

INTEROCULAR ASYMMETRY OF PERIPAPILLARY HYPERREFLECTIVE OVOID MASS-LIKE STRUCTURES IN INTRAPAPILLARY HEMORRHAGE WITH ADJACENT PERIPAPILLARY SUBRETINAL HEMORRHAGE

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Purpose: To characterize peripapillary hyperreflective ovoid mass-like structures (PHOMS) in affected and fellow eyes of patients with intrapapillary hemorrhage with adjacent peripapillary subretinal hemorrhage (IHAPSH), and to assess whether PHOMS height is associated with IHAPSH involvement.

Methods: This retrospective observational study included 14 IHAPSH patients who underwent optic nerve head optical coherence tomography. PHOMS presence, distribution, and height were characterized in affected and fellow eyes. Interocular differences in PHOMS height, spherical equivalent (SE), and optic disc tilt were compared. The association between PHOMS height and IHAPSH involvement was then analyzed using a linear mixed-effects model (LMM), adjusting for SE and optic disc tilt.

Results: All 14 IHAPSH patients had unilateral involvement. PHOMS were detected in all affected eyes and 78.6% (11/14) of fellow eyes. PHOMS were nasally located, with occasional superior or inferior extension. PHOMS height was greater in affected eyes ($546.37 \pm 98.33 \mu\text{m}$) than in fellow eyes ($357.12 \pm 224.12 \mu\text{m}$; $P = 0.002$). Affected eyes showed more myopic SE ($-3.87 \pm 1.57 \text{ D}$ vs. $-3.13 \pm 1.76 \text{ D}$; $P = 0.007$), with no difference in optic disc tilt ($P = 0.457$). In the LMM, PHOMS height was independently associated with IHAPSH involvement, with affected eyes showing $159.07 \mu\text{m}$ greater height than fellow eyes ($\beta = 159.07 \mu\text{m}$; $P = 0.011$) after adjustment for SE and optic disc tilt.

Conclusion: PHOMS height was greater in affected than in fellow eyes and independently associated with IHAPSH involvement, suggesting that increased PHOMS height may reflect structural susceptibility to IHAPSH.

RETINA 46:1106–1114, 2026

Intrapapillary hemorrhage with adjacent peripapillary subretinal hemorrhage (IHAPSH) is a rare clinical syndrome that typically occurs in young myopic individuals, especially of Asian descent. It is characterized

by acute intrapapillary hemorrhage accompanied by adjacent peripapillary subretinal hemorrhage, sometimes with extension into the vitreous cavity, yet paradoxically followed by spontaneous resolution with typically good visual outcomes.^{1,2} This combination of dramatic hemorrhagic presentation and favorable prognosis distinguishes IHAPSH from other causes of optic disc hemorrhage. Although myopia is a well-established predisposing factor, IHAPSH affects only a small subset of this large population, suggesting that additional structural predispositions may contribute to its occurrence.

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This study received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

None of the authors has any financial/conflicting interests to disclose.

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Despite recognition of its clinical features,² the structural basis of IHAPSH remains unclear. Proposed mechanisms—including vitreopapillary traction (VPT),^{1,3} optic disc crowding,⁴ optic disc tilt,⁵ and morphologically vulnerable optic discs in myopia⁶—provide valuable but incomplete explanations. These factors fail to fully account for key features of the syndrome, such as its abrupt onset, typically unilateral involvement, and nonrecurrent course. These observations suggest that additional anatomical or structural predispositions may underlie disease development.

Peripapillary hyperreflective ovoid mass-like structures (PHOMS) are optical coherence tomography (OCT) findings^{7,8} frequently observed in myopic children and adolescents. These structures are reported in up to 25.8% of myopic children,⁹ with established associations with myopia severity and optic disc tilt.^{9–11} PHOMS predominantly localize to the nasal and superior peripapillary regions^{9,11}—areas commonly involved in subretinal hemorrhage in IHAPSH. This demographic and anatomical overlap suggests that PHOMS and IHAPSH may share common underlying structural vulnerabilities in the peripapillary region, raising the possibility that PHOMS may reflect structural susceptibility to IHAPSH. Although a recent case series noted the coexistence of PHOMS and IHAPSH,¹² no study has systematically investigated their structural relationship or characterized PHOMS features in relation to IHAPSH involvement.

In this study, we retrospectively analyzed 14 patients with IHAPSH who underwent optic nerve head (ONH) OCT examination to characterize PHOMS in affected and fellow eyes, and to assess whether PHOMS height is associated with IHAPSH involvement.

Methods

Subjects

This retrospective, single-center study was conducted at Daping Hospital with institutional ethics committee approval. The requirement for informed consent was waived because of the retrospective design. Medical records of patients diagnosed with IHAPSH who underwent ONH OCT between January 2018 and January 2024 were reviewed.

Inclusion criteria:

1. IHAPSH, with or without vitreous hemorrhage;
2. Available ONH OCT scans of both eyes.

Exclusion criteria:

1. Isolated optic disc hemorrhage without adjacent peripapillary subretinal involvement;
2. Coexisting ocular pathologies affecting ONH evaluation (e.g., peripapillary choroidal neovascularization, ischemic optic neuropathy, Terson syndrome, polypoidal choroidal vasculopathy, optic disc drusen [ODD], juxtapapillary neovascular membranes, or glaucomatous disc hemorrhage);
3. Poor-quality OCT images precluding PHOMS assessment;
4. Absence of clinical follow-up.

Ophthalmic Examinations and Image Analysis

All patients underwent comprehensive ophthalmic evaluation, including best-corrected visual acuity (BCVA), subjective refraction, intraocular pressure measurement, slit-lamp biomicroscopy, and fundus photography.

ONH OCT was performed in all patients using either spectral-domain OCT (Heidelberg Spectralis, Heidelberg Engineering, Heidelberg, Germany) or swept-source OCT (VG1100C, SVision Imaging, Luoyang, China). Both eyes were scanned using identical acquisition protocols. In most cases, horizontal, vertical, and radial B-scans centered on the optic disc were obtained (6 × 6-mm scan area, 64 B-scans). Fluorescein angiography (FA) was performed in six patients (12 eyes) using Heidelberg Spectralis (software version 6.9a, Heidelberg Engineering) to evaluate for optic disc leakage. VPT was assessed on ONH OCT in all patients and on B-scan ultrasonography in 10 patients (20 eyes; MD-2300 A/B-scan Ultrasound System, Tianjin Maida Medical Technology Co., Ltd., Tianjin, China).

PHOMS presence was evaluated in affected and fellow eyes on OCT images. PHOMS distribution was recorded by quadrant (nasal, superior, inferior, and temporal). PHOMS height was measured on the OCT B-scan showing maximal lesion elevation, defined as the vertical distance from Bruch membrane to the apex of the PHOMS (Figure 1). Measurements were performed using the proprietary software provided by the respective OCT platforms (HEYEX v1.9.10.0 for Spectralis; SVision v3.0.283 for VG1100C). PHOMS were categorized as small (<300 μm), medium (300–500 μm), or large (≥500 μm)^{13,14} to facilitate descriptive comparisons between affected and fellow eyes.

Optic disc tilt angle was measured using ImageJ software (v1.54, NIH) on the B-scan showing maximal tilt, defined as the angle between a Bruch membrane baseline connecting the nasal and temporal disc margins and a line from the nasal edge to the innermost temporal scleral canal opening.^{15,16}

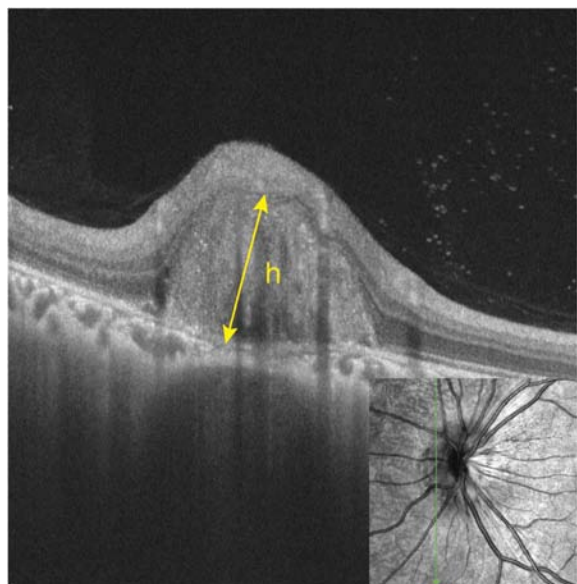


Fig. 1. Measurement of PHOMS height on OCT. A longitudinal B-scan through the nasal optic disc showing maximal PHOMS elevation. The yellow measurement line (h) indicates the maximal vertical distance from Bruch membrane to the apex of the PHOMS.

Two independent investigators (J.W. and S.F.) confirmed diagnoses and performed all measurements. Discrepancies were resolved by consensus with a senior ophthalmologist (W.L.), and the mean of two measurements was used for analysis.

Statistical Analysis

The distribution of continuous variables was assessed using the Shapiro–Wilk test. Comparisons between affected and fellow eyes were performed using the chi-square test or Fisher exact test for categorical variables, and paired *t*-test or Wilcoxon signed-rank tests for continuous variables, as appropriate. For eyes without detectable PHOMS, PHOMS height was coded as zero for all analyses. A linear mixed-effects model was used to evaluate the association between PHOMS height and IHAPSH involvement (affected vs. fellow eye), with subject included as a random intercept and spherical equivalent (SE) and optic disc tilt entered as covariates. Sensitivity analyses additionally adjusted for age and sex.

All statistical analyses were performed using SPSS version 19.0 (IBM Corp., Armonk, NY), with *P* < 0.05 considered statistically significant.

Results

Patient Demographics

Fourteen patients with IHAPSH were included, all with unilateral involvement (mean age: 19.7 ± 7.0

years; 11 females, three males; Table 1). All patients had normal anterior segment findings and intraocular pressure. All patients were otherwise healthy, except one with a history of scleral buckling for retinal detachment in the fellow eye (BCVA 20/200). The most common presenting symptoms were floaters (42.9%), scotoma (35.7%), blurred vision (28.6%), and reduced visual acuity (21.4%), with some patients reporting multiple symptoms. In one case, symptom onset was temporally associated with emotional stress, whereas no identifiable triggers were reported in the others.

Fundus examination revealed intrapapillary hemorrhage accompanied by nasal or superonasal peripapillary subretinal hemorrhage in all affected eyes. Nasal disc elevation with blurred margins was observed in all evaluable affected eyes (8/14), whereas assessment was precluded in the remaining six because of overlying hemorrhage. Among fellow eyes, 11 of 14 (78.6%) exhibited similar nasal disc elevation, whereas the remaining three showed well-defined disc margins. FA was performed in six of 14 patients (12 eyes: six affected and six fellow eyes) and revealed no fluorescein leakage in any examined eye (0/6 affected eyes; 0/6 fellow eyes). VPT was assessed on ONH OCT in all patients and on B-scan ultrasonography in 10 patients (20 eyes). No evidence of VPT was identified on either imaging modality (0/28 eyes on OCT; 0/20 eyes on B-scan ultrasonography).

Table 1. Patient Demographics and Clinical Characteristics

Characteristic	Value
Total patients, n	14
Age (years), mean $\pm$ SD	19.7 ± 7.0
Female, n (%)	11 (78.6)
IHAPSH-affected eye (OD/OS)	6/8
Bilateral PHOMS, n (%)	11 (78.6)
Presenting symptoms, n (%) [*]	
Floaters	6 (42.9)
Scotoma	5 (35.7)
Blurred vision	4 (28.6)
Reduced visual acuity	3 (21.4)
Final BCVA, affected eye	
20/20, n (%)	13 (92.9)
20/32, n (%)	1 (7.1)
Final BCVA, fellow eye	
20/20, n (%)	13 (92.9)
20/200, n (%)	1 (7.1%) [†]
Follow-up duration (months), mean $\pm$ SD	9.5 ± 13.8 (range: 0.5–48)

^{*}Multiple symptoms per patient possible.

[†]Patient with history of retinal detachment and scleral buckling surgery in fellow eye.

OD, right eye; OS, left eye.

The mean follow-up duration was 9.5 ± 13.8 months (range, 0.5–48 months). Throughout follow-up, no affected eyes experienced recurrence, and no fellow eyes developed new-onset IHAPSH. At the final visit, 13 of 14 patients (92.9%) achieved a BCVA of 20/20 in the affected eye, with one patient achieving 20/32. Among fellow eyes, 13 patients (92.9%) maintained 20/20 vision, whereas one patient with previous retinal detachment had stable vision at 20/200 (Table 1).

PHOMS Features and Interocular Differences

PHOMS were detected in all affected eyes (14/14, 100%) and in 11 of 14 fellow eyes (78.6%), with no significant difference in detection rates ($P = 0.222$). Two distinct distribution patterns were observed: bilateral PHOMS (11/14 patients, 78.6%) (Figure 2) and unilateral PHOMS (3/14 patients, 21.4%) (Figure 3).

On OCT, PHOMS consistently appeared as nasal peripapillary ovoid hyperreflective lesions, frequently extending into the superior and inferior quadrants. No temporal involvement was observed (Table 2).

All continuous variables followed a normal distribution (Shapiro–Wilk test, all $P > 0.05$). The mean PHOMS height was significantly greater in affected eyes ($546.37 \pm 98.33 \mu\text{m}$) than in fellow eyes ($357.12 \pm 224.12 \mu\text{m}$; $P = 0.002$). Affected eyes had significantly more myopic SE ($-3.87 \pm 1.57 \text{ D}$) than fellow eyes ($-3.13 \pm 1.76 \text{ D}$; $P = 0.007$), whereas optic disc tilt angle showed no significant interocular difference ($P = 0.457$).

To further characterize the observed PHOMS height difference, large PHOMS were more frequently observed in affected eyes (10/14, 71.4%) than in fellow eyes (3/11, 27.3%), whereas medium-sized lesions predominated in fellow eyes. Small PHOMS were observed only in one fellow eye (Table 2).

Regression Analysis of PHOMS Height and Clinical Parameters

In the linear mixed-effects model, PHOMS height was independently associated with IHAPSH involvement, with affected eyes showing $159.07 \mu\text{m}$ greater height than fellow eyes ($\beta = 159.07 \mu\text{m}$; $P = 0.011$).

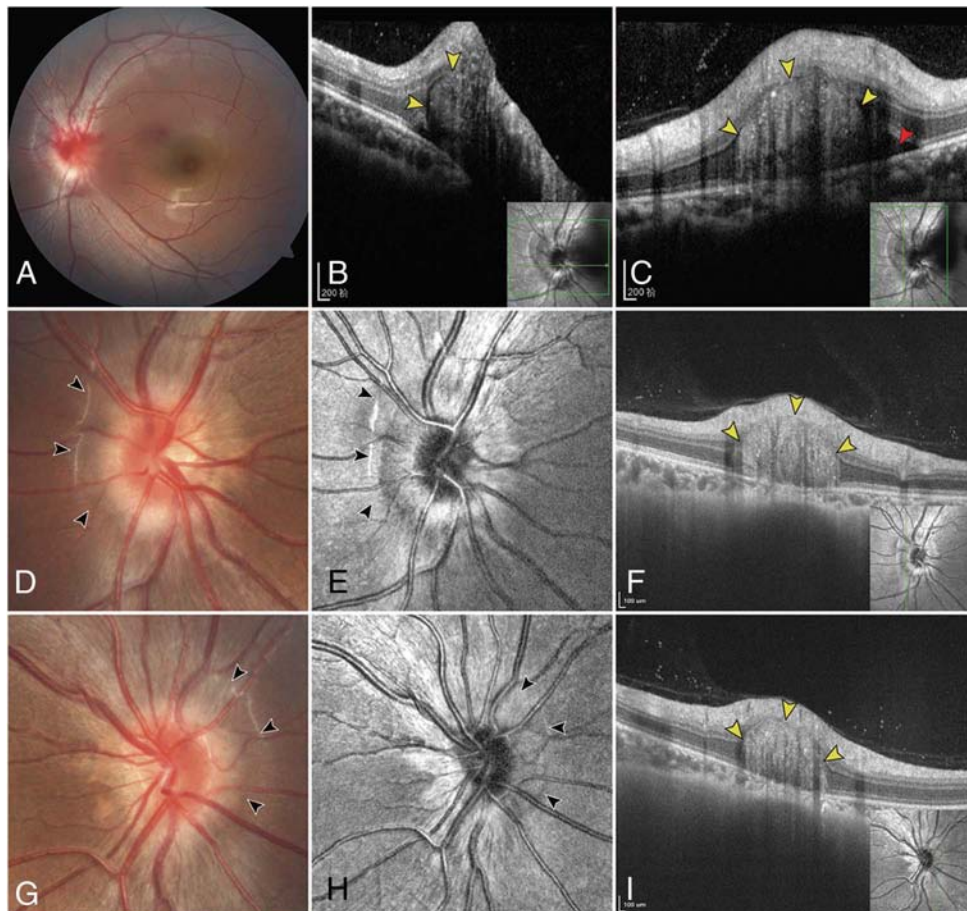
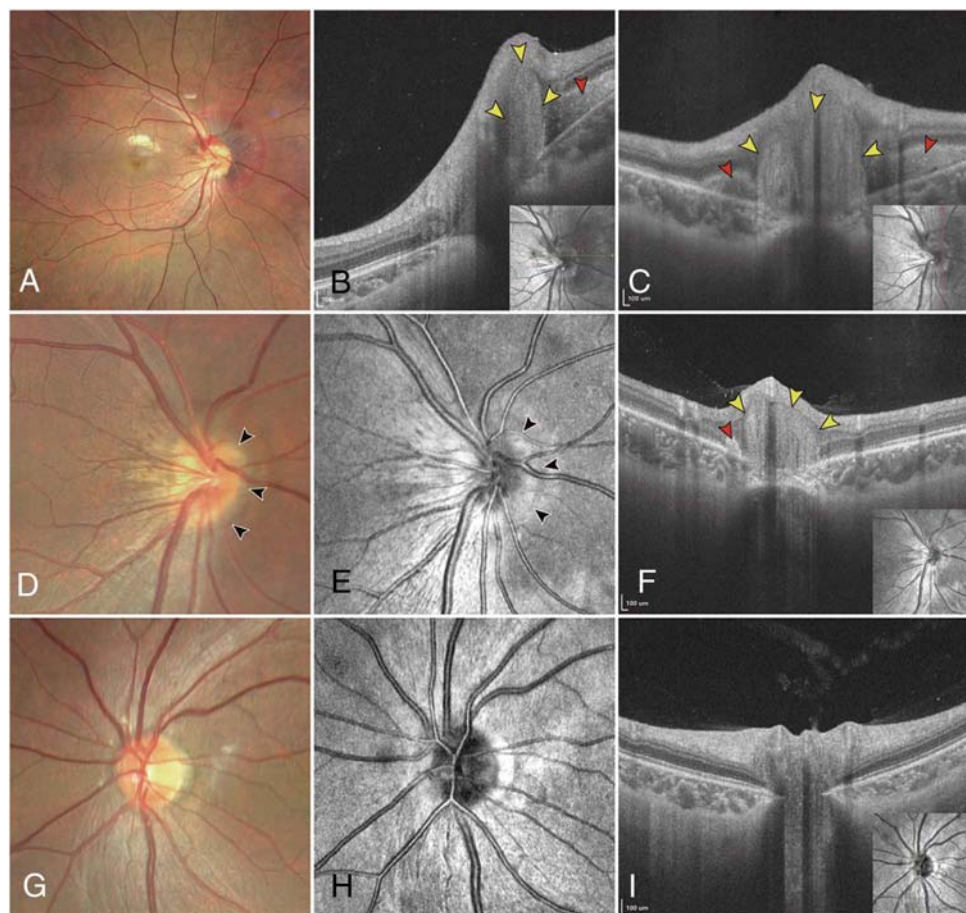


Fig. 2. Bilateral PHOMS in IHAPSH. Panels A–I show multimodal images from a single patient: the affected eye at presentation (A–C), after hemorrhage resolution (D–F), and the fellow eye (G–I). OCT B-scans (B, C, F, and I) show PHOMS at maximal height. At presentation, FP (A) shows mild vitreous, intrapapillary, and nasal subretinal hemorrhages. Horizontal (B) and vertical (C) SD-OCT scans reveal hyperreflective ovoid lesions (yellow arrows) within subretinal hemorrhage (red arrows), consistent with PHOMS. After hemorrhage resolution, FP (D) and IR (E) show nasal optic disc elevation with indistinct margins (black arrows). SS-OCT (F) confirms persistent PHOMS (yellow arrows; height = $576.6 \mu\text{m}$). In the fellow eye, FP (G) and IR (H) show a similar optic disc appearance (black arrows); SS-OCT (I) reveals a PHOMS lesion of smaller height (yellow arrows; height = $482.7 \mu\text{m}$), indicating greater PHOMS height in the affected eye ($\Delta\text{height} = 93.9 \mu\text{m}$). FP, fundus photography; IR, infrared reflectance; SD-OCT, spectral-domain OCT; SS-OCT, swept-source OCT.

Fig. 3. Unilateral PHOMS in IHAPSH. Panels A–I show multimodal images from a single patient: the affected eye at 2-week follow-up (A–C), after hemorrhage resolution (D–F), and the fellow eye (G–I). OCT B-scans (B, C, F) show PHOMS at maximal height. At 2 weeks, FP (A) shows near-complete absorption of vitreous hemorrhage with persistent intrapapillary and peripapillary subretinal hemorrhages. Horizontal (B) and vertical (C) SS-OCT scans reveal a hyper-reflective ovoid lesion (yellow arrows) within the subretinal hemorrhage zone (red arrows). After hemorrhage resolution, FP (D) and IR (E) show nasal optic disc elevation with indistinct margins (black arrows), whereas SS-OCT (F) confirms PHOMS (yellow arrows; height = 375.6 μm) with mild residual subretinal hyperreflectivity (red arrows). The fellow eye shows normal optic disc appearance on FP (G) and IR (H), and no detectable PHOMS on SS-OCT (I). FP, fundus photography; IR, infrared reflectance; SS-OCT, swept-source OCT.



In contrast, neither SE nor optic disc tilt showed significant effects on PHOMS height (both $P > 0.05$).

This association between PHOMS height and IHAPSH involvement remained significant in the

sensitivity analysis additionally adjusting for age and sex ($\beta = 151.55 \mu\text{m}$; $P = 0.018$).

Detailed regression results are presented in Table 3.

Table 2. PHOMS Detection, Distribution, and Quantitative Comparison

Parameters	Affected Eyes (n = 14)	Fellow Eyes (n = 14)	P
PHOMS presence, n (%)	14 (100.0)	11 (78.6)	0.222*
PHOMS quadrant distribution†			
Nasal, n (%)	14 (100.0)	11 (100.0)	—
Superior, n (%)	12 (85.7)	8 (72.7)	—
Inferior, n (%)	8 (57.1)	8 (72.7)	—
Temporal, n (%)	0 (0.0)	0 (0.0)	—
PHOMS height (μm)	546.37 $\pm$ 98.33	357.12 $\pm$ 224.12	0.002‡
Spherical equivalent (D)	−3.87 $\pm$ 1.57	−3.13 $\pm$ 1.76	0.007‡
Disc tilt angle (°)	13.53 $\pm$ 2.51	12.50 $\pm$ 5.18	0.457‡
PHOMS size categories‡			
Small (<300 μm), n (%)	0 (0.0)	1 (9.1)	—
Medium (300–500 μm), n (%)	4 (28.6)	7 (63.6)	—
Large ($\geq$ 500 μm), n (%)	10 (71.4)	3 (27.3)	—

Values are presented as N (%); D = diopters. Bold values indicate statistical significance ($P < 0.05$).

*Fisher exact test.

†Analyzed in eyes with PHOMS only (affected eyes, n = 14; fellow eyes, n = 11).

‡Paired t-test.

Discussion

To our knowledge, this study is the first to provide a systematic characterization of PHOMS in IHAPSH, demonstrating that PHOMS height is independently associated with IHAPSH involvement. Furthermore, large PHOMS ($\geq 500 \mu\text{m}$) were observed in 71.4% of affected eyes compared with 27.3% of fellow eyes. In multivariate analysis, PHOMS height was independently associated with IHAPSH involvement, whereas SE and optic disc tilt showed no significant association.

Although the coexistence of PHOMS and IHAPSH has been noted,¹² it is important to recognize that PHOMS are a nonspecific structural OCT finding observed in various optic nerve conditions, including ODD, tilted disc syndrome, anterior ischemic optic neuropathy, optic neuritis, and Leber idiopathic stellate neuroretinitis.^{17,18} In our study, PHOMS were detected in all affected eyes (100%) and in most fellow eyes (78.6%)—detection rates substantially higher than previously reported in myopic children (25.8%)⁹ and in unselected children from a population-based cohort (8.9%).¹¹ This high bilateral detection reflects the nonspecific nature of PHOMS and highlights the need for cautious interpretation. To distinguish a potential pathophysiologic relationship from coincidental coexistence, we analyzed five lines of evidence: (1) temporal relationships; (2) spatial concordance; (3) optic disc configuration; (4) bilaterality patterns; and (5) size-dependent susceptibility.

First, temporal observations indicate that PHOMS are preexisting rather than reactive structures. PHOMS were present at presentation, remained morphologically stable during follow-up, and were observed in 78.6% of fellow eyes without previous hemorrhage.

Second, IHAPSH hemorrhages and PHOMS show similar spatial distributions, suggesting a localized

structural predisposition. IHAPSH hemorrhages occur most frequently in the nasal peripapillary region, occasionally extending superiorly or inferiorly and rarely involving the temporal aspect.^{2,4,19} Similarly, PHOMS are predominantly localized to the nasal and superior peripapillary regions,^{9,11} with minimal temporal involvement. This spatial overlap between PHOMS distribution and IHAPSH-associated hemorrhage sites suggests that PHOMS may contribute to localized structural vulnerability within these regions. In our series, PHOMS were present in 78.6% of fellow eyes and exhibited similar quadrant distributions, consistent with bilateral anatomic susceptibility that may underlie rare sequential bilateral cases.²

Third, PHOMS may account for the nasal optic disc elevation with blurred margins that has been frequently described in IHAPSH.^{2,4,6} In our case series, this configuration was consistently observed in all evaluable affected and fellow eyes with PHOMS but was absent in eyes without PHOMS. This morphology likely reflects PHOMS obscuring the scleral rim, a mechanism previously described to account for nasal disc elevation in myopic tilted optic discs.²⁰ We reviewed published IHAPSH cases with available OCT images and found PHOMS underlying the elevated nasal disc regions in a subset of cases.^{5,21} Consistent with this observation, similar optic disc morphology has been reported in pediatric patients with PHOMS-associated pseudopapilledema.²²

Fourth, the high bilateral detection frequency of PHOMS (78.6%), consistent with previous reports in myopic populations,^{9–11} suggests that they reflect structural alterations associated with myopia or optic disc tilt rather than IHAPSH itself. This pattern contrasts with the consistently unilateral nature of IHAPSH, supporting the interpretation that PHOMS represent generalized myopia-related structural changes rather than IHAPSH-specific findings.

Table 3. LMM Analysis of PHOMS Height and Clinical Parameters

Variable	β -Coefficient (μm)	95% Confidence Interval	P
Main model			
IHAPSH (affected vs. fellow eye)	159.07	43.13–275.02	0.011
Spherical equivalent (D)	−32.55	−84.96 to 19.86	0.209
Optic disc tilt angle (°)	8.17	−9.33 to 25.67	0.338
Adjusted model (sensitivity analysis)			
IHAPSH (affected vs. fellow eye)	151.55	30.43–272.67	0.018
Spherical equivalent (D)	−38.89	−100.79 to 23.01	0.200
Optic disc tilt angle (°)	9.11	−9.22 to 27.43	0.306
Age (years)	−3.89	−22.24 to 14.45	0.648
Sex (male)	11.91	−225.55 to 249.36	0.913

The model included random intercepts for subjects (CaseNo). Sex (male) was coded as 1 = male, 0 = female. Bold values indicate statistical significance ($P < 0.05$).

β , regression coefficient; D, diopters.

Fifth, although PHOMS are frequently bilateral in association with myopia or optic disc tilt, PHOMS height has pathophysiologic relevance for IHAPSH. Although PHOMS likely represent generalized myopia-related structural changes rather than an IHAPSH-specific finding, the magnitude of PHOMS enlargement—not merely their presence—distinguishes affected from fellow eyes. Multivariate analysis revealed that PHOMS height was independently associated with IHAPSH involvement, whereas SE and optic disc tilt were not. In our case series, large PHOMS ($\geq 500 \mu\text{m}$) were more common in affected eyes (71.4%) than in fellow eyes (27.3%), consistent with previous reports linking larger PHOMS to reduced peripapillary vessel density.¹⁴ These findings support a potential size-related microvascular mechanism underlying IHAPSH.

Taken together, these five lines of evidence suggest that the association between PHOMS and IHAPSH may reflect a pathophysiologic relationship rather than coincidental coexistence. However, a critical question remains: in this case series, PHOMS remained morphologically stable across a mean follow-up of 9.5 ± 13.8 months, yet IHAPSH presents acutely—how can a chronically present, structurally stable feature be reconciled with an acute hemorrhagic presentation?

Several mechanisms have been proposed to explain the acute hemorrhagic nature of IHAPSH. Early reports by Cibis et al³ and Katz and Hoyt¹ attributed the hemorrhage to VPT, with the latter also describing optic disc edema and fluorescein leakage. However, subsequent studies have not consistently demonstrated VPT on B-scan ultrasonography or ONH OCT,^{2,6} nor diffuse vascular leakage on FA.^{2,4,6,23} In our series, no VPT was identified on OCT or B-scan ultrasonography, and no fluorescein leakage was observed. Transient hemodynamic fluctuations, such as Valsalva maneuvers, have been reported in isolated cases,^{2,5} and one patient in our series experienced onset after emotional stress. Other reports have described onset upon awakening,¹⁹ suggesting a possible influence of circadian blood pressure dynamics. However, such triggers are not consistently observed. Structural factors—such as small scleral canal,⁴ optic disc tilt,⁵ and myopia-related peripapillary remodeling⁶—have also been proposed and may contribute to structural vulnerability. However, because these features are relatively static, additional dynamic processes are likely required to explain the abrupt and typically nonrecurrent presentation.

Although PHOMS appeared morphologically stable during our limited follow-up, longitudinal studies show that they can undergo dynamic volumetric changes over extended periods. Enlargement has been

reported during active myopic progression and axial elongation,^{9,10,24} whereas regression has been described in pediatric tilted disc syndrome and ODD.^{25,26} Notably, concurrent enlargement, regression, de novo formation, and stability of PHOMS have been reported within individual patients during extended follow-up.²⁷ These findings suggest that current studies capture different phases of longer-term PHOMS volumetric changes rather than full temporal dynamics.

To reconcile these observations with the acute hemorrhagic presentation of IHAPSH, we propose a threshold–trigger mechanism as one plausible model. In this model, progressive PHOMS enlargement during active myopic progression creates structural vulnerability (threshold), whereas transient physiologic fluctuations precipitate acute hemorrhage (trigger). Although the precise pathogenesis of PHOMS is incompletely understood, current evidence suggests that they reflect herniation of distended axons with axoplasmic stasis into the peripapillary region.^{20,28} OCT angiography (OCTA) studies show that large PHOMS ($\geq 500 \mu\text{m}$) are associated with reduced peripapillary vessel density,¹⁴ supporting the concept that PHOMS enlargement compromises microvascular perfusion. As PHOMS enlarge, prelaminar tissue may compress the peripapillary microvasculature, reducing perfusion reserve and adaptive capacity. Once PHOMS reach a critical size, modest fluctuations in intraocular pressure, systemic blood pressure, or impaired vascular autoregulation may exceed the eye's limited hemodynamic reserve and precipitate intrapapillary and peripapillary hemorrhage.

This threshold–trigger model may explain the acute hemorrhagic presentation and characteristic clinical patterns of IHAPSH: (1) age-specific susceptibility. IHAPSH primarily affects individuals aged 10 to 30 years,^{1,2,4,6} coinciding with active myopic progression when PHOMS may enlarge toward maximal dimensions. Older myopic patients rarely develop IHAPSH, likely because PHOMS have stabilized or regressed; (2) nonrecurrence despite persistent risk factors. Hemorrhage likely occurs only when PHOMS reach a critical size threshold; once they regress below this threshold, mechanical compression lessens and the substrate for recurrent hemorrhage is removed; (3) unilateral involvement. Asynchronous PHOMS enlargement between eyes means that only the eye with critically enlarged PHOMS is vulnerable at a given time, explaining unilateral presentation even when systemic triggers affect both eyes equally. Rare sequential bilateral cases occur when the fellow eye later reaches the same threshold; (4) infrequent identification of precipitating events. Most IHAPSH cases,

including ours, lack clear triggers; within this framework, critically enlarged PHOMS may require only minimal physiologic fluctuations—well within normal ranges—to exceed diminished microvascular adaptive capacity and cause hemorrhage.

This study has several limitations. First, the inclusion of only IHAPSH patients who underwent ONH OCT imaging may have introduced selection bias, limiting generalizability. Second, the use of two different OCT devices and acquisition protocols may have caused measurement variability; however, the application of standardized grading criteria and independent image assessments helped minimize this effect. Third, axial length was not recorded, and SE was measured without cycloplegia, potentially leading to an overestimation of myopia, particularly in pediatric cases. Finally, the small sample size reflects the rarity of IHAPSH but inevitably limits statistical power.

Future studies should include larger IHAPSH cohorts with longitudinal PHOMS assessments to validate whether PHOMS height represents a structural risk marker and to define the temporal dynamics of PHOMS volumetric change. Advanced imaging techniques, such as OCTA and volumetric PHOMS quantification,²⁶ may provide further insights into the microvascular and biomechanical mechanisms underlying IHAPSH.

In conclusion, this study demonstrates that PHOMS height—rather than mere presence—was independently associated with IHAPSH involvement after adjustment for SE and optic disc tilt, with large PHOMS markedly more common in affected eyes. These findings suggest structural susceptibility associated with PHOMS enlargement and, when considered alongside longitudinal evidence that PHOMS undergo dynamic volumetric changes, provide a rationale for a threshold–trigger hypothesis. Prospective longitudinal studies will be required to validate this framework and elucidate the mechanisms linking PHOMS to IHAPSH.

Key words: intrapapillary hemorrhage with adjacent peripapillary subretinal hemorrhage, myopia, optic disc tilt, optical coherence tomography, peripapillary hyperreflective ovoid mass-like structures.

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