that could lead to this clinical picture were considered as NAION sequelae. Patients with etiological causes of optic disc edema other than NAION were not included in the study. Patients were divided into three groups based on age: Under 50 years, 50–65 years, and over 65 years. The visual acuity of NAION patients was classified into three levels: good, moderate, and poor. According to the Snellen chart, a BCVA of 0.8–1.0 was considered good, 0.2–0.7 was considered moderate, and 0.1 or below was considered poor. A decrease in BCVA by 2 lines or more at the final visit was classified as decreased visual acuity, whereas an increase by 2 lines or more was classified as improved visual acuity.

Statistical Analyses

Data analyses were performed using the Statistical Package for the Social Sciences (SPSS) for Windows, version 22.0 (SPSS Inc., Chicago, IL, USA). Continuous data were described as mean±standard deviation, and categorical data were described as the number of cases (%).

Results

Demographic Characteristics

A total of 143 eyes of 72 patients diagnosed with NAION were examined, with one eye being a prosthesis. Fourteen patients (19.4%) had bilateral involvement, either in the same eye (2 patients, 2.7%) or at different times (12 patients, 16.7%). The average duration between the involvement of both eyes in patients diagnosed with NAION in both eyes was 27.9±31.6 months (0–90 months). Eighty-eight eyes were included in the study with an NAION diagnosis, and 55 eyes were included as the other eye. Among the patients, 35 (48.6%) were female and 37 (51.4%) were male, with a mean age of 62.35±9.2 years (43–84 years). The average follow-up duration was 14.6±15.3 months (0–62 months). Thirteen patients had no follow-up after the initial examination; six of these patients were newly diagnosed. Demographic data are summarized in Table 1.

Systemic Disease Characteristics

All patients had one or more systemic diseases. Thirty-nine patients (54.1%) had multiple systemic diseases. The systemic diseases identified were as follows: Diabetes in 38 patients (52.7%), HT in 36 patients (50%), HL in 15 patients (20.8%), CAD in 9 patients (12.5%), hypothyroidism in 4 patients, anemia in 3 patients (4.1%), chronic kidney disease (CKD) in 2 patients, chronic obstructive pulmonary disease (COPD) in 2 patients, vitamin B12 deficiency in 2 patients, arrhythmia in 2 patients, psoriasis in 2 patients, lymphoma in 1 patient, rheumatoid arthritis in 1 patient, systemic lupus erythematosus in 1 patient, ankylosing spondylitis in 1 patient, Behçet's disease in 1 patient, and pseudotumor cerebri in 1 patient. A history of smoking was detected in 31 patients. The distribution of systemic diseases by age groups is summarized in Table 2.

Table 1. Demographic characteristics of patients followed with non-arteritic anterior ıschemic optic neuropathy

Gender (M/F)	37/35
Average age (years)	62.35±9.2
Average follow-up (months)	14.6±15.3
Unilateral involvement (patients, %)	77.7
Sequential bilateral involvement (patients, %)	19.4
Simultaneous bilateral involvement (patients, %)	2.7

Table 2. Gender and systemic disease distribution of patients with non-arteritic anterior ischemic optic neuropathy by age groups

	Under 50	50–65	Over 65	All patients
Gender (M/F)	6/1	15/23	16/11	37/35
Number of patients, %	7, 9.7	38, 52.8	27, 37.5	72
DM	4	22	12	38
HT	2	16	12	30
HL	0	6	9	15
CAD	0	5	4	9

DM: Diabetes mellitus; HT: Hypertension; HL: Hyperlipidemia; CAD: Coronary artery disease.

Surgical History

Five patients had a history of cardiac angiography and stent implantation, two patients had cardiovascular surgery, two patients had renal surgery, and two patients had thyroidectomy. Additionally, 14 patients had a history of cataract surgery, one patient had vitreoretinal surgery, one patient had penetrating keratoplasty, and one patient had dacryocystorhinostomy. The average time between the date of surgery and the diagnosis of NAION was 27.9±31.9 months (0–120 months).

Ocular Examination Findings

In the initial examination of 88 eyes with NAION from the 72 patients included in the study, the mean BCVA was 0.41±0.32 (range: 0–1), and the average IOP was 13.8±3.6 mmHg (range 7–28 mmHg). At the final examination, the mean BCVA was 0.38±0.36 (range 0–1). Evaluation of visual acuity in initial and final examinations of patients is summarized in Table 3.

Table 3. Evaluation of visual acuity in ınitial and final examinations of patients followed with non-arteritic anterior ıschemic optic neuropathy

Visual acuity	Value (%)
Initial examination, good vision level	34.1
Initial examination, moderate vision level	37.5
Initial examination, poor vision level	28.4
Final examination, good vision level	36.9
Final examination, moderate vision level	33.8
Final examination, poor vision level	29.2
Eyes with stable BCVA	53.6
Eyes with decreased BCVA	8.3
Eyes with ımproved BCVA	16.7

BCVA: Best corrected visual acuity.

Fifty-seven patients (79.2%) were newly diagnosed, and 15 patients (20.8%) had sequelae of NAION. In the initial examination of the eyes with newly diagnosed NAION, optic disc edema was observed in 59 eyes. In the initial examination of patients with sequelae of NAION, optic disc pallor was detected in 14 eyes, and optic atrophy in 6 eyes. Among the non-NAION eyes, 46 (86.8%) had a crowded disc, and 7 (13.2%) had a normal optic disc appearance. In the final examination of the NAION eyes being followed up, optic disc pallor was found in 44 eyes, and optic atrophy had developed in 27 eyes.

When examining relative afferent pupillary defect (RAPD) in newly diagnosed NAION patients, it was positive in 44 (78.6%), and color vision was impaired in 27 (48.2%). In patients with sequelae NAION, RAPD was negative in all, and color vision was impaired in 3 (15%). Visual field tests were available for 64 eyes with NAION; 55 eyes (85.9%) had an inferior altitudinal defect, 6 eyes (9.4%) had a superior altitudinal defect, and 3 eyes (4.7%) had concentric constriction. Glaucoma was present in 3 patients, keratoconus in 1 patient, and optic disc drusen in 1 patient.

The average RNFL thickness of newly diagnosed eyes was measured at 188.7±41.1 µm (118–277) at the initial examination and 62.2±15.5 µm (23–93) at the final examination. In patients with sequelae NAION, the average RNFL thickness was 62.6±16.5 µm (33–81) at the initial examination and 55.2±15 µm (31–87) at the final examination.

Different treatments were applied considering the patients' systemic diseases. The treatment methods included 1 mg/kg oral methylprednisolone tapered by 16 mg every 3 days, 100 mg or 300 mg oral acetylsalicylic acid, and topical brimonidine and coenzyme Q10 for their neuroprotective effects. Twenty-two patients (30.2%) did not receive any treatment. Twenty patients (27.8%) used brimonidine and coenzyme Q10 drops twice daily, 12 patients (16.7%) received oral prednisolone along with brimonidine and coenzyme Q10 drops twice daily, 11 patients (15.3%) were treated with oral acetylsalicylic acid and brimonidine drops twice daily, and 7 patients (9.7%) received only oral acetylsalicylic acid. The ocular examination and treatment out-comes of the patients are summarized in Table 4.

Discussion

NAION represents the most prevalent acute optic neuropathy in middle-aged and elderly populations, resulting in irreversible vision loss with potential bilateral involvement. From a public health perspective,

Table 4. Eye examination and treatment of patients with non-arteritic anterior ischemic optic neuropathy

Initial examination, mean BCVA	0.41±0.32
Final examination, mean BCVA	0.38±0.36
Mean ıntraocular pressure, mmHg	13.8±3.6 mmHg
RAPD positivity, new diagnosis	44, 78.6%
RAPD positivity, chronic	0
Color vision deficiency, new diagnosis	27, 48.2%
Color vision deficiency, chronic	3, 15%
Visual field, eyes, %	
Inferior altitudinal defect	55, 85.9%
Superior altitudinal defect	6, 9.4%
Concentric narrowing	3, 4.7%
Time between eye ınvolvements, mean (months)	27.9±31.6
Mean RNFL thickness, new diagnosis, ınitial examination	188.7±41.1
Mean RNFL thickness, new diagnosis, final examination	62.2±15.5
Mean RNFL thickness, chronic, ınitial examination	62.6±16.5
Mean RNFL thickness, chronic, final examination	55.2±15.0
Treatment (%)	
No treatment	22 patients (30.2)
Brimonidine and coenzyme Q10 drops	20 patients (27.8)
Oral prednisone+brimonidine and coenzyme Q10 drops	12 patients (16.7)
Oral acetylsalicylic acid and brimonidine drops	11 patients (15.3)
Oral acetylsalicylic acid	7 patients (9.7)

BCVA: Best corrected visual acuity; RNFL: Retinal nerve fiber layer.

understanding its risk factors, demographic characteristics, and clinical manifestations is crucial.

While several large-scale studies have reported male predominance in NAION development, our findings, consistent with most previous research, demonstrate nearly equal gender distribution.[6-9] These investigations have documented higher rates of comorbidities and cerebrovascular disease in males compared to females, suggesting potential hormonal influences in NAION pathophysiology.[8,10] Our study confirms this gender distribution pattern, noting male predominance in cohorts under 50 and over 65 years, whereas females showed higher prevalence be-tween 50 and 65 years, potentially attributable to post-menopausal hormonal changes. The mean age of NAION onset typically ranges between 60 and 65 years, aligning with our observations. However, NAION can manifest in younger individuals, with prevalence rates of 10.8–23.2% among patients under 50 years.[11,12]

Evidence suggests that systemic vascular diseases may compromise autoregulation of optic nerve head blood flow in NAION pathogenesis, necessitating thorough investigation of vascular risk factors.[3] Associated risk factors include HT, DM, CAD, cerebrovascular disease, and HL, with approximately 50% of patients presenting with HT and 25% with DM.[2,6,8] Cestari et al.[8] demonstrated NAION development probability of 62–79% in patients with both complicated and uncomplicated HT, whereas complicated DM increased diagnosis likelihood by 27% compared to uncomplicated cases.

Hayreh et al.'s[13] prospective analysis of 406 NAION patients revealed elevated prevalence of HT, DM, cerebrovascular disease, ischemic heart disease, COPD, and thyroid disorders. Additional contributing factors included massive hemorrhage, hemodialysis, arterial hypotension, migraine, vasculitis, embolic disorders, and nocturnal arterial hypotension. The concurrent presence of HT and DM significantly increased cerebrovascular disease incidence. Their findings emphasize the importance of evaluating systemic conditions, vasculitis, cardiac and carotid embolic sources, and hematological abnormalities, while maintaining optimal control of underlying systemic diseases in high-risk populations.

Our study population demonstrated HT or DM in half of the patients, with multiple systemic comorbidities present in over 50%. In addition, we documented histories of HL, rheumatologic vascular diseases, CKD, thyroid disorders, and anemia all potentially contributing to NAION pathogenesis. These findings emphasize the critical importance of identifying and managing systemic disease associations, particularly microvascular pathologies, to prevent multiorgan complications.

Visual acuity decline represents the primary presenting symptom prompting ophthalmological consultation in NAION patients. Monitoring visual acuity changes throughout disease progression holds significant clinical importance. Ceylan et al.,[14] in their study of 42 NAION patients, reported initial BCVA ≥0.8 in 32% and ≤0.05 in 20% of cases at presentation. Sawle et al.[15] documented visual acuity ≥6/9 in 39.5% and ≤6/60 in 35.1% of patients at initial examination. Hayreh et al.'s[16] investigation revealed that 23% of patients presented with initial visual acuity below 20/200, while 49% maintained ≥20/30. Among patients with initial BCVA ≤20/70, 36% demonstrated improvement and 18% showed deterioration at 2-year follow-up, with 36% achieving BCVA ≥20/30 at final assessment.

Our findings demonstrate poor initial visual acuity in 28.4% and good visual acuity in 34.1% of cases, aligning with previous literature. Among newly diagnosed patients maintaining follow-up, comparative analysis of initial and final visual acuity revealed deterioration in 8.3% and im-provement in 16.7% outcomes consistent with published data. These visual acuity trajectories provide valuable prognostic information for patient counseling.[16]

NAION demonstrates age-related associations, with younger patients exhibiting unilateral involvement showing increased risk for contralateral eye involvement. Literature indicates a 15% probability of contralateral involvement within 5 years of initial presentation, with poor visual acuity in the affected eye and concurrent DM elevating this risk. Kavuncu et al.'s[17] study of 229 NAION patients reported contralateral involvement rates of 15.4% in patients under 50 and 14.7% in those over 50 years. Our observed rates of contralateral involvement parallel these findings.

Structural factors, including small optic disc size and reduced cup-to-disc ratio, represent established NAION risk factors.[18,19] Axonal edema in crowded optic nerve heads precipitates ganglion cell death. Absence of crowded disc morphology in the contralateral eye should prompt consideration of alternative diagnoses.[3] Hayreh et al.'s[20] examination of fellow eyes revealed C/D ratios below 0.15 in 37% and below 0.25 in 75% of cases. Beck et al.[21] similarly reported C/D ratios below 0.15 in 48% and below 0.25 in 71% of patients. Our findings corroborate the significance of small, crowded optic disc morphology in NAION pathogenesis.

OCT represents an established non-invasive imaging modality for monitoring RNFL thickness in optic neuropathies.[22] In NAION, OCT enables quantification of RNFL thickening during acute phases and subsequent assessment following resolution of disc edema. Bellusci et al.'s [23] study of 16 eyes demonstrated mean RNFL thickness of 188.9 µm initially, decreasing to 63.1 µm at follow-up. Larrea et al.[24] reported mean RNFL measurements of 150.35 µm in acute phases and 64.80 µm in chronic stages. Our RNFL findings align with these observations, con-firming OCT's utility in tracking NAION-associated changes characterized by acute phase thickening followed by significant atrophic thinning in chronic stages.

Study limitations include its retrospective design, absence of a control cohort, and incomplete follow-up in 13 patients. Nevertheless, this investigation contributes valuable demographic and neuro-ophthalmological data regarding NAION patients managed at a tertiary care neuro-ophthalmology center.

Conclusion

We have conducted a comprehensive analysis of demographic, ocular, and systemic risk factors associated with NAION pathogenesis. Our findings demonstrate concordance with the existing literature regarding gender distribution, mean age of onset, and patterns of systemic comorbidi-ties. Notably, our analysis reveals a significant female predominance in the 50–65 age cohort, suggesting a potential correlation with hormonal alterations during the perimenopausal period. This observation warrants particular attention to the increased NAION incidence among women in this age group, where endocrine changes are most pronounced.

In the evaluation of disease etiology, particular emphasis should be placed on systemic comorbidities, including HT, DM, and HL, which lend support to the vascular occlusion hypothesis at the optic nerve head. Initial visual acuity measurements have emerged as potential predictive in-dicators for final visual outcomes. While bilateral crowded disc morphology is characteristic, the absence of a "disc at risk" configuration in the contralateral eye should prompt thorough differ-ential diagnostic consideration in cases of suspected NAION.

Given the current limitations in therapeutic interventions for NAION, there remains a critical need for continued research to elucidate the demographic and pathophysiological mechanisms underlying this condition. Such investigations are essential for the development of effective treatment strategies and improved patient outcomes.

Ethics Committee Approval: The Ankara Training and Research Hospital University Ethics Committee granted approval for this study (date: 26.07.2024, number: E-24-164).

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