American Journal of Ophthalmology Case Reports 38 (2025) 102329

Contents lists available at ScienceDirect

American Journal of Ophthalmology Case Reports

journal homepage: www.ajocasereports.com/

Clinical presentation and optical coherence tomography findings of intrapapillary hemorrhage with adjacent peripapillary subretinal hemorrhage

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ARTICLE INFO

Keywords:
Intrapapillary hemorrhage with adjacent peripapillary subretinal hemorrhage (IHAPSH)
Peripapillary hyperreflective ovoid mass–like structures (PHOMS)
Optic disc drusen
Myopia
Optical coherence tomography (OCT)

ABSTRACT

Introduction: Case reports of intrapapillary hemorrhage with adjacent peripapillary subretinal hemorrhage (IHAPSH) have been increasing in recent years, and its relationship with myopia-associated optic disc changes has been suggested. In this study, we examined clinical features and fundus imaging (optical coherence tomography [OCT] and OCT angiography [OCTA]) of cases of IHAPSH.
Method: We retrospectively studied 5 patients diagnosed with IHAPSH at our department in the last 8 years.
Results: Mean onset age was 18.6 years (range, 12–30 years) with 1 male and 4 female patients. The affected eyes were 2 right and 4 left (1 case of bilateral involvement). Mean spherical equivalent was −5.38D (range, −1.75 to −7.0D), and mean axial length was 26.30mm (range, 24.73–27.34mm). Subretinal hemorrhage adjacent to the nasal-to-superior side of the optic nerve head, hemorrhage within optic disc and disc swelling were observed in all onset eyes. Vitreous hemorrhage was noted in 3 eyes. Peripapillary chorioretinal atrophy was observed in all cases, and disc structural abnormalities were detected in 3 eyes (optic disc drusen, tilted disc and small disc). OCT revealed peripapillary hyperreflective ovoid mass-like structures (PHOMS) in all cases. No obvious abnormal findings were observed in 4 cases that underwent OCTA imaging.
Conclusion: Myopia-associated optic disc changes and disc structural abnormalities including PHOMS could be related to the onset of IHAPSH.

1. Introduction

Intrapapillary hemorrhage with adjacent peripapillary subretinal hemorrhage (IHAPSH) is a syndrome characterized by the following: (1) it is commonly observed in young Asian women with myopia, (2) it manifests as hemorrhage in the optic disc and subretinal hemorrhage around the disc without any clear precipitating factors such as trauma to the eye, and (3) it tends to resolve spontaneously, with a good visual prognosis and rare recurrence. It often occurs unilaterally, and approximately 80 % of cases are reported to be accompanied by optic disc swelling.[1] Patients typically go to the doctor due to symptoms such as floaters or blurred vision caused by secondary vitreous hemorrhage. This may be caused by posterior vitreous detachment, optic disc abnormalities such as tilted disc, small disc, optic disc hypoplasia, optic disc drusen, progressive myopia, and the Valsalva effect,[1–3] but the exact pathogenesis remains unclear. The first report on IHAPSH is believed to be by Cibis et al., in 1975, who considered posterior vitreous detachment as the cause.[4] In the 1980s, several cases of young patients with myopia were reported in Japanese local journals, which were lastly described as myopic optic disc hemorrhage. Subsequently, cases of IHAPSH with optic disc shape abnormalities, such as small discs and tilted discs, were also reported.[2] In 2004, Kokame et al. proposed the disease concept of IHAPSH.[1] Recently, especially since 2020, case reports have been increasing again, mainly in Japan.[3,5–9] In this study, we present representative cases seen at Kanazawa University Hospital (Kanazawa, Japan) and examine the clinical presentations and imaging findings of these cases. We report that several kinds of abnormalities in the optic disc were noted in the majority of cases, and peripapillary hyperreflective ovoid mass–like structures (PHOMS) were observed in all cases.

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https://doi.org/10.1016/j.ajoc.2025.102329
Received 15 October 2024; Received in revised form 20 March 2025; Accepted 6 April 2025
Available online 10 April 2025

2. Subjects and methods

All cases (5 cases) diagnosed with IHAPSH at the Department of Ophthalmology at Kanazawa University Hospital over 8 years from January 2016 were included in this study. We retrospectively investigated their clinical presentations and findings from optical coherence tomography (OCT) and OCT angiography (OCTA) by reviewing medical records. Tilted disc was defined as a condition in which the superotemporal optic disc is elevated and the inferonasal disc is posteriorly displaced, resulting in an oval-appearing optic disc, with its long axis obliquely oriented on fundus photographs.[10] Small disc was defined that the ratio of the distance between the centre of the optic disc and the fovea centralis, to the diameter of the optic disc is obviously greater than 3.0 using fundus photographs.[11] The study adhered to the tenets of the Declaration of Helsinki. The institutional review board of Kanazawa University approved the research.

3. Result

3.1. Presentation of representative cases

Case 1. 21-year-old female

Chief Complaint: Photopsia in the left eye.

History of Present Illness: The patient began experiencing photopsia when closing her left eye and afterimages when blinking. She visited a local ophthalmologist, where the possibility of an intracranial disease was suspected. She was referred to a neurosurgeon and underwent magnetic resonance imaging (MRI) of her head, which revealed no abnormalities. She was then referred to our hospital for further evaluation.

Past Medical History: None.

Initial Findings: She had myopia of −7.00D diopters in both eyes, and her best-corrected visual acuity (BCVA) was 20/16 in both eyes. Intraocular pressure measured with a non-contact tonometer was 15 mmHg in the right eye and 13 mmHg in the left eye. The pupils were round and there was no anisocoria, with normal direct and consensual light reflexes in both eyes. The critical flicker-fusion frequency was 38 Hz in both eyes. Static visual field testing with the Humphrey Field Analyzer (24-2 SITA Standard) and color vision screening (Ishihara test) showed no abnormalities in either eye. Slit-lamp examination revealed no abnormalities in the anterior segment or the vitreous. Fundus examination of the left eye showed redness and swelling at the nasal margin of the optic disc, optic disc hemorrhage, and a crescent-shaped subretinal hemorrhage adjacent to the nasal superior side of the disc (Fig. 1). Both eyes exhibited tigroid fundus, vertically elongated optic discs, and peripapillary chorioretinal atrophy (PPA) on the temporal side of the optic discs. Additionally, a retinal hole was noted in the peripheral region of the left eye. OCT B-scan of the optic disc revealed subretinal hemorrhage and PHOMS (Fig. 2). Posterior vitreous detachment was not observed on fundus examination and OCT imaging. Fundus autofluorescence and ultrasonography performed to search for optic disc drusen showed normal findings. Blood tests revealed that the complete blood count, coagulation factors, liver enzymes, creatinine, electrolytes, blood glucose, and C-reactive protein levels were all within normal ranges. Serum anti-aquaporin 4 antibody, anti-SSA antibody, anti-SSB antibody, antinuclear antibody, myeloperoxidase anti-neutrophil cytoplasmic antibody, proteinase 3 anti-neutrophil cytoplasmic antibody, and anti-cardiolipin antibody were all negative. Angiotensin-converting enzyme and soluble interleukin-2 receptor levels were within normal ranges. Serological tests for syphilis were negative, and tuberculosis tests were also negative.

Progress: The optic disc hemorrhage and subretinal hemorrhage in the left eye improved rapidly without treatment. The subretinal hemorrhage completely resolved in approximately 3 months, and the optic disc redness and swelling gradually improved. Fluorescein angiography performed approximately 1 year after onset showed no evidence of capillary dilation or leakage at the optic disc margin during the early phase, and hyperfluorescence was observed at the nasal margin of the optic disc in the mid to late phase of the angiogram (Fig. 3). Additionally, OCTA of the optic disc showed no reduction in radial peripapillary capillary density in either eye, and no significant abnormalities in vessel morphology or density, such as microvasculature dropout, were observed (Fig. 4). At a follow-up examination 1 year and 7 months after onset, optic disc hemorrhage and subretinal hemorrhage were noted in the right eye (Fig. 5), but there were no symptoms, and these fundoscopic findings improved rapidly and naturally. Since then, there have been no recurrences of hemorrhage in either eye. Additionally, retinal photocoagulation was performed around the retinal hole in the left eye to prevent retinal detachment.

Case 2. 16-year-old female

Chief Complaint: Blurred vision in the left eye.

History of Present Illness: The patient experienced blurred vision in the left eye after going running, and visited a local ophthalmologist the following day. She was diagnosed with optic disc hemorrhage and mild vitreous hemorrhage in the left eye. As intracranial disease was suspected, the patient underwent MRI of her head. However, no abnormalities were found, which led to a referral for further evaluation at our

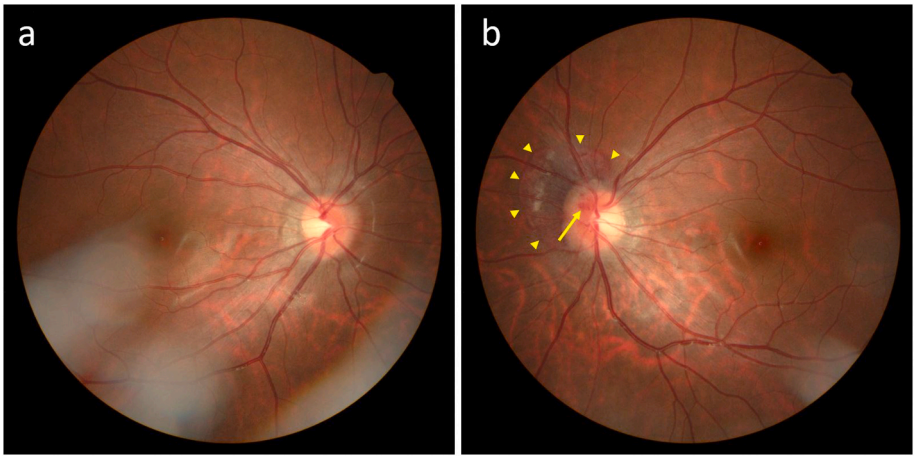

Fig. 1. Fundus photographs at the initial visit of Case 1 (a: right eye, b: left eye).
Both eyes show tigroid fundus, vertically elongated optic nerve head, and PPA on the temporal side of the optic nerve head (a, b). In the left eye, there is redness and swelling at the nasal edge of the optic nerve head, optic nerve head bleeding (yellow arrow), and subretinal hemorrhage (yellow arrowhead) (b). PPA, peripapillary chorioretinal atrophy.

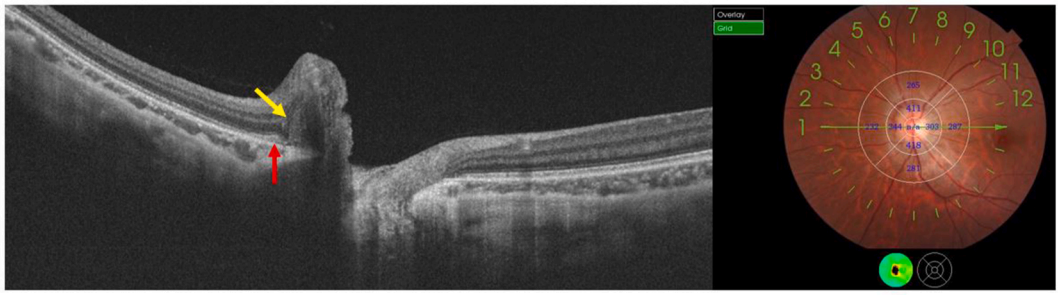

Fig. 2. OCT horizontal B-scan image of the left optic nerve head in Case 1.
This image was captured using swept-source OCT (Triton; Topcon, Tokyo, Japan). The red arrow indicates subretinal hemorrhage, and the yellow arrow points to PHOMS.
OCT, optical coherence tomography; PHOMS, peripapillary hyperreflective ovoid mass-like structures.

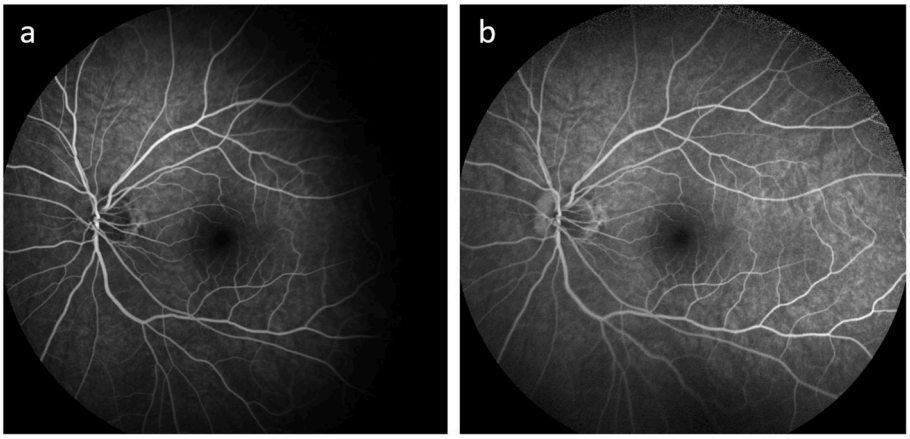

Fig. 3. Fluorescein fundus images of the left eye in Case 1 (a: 2 minutes after intravenous injection, b: 10 minutes after intravenous injection).
In the mid-phase of the imaging, hyperfluorescence is observed at the nasal edge of the optic nerve head, considered to be tissue staining (b).

hospital.

Past Medical History: No systemic diseases were noted. The patient had been wearing glasses since the age of 3 years due to suspected amblyopia and had previously been identified with optic disc shape abnormalities.

Initial Findings: She had myopia of −6.50D diopters in the right eye and −6.25D diopters in the left eye. The BCVA was 20/16 in both eyes. Intraocular pressure measured with a non-contact tonometer was 12 mmHg in the right eye and 14 mmHg in the left eye. The pupils were round and there was no anisocoria, with normal direct and consensual light reflexes in both eyes. The critical flicker fusion frequency was 44 Hz in the right eye and 42 Hz in the left eye. Color vision testing with standard pseudoisochromatic plates part 3 showed no abnormalities in either eye. Goldmann kinetic perimetry revealed a lower visual field defect in the right eye and an enlarged Mariotte's blind spot and decreased lower visual field sensitivity in the left eye (Fig. 6). Slit-lamp examination revealed no abnormalities in the anterior segment or vitreous. Fundus examination showed superior segmental optic hypoplasia (SSOH) in the right eye and optic disc swelling, optic disc hemorrhage, and a crescent-shaped subretinal hemorrhage adjacent to the nasal superior side of the disc in the left eye (Fig. 7).

Progress: The optic disc hemorrhage and subretinal hemorrhage in the left eye resolved rapidly and disappeared within approximately 1 month, and the optic disc swelling also improved. Fundus autofluorescence taken at this time showed no abnormalities in the right eye, but revealed hyperfluorescence within the optic disc in the left eye, which was considered to be optic disc drusen (Fig. 8). OCT B-scan of the optic disc showed a low-reflective finding suggestive of optic disc drusen inside the optic disc in the left eye and PHOMS in both eyes (Fig. 9). No recurrence of hemorrhage was observed in the left eye, and no onset was noted in the right eye.

3.2. *Examination of clinical presentation and fundus imaging findings*

A summary of the clinical presentations of all cases is shown in Table 1, and fundus photographs of the optic disc from cases other than the above are shown in Fig. 10. The age at onset ranged from 12 to 30 years (mean 18.6 years), with 1 male and 4 female patients. The affected eyes were 2 right eyes and 4 left eyes (1 case had bilateral onset). The equivalent spherical refractive values of the affected eyes ranged from −1.75 to −7.0D (mean −5.38D), and axial lengths ranged from 24.73 to 27.34 mm (mean 26.30 mm). None of the patients had a history of systemic diseases or trauma, although 1 patient had exercised (running) prior to onset. Retinal holes were observed in 1 patient, but none had posterior vitreous detachment involving the posterior pole of the fundus. Visual field abnormalities were observed in 2 eyes (Mariotte's blind spot enlargement and decreased lower visual field sensitivity in Case 2, and Mariotte's blind spot enlargement in Case 5), but visual function impairment was mild in all cases, with no abnormalities in critical flicker fusion frequency or light reflexes. In all cases, fundoscopic findings improved naturally without treatment. In Case 2 and 5, Mariotte's blind spot enlargement also improved.

In all affected eyes (5 cases of 6 eyes), subretinal hemorrhage in a crescent-shaped pattern adjacent to the nasal and superior areas of the optic disc, along with optic disc hemorrhage and swelling, was observed. Vitreous hemorrhage was noted in 3 eyes. All cases exhibited papillary temporal conus (i.e. PPA), and obvious optic disc shape or structural abnormalities (optic disc drusen, tilted disc, small disc) were observed in

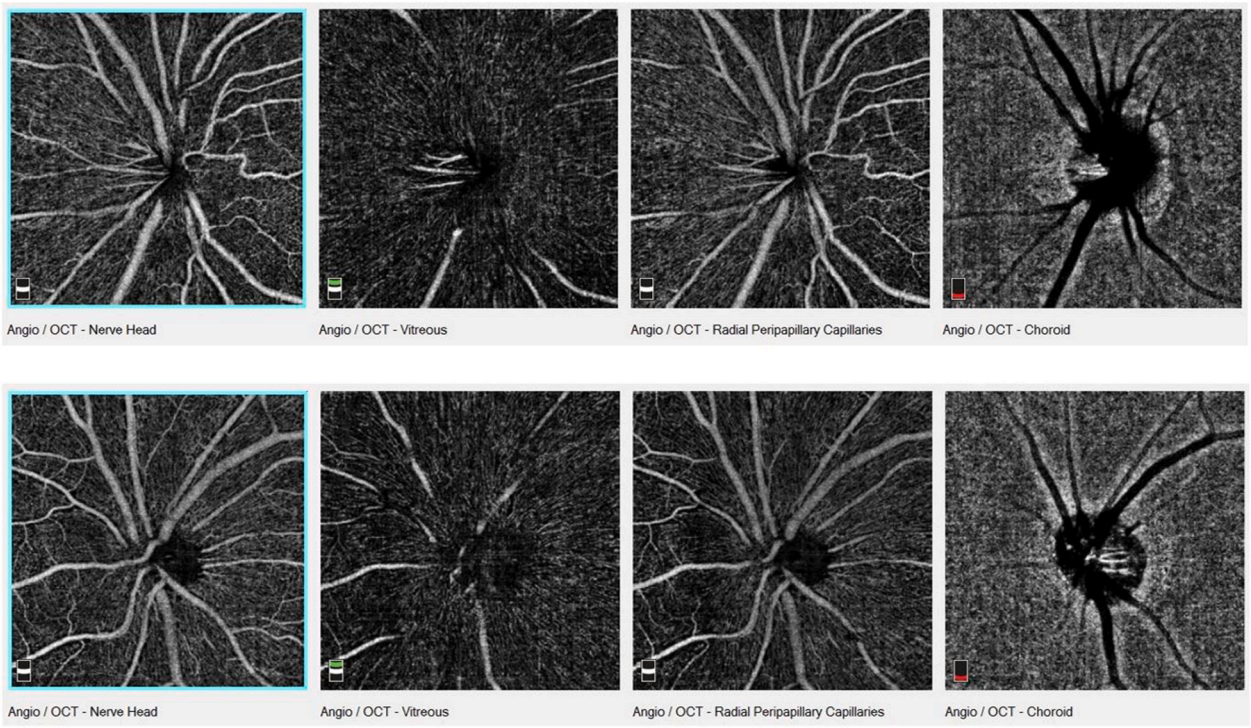

Fig. 4. OCT angiography (OCTA) images after hemorrhage resolution in Case 1 (top row: right eye, bottom row: left eye).
These images were captured using Spectral-Domain OCT (RTVue XR Avanti; Optovue, Fremont, CA, USA) with a scan size of 4.5 × 4.5 mm. No significant abnormalities in vessel morphology or density were observed in any of the segments, from superficial to deep.
OCT, optical coherence tomography; OCTA, optical coherence tomography angiography.

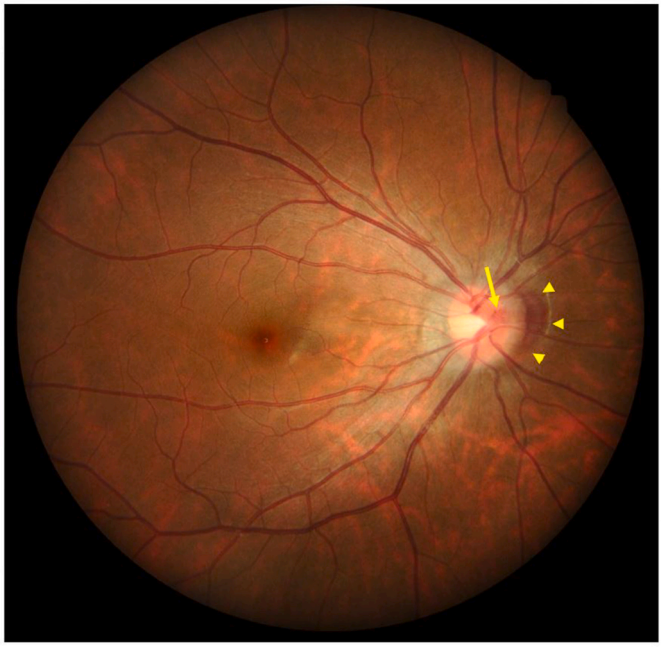

Fig. 5. Fundus photograph of the right eye at the time of onset in Case 1.
The yellow arrow indicates papillary hemorrhage, and the yellow arrowheads point to subretinal hemorrhage.

3 eyes. We examined the size of the optic disc using the disc diameter (minor axis)/disc-to-macula distance (DD/DM) ratio. Accurate measurement was not possible for the left eye in Cases 2 and 3 due to severe swelling and unclear boundaries. However, in all cases except Case 1, the DD/DM ratio was less than 0.35, indicating small disc and a tendency to optic disc hypoplasia.[12] OCT findings of PHOMS were observed in all cases (Fig. 11). After resolution of hemorrhage, OCTA findings showed no significant abnormalities, except in 1 case (Case 2) for whom imaging could not be performed.

4. Discussion

We presented representative cases of IHAPSH from our hospital and examined the clinical presentations and imaging findings of all cases. None of the patients had a history of trauma, and only 1 patient had an episode that could potentially have been influenced by the Valsalva effect (i.e. running). Additionally, no patients had posterior vitreous detachment in the posterior pole of the fundus. On the other hand, all patients exhibited myopia, and in 1 patient (Case 3), myopia in the affected eye was first noted during a school health check before the onset of symptoms. Fundoscopic examination revealed PPA in all cases, and 3 eyes exhibited clear optic disc abnormalities (tilted disc, small disc, optic disc drusen). According to Jonas et al.'s hypothesis regarding structural changes in the optic nerve head due to the progression of myopia, as the axial length of the eye elongates, the Bruch's membrane opening of the optic nerve head shifts temporally relative to the anterior scleral opening. These events result in the formation of PPA on the temporal side of the disc, while on the nasal side of the disc, the end of Bruch's membrane opening protrudes toward the disc.[13] It is thought that continuous horizontal shear stress develops at the nasal boundary of the optic disc. This stress may cause tissue rupture or failure of the arteries that run through this area (such as branches of the short posterior ciliary arteries or arteries at the choroid and choriocapillaris), potentially leading to relatively massive optic disc hemorrhages that in some cases extend into the vitreous. Additionally, the presence of subretinal hemorrhage is a characteristic feature of IHAPSH. Two reasons for this can be considered. First, there may be a breakdown of tissues and vessels at the subretinal layer level, specifically at the choriocapillaris. Second, the internal hemorrhage may migrate towards the subretinal space, where

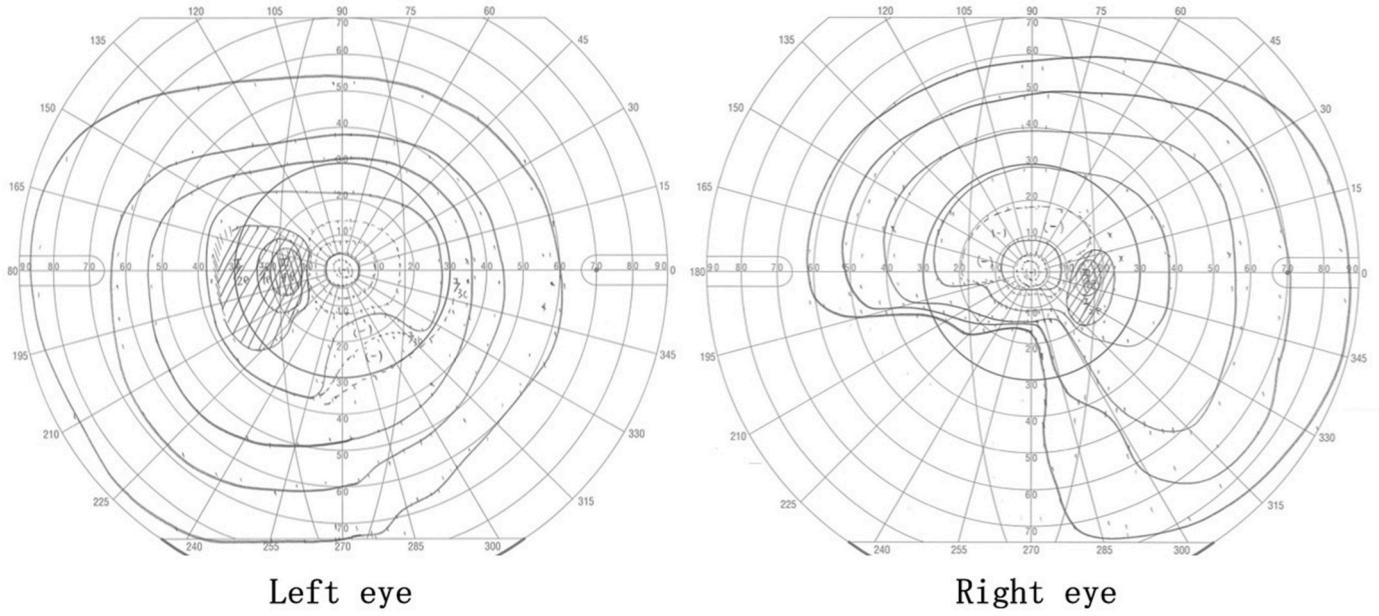

Fig. 6. Goldmann perimetry at the initial visit for Case 2.
Inferior visual field defect was observed in the right eye. Enlargement of Mariotte's blind spot as well as decreased sensitivity in the lower visual field were noted in the left eye.

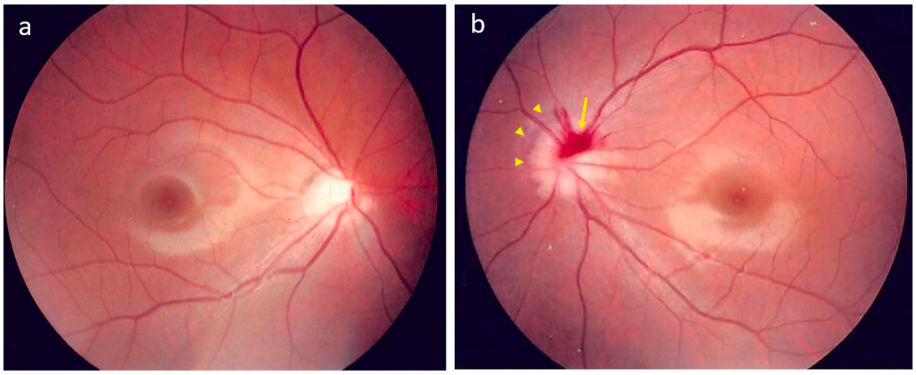

Fig. 7. Fundus photographs at the initial visit for Case 2. SSOH was seen in the right eye (a), and in the left eye, there was papillary edema, papillary hemorrhage (yellow arrow), and subretinal hemorrhage (yellow arrowheads) (b).
SSOH, superior segmental optic hypoplasia.

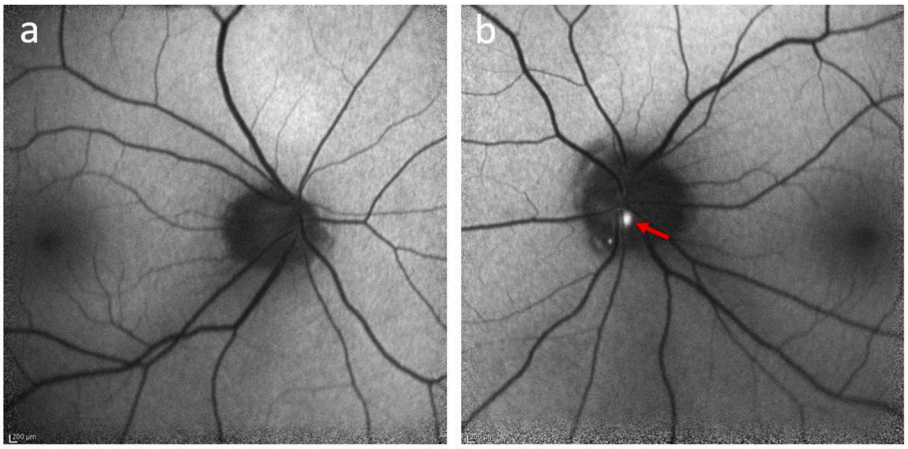

Fig. 8. Fundus autofluorescence images for Case 2 (a: right eye, b: left eye).
Hyperfluorescence within the papilla of the left eye was observed, indicating optic disc drusen (red arrow) (b).

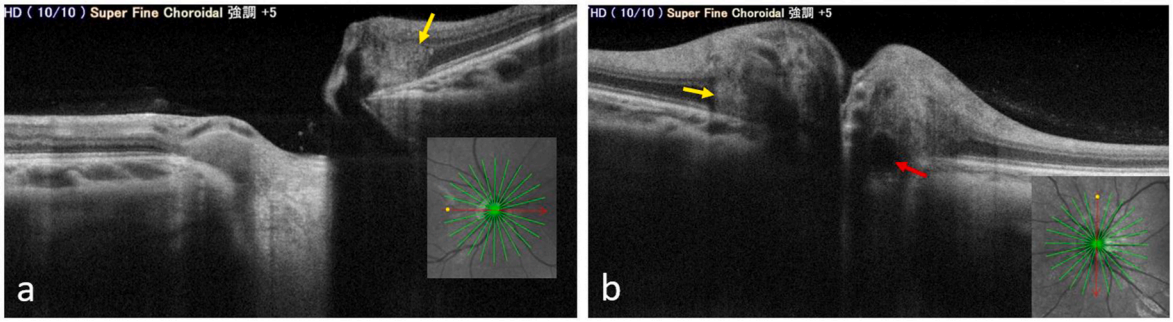

Fig. 9. OCT B-scan images of the optic nerve head in Case 2 (a: horizontal section of the right eye, b: vertical section of the left eye).
These images were captured using spectral-domain OCT (RS-3000 Advance; Nidek, Gamagori, Japan). The red arrow indicates optic disc drusen, and the yellow arrow denotes PHOMS.
PHOMS, peripapillary hyperreflective ovoid mass–like structures.

Table 1
Summary of Cases 1 to 5
OCTA, optical coherence tomography angiography; PHOMS; peripapillary hyperreflective ovoid mass–like structures; PPA.peripapillary chorioretinal atrophy; SSOH, superior segmental optic hypoplasia.

Case	Age	Sex	Eye	Spherical equivalent (D)	Axial length (mm)
1	21	Female	Left→right	−7.00	26.91
2	16	Female	Left	−6.25	26.55
3	12	Female	Left	−1.75	24.73
4	30	Female	Left	−5.75	27.34
5	14	Male	Right	−4.50	25.51

Case	Abnormality in disc shape	Abnormality in visual field	Vitreous hemorrhage	Nasal disc swelling
1	PPA	–	–	Presence
2	Optic disc drusen (SSOH in contralateral eye), PPA	Presence	Presence	Presence
3	PPA	–	–	Presence
4	Tilted disc, PPA	–	Presence	Presence
5	Small disc, PPA	Presence	Presence	Presence

Case	PHOMS	Abnormality in OCTA	DD/DM ratio(right/left)
1	Presence	–	0.38/0.37
2	Presence	(no data)	0.31/-
3	Presence	–	0.32/-
4	Presence	–	0.29/0.28
5	Presence	–	0.27/0.34

the adhesion between layers is relatively weak. Moreover, in eyes with structural abnormalities of the optic disc, such as a small disc, tilted disc, or optic disc drusen, mechanisms such as compression or circulation disturbances due to high-density or asymmetric tissue composition within the disc may further increase the likelihood of the above-mentioned situations occurring.

Previous reports about IHAPSH have shown that cases are predominantly found in East Asian populations, with a significant majority occurring in individuals with myopia. From its epidemiological perspective, it is reasonable to hypothesize that some structural abnormality of the optic nerve head related to myopia is a primary cause of IHAPSH. Furthermore, reports from Japan indicate that the majority of cases occur in school-aged children and young adults, suggesting a link with the elongation process of the axial length. The recent increase in reported cases in Japan is also noteworthy, and the authors speculate it may be related to social factors. Currently, the progression of myopia in younger populations is recognized as an important social issue, with factors such as the rapid spread of tablet computers among children being suspected. Investigating how changes in visual environments impact the eyes is an urgent task.

OCT is a useful tool for non-invasively assessing the structural details of ocular tissues, and its application in IHAPSH is expected to advance the understanding of this condition. Zou et al. investigated OCT findings in 37 cases of IHAPSH and quantitatively reported that the optic nerve head of the affected eye had a narrower and deeper cup compared to the contralateral eye.[14] Takahashi et al. studied 5 cases and reported that the eye affected by IHAPSH had a larger tilt angle than the contralateral eye in all cases.[15] In our study, OCT findings of PHOMS were observed in all 5 cases.

PHOMS was first identified as an OCT finding that appeared diffusely hyperreflective and ovoid in shape around the optic nerve head, distinct from optic disc drusen, as described in the 2018 report by Malmqvist et al. regarding the Optic Disc Drusen Studies Consortium recommendations.[16] It is peripapillary in location partially or circumferentially, situated just above Bruch's membrane at the lip of Bruch's membrane

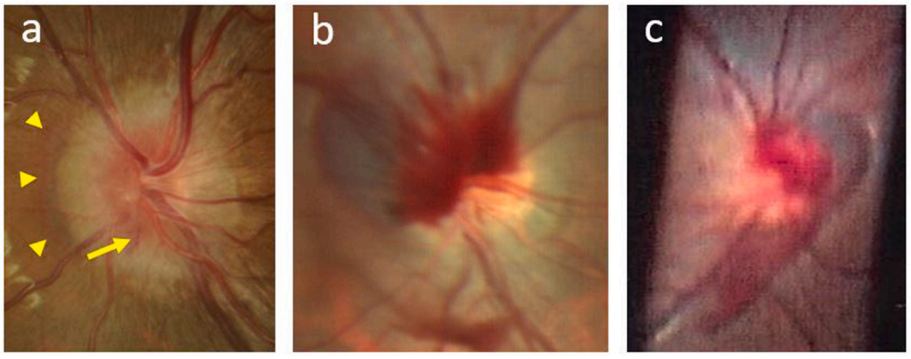

Fig. 10. Fundus photographs of 3 cases (a: Case 3, b: Case 4, c: Case 5).
The yellow arrow indicates papillary hemorrhage, and the yellow arrowheads denote subretinal hemorrhage (a).

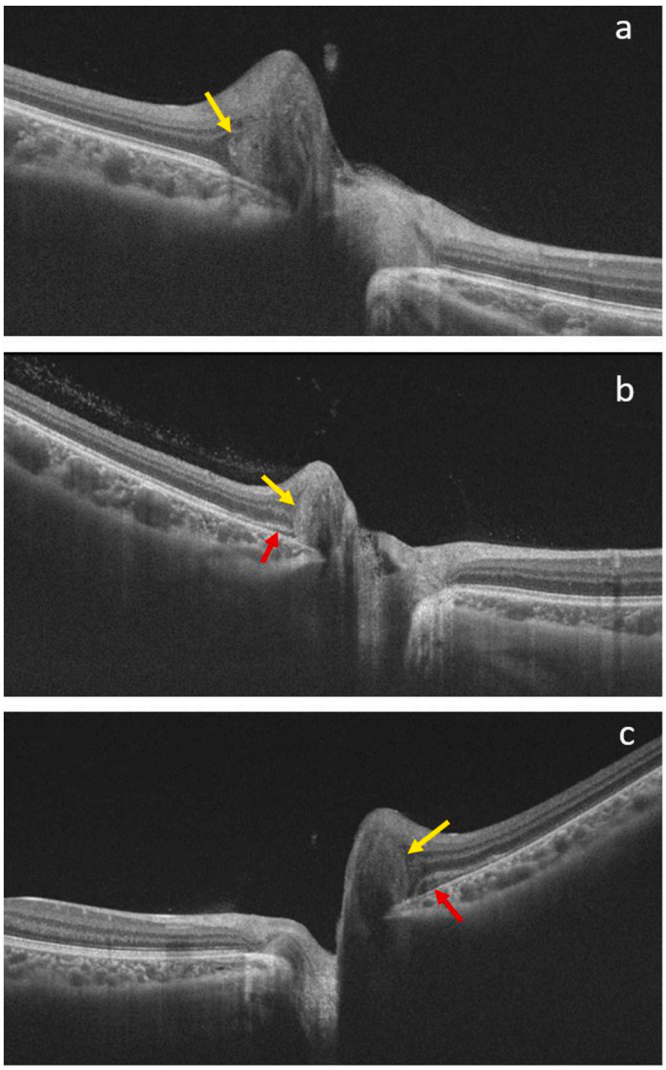

Fig. 11. OCT B-scan images of the optic nerve head in the affected eyes of 3 cases. a: Case 3 (left eye), b: Case 4 (left eye), c: Case 5 (right eye).
These images were captured using swept-source OCT (Triton; Topcon, Tokyo, Japan). The red arrow indicates subretinal hemorrhage (b, c), and the yellow arrow denotes peripapillary hyperreflective ovoid mass–like structures (PHOMS) (a, b, c). Case 3 shows images after hemorrhage resolution (a). In case 4, red blood cells were observed in the vitreous cavity (b).

opening and external to the optic disc itself. In 2022, Tokuhisa et al. reported the first case of IHAPSH with PHOMS findings.[9] However, PHOMS has also been reported in other conditions that cause optic disc swelling, such as choked disc, anterior ischemic optic neuropathy, central retinal vein occlusion, and optic neuritis.[17] Mezad-Koursh et al. reported that in a retrospective cohort study of 64 eyes from 32 children diagnosed with pseudopapilledema, all the children (63 eyes) exhibited PHOMS.[18] Thus, the disease specificity of PHOMS may not be high, and its pathophysiology and significance are not yet fully understood. In the 2023 report by Behrens et al., which examined 1407 healthy children aged 11–12 years, PHOMS was found in 8.9 % of the cases, mainly located in the superior nasal quadrant. PHOMS was significantly more common in the eyes of children with myopia and tilted discs, and it tended to be more frequent in eyes with a smaller diameter of the Bruch's membrane opening. The presence of a small optic disc and myopic changes (optic disc tilt) were suggested as potential risk factors for PHOMS.[19] While the similarities in characteristics between IHAPSH- and PHOMS-affected eyes suggest a potential association, further investigation with a larger number of IHAPSH cases is needed.

The onset of IHAPSH may be related to optic disc structural abnormalities or changes associated with myopia. Recently, the concept of myopic optic neuropathy has been proposed, which raises interesting considerations regarding its association with IHAPSH and PHOMS. Further reports on OCT and OCTA imaging findings in a large number of IHAPSH cases with long-term follow-up are awaited.

CRediT authorship contribution statement

Daisuke Takemoto: Writing – original draft, Visualization, Resources, Data curation. **Shinji Ohkubo:** Writing – review & editing. **Sachiko Udagawa:** Writing – review & editing. **Tomomi Higashide:** Writing – review & editing, Supervision, Resources.

Patient consent

The patients formally assigned the written consent for publication.

Authorship

All authors attest that they meet the current ICMJE criteria for Authorship.

Funding

No funding or grant support

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

None.

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