Within the PPA–OR, 3.02; P were significantly associated with straight-BM–type, presence and 27 normal eyes) or downward-curved (19 and 8 eyes) Bruch’s membrane (BM) or of a downward-bending slope lacking BM (BM defect; 51 and 28 eyes). Multivariate analysis revealed that absence of POAG (odds ratio [OR], 0.36; P = 0.0012), the PPA bed was composed of straight (14 POAG and 27 normal eyes) or downward-curved slope lacking BM (BM defect; 51 and 28 eyes). Multivariate analysis revealed that absence of POAG (odds ratio [OR], 0.36; P = 0.0012) and less myopic refractive error (OR, 1.43; P = 0.009) were significantly associated with straight-BM–type, presence of POAG (OR, 5.74; P = 0.008) and less myopic refractive error (OR, 3.02; P < 0.001) with curved-BM–type, and myopic refractive error (OR, 0.34; P < 0.001) with BM-defect–type. Within the PPA–β region, all retinal layers except for the nerve fiber layer frequently disappeared before reaching the disc edge, showing no significant intergroup difference (P > 0.05) between POAG and normal eyes. Conclusions. PPA bed configurations detected by SD-OCT were classified into three types. The lack of BM on the PPA bed was closely associated with glaucoma. The downward-curved appearance of BM may be related to the anatomic changes associated with glaucoma. (Invest Ophthalmol Vis Sci. 2012;53:1499–1505) DOI:10.1167/iovs.11-8572

Peripapillary atrophy (PPA), ophthalmoscopically divided into a central zone β (PPA–β) and a peripheral zone (PPA–α), has been known to be associated with two factors of clinical importance: myopia and glaucomatous optic neuropathy.1–5 Several population-based studies have shown that the prevalence of PPA in normal eyes increased significantly with the increase in diopeters of myopia,4,5 but the extent of the PPA is independent of6 or increases slightly7 with myopic refractive error. Cross-sectional studies have shown that the extent and the location of PPA, especially PPA–β, correlated significantly with glaucomatous damage in the optic nerve head2,8,9 and visual fields2,3,10–11 in eyes with primary open-angle glaucoma (POAG). In addition, findings in some longitudinal studies12–14 and retrospective cohort studies15,16 have suggested that the presence and the extent of PPA–β are predictive of visual field deterioration in POAG.

Histologic studies of PPA are limited, and both congenital misalignment of the retinal tissues and acquired atrophy have been suggested as etiologic mechanisms.17–20 Despite several studies based on color fundus photography,1–3,8 confocal scanning laser ophthalmoscopy,21 or spectral-domain optical coherence tomography (SD-OCT),22,23 which enabled ophthalmologists to perform detailed in vivo retinal, choroidal, and, on some occasions, scleral examinations,24,25 the possible influences of myopia and glaucoma on the histology or structure of the PPA have been poorly understood. We previously used SD-OCT to demonstrate the anatomic configurations of PPA in normal eyes.26 In the present study we further analyzed the SD-OCT B-scan images of PPA–β to investigate the characteristic features relating to myopia and glaucoma.

Methods

One hundred consecutive patients with POAG and 100 normal emmetropic or myopic subjects who met the inclusion criteria were enrolled in this cross-sectional study between March 2007 and September 2008 at the Department of Ophthalmology, University of Tokyo, Graduate School of Medicine. The study was approved by the institutional review board and complied with the Declaration of Helsinki. All participants provided written informed consent before the start of the study.

The inclusion criteria for the selection of patients with POAG included visual acuity (VA) exceeding 20/25, refractive error (spherical equivalent) within ±8 D, a reproduced and reliable (fixation errors, false-positive/negative errors <20%) glaucomatous visual field defect (Humphrey Field Analyzer [HFA], 30-2 SITA Standard; Carl Zeiss Meditec, Dublin, CA), and no other fundus abnormalities or media opacities except mild cataract. Glaucoma was diagnosed based on glaucomatous changes in the optic disc and/or retinal nerve fiber layer (RNFL) and the corresponding visual field defect. The glaucomatous fundus changes included an enlarged vertical cup-to-disc ratio, thinning of the rim width, a RNFL defect, or all of those. A glaucomatous visual field defect was defined as the presence of at least one of the following based on the criteria of Anderson and Patella:1,2 a pattern deviation probability plot showing a cluster of three or more points that were...
not on the edge with a probability of less than 5% and at least one point with a probability less than 1% in an expected location, a pattern SD with a probability less than 5%, or a glaucoma hemifield test that indicated that the field was outside normal limits. If both eyes were eligible, one randomly chosen eye of each patient was used for the analyses.

Normal subjects were recruited from volunteers, all of whom had a best corrected VA of 20/20 or better; refractive error (spherical equivalent) within ± 8 D; intraocular pressure (IOP) below 21 mm Hg; no abnormal findings in reliable visual field perimeter results according to the criteria of Anderson and Patella27; and no apparent ocular, neurologic, or systemic pathology that could cause an optic nerve abnormality. One eye of each subject was randomly selected.

Subjects underwent complete ophthalmic examinations, including autorefractometry (ARK-900; Nidek, Gamagori, Japan), VA testing, slit lamp biomicroscopy, application tomometry, gonioscopy, funduscopy, measurement of the axial length (IOLMaster; Carl Zeiss Meditec), and visual field testing (HFA 30-2 SITA Standard Program; Carl Zeiss Meditec). Subjects with a shallow anterior chamber, pseudoxeflation, or a history of intracocular surgery or all of those were excluded.

SD-OCT Imaging Protocols

Imaging of the peripapillary fundus was conducted with an OCT system (3D OCT-1000) ver. 2.13; Topcon Corp., Tokyo, Japan) that combines SD-OCT technology with a nonmydriatic fundus camera (corresponding to a commercially available nonmydriatic fundus camera [TRC-NW200; Topcon]). Raster scanning over a 6-mm² area centered on the optic disc was conducted, with a scan density of 512 A-scan (horizontal) × 128 B-scan (vertical) (Fig. 1). A color fundus photograph with a view angle of 45° was automatically taken with fundus camera function, immediately after OCT scanning through the undilated pupil. The projection (en face) OCT image was first automatically transformed and aligned with a color fundus photograph according to the information of the retinal vessel location. Further, an experienced examiner manually adjusted the superimposed projection image on the color fundus photograph (3D OCT-1000, TrueMap Software, ver. 2.1; Topcon Corporation). The criteria for acceptable SD-OCT images were defined as the absence of significant ocular movements (seen as no shift of large retinal vessels in the projection image) with a quality factor exceeding 60%.

SD-OCT Image Analyses

First, one investigator (KH) analyzed the color fundus photographs. The presence of PPA-β was defined as marked atrophy of the RPE and the choriocapillaris, of which horizontal width was apparently larger than the major retinal vein diameter at the optic disc edge. The area of PPA-β was measured two dimensionally by using the planimetry function included in the OCT system by manually delineating its margin within the color fundus photographs. The actual size of a retinal feature was estimated according to the formula provided by the manufacturer (modified Littman's method) based on the results of autorefractometry and axial length measurements.28 Because it is often difficult to draw the shape of the area of the PPA-α clearly on fundus photographs, only the area of PPA-β was measured in the present study.

Second, SD-OCT B-scan images were analyzed by two investigators (KH, AT) independently, without knowledge of the subject’s background or diagnosis. The cross-sectional configuration of PPA-β was evaluated on horizontal B-scan images, in which the axial length could be changed between one and four times compared with the horizontal length. Only B-scan images between the 8 and 10 o’clock positions in the right eyes (the mirror image was applied to the left eyes) were evaluated, because the 3-D data sets were obtained horizontally, and B-scan images in the other regions were far from being perpendicular to the optic disc edge (Fig. 1). The number of analyzed B-scan images for each eye averaged 13.9 ± 4.5 (range, 7–27) in POAG eyes and 14.1 ± 5.4 (range, 7–27) in normal eyes (P = 0.7929, unpaired t-test). The choroid, RPE and retinal layers, including the RNFL, ganglion cell layer (GCL), inner plexiform layer (IPL), inner nuclear layer, outer plexiform layer (OPL), outer nuclear layer, external limiting membrane (ELM), and photoreceptor inner segment–outer segment junction (IS/OS), were identified on the B-scan images (Fig. 2). Since BM was not clearly differentiated from RPE in the areas without PPA-β, we referred to this structure as the RPE/BM complex.

Definition of PPA Bed Configuration

In eyes with PPA-β, the IS/OS and RPE/BM complex lines terminated at the distal edge of PPA-β and, instead, a high-intensity-signal tissue complex was observed under the retina that was referred to in this study as the PPA bed. B-scan images of the PPA bed could be classified into the following three types: In some of the eyes, a highly reflective line that was continuous with the RPE/BM complex and terminated at the optic disc edge was seen. This line was thought to represent the thickened BM on the basis of the previous histologic studies demonstrating RPE-bared, thickened BM within the region of PPA-β.18–20 These presumed BM lines looked (1) straight (Fig. 2A) or (2) curved downward (Fig. 2B). In other eyes, the PPA bed was composed of an acute downward-curving slope and was thought to be (3) defective in BM (Fig. 2C). Further, configuration of PPA was classified into the following three categories: (1) PPA with a PPA bed configuration showing a straight BM (straight-BM-type) in B-scan images; (2) PPA with PPA bed configuration showing a downward-curved BM (curved-BM-type) in most B-scan images; and (3) PPA with a PPA bed configuration exclusively showing a defective BM (BM-defect-type) in the B-scan images.
When the two investigators disagreed on the PPA classification, they discussed the following points and reached a final consensus: The presence of BM was determined when a thin, highly reflective line was observed on the surface of the PPA bed in several continuous B-scan images and could be traced to the optic disc edge. A downward curve of the BM line was judged in the B-scan images without axial magnification and was determined when the BM line was curved downward compared with the RPE/BM complex line outside the PPA area.

In a subanalysis, we investigated the prevalence of optic disc phenotype according to the classification of Nicolela and Drance: The focal ischemic (FI) type has a focal loss of nerve fibers on the neuroretinal rim and the other areas are normal; the myopic (MY) type has a slight tilting of the disc with myopic temporal crescent and thinning of the superior and/or inferior rim; the senile sclerotic (SS) type has saucerized, shallow cupping with atrophic halo (chorioretinal atrophy) around the optic disc; and the generalized enlargement (GE) phenotype.
type has large, deep cupping, especially nasally, without localized defect of the neuroretinal rim. Correlation between optic disc type and PPA subtype was investigated. Eyes with nonclassifiable discs or with mixtures of more than one pattern were excluded from the subanalysis.

Assessment of Peripapillary Retinal Structures

In a previous study, we demonstrated that in normal eyes, all retinal layers without PPA-β reach the edge of the optic disc, whereas these layers other than RNFL frequently disappear within PPA-β before reaching the optic disc edge. In the present study, one investigator (KH) determined the termination point of each retinal layer in axially magnified horizontal B-scan images, and the prevalence of the disappearance of each retinal layer before reaching the optic disc edge was compared between POAG and normal eyes. Measurements were repeated twice by the same investigator at a minimum interval of 1 day.

Statistical Analyses

Intergroup differences in mean values and proportions were analyzed with the unpaired t-test and Fisher’s exact test. \( P < 0.05 \) with the Bonferroni correction for multiple comparisons was accepted as statistically significant. Multiple logistic regression analysis, in which explanatory variables were age, sex, refractive error, extent of PPA, axial length, mean untreated IOP, and presence or absence of POAG, was used to evaluate factors associated with each type of PPA bed configuration. Since the refractive error and axial length strongly correlated \((r = 0.77; P < 0.005)\), it would not be adequate to use both of them as explanatory variables. We adopted refractive error as an explanatory variable, since refraction is directly related to myopia, the one of two clinical features that we wanted to correlate with PPA-β. The role of each variable is expressed as an odds ratio (OR) with 95% CI.

RESULTS

The demographic data are shown in Table 1. PPA-β was found in 84 (84.0%) of the 100 POAG eyes and 63 (63.0%) of the 100 normal eyes \((P = 0.0012, \text{ Fisher’s exact test})\). Among the PPA-β-positive eyes, there were no significant \((P > 0.05, \text{ unpaired } t\text{-test})\) intergroup differences between POAG and normal eyes in age or axial length, whereas the female sex was more prevalent, spherical equivalent refractive error was slightly more myopic, and the extent of PPA-β was greater in POAG eyes than in normal eyes \((P < 0.05)\). The POAG group consisted of 86 eyes with untreated IOP \(\leq 21 \text{ mm Hg} \) and 14 with untreated IOP \(> 21 \text{ mm Hg} \). The prevalence of PPA-β showed no intersubgroup difference \((83.7\% \text{ vs. } 85.7\%; P = 0.9999)\).

The prevalence of each type of PPA is shown in Table 2. Interobserver reproducibility regarding the PPA subtype classification was almost perfect \((\text{Cohen’s } k = 0.82)\). Multivariate analysis revealed that the straight-BM-type was significantly associated with the absence of POAG \((\text{OR}, 0.36; 95\% \text{ CI}, 0.14 – 0.93; P = 0.034)\) and less myopic refractive error \((\text{OR}, 1.43; 95\% \text{ CI}, 1.09 – 1.87; P = 0.009)\); curved-BM-type was significantly associated with the presence of POAG \((\text{OR}, 5.74; 95\% \text{ CI}, 1.59 – 20.74; P = 0.008)\) and less myopic refractive error \((\text{OR}, 3.02; 95\% \text{ CI}, 1.87 – 4.88; P < 0.001)\); and BM-defect-type was significantly associated only with myopic refractive error \((\text{OR}, 0.34; 95\% \text{ CI}, 0.23 – 0.49; P < 0.001)\). Age, sex, extent of PPA-β, and untreated mean IOP did not have an association with any type of PPA (Table 3). Among the current 84 POAG eyes with PPA-β, the FI type optic disc was most common \((21 \text{ eyes})\), followed by MY \((18 \text{ eyes})\), GE \((4 \text{ eyes})\), and SS \((2 \text{ eyes})\). The remaining 39 eyes could not be classified into any of the four types. All the MY-type discs had BM-defect-type \((P < 0.0001, \chi^2 \text{-test})\), whereas other types of the disc did not show any association with PPA subtype \((P > 0.05)\).

As demonstrated in our previous study, all retinal layers in normal eyes without PPA-β reached the edge of the optic disc and the same was true in POAG eyes without PPA-β. In contrast, these layers, other than the RNFL, frequently disappeared in both POAG and normal eyes with PPA-β before reaching the optic disc edge (Table 4). In both POAG and normal eyes, IS/OS always terminated just before the distal edge of PPA-β, demonstrating the irregularity and the loss of photoreceptors within the area of PPA-β. In other retinal layers \((\text{GCL, IPL, OPL, and ELM})\), the prevalence of the disappearance of each retinal layer before the optic disc edge did not differ between POAG and normal eyes.

![Table 1. Demographic Data from Patients and Normal Subjects](https://iovs.arvojournals.org/pdfaccess.ashx?url=/data/journals/iovs/933464/ on 01/19/2019)

|                | POAG  
<table>
<thead>
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<tbody>
<tr>
<td></td>
<td>(n = 100)</td>
</tr>
<tr>
<td>Eyes without PPA-β, (n (%))</td>
<td>16 (16)</td>
</tr>
<tr>
<td>Age, y</td>
<td>58.1 ± 10.9</td>
</tr>
<tr>
<td>Men/women, n</td>
<td>6/10</td>
</tr>
<tr>
<td>Axial length, mm</td>
<td>23.74 ± 0.88</td>
</tr>
<tr>
<td>Refractive error, D</td>
<td>–0.7 ± 2.0</td>
</tr>
<tr>
<td>Eyes with PPA-β, (n (%))</td>
<td>84 (84)</td>
</tr>
<tr>
<td>Age, y</td>
<td>55.1 ± 11.0</td>
</tr>
<tr>
<td>Men/women, n</td>
<td>34/50</td>
</tr>
<tr>
<td>Axial length, mm</td>
<td>24.57 ± 1.09</td>
</tr>
<tr>
<td>Refractive error, D</td>
<td>–2.5 ± 2.1</td>
</tr>
<tr>
<td>Extent of PPA-β, mm²</td>
<td>1.04 ± 0.55</td>
</tr>
<tr>
<td>Untreated IOP, mm Hg</td>
<td>16.9 ± 3.7</td>
</tr>
<tr>
<td>HFA MD, dB</td>
<td>–6.5 ± 5.2</td>
</tr>
</tbody>
</table>

\(n = 100\), both groups. MD, mean deviation.

* Fisher’s exact test. Values are expressed as the mean ± SD. MD, mean deviation.

![Table 2. Prevalence of Each Type of PPA Classified According to PPA Bed Configuration](https://iovs.arvojournals.org/pdfaccess.ashx?url=/data/journals/iovs/933464/ on 01/19/2019)

<table>
<thead>
<tr>
<th>PPA Classification</th>
<th>POAG (n = 84)</th>
<th>Normal (n = 63)</th>
<th>(P^*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Straight BM</td>
<td>14 (16.7)</td>
<td>27 (42.9)</td>
<td>0.0007^*</td>
</tr>
<tr>
<td>Curved BM</td>
<td>19 (22.6)</td>
<td>8 (12.7)</td>
<td>0.1379</td>
</tr>
<tr>
<td>BM defect</td>
<td>51 (60.7)</td>
<td>28 (44.4)</td>
<td>0.0659</td>
</tr>
</tbody>
</table>

Data are the number of subjects (percentage of the total group).

* Fisher’s exact test.
TABLE 3. Factors Associated with Each Type of PPA Classified According to PPA Bed Configuration

<table>
<thead>
<tr>
<th></th>
<th>Straight BM</th>
<th>Curved BM</th>
<th>BM Defect</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR</td>
<td>95% CI</td>
<td>P</td>
</tr>
<tr>
<td>Age</td>
<td>1.03</td>
<td>0.98-1.07</td>
<td>0.23</td>
</tr>
<tr>
<td>Women</td>
<td>0.49</td>
<td>0.19-1.24</td>
<td>0.13</td>
</tr>
<tr>
<td>Ref</td>
<td>1.43</td>
<td>1.09-1.87</td>
<td>0.009</td>
</tr>
<tr>
<td>Extent of PPA</td>
<td>0.52</td>
<td>0.20-1.35</td>
<td>0.18</td>
</tr>
<tr>
<td>IOP</td>
<td>1.06</td>
<td>0.93-1.21</td>
<td>0.40</td>
</tr>
<tr>
<td>Presenting POAG</td>
<td>0.36</td>
<td>0.14-0.93</td>
<td>0.054</td>
</tr>
<tr>
<td>Males</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ref</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extent of PPA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IOP</td>
<td></td>
<td></td>
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<tr>
<td>Presenting POAG</td>
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</tbody>
</table>

* Fisher’s exact test.

DISCUSSION

In a previous histologic study on PPA, Fantes and Anderson17 reported that misalignment of the end points of the sclera, choroid, and retina, in that order, from the optic disc edge was assumed to occur congenitally in eyes with an oblique exit canal in the optic nerve; and/or the misalignment could be caused by axial elongation due to myopia. They also indicated that, with this type of PPA, BM (and also the choriocapillaris) should always end at the same place as RPE. Strouthidis et al.30–32 investigated the optic disc margin anatomy within 3-D histomorphometric reconstructions of the monkey optic nerve head. They proposed the concept of the neural canal, which begins at the anatomic opening in BM, extends through a choroidal component bound on either side by the border tissue of Elschnig and the scleral component, and terminates where the optic nerve leaves the globe. They demonstrated that the border tissue orientation was commonly internally oblique and the disc margin was composed of the anatomic opening of BM. However, in some of the monkey eyes, border tissue orientation was externally oblique in the temporal half of the disc, in which the disc margin was composed of the innermost termination of border tissue (or the anterior scleral canal opening where visible). Since an extreme form of the latter orientation was visualized by SD-OCT in human myopic eyes corresponding with the region of PPA31,33 and was holding the characteristics of congenital misalignment of the sclera, choroid, and retina, the authors concluded that this orientation was due to the oblique exit of the neural canal in the myopic globe. Since BM-defect-type PPA in the present study was significantly associated with myopic refractive error and the myopic disc phenotype29 and since frequent disappearance of retinal layers before the optic disc edge matched the characteristic features of congenital misalignment, we concluded that the current SD-OCT appearance of the BM-defect-type PPA corresponds to the externally oblique border tissue previously proposed.30–32 Recently, Park et al.23 evaluated the SD-OCT B-scan images of temporal PPA-β in 24 eyes of 24 patients with glaucoma or suspected glaucoma. Although the patient’s refractive error was similar to that in our study, they found a somewhat higher prevalence of the externally oblique border tissue of Elschnig (83%) than that in the present study (60.7%). Since they analyzed five horizontal B-scans equally spaced within the vertical diameter of the optic disc, this discrepancy may be attributed to the different areas analyzed.

The histologic evidence on the acquired mechanisms of PPA development has shown that the thickening of the inner BM, abnormalities of the RPE basal lamina, and selective loss of rods observed within the area of PPA-β resemble the age-related degeneration found in the macula and periphery of normal eyes.18,19 In such acquired instances, the peripapillary choriocapillaris was reported to be less densely vascularized or absent when the RPE was completely lost, whereas the retinal photoreceptors were still partially present in histologic specimens of PPA-β.18,19 Kubota et al.19 suggested that the reduced choroidal blood flow in the parapapillary region leads first to damage of the RPE cells and later to photoreceptor loss. In the current SD-OCT findings, the high reflectivity of the PPA bed was observed in both straight-BM-type and curved-BM-type PPA, and these may correspond to the age-related thickening of BM.

The other interesting finding was that curved-BM-type PPA was significantly associated with the presence of POAG. In the current cross-sectional study, we were uncertain whether curved-BM-type PPA predisposes to the development of glaucoma or results from anatomic changes, such as choroidal thinning or the posterior mechanical stretching of the lamina cribrosa commonly found in glaucomatous eyes.34–36 To investigate possible roles of a curved-BM PPA bed configuration more closely in the pathogenesis of glaucoma, not only would a longitudinal SD-OCT observation of PPA-β be useful, but also an SD-OCT system using a light source that could penetrate...
more deeply to the choroid and sclera and could visualize the structure of the choriocapillaris, choroidal–scleral interface, and sclera.

The present study has several limitations. First, the prevalence of PPA-β in the general population was reportedly 20% or less,4,6,7 and therefore, the current prevalence rate of 65% may be considerably higher than is reported in the existing literature. The prevalence of PPA-β in the normal subjects who were recruited for our current study may be biased from that in the Japanese general population. Further, ethnic variations may be partly responsible for the differences in the prevalence of PPA-β between the current normal subjects and the general populations of other countries.4,5,7 Second, we analyzed the horizontal B-scan images of PPA-β only between the 8 and 10 o’clock positions in eyes in the relatively early stages of glaucoma (average MD, −6.5 dB) and therefore, the analyzed area may not correspond to the evident glaucomatous visual field damage. However, in recent studies, SD-OCT scans showed that both the macular ganglion cell complex and circumpapillary RNFL thickness were significantly reduced, even in the perimetrically normal hemifields of glaucomatous eyes.37–39 Considering that the perimetrically normal hemifields of glaucomatous eyes compared with those of normal eyes.37–39 Considering that the temporal RNFL thickness of current POAG eyes was significantly thinner than that of normal eyes (58.9 ± 15.8 μm vs. 83.2 ± 15.4 μm; P < 0.0001), structural changes associated with glaucoma is thought to be evident in the analyzed area.

Finally, a limitation of the present study is the artifacts associated with the OCT system: Where the tissue inclines against the object beam, reflected light is deflected from the reference beam; as a consequence, the light intensity that reaches the detector decreases, and the tissue reflectivity becomes lower than actual. According to this artifact, a curved BM line is relatively obscure compared with a straight BM line. Although such artifacts may be improved by using the newest generation of SD-OCT, only the current SD-OCT system (3D OCT-1000 version 2.13; Topcon Corporation) was available at the time of the present study, and interobserver reproducibility regarding the PPA subtype classification was almost perfect (Cohen κ = 0.82).

In conclusion, in the current cross-sectional study, we used SD-OCT to characterize the peripapillary cross-sectional structures of PPA-β in the temporal sector of the optic disc, especially those of the PPA bed, in vivo in glaucomatous and normal eyes. The lack of BM on the PPA bed correlated significantly with myopic refractive error and was thought to represent an oblique exit neural channel in a myopic globe. The downward-curved appearance of BM correlated significantly with the presence of POAG and may be related to peripapillary anatomic change in POAG. Histologic or pathogenetic associations among PPA, myopia, and glaucomatous optic neuropathy deserve further investigation.

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