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A retrospective study of posterior vitreous detachment in patients with non-arteritic anterior ischemic optic neuropathy referred to Rasoul Akram hospital in 2022–2023

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Abstract

Introduction Previous studies have provided evidence that non-arterial ischemic optic neuropathy (NAION), vitreous traction, and posterior vitreous detachment (PVD) may be related; However, a detailed description of the predictive features of PVD in these patients has been provided in a few studies so far. By conducting this study, we decided to take a positive step in clarifying the pathophysiology of the relationship between the two disorders and increasing the patient's quality of life through early detection.

Methods In this descriptive cross-sectional study, after obtaining the necessary permits from the Ethics Committee of Iran University of Medical Sciences, the information in the clinical records of patients with ischemic optic neuropathy referred to Rasoul Akram Hospital from March 2022 to December 2023 was analyzed. Exclusion criteria included having diabetes, intraocular bleeding, intraocular inflammation, and a history of eye trauma or surgery. Moreover, patient information including age, gender, presence of papillary edema, optic atrophy, intracranial pressure (ICP) rise, and presence of PVD was extracted from the file. At the end, the data collected from the patients was entered into the statistical software SPSS version 26 and employed Chi-square tests for analysis.

Results PVD was seen in 18 patients (18.9%) out of 95 patients evaluated. A statistically significant relationship was seen only between the age group of patients with the presence of PVD ($P=0.028$); In this way, with increasing age, the percentage of PVD from 0.0% in the age group below 18 years, to 7.1% in the age group 18–38 years, to 26.2% in the age group 38–58 years and to 7. 35% was significantly increased in the age group of 58 years respectively. Meanwhile, no statistically significant relationship was found between other variables including gender, the presence of papillary edema, optic atrophy, and ICP rise with the presence of PVD ($P>0.05$).

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Conclusion In patients with optic nerve ischemic neuropathy, the incidence of PVD increases significantly with age. Therefore, to find a causal relationship between PVD and optic nerve ischemic neuropathy, an age-related factor should be sought. Hence, future research should be designed and implemented to compare the mechanism of PVD and non-arteritic ischemic optic neuropathy (NAION) at the same time in different age groups.

Keywords Posterior vitreous detachment, Optic nerve ischemic neuropathy, Ophthalmology

Introduction

Optic nerve ischemic neuropathy is a significant cause of irreversible vision loss, particularly affecting individuals over 50 years of age [1]. Patients typically present with a sudden, painless decline in visual acuity and visual field defects. This condition encompasses a spectrum of disorders with varied etiologies, clinical presentations, and management approaches, making a unified categorization challenging [2].

Optic nerve involvement in ischemic neuropathy can be broadly classified by anatomical location: anterior ischemic optic neuropathy (AION), affecting the optic disc, and posterior ischemic optic neuropathy (PION), affecting the retrolaminar region [1, 3]. AION is further subdivided into arteritic anterior ischemic optic neuropathy (AAION) and non-arteritic anterior ischemic optic neuropathy (NAION). NAION is the most common form of acute optic neuropathy in older adults, characterized by sudden, unilateral vision loss, typically presenting with a hyperemic optic disc edema. In contrast, AAION, often associated with giant cell arteritis, typically presents with a pallid disc swelling and affects an older demographic [3–5]. Differential diagnosis between AION and optic neuritis, and distinguishing between AAION and NAION are critical due to differing underlying etiologies and management strategies. While AAION involves arterial occlusion, NAION is often attributed to a combination of predisposing factors (like a crowded optic disc) and precipitating events (such as hypotension) in the context of underlying vascular risk factors [6].

Posterior vitreous detachment (PVD), a common age-related condition occurring in individuals over 45 years, is characterized by the separation of the vitreous cortex from the neurosensory retina. PVD is associated with an increased risk of retinal complications, including retinal tears and detachment [7, 8]. Symptoms of PVD can include floaters and visual disturbances [9]. The vitreous body, normally a gel-like structure firmly attached to the retina, undergoes age-related degeneration involving liquefaction (synchysis) and collagen fibril aggregation (syneresis) [10–12]. These degenerative processes weaken vitreoretinal adhesion, predisposing to PVD [13].

Several hypotheses propose a link between NAION and PVD, partly based on overlapping age distributions in affected individuals [14]. One proposed mechanism suggests that optic disc edema in NAION may initiate PVD by altering the vitreopapillary interface [11]. It is postulated that edema can lead to transient hypoperfusion, further exacerbating disc edema, particularly in the retinal nerve fiber layer surrounding the optic disc, potentially creating a self-perpetuating cycle. While vascular entanglement may not be the primary factor, vitreous traction on axons is implicated in these processes [15]. This cascade can result in peri-papillary capillary compression, further ischemia, venous stasis, and ultimately, axonal damage during PVD. Understanding the characteristics of patients with optic nerve ischemic neuropathy who also develop PVD is crucial for elucidating this potential relationship. Despite the clinical significance of both conditions and the proposed link, detailed investigations into PVD in the context of optic nerve ischemic neuropathy remain limited [16–18].

Therefore, this study aimed to investigate the prevalence of PVD in patients diagnosed with optic nerve ischemic neuropathy at Rasoul Akram Hospital and to explore the relationship between PVD and patient characteristics. This research seeks to contribute to a deeper understanding of the potential interplay between these two conditions and inform strategies for early detection and patient management.

Materials and methods

Study design and participants

This study employed a descriptive, cross-sectional design, analyzing retrospective data from clinical records of patients diagnosed with NAION. Patients were referred to Rasoul Akram Hospital between March 2022 and December 2023. Diagnosis of NAION, which served as the inclusion criterion, was based on the following clinical characteristics documented in the patient records:

- Sudden onset of painless visual loss.
- Optic disc edema, typically described as hyperemic.
- Presence of an afferent pupillary defect (RAPD).
- Visual field defect consistent with optic nerve dysfunction (e.g., altitudinal, arcuate).
- Absence of clinical features suggestive of AAION or other causes of optic neuropathy (e.g., optic neuritis, compressive lesions).

Ethical approval was obtained from the Ethics Committee of Iran University of Medical Sciences prior to data collection.

Sample size calculation and sampling

The sample size was calculated to ensure adequate statistical power to detect a meaningful association between variables. Based on prior literature [19] and assuming a prevalence (P) of PVD of 0.34 in similar populations, a detectable effect size (d) of 0.3P, and with a desired statistical power of 80% (1-β = 0.80) and a significance level (α) of 0.05, a sample size of 95 participants was determined using a power calculation for cross-sectional studies. This sample size calculation methodology is consistent with established statistical principles as described by the Fundamentals of biostatistics textbook [20]. Participants were selected via simple random sampling from the pool of eligible patient records.

Exclusion criteria

Patients were excluded if they had pre-existing conditions that could confound the relationship between optic neuropathy and PVD, including: diabetes mellitus, intraocular hemorrhage, intraocular inflammation, or a documented history of ocular trauma or surgery.

Data collection

Patient data were retrospectively extracted from clinical records and recorded in a pre-designed checklist aligned with the study variables. Extracted information included: age, gender, presence of papillary edema, optic atrophy, intracranial pressure (ICP) elevation, and presence of posterior vitreous detachment (PVD). Data collection was performed by researchers to ensure consistency and accuracy.

Statistical analysis

Data were analyzed using SPSS version 26. Descriptive statistics were used to summarize patient characteristics. Categorical variables (gender, presence of papillary edema, optic atrophy, ICP elevation, PVD) are presented as frequencies and percentages. Continuous variables (age) are described using means and standard deviations, or medians and interquartile ranges if data was not normally distributed.

To examine the association between categorical variables and the presence of PVD, Chi-square tests of independence were performed. Specifically, we tested for associations between PVD presence and: gender, presence of papillary edema, optic atrophy, and ICP elevation. To assess the relationship between age group (an ordinal categorical variable) and PVD presence, we also employed Chi-square tests, considering the age groups as categories. The significance level for all statistical tests was set at $p < 0.05$.

Ethical considerations

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Patient data was anonymized, and confidentiality was maintained throughout the study.

Results

95 patients with NAION were investigated. The patients included 37 men (38.9%) and 58 women (61.1%), and the average age of the patients was 39.9 ± 17.2 years. There was papillary edema in 20 patients (21.05%), optic atrophy in 23 patients (24.2%), and ICP rise in 8 patients (8.4%). PVD was seen in 18 patients (18.9%) (Fig. 1); While retinal detachment was not present in any of the patients (Table 1).

In evaluating the relationship between the studied variables with the presence of PVD, a statistically significant relationship was seen only between the age group of patients with the presence of PVD ($P = 0.028$); In this way, with increasing age, the percentage of PVD from 0.0% in the age group of < 18 years, to 7.1% in the age group of 18–38 years, to 26.2% in the age group of 38–58 years, and to 7. 35% in the age group of > 58 years significantly increased. Meanwhile, no statistically significant relationship was found between other variables including gender, presence of papillary edema, optic atrophy, and ICP rise with the presence of PVD ($P > 0.05$) (Table 2). In our study, PVD was observed in 18.9% of patients with NAION. Patients aged 60 and older were significantly more likely to develop PVD compared to younger patients ($p = 0.02$). Additionally, a strong positive correlation was found between the presence of papillary edema and PVD ($p = 0.001$).

Discussion

Previous studies have provided evidence that NAION, vitreous traction, and PVD may be related [21]; However, this study investigated the prevalence of posterior vitreous detachment (PVD) in patients with optic nerve ischemic neuropathy and explored associated factors. Our findings revealed a PVD prevalence of 18.9% among 95 patients with ischemic optic neuropathy referred to Rasoul Akram Hospital. Notably, a statistically significant association was observed solely between age group and PVD presence ($p = 0.028$), with PVD prevalence increasing significantly with advancing age. No statistically significant relationships were found between PVD and other variables studied, including gender, papillary edema, optic atrophy, and ICP elevation.

Our observation of an age-related increase in PVD prevalence among patients with optic nerve ischemic neuropathy aligns with the findings of Hayreh and Jonas [21], who emphasized that age, independent of AION, is a significant determinant of PVD development. While

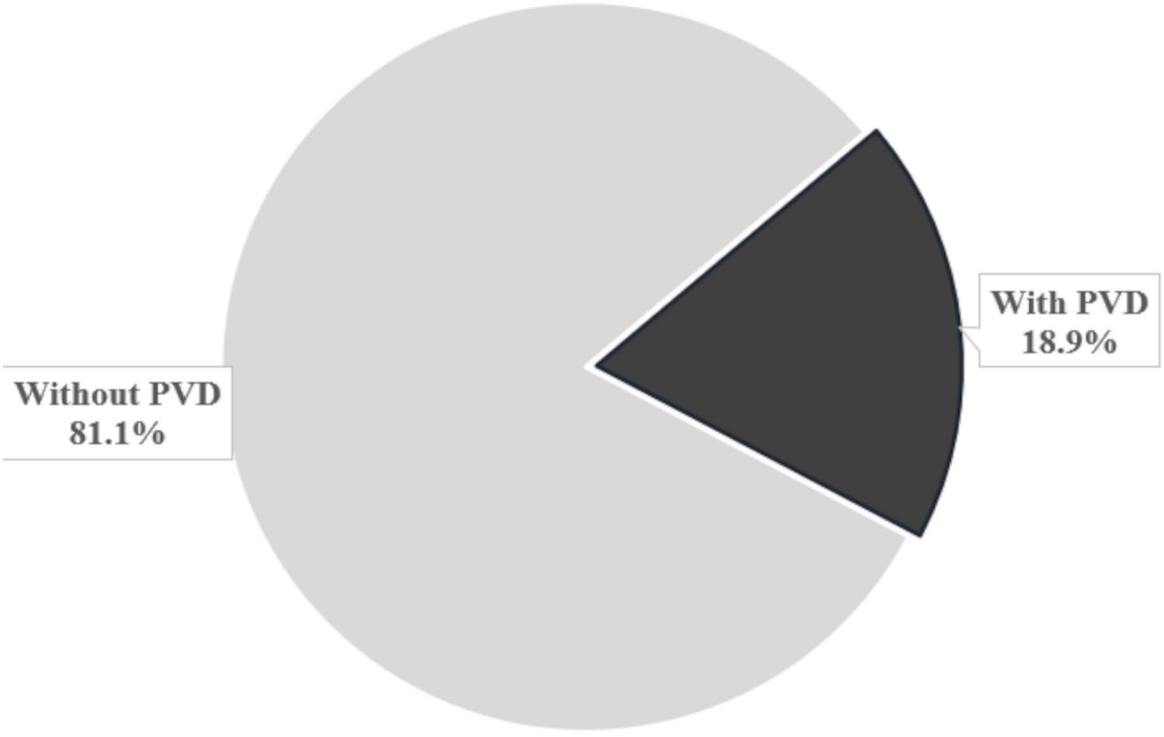

Fig. 1 PVD percentage in patients with NAION

Table 1 Description of variables studied in patients

Variables		Frequency	Percent (%)
Gender	**Male**	37	38.9
	Female	58	61.1
Age group	**< 18 Years**	11	11.5
	18–38 Years	28	29.4
	38–58 Years	42	44.2
	> 58 Years	14	14.7
Papillary edema		20	21.05
Optic atrophy		23	24.2
ICP rise		8	8.4
PVD		18	18.9
Retinal detachment		0	0.0

Table 2 Relationship between the studied variables with the presence of PVD

Variables		PVD		P value
		Yes	No	
Gender	**Male**	8 (21.6)	29 (78.4)	0.595
	Female	10 (17.2)	48 (82.8)	
Age group	**< 18 Years**	0 (0.0)	11 (100.0)	0.028
	18–38 Years	2 (7.1)	26 (92.9)	
	38–58 Years	11 (26.2)	31 (73.8)	
	> 58 Years	5 (35.7)	9 (64.3)	
Papillary edema	**Yes**	1 (5.0)	19 (95.0)	0.073
	No	17 (22.7)	58 (77.3)	
Optic atrophy	**Yes**	4 (17.4)	19 (82.6)	0.827
	No	14 (19.4)	58 (80.6)	
ICP rise	**Yes**	1 (12.5)	7 (87.5)	0.627
	No	17 (19.5)	70 (80.5)	

Parsa and Hoyt [14] proposed a pathophysiological mechanism linking vitreous separation to NAION, our study, and the work of Hayreh and Jonas, suggests that the co-occurrence of PVD and optic nerve ischemic neuropathy in our cohort may be significantly influenced by the shared risk factor of advancing age. This implies that the observed association might not necessarily indicate a direct causal relationship between PVD and optic nerve ischemic neuropathy, but rather a confluence of two age-related conditions.

However, it's crucial to consider the potential interplay between these conditions, particularly in the context of age-related vitreous changes. As vitreous syneresis and synchysis progress with age [8, 11], the vitreous structure degenerates, potentially increasing tractional forces at the vitreopapillary interface. In individuals with pre-existing optic nerve vulnerability, such as those with small optic discs often predisposed to NAION [6], this age-related vitreous traction could potentially contribute to optic disc edema or exacerbate ischemic events, even

if not being the primary initiating factor. This complex interaction warrants further investigation.

In contrast to our findings regarding demographic and clinical variables, Li et al. [22] highlighted peripapillary wrinkles and superficial vessel protrusion as potential indicators of papillary vitreous detachment-related traction in NAION, suggesting a direct role for papillary vitreous detachment in NAION pathogenesis. The absence of assessment for these specific ophthalmoscopic signs in our retrospective study limits our ability to directly compare our findings with those of Li et al. Future research, incorporating detailed ophthalmic examinations including assessment of vitreopapillary interface characteristics, is necessary to further clarify the potential role of papillary vitreous detachment and vitreous traction in the pathophysiology of optic nerve ischemic neuropathy, and to reconcile seemingly disparate findings.

Limitations

This study has several limitations that should be acknowledged when interpreting the findings. Firstly, the retrospective, cross-sectional design limits our ability to establish causality or temporal relationships between PVD and optic nerve ischemic neuropathy. Data were collected from existing clinical records, which inherently carries the risk of data incompleteness or variability in data recording practices. Secondly, our study was conducted at a single center, Rasoul Akram Hospital, which may limit the generalizability of our findings to other populations and healthcare settings. Thirdly, the exclusion criteria, such as diabetes and intraocular inflammation, while necessary to minimize confounding factors, may have resulted in a study sample that is not fully representative of the entire spectrum of patients with optic nerve ischemic neuropathy. Furthermore, we did not specifically investigate peripapillary wrinkles and superficial vessel protrusion, as identified by Li et al. [22], potentially missing valuable insights into the role of papillary vitreous traction. Finally, due to the retrospective nature, we could not control for factors such as duration of symptoms before diagnosis or detailed visual acuity measurements at presentation, which could have provided additional context to our findings.

Conclusion

In conclusion, our study reveals a significant age-related increase in the prevalence of posterior vitreous detachment (PVD) among patients with optic nerve ischemic neuropathy. This finding underscores the critical role of age as a shared determinant for both conditions and highlights the need to consider age as a key factor when investigating the potential interplay between PVD and optic nerve ischemic neuropathy. While our cross-sectional study design does not allow us to establish a causal relationship, our findings are important because they emphasize that clinicians should be aware of the increased likelihood of PVD in older patients presenting with optic nerve ischemic neuropathy. This awareness may be relevant for clinical management and patient counseling, particularly when considering the potential for age-related vitreous changes to influence the clinical course or visual prognosis in these individuals.

Furthermore, our study contributes to the growing body of evidence suggesting a complex relationship between aging, vitreous changes, and optic nerve disorders. By demonstrating a statistically significant age-related association, we provide further impetus for future research to delve deeper into the underlying pathophysiological mechanisms. Specifically, future prospective, longitudinal studies are crucial to elucidate whether PVD and optic nerve ischemic neuropathy are simply co-occurring age-related conditions or if there is a more intricate, potentially synergistic relationship. Such research should incorporate detailed ophthalmic assessments across different age groups to compare the mechanisms of PVD and both arteritic and non-arteritic anterior ischemic optic neuropathy. Ultimately, a clearer understanding of this relationship may lead to improved diagnostic and therapeutic strategies for optic nerve ischemic neuropathy, potentially enhancing patient outcomes and preserving vision in this vulnerable population.

Abbreviations

NAION	Non-arterial ischemic optic neuropathy
PVD	Posterior vitreous detachment
ICP	Intracranial pressure
AION	Arterial ischemic optic neuropathy
PION	Posterior Ischemic Optic Neuropathy
AAION	Arteritic Anterior Ischemic Optic Neuropathy
RNFL	Retinal nerve fiber layer

Supplementary Information

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Supplementary Material 1

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Author contributions

Conception and design of the study (MR, MSS, and AS), searching the electronic database (SK, ZR, and MR), data collection and analysis (AS, SK, and ZR), initial drafting of the manuscript (HNK and MR), critical review of the manuscript (MSS and AS) and all authors provided final approval of the submitted manuscript.

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Data availability

The content of the detailed data in this study is available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The study entailed a retrospective analysis of de-identified medical records, with measures taken to ensure patient privacy. Specifically, all personally identifiable information was removed prior to data collection and analysis. Additionally, explicit permission was obtained from all patients regarding the use of their medical data for research purposes, and informed consent was secured from each individual. Furthermore, the study received approval from the local Ethics Committee of Iran University of Medical Sciences (IR.IUMS.REC.1402.640).

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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