

Myopia: Anatomy, Clinics and Aspects of its Etiology

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Financial Disclosures

- Patent holder with Biocompatibles UK Ltd. (Franham, Surrey, UK) (Title: Treatment of eye diseases using encapsulated cells encoding and secreting neuroprotective factor and / or anti-angiogenic factor; Patent number: 20120263794);
- Patent application: European patent application 16 720 043.5 and US patent application US 2019 0085065 A1 („Agents for use in the therapeutic or prophylactic treatment of myopia or hyperopia);
- Patent application: Agents for the use in the therapeutic or prophylactic treatment of retinal pigment epithelium associated diseases;

Definition: Myopic Retinopathy*

Category 0: No myopic retinal degenerative lesion

Category 1: Tessellated fundus

Category 2: Diffuse chorioretinal atrophy

Category 3: Patchy chorioretinal atrophy

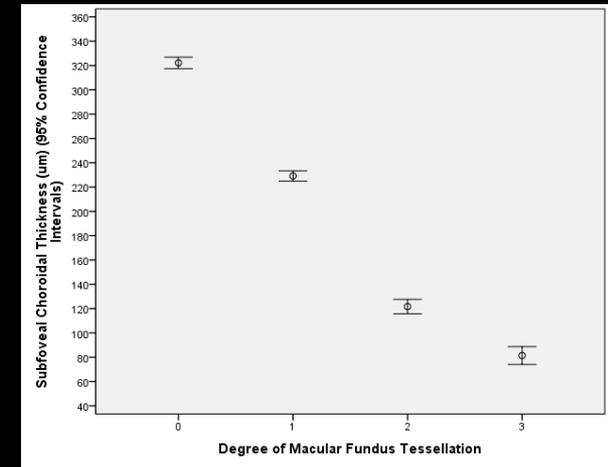
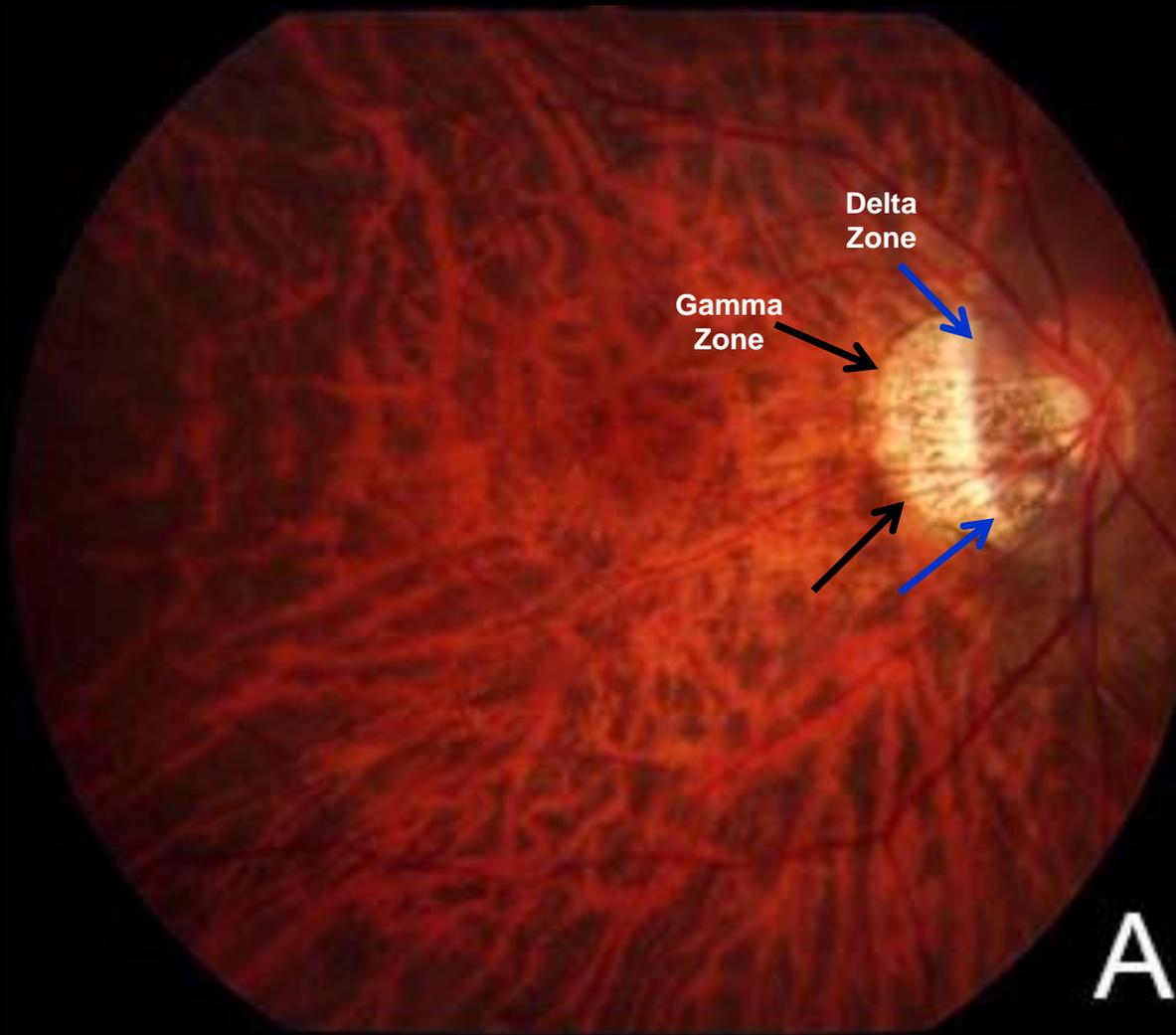
Category 4: Macular atrophy

Plus lesions:

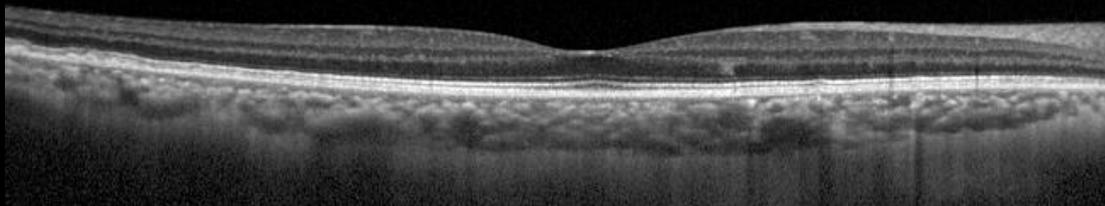
- Lacquer cracks,
- Myopic choroidal neovascularization
- Fuchs' spot
- (Posterior staphyloma)

*Ohno-Matsui K, Kawasaki R, Jonas JB, Gemmy-Cheung CM, Saw SM, Verhoeven V, Klaver C, Moriyama M, Shinohara K, Kawasaki Y, Yamazaki M, Meuer S, Ishibashi T, Yasuda M, Yamashita H, Sugano A, Wang JJ, Mitchell P, Wong TY, for the META-analysis for Pathologic Myopia (META-PM) Study Group. International classification and grading system for myopic maculopathy. Am J Ophthalmol. 2015;159:877-883.

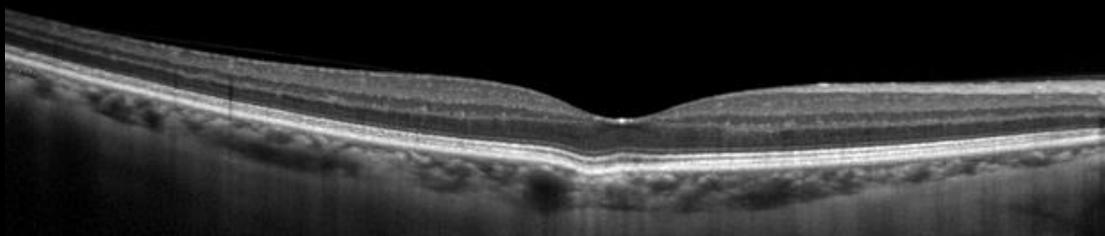
META-analysis for Pathologic Myopia (META-PM) Study Group, Myopic Retinopathy: Category 1: Tessellated Fundus



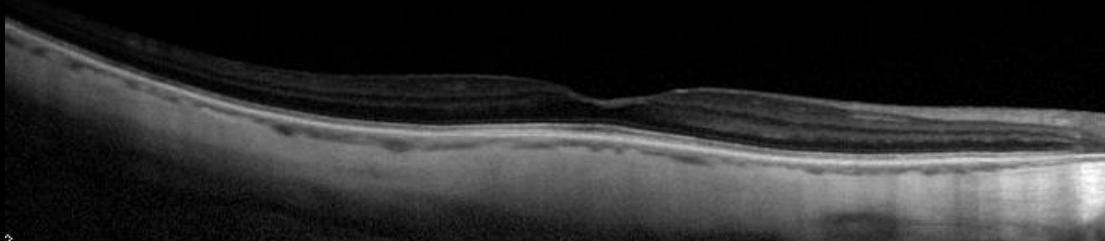
Beijing Eye Study: Choroidal Thickness



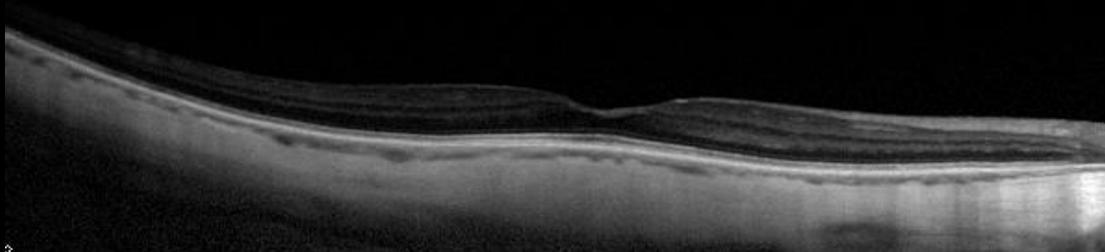
0 dpt; 55 years; 244 μm



-6.0 dpt; 56 years; 179 μm

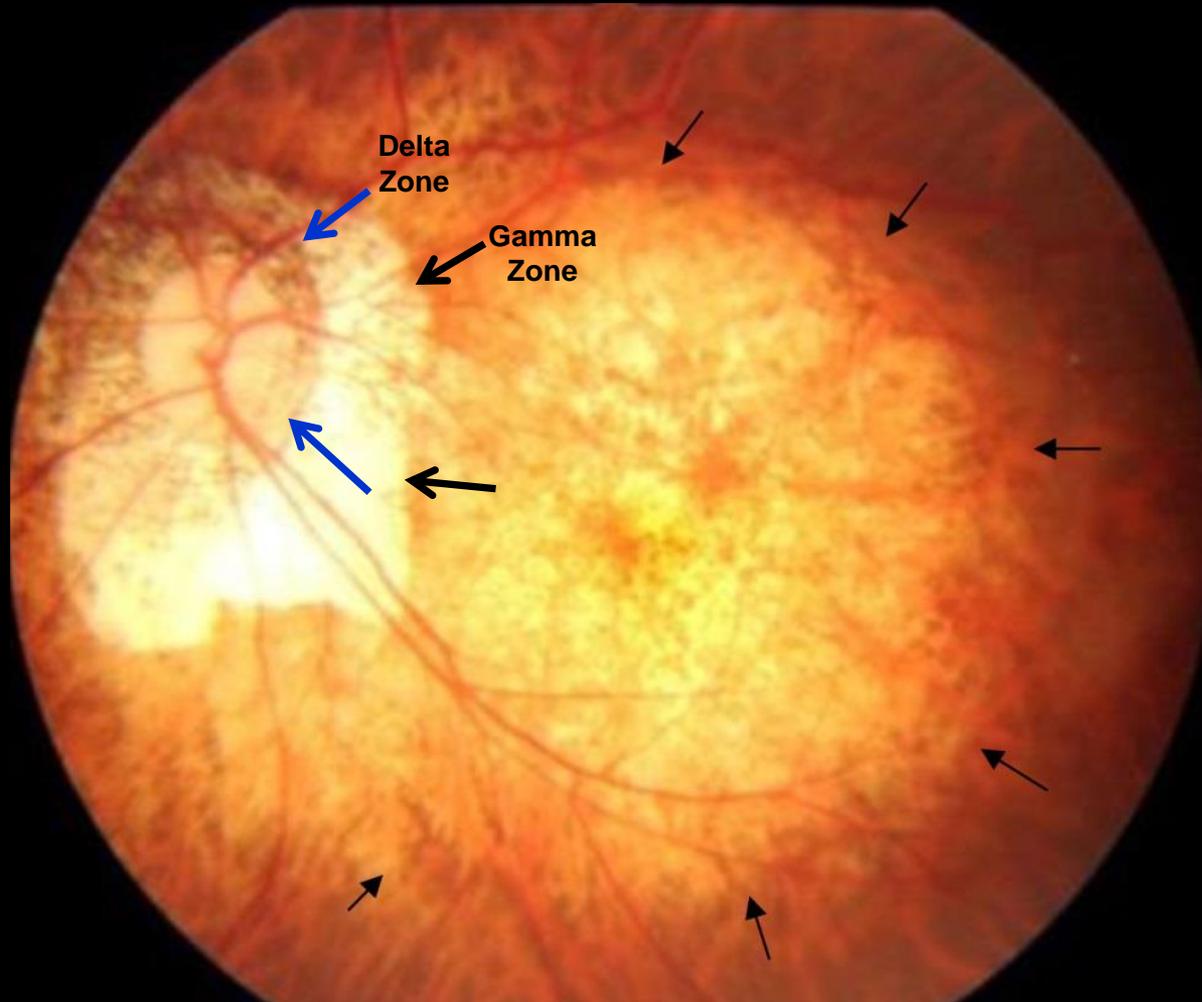


-9.5 dpt; 70 years; 57 μm



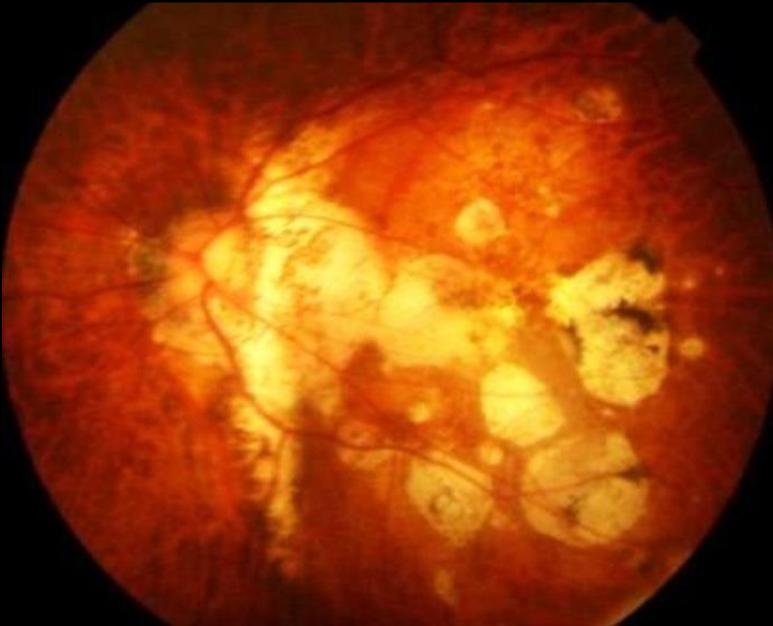
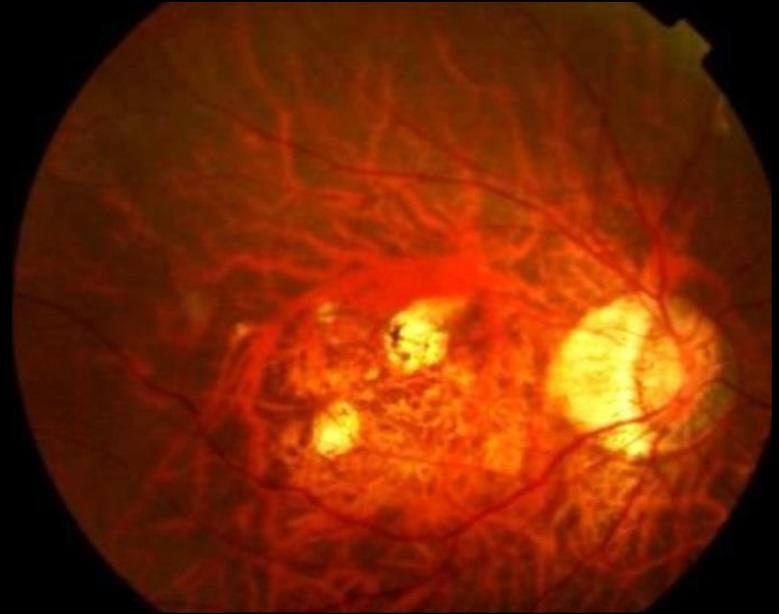
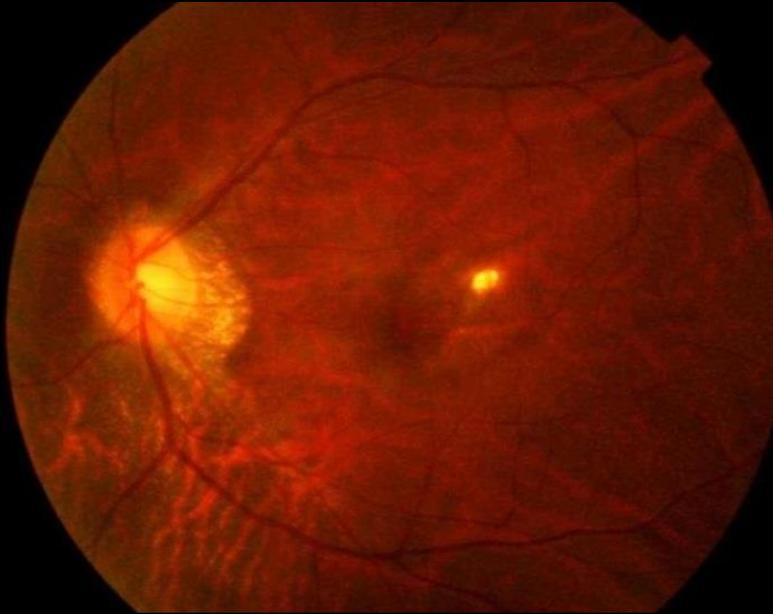
-19.0 dpt; 70 years; 8 μm

Myopic Retinopathy: Category 2: Diffuse Chorioretinal Atrophy

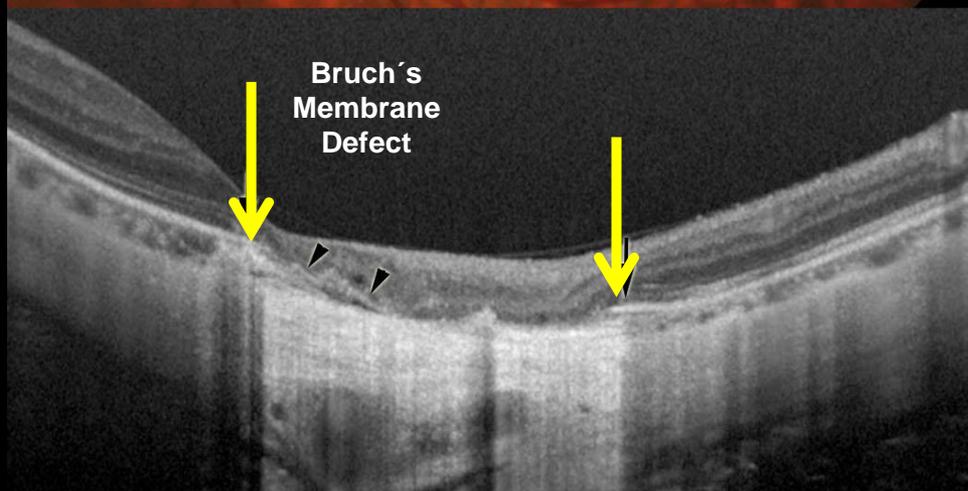
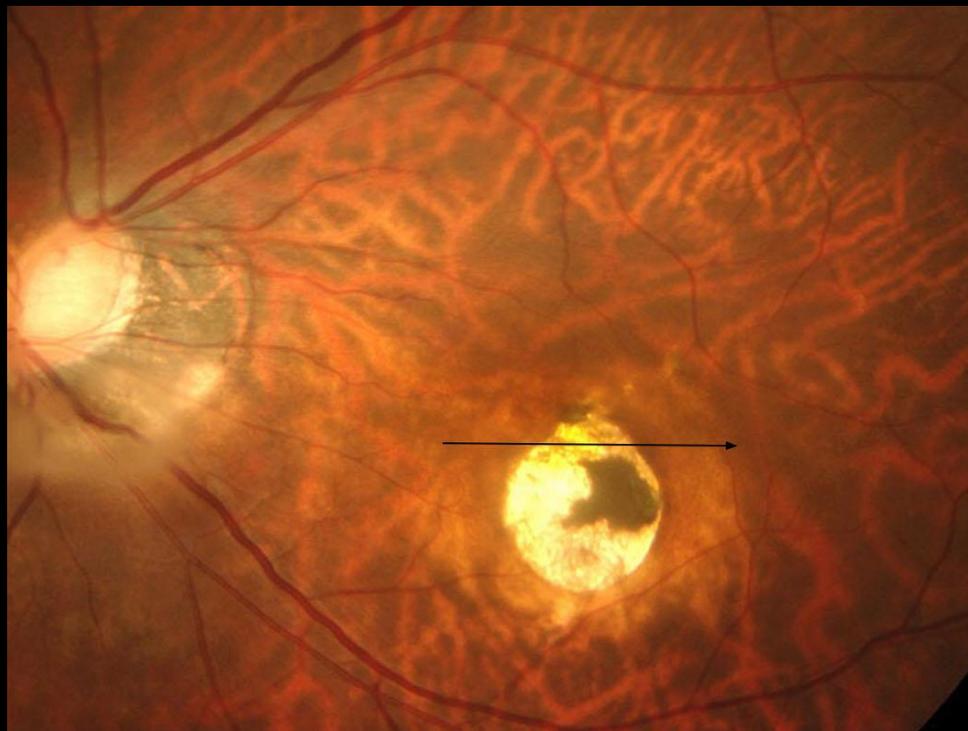


Ohno-Matsui K, Kawasaki R, Jonas JB, Gemmy-Cheung CM, Saw SM, Verhoeven V, Klaver C, Moriyama M, Shinohara K, Kawasaki Y, Yamazaki M, Meuer S, Ishibashi T, Yasuda M, Yamashita H, Sugano A, Wang JJ, Mitchell P, Wong TY, for the META-analysis for Pathologic Myopia (META-PM) Study Group. International classification and grading system for myopic maculopathy. *Am J Ophthalmol.* 2015;159:877-883.

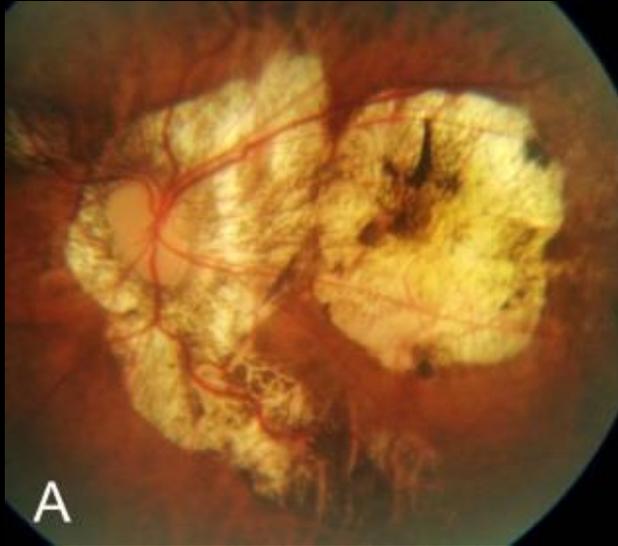
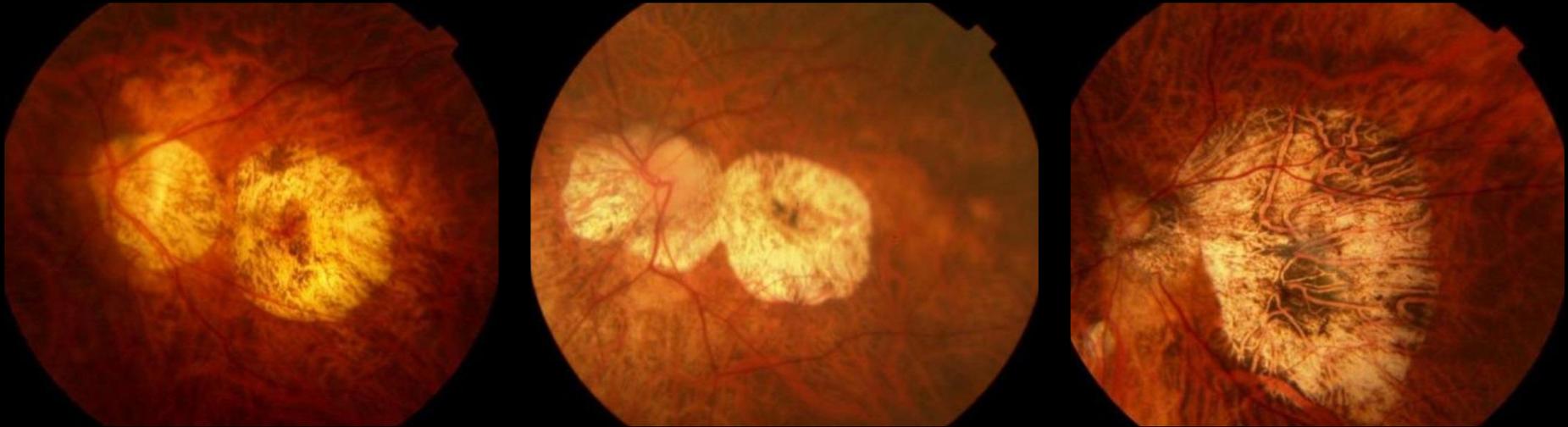
Myopic Retinopathy: Category 3: Patchy Chorioretinal Atrophy



Myopic Retinopathy: Category 3: Patchy Chorioretinal Atrophy



Myopic Retinopathy: Category 4: Macular Atrophy



A

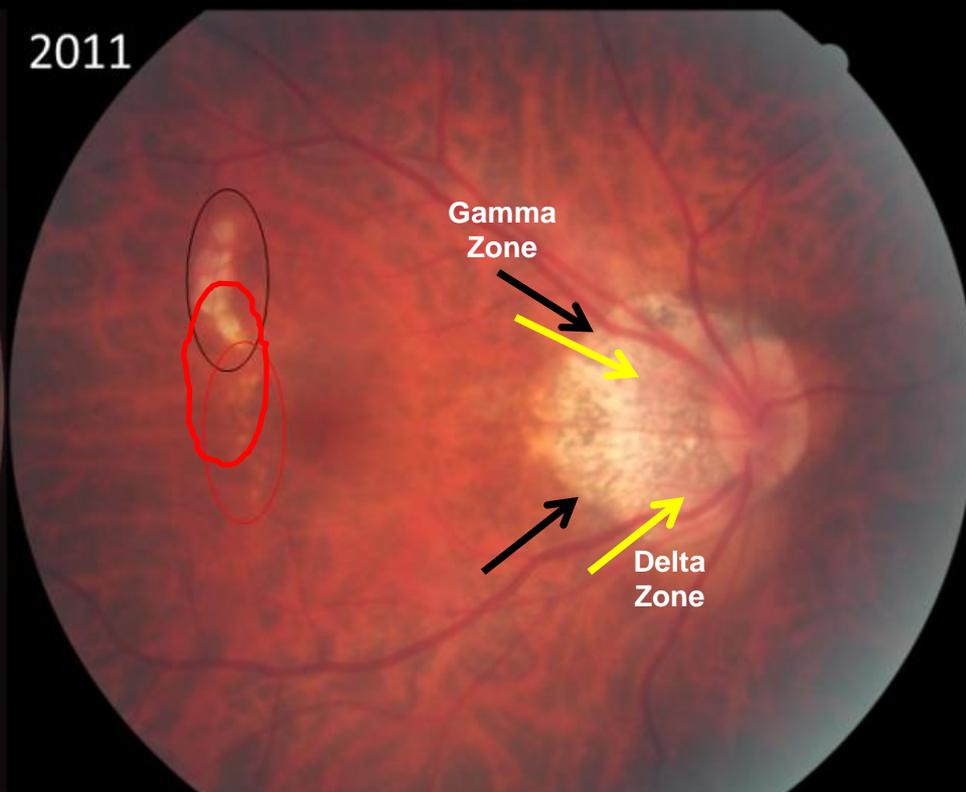
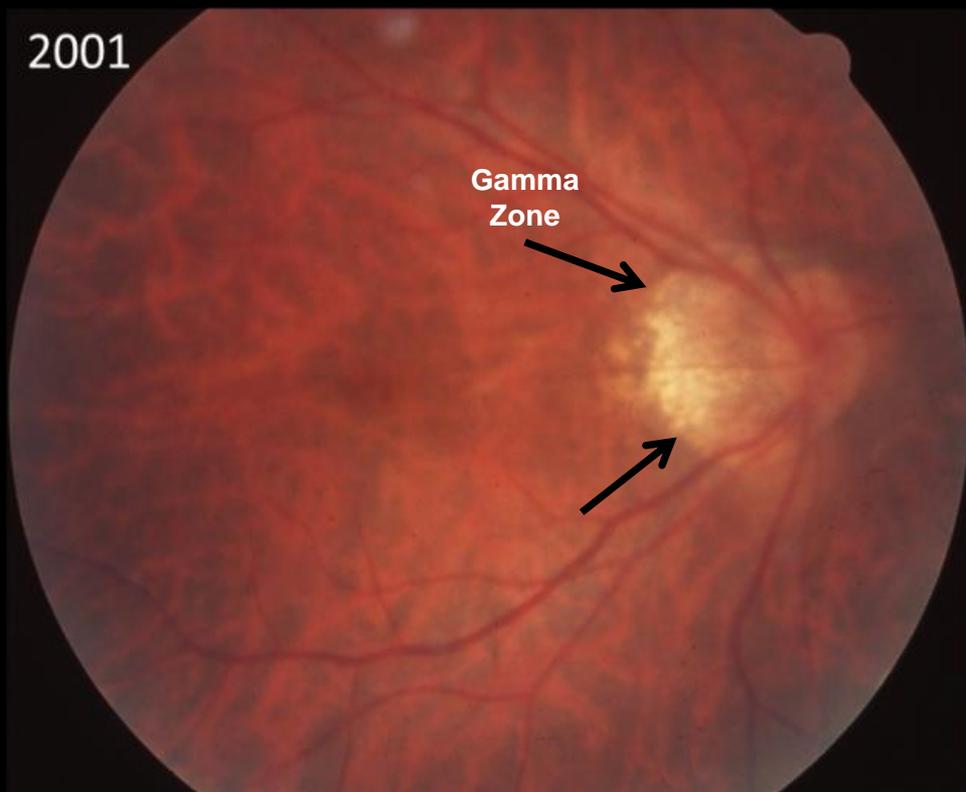


B

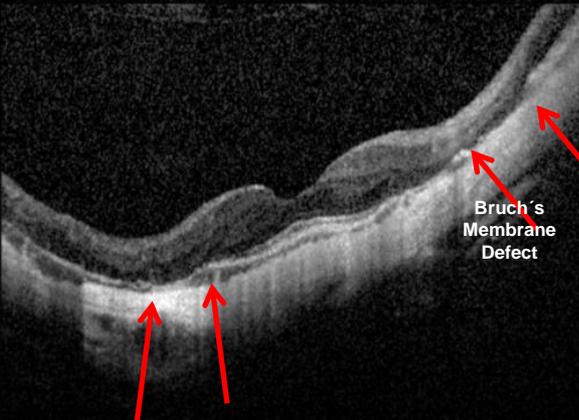
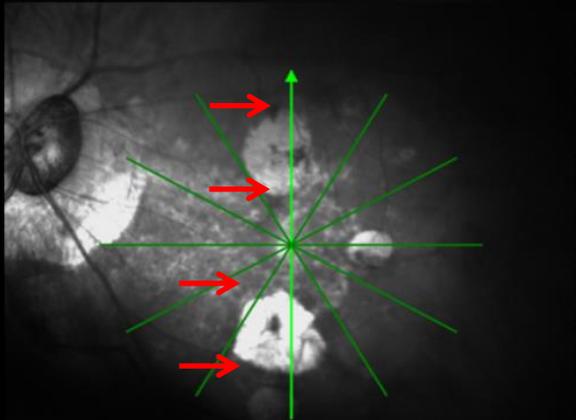
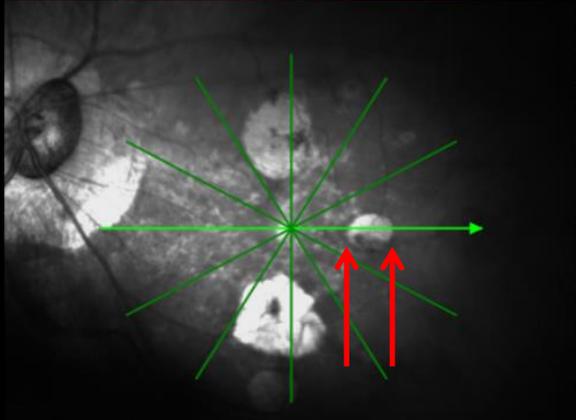
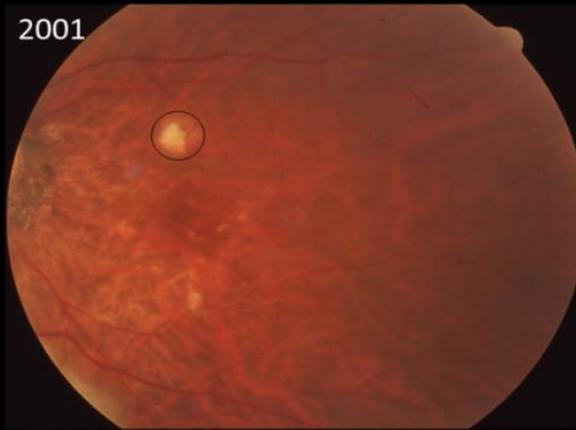
Category 5: Plus Lesions: Lacquer Cracks, CNV



Beijing Eye Study 2001 / 2011



Beijing Eye Study 2001 / 2011



Beijing Eye Study 2001 / 2011

- Out 4439 subjects in 2001, 2695 (66.4%) participants in 2011
- Out of 110 highly myopic eyes at baseline, 39 (35.5%) eyes showed progression:
- 15 (19%) of 79 eyes with tessellated fundus at baseline
- 17 (71%) of 24 eyes with diffuse chorioretinal atrophy
- All 6 (100%) eyes with patchy chorioretinal atrophy
- The one eye with macular atrophy at baseline.
- Lacquer cracks in 2 eyes developed into a small patchy atrophy (1 eye) or widened (one eye).
- Five eyes developed new lacquer cracks.

Prof. Kyoko Ohno-Matsui, Tokyo: Progression of Myopic Maculopathy During 18-Year Follow-Up

810 eyes of 432 patients (age: 42.3 ± 16.8 years; axial length: 28.8 ± 1.9 mm; mean follow-up: 18.7 ± 7.1 years).

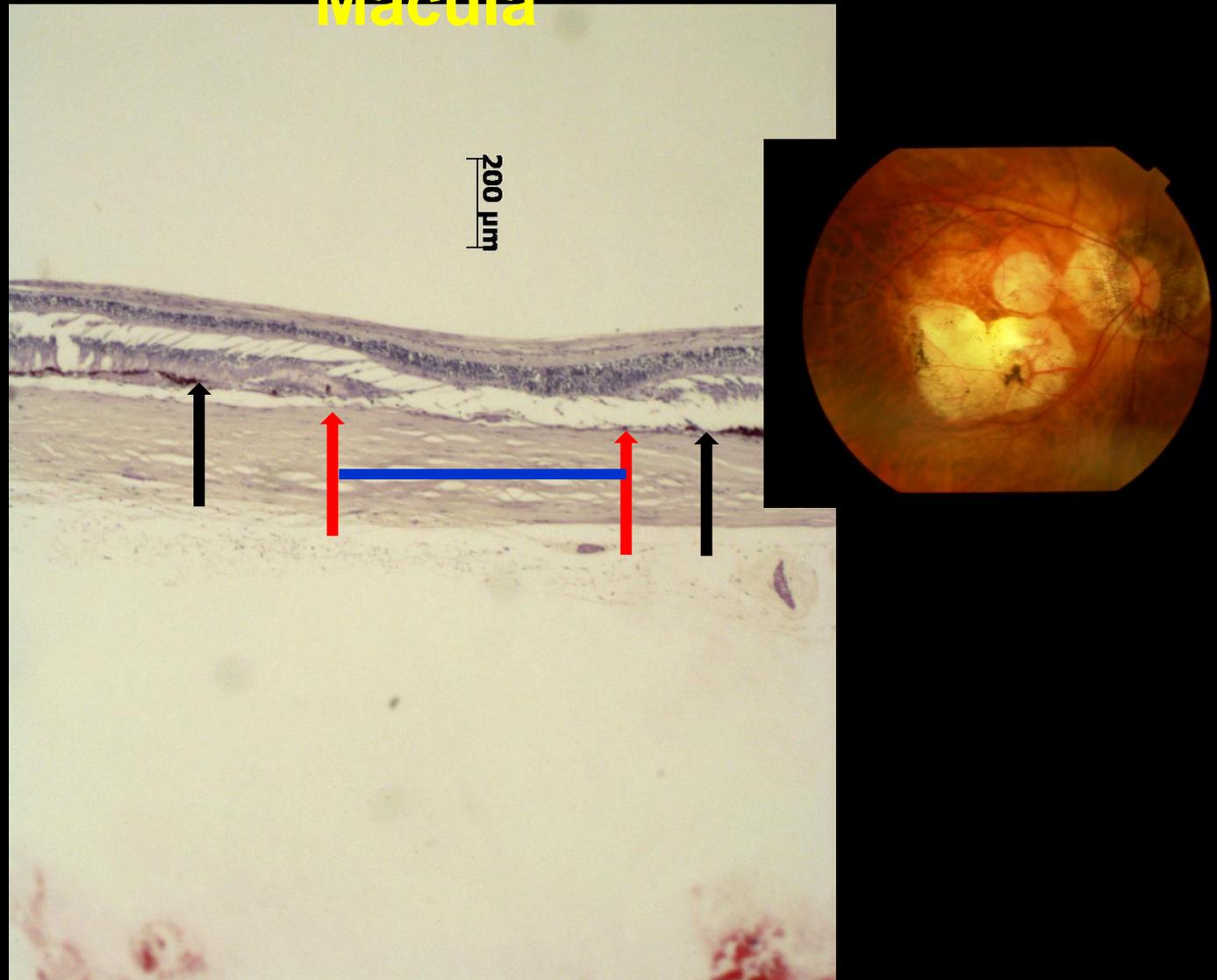
Within the pathologic myopia (PM) group (n=521 eyes), progression of myopic maculopathy was associated with:

- Female gender (OR: 2.21; $P=0.001$),
- Older age (OR: 1.03; $P=0.002$),
- Longer axial length (OR: 1.20; $P=0.007$),
- Greater axial elongation (OR: 1.45; $P=0.005$), and
- Development or enlargement of parapapillary atrophy (OR: 3.14; $P<0.001$).

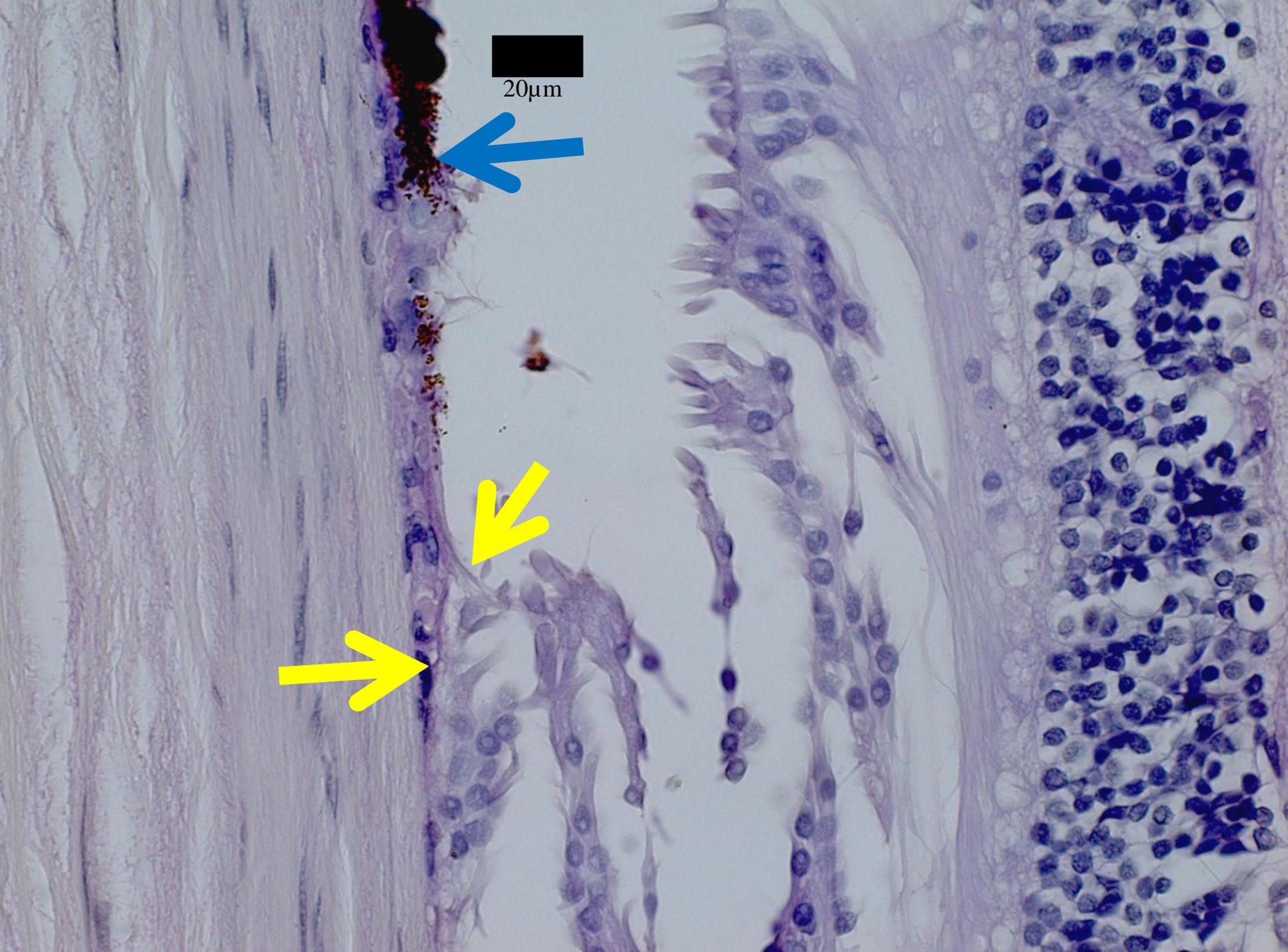
Myopic Maculopathy, Histology



Bruch's Membrane Defect in the Highly Myopic Macula



Black arrows: end of RPE; Red arrows: end of BM; Blue line: region without BM



20μm



Primary Macrodiscs Versus Secondary Macrodiscs



- Jonas JB, Gusek GC, Naumann GOH. Optic disk morphometry in high myopia. *Graefes Arch Clin Exp Ophthalmol* 1988; 226: 587-590
- Xu L, Li Y, Wang S, Wang Y, Wang Y, Jonas JB. Characteristics of highly myopic eyes. *The Beijing Eye Study. Ophthalmology* 2007;114:121-6.

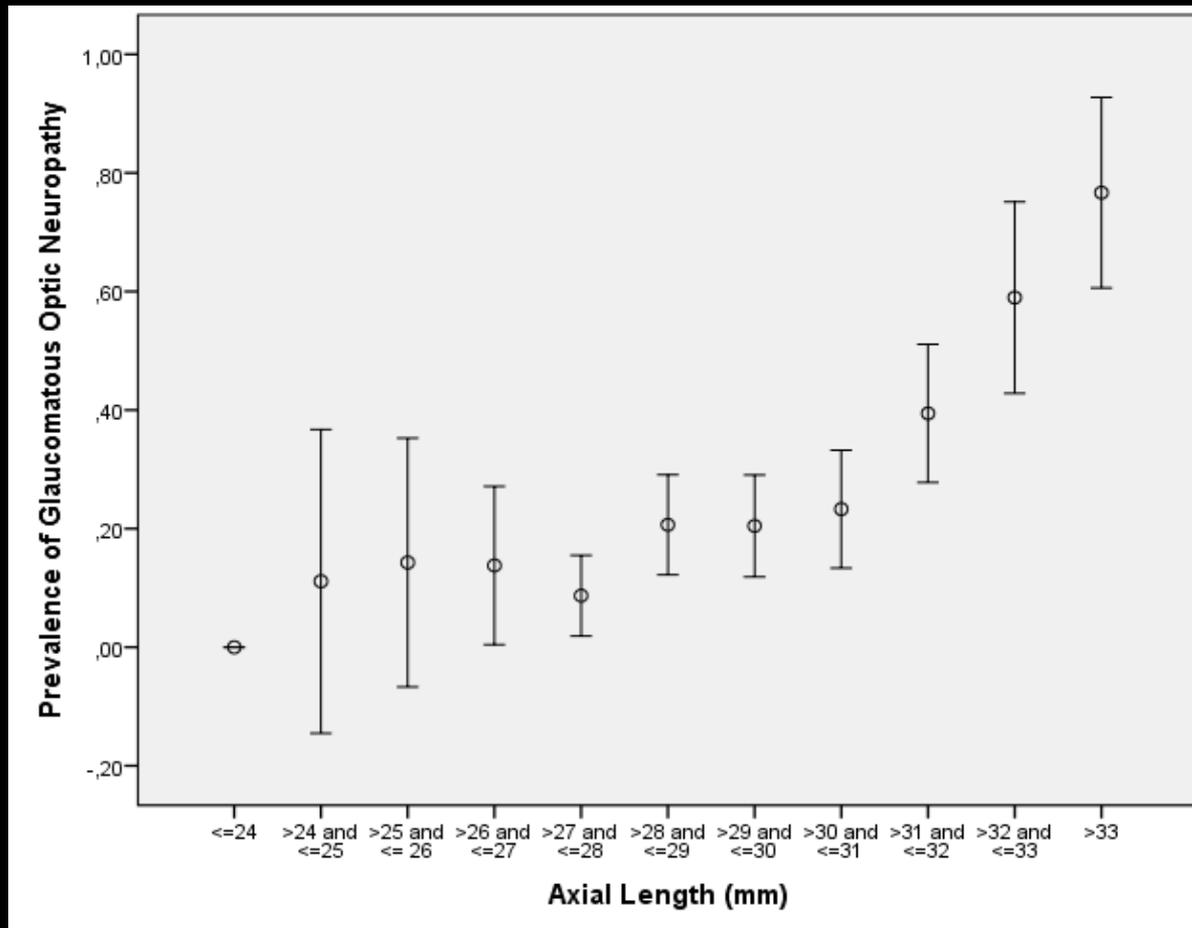
Beijing Eye Study: High Myopia and Glaucoma*

- Glaucoma prevalence higher ($p=0.001$) in marked or high myopia (>-6 dpt) than in moderate myopia, low myopia, emmetropia, and hyperopia



High Myopia and Glaucoma

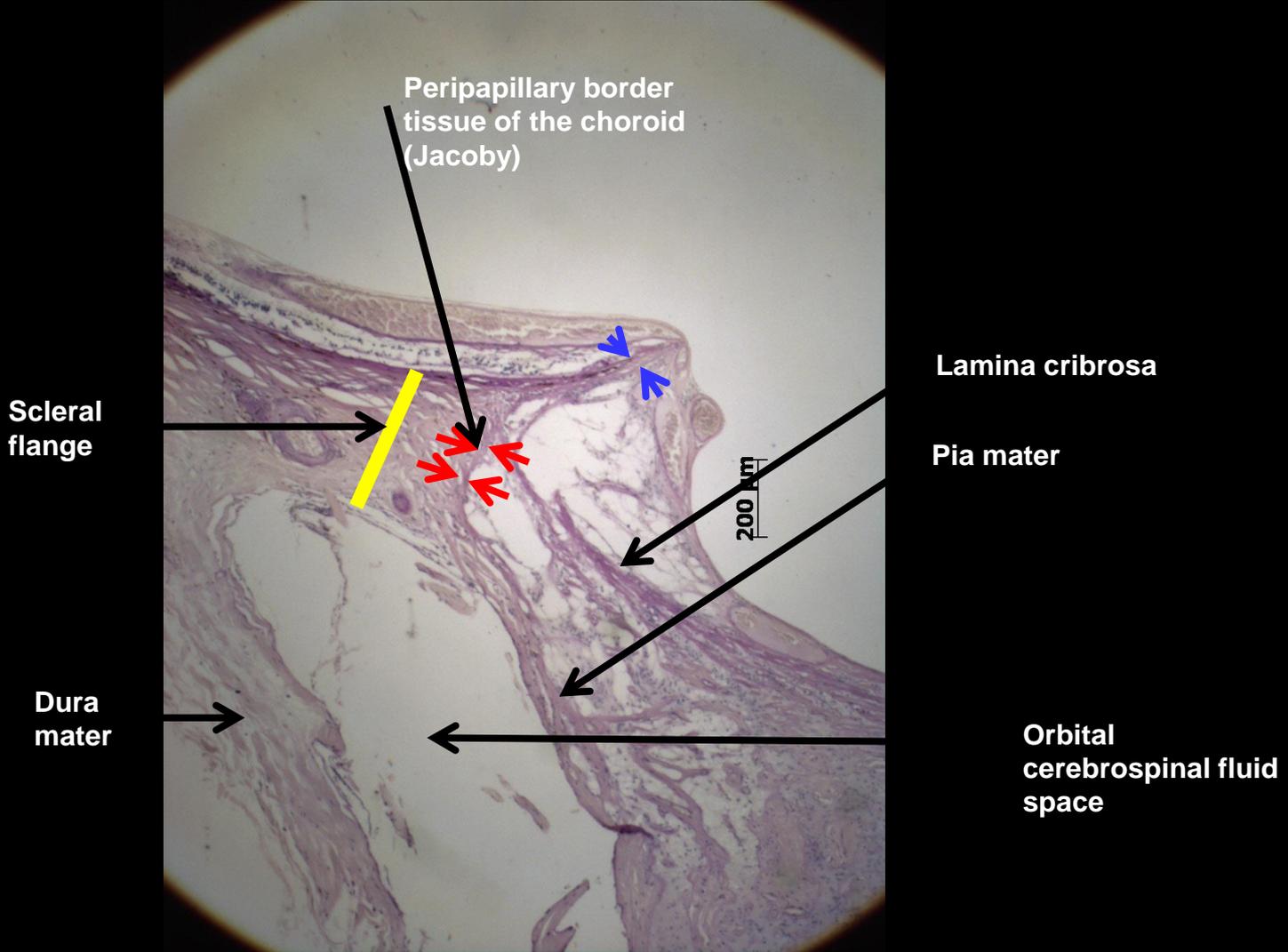
- Glaucomatous optic neuropathy was present in 141 (27.2%). increased from 12.2% in axial length $<26.5\text{mm}$ to 42.1% in axial length $\geq 30\text{mm}$



Histological Changes in the Optic Head in Highly Myopic Glaucoma



Jonas JB, Berenshtein E, Holbach L. Lamina cribrosa thickness and spatial relationships between intraocular space and cerebrospinal fluid space in highly myopic eyes. *Invest Ophthalmol Vis Sci* 2004; 45: 2660-2665



Peripapillary border
tissue of the choroid
(Jacoby)

Scleral
flange

Dura
mater

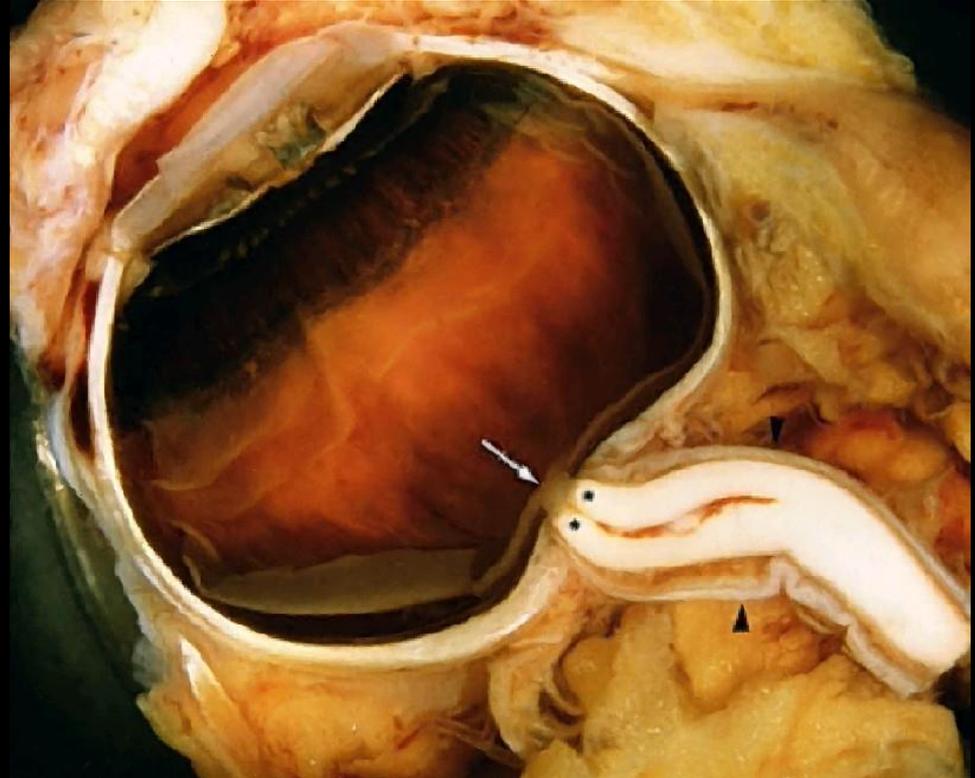
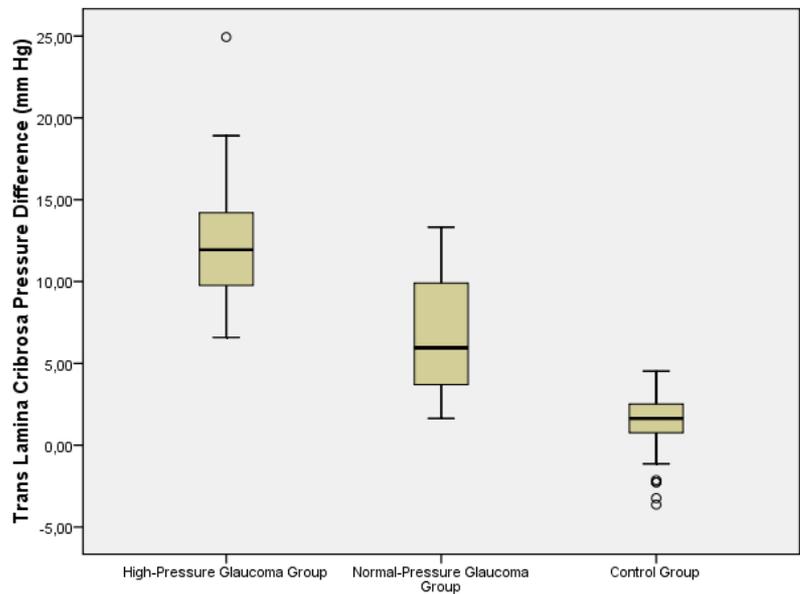
Lamina cribrosa

Pia mater

Orbital
cerebrospinal fluid
space

200 μm

Cerebrospinal Fluid Pressure: Component in Normal-Pressure Glaucoma?*



-Ren R, Jonas JB, Tian G, Zhen Y, Ma K, Li S, Wang H, Li B, Zhang X, Wang N. Cerebrospinal fluid pressure in glaucoma. A prospective study. *Ophthalmology* 2010;117:259-266

-Jonas JB. Role of cerebrospinal fluid pressure in the pathogenesis of glaucoma. *Acta Ophthalmol* 2011;89:505-514.

-Ren R, Zhang X, Wang N, Li B, Tian G, Jonas JB. Cerebrospinal fluid pressure in ocular hypertension. *Acta Ophthalmol* 2011;89:E142-E148

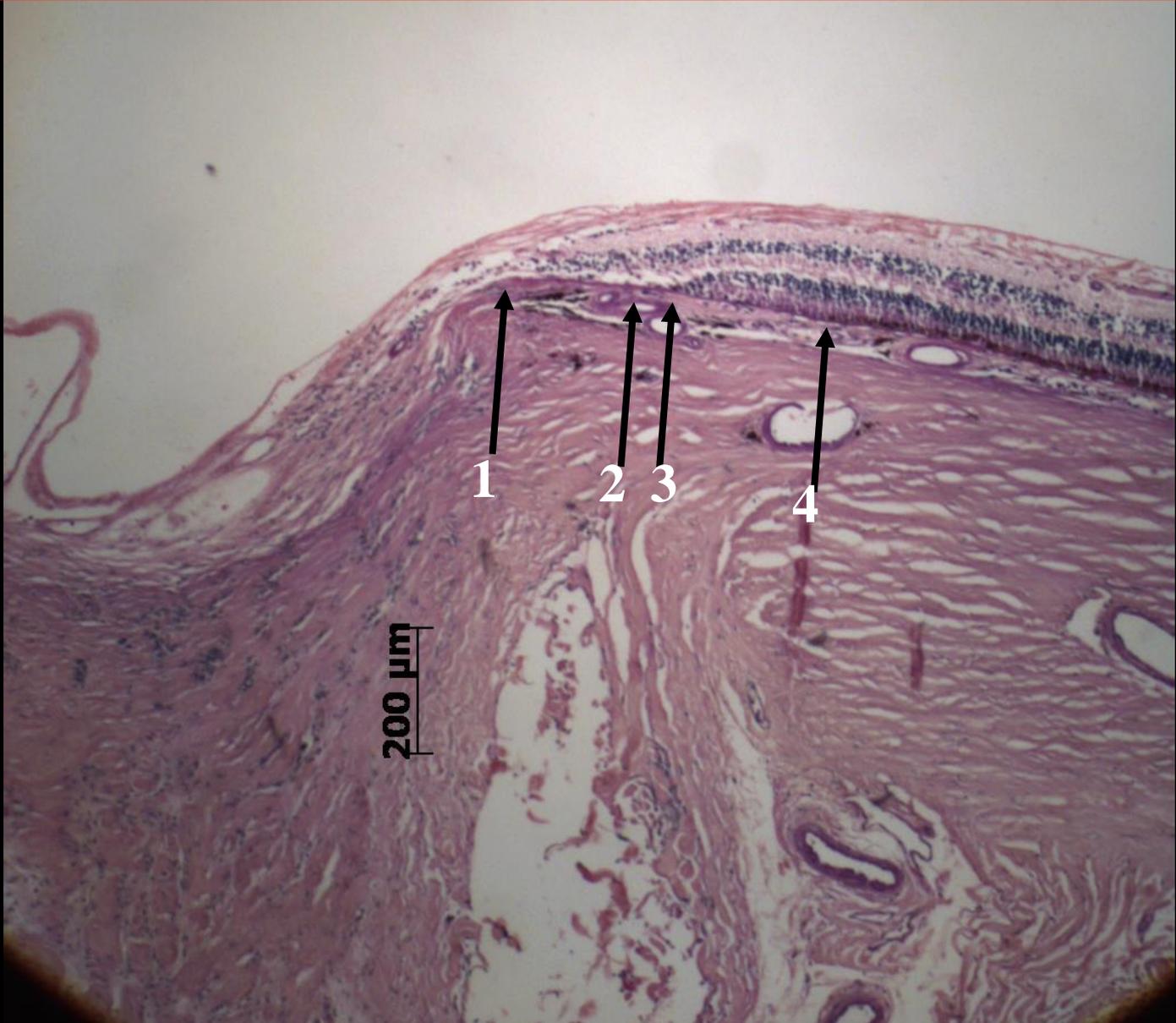
- Ren R, Wang NL, Zhang X, Tian G, Jonas JB. Cerebrospinal fluid pressure correlated with body mass index. *Graefes Arch Clin Exp Ophthalmol* 2012;250:445-446

- Jonas JB, Wang NL. Association between arterial blood pressure, cerebrospinal fluid pressure and intraocular pressure in the pathophysiology of optic nerve head diseases. *Clin Exp Ophthalmol* 2012;40:e233-234

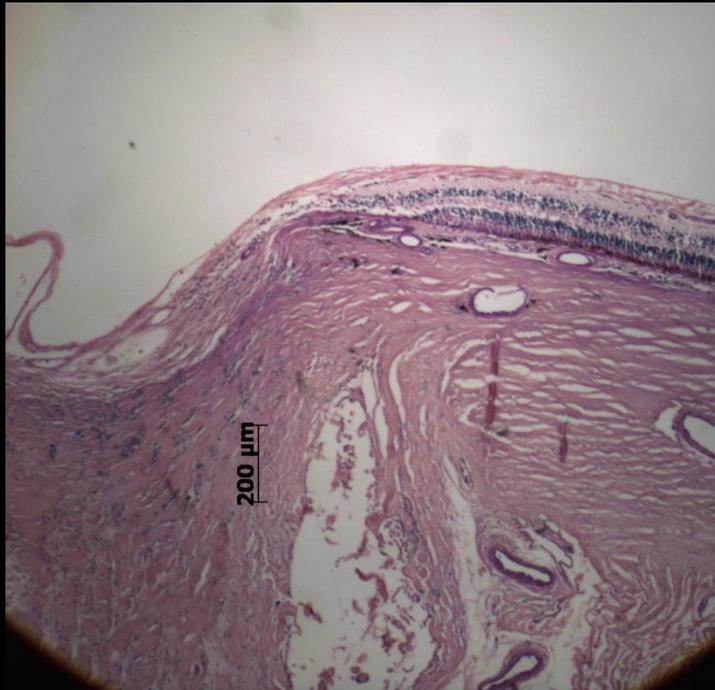
- Xu L, Wang YX, Wang S, Jonas JB. Neuroretinal rim area and body mass index. *PLoS One*. 2012;7:e30104.

- Wang N, Xie X, Yang D, Xian J, Li Y, Ren R, Wang H, Zhang S, Kang Z, Peng X, Sang J, Zhang Z, Jonas JB, Weinreb RN. Orbital cerebrospinal fluid space in glaucoma. *Ophthalmology*. 2012 Oct;119(10):2065-2073.e1

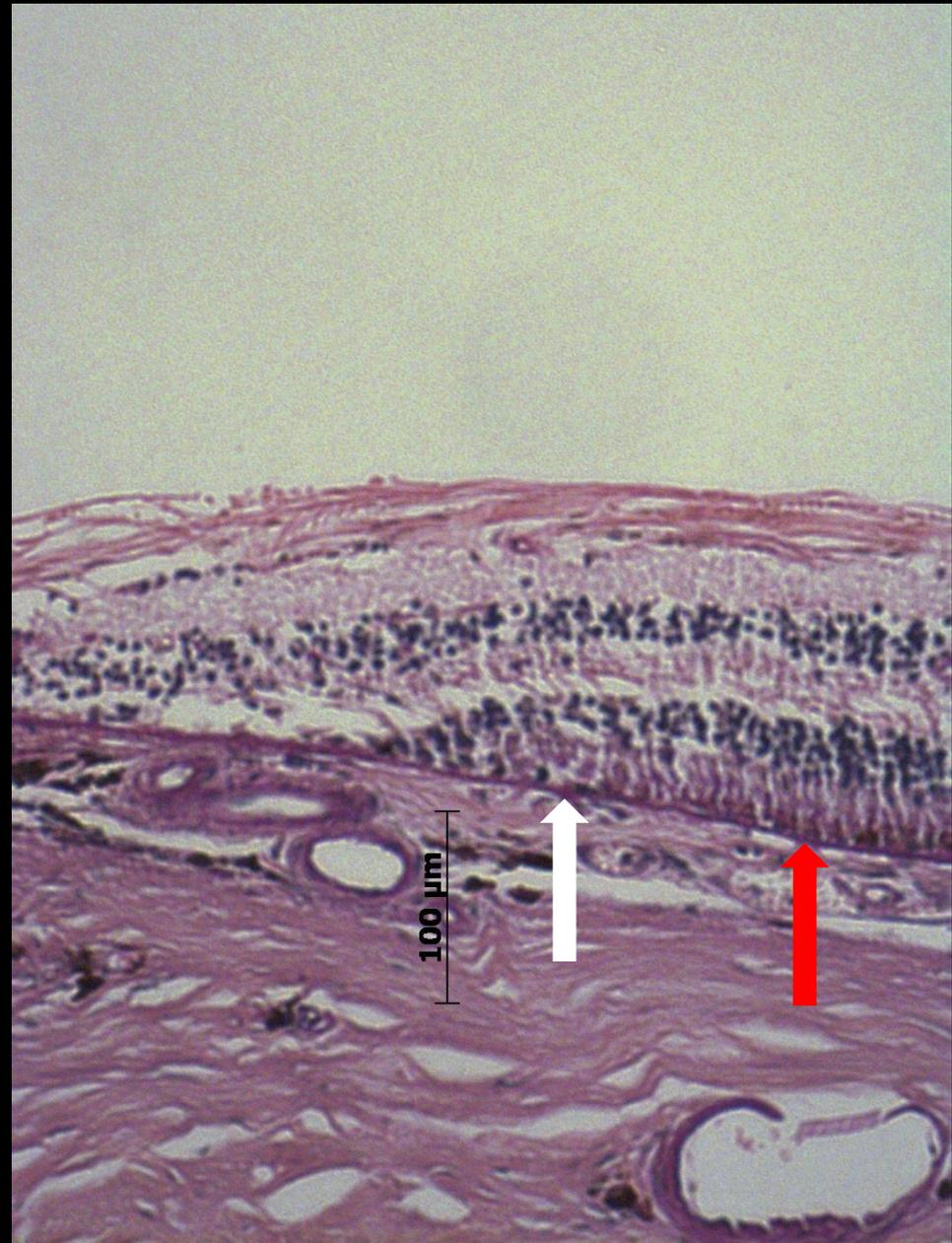
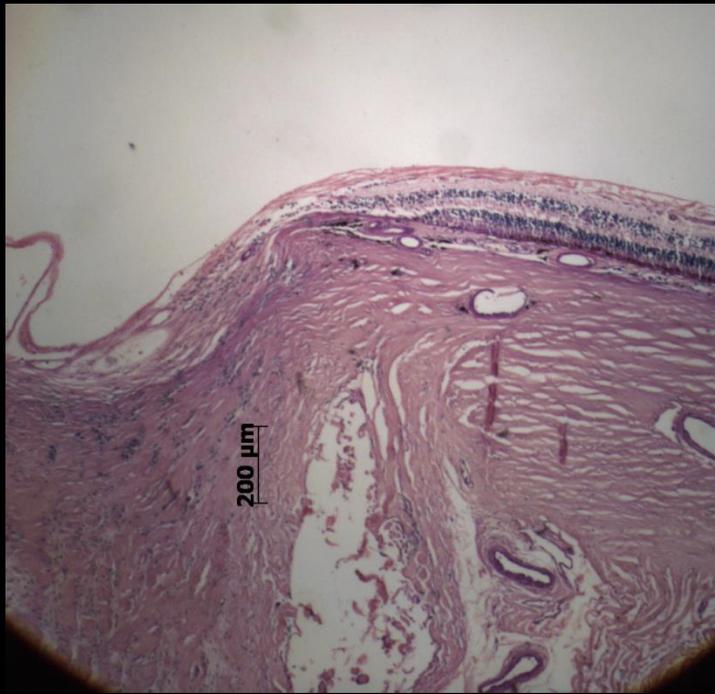
Alpha and Beta Zone of Parapapillary Region



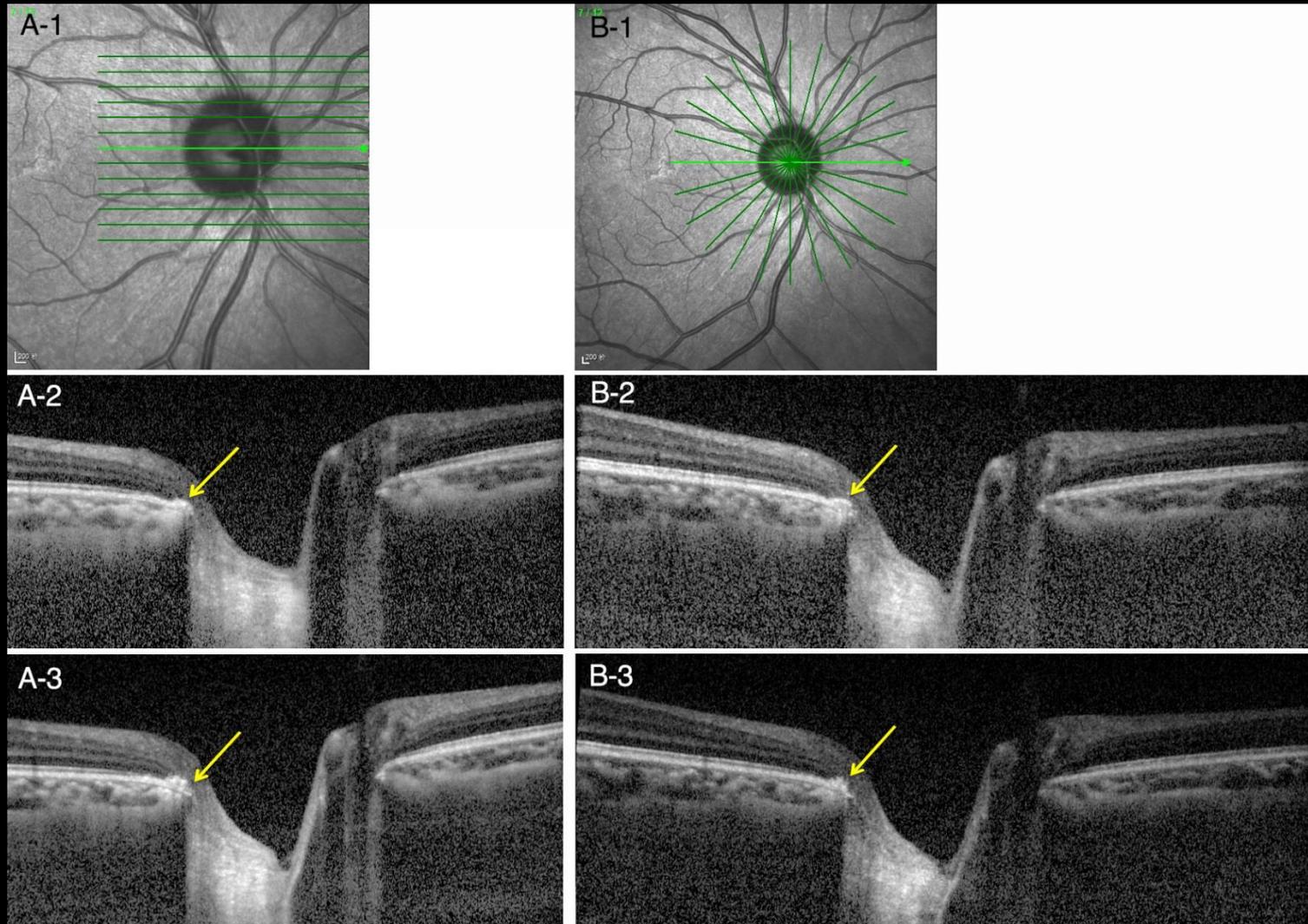
Alpha and Beta Zone of Parapapillary Region



Alpha and Beta Zone of Parapapillary Region

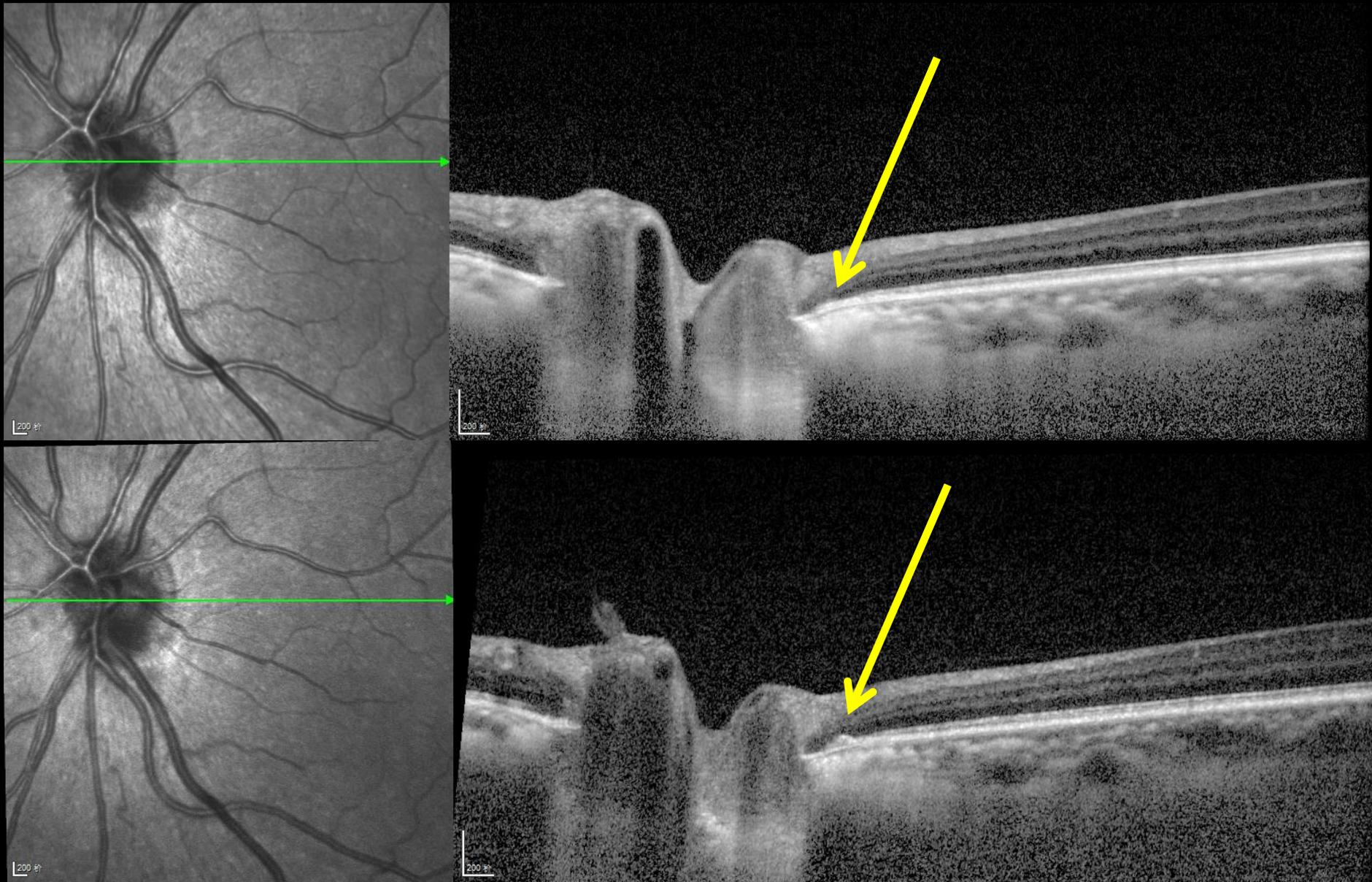


Dark Room Adaptation Test with IOP Rise from 22 mmHg to 50 mmHg



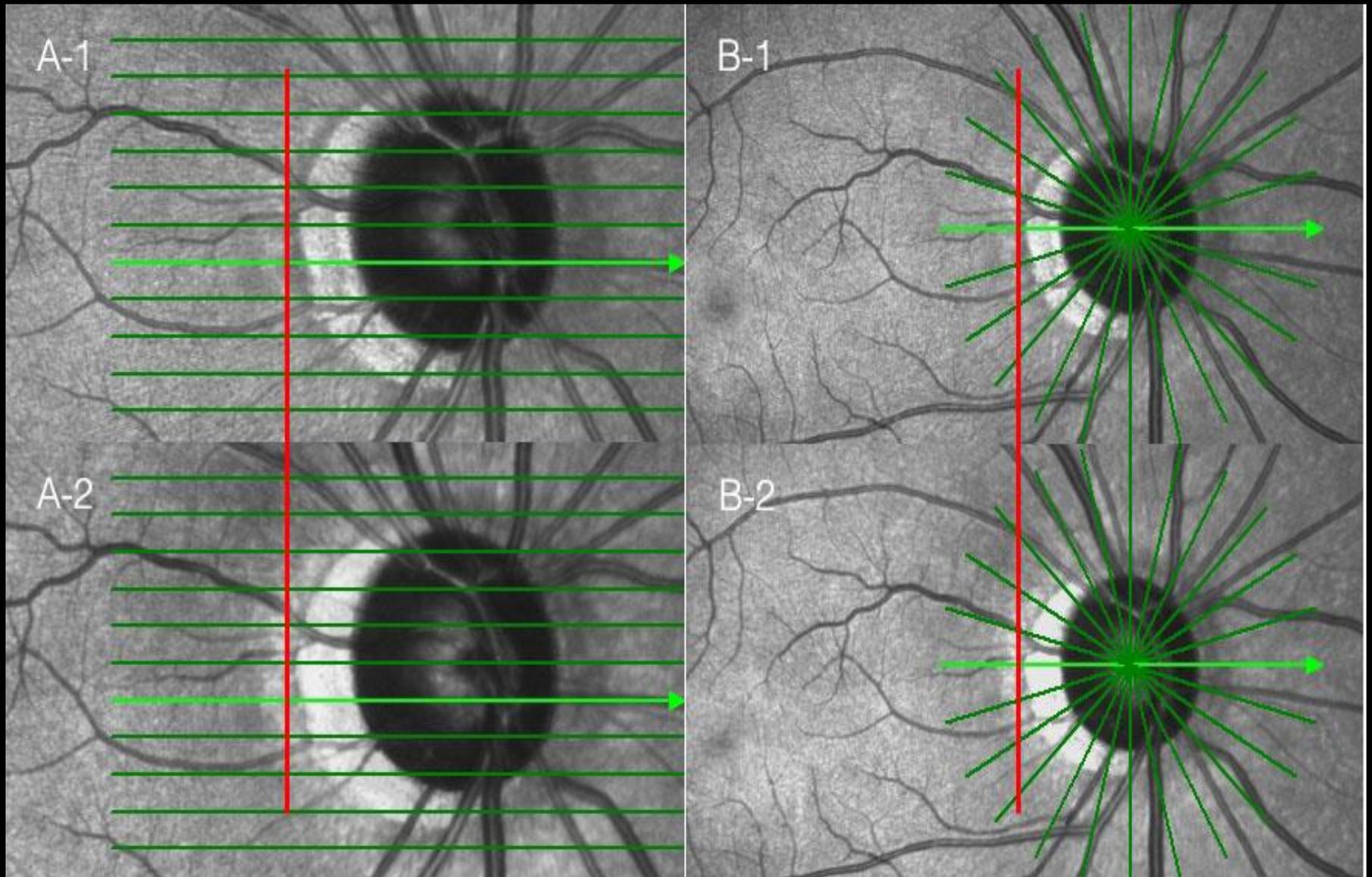
Wang YX, Jiang R, Wang NL, Xu L, Jonas JB. Acute peripapillary retinal pigment epithelium changes associated with acute intraocular pressure elevation. *Ophthalmology* 2015; In Print

Dark Room Adaptation Test with IOP Rise



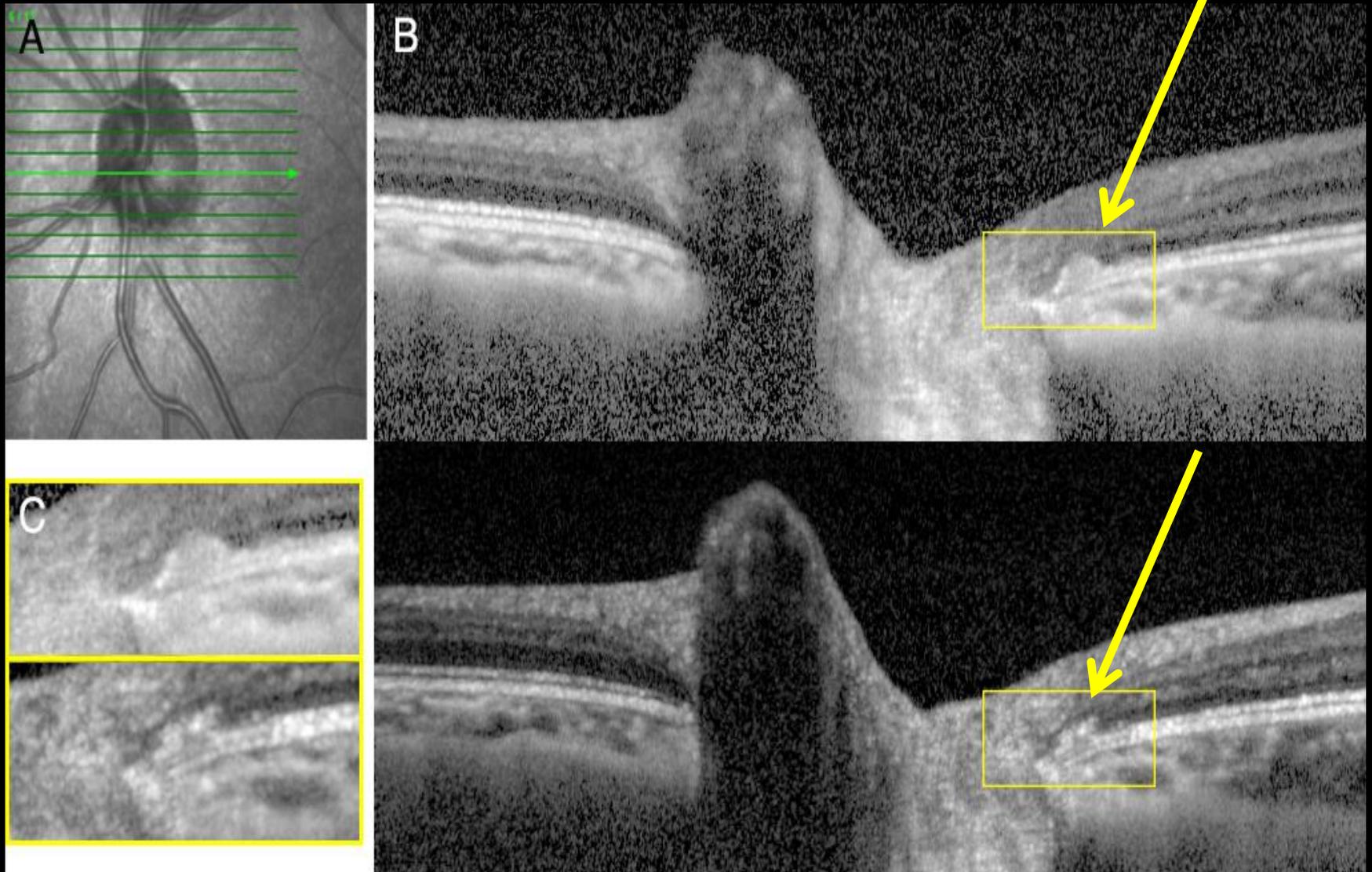
Wang YX, Jiang R, Wang NL, Xu L, Jonas JB. Acute peripapillary retinal pigment epithelium changes associated with acute intraocular pressure elevation. *Ophthalmology* 2015; In Print

Dark Room Adaptation Test with IOP Rise from 13 mmHg to 47 mmHg



Wang YX, Jiang R, Wang NL, Xu L, Jonas JB. Acute peripapillary retinal pigment epithelium changes associated with acute intraocular pressure elevation. *Ophthalmology* 2015; In Print

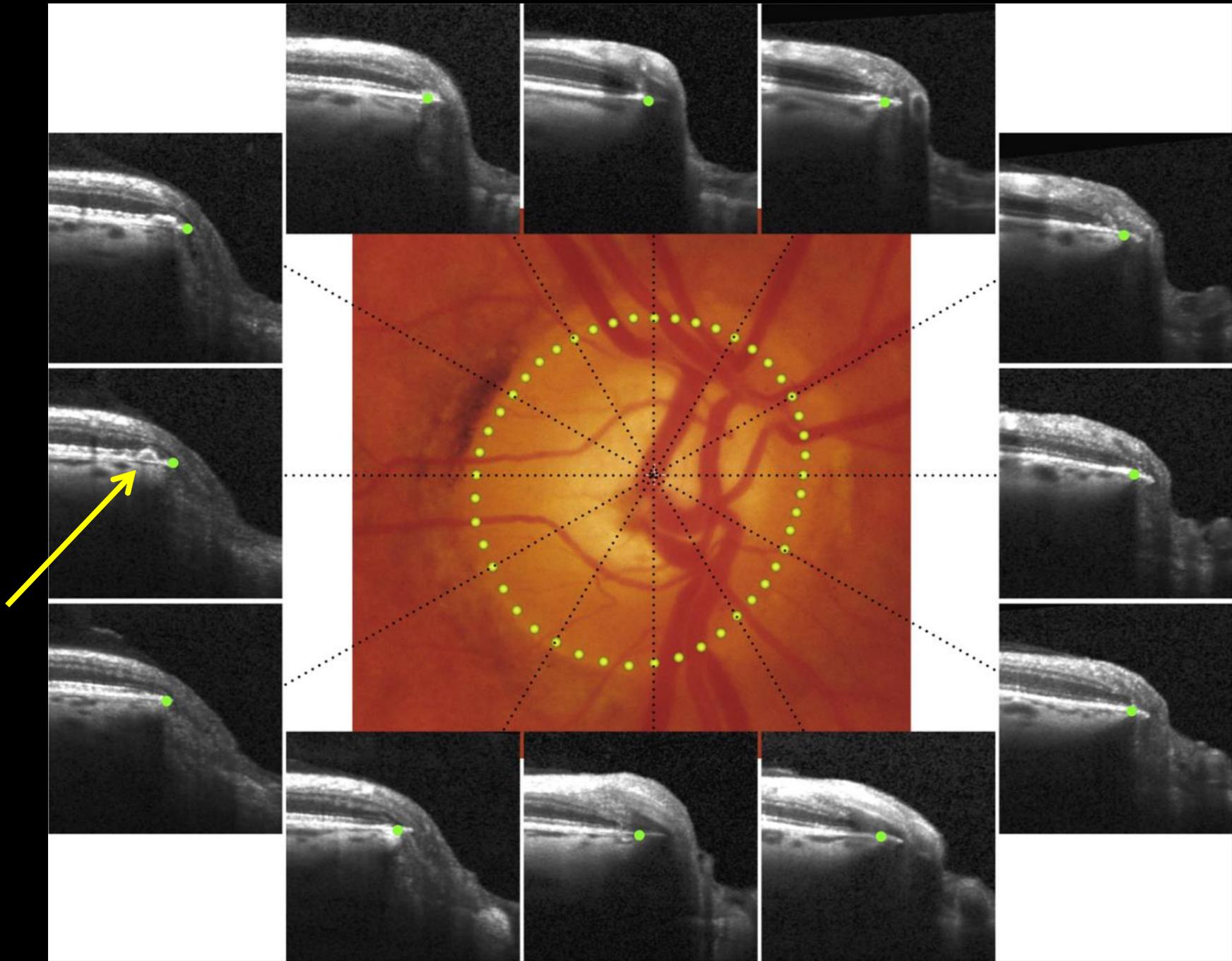
Dark Room Adaptation Test with IOP Drop from 57 mmHg to 17 mmHg



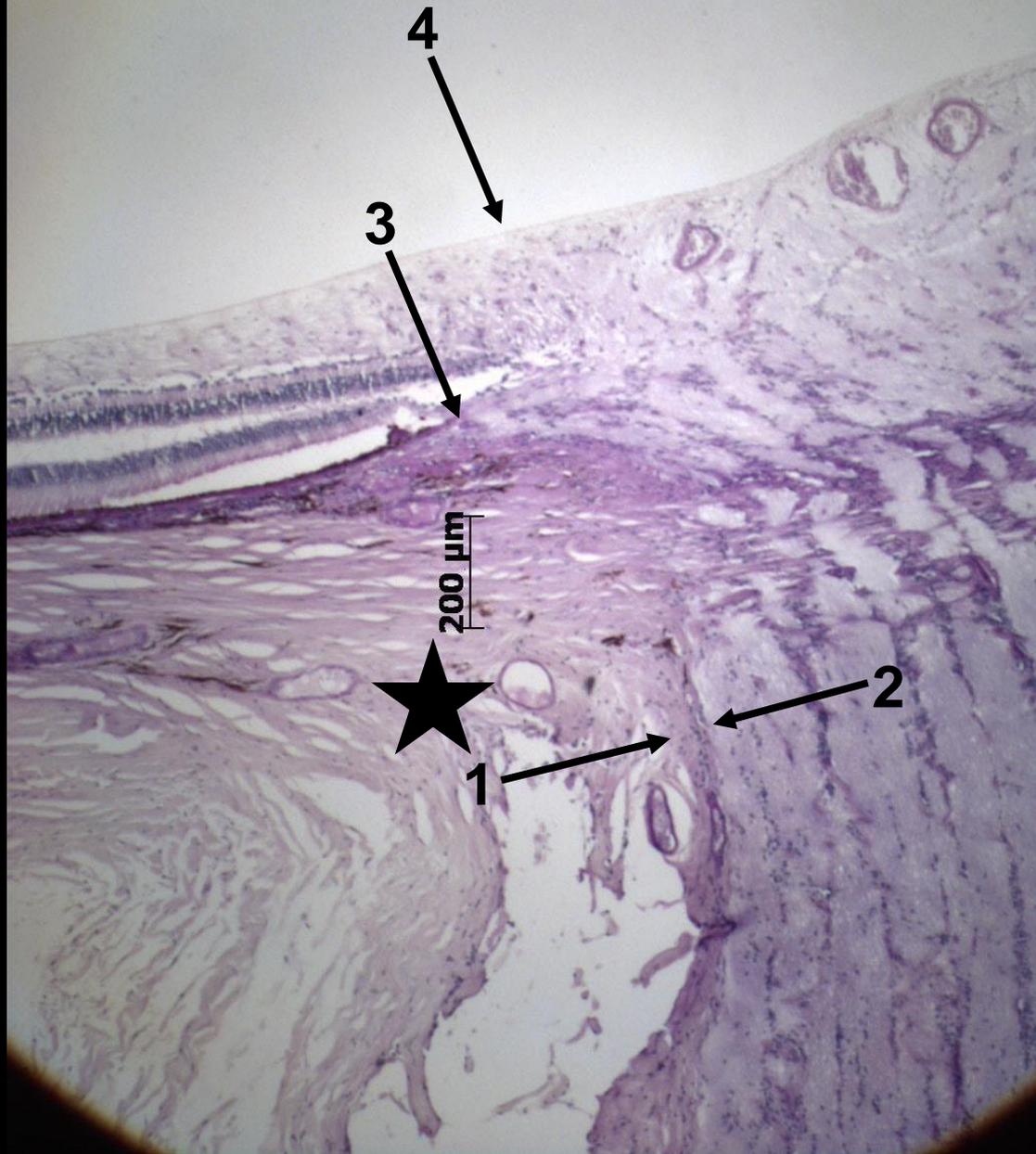
Wang YX, Jiang R, Wang NL, Xu L, Jonas JB. Acute peripapillary retinal pigment epithelium changes associated with acute intraocular pressure elevation. *Ophthalmology* 2015; In Print

Parapapillary Drusen of the RPE

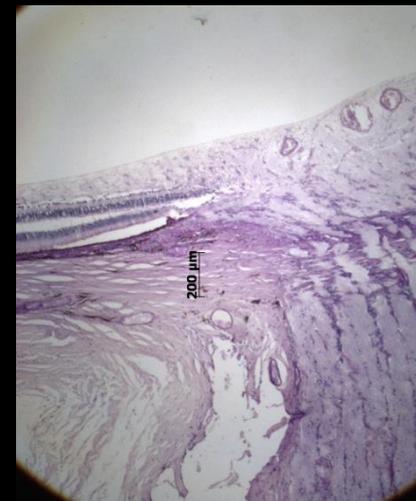
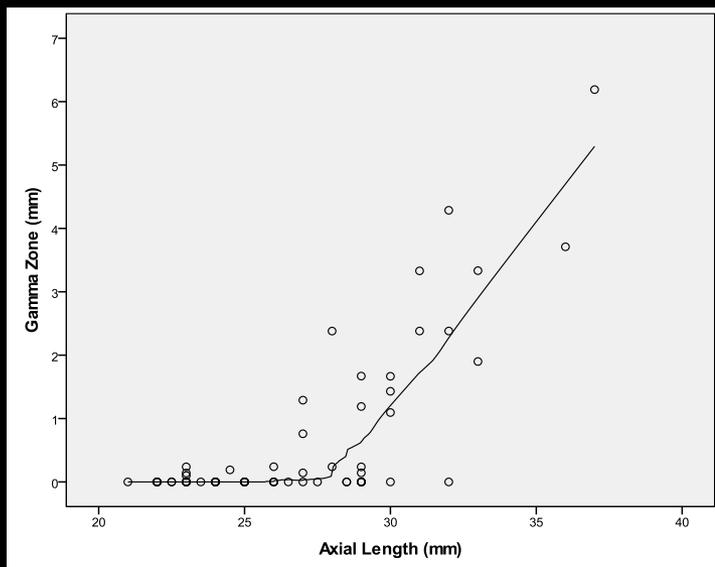
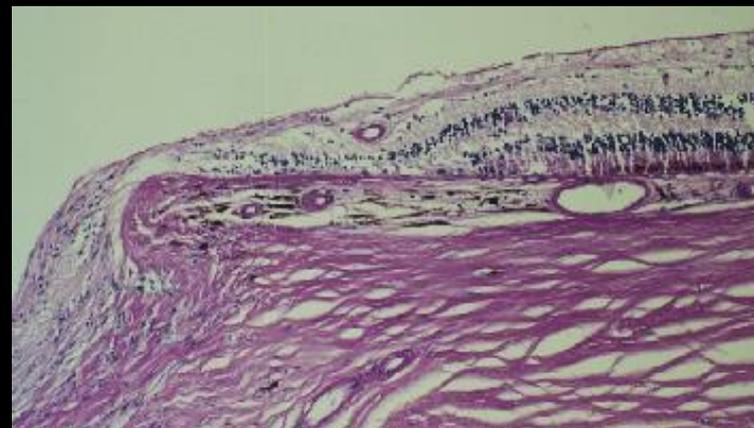
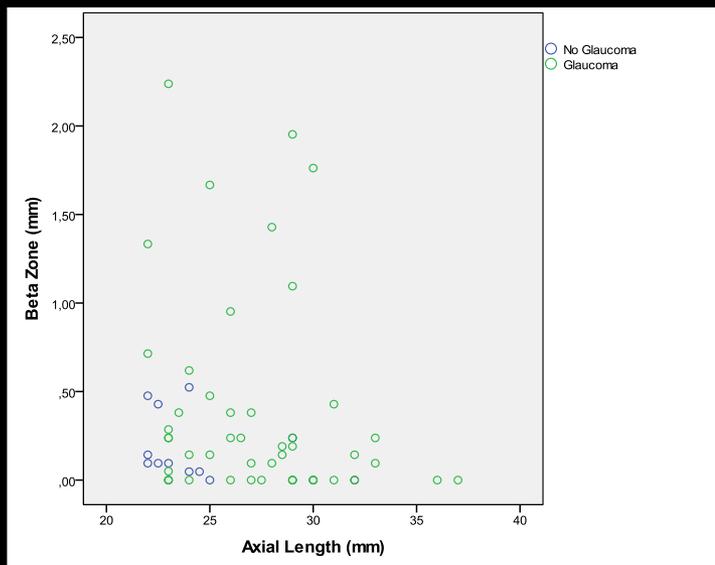




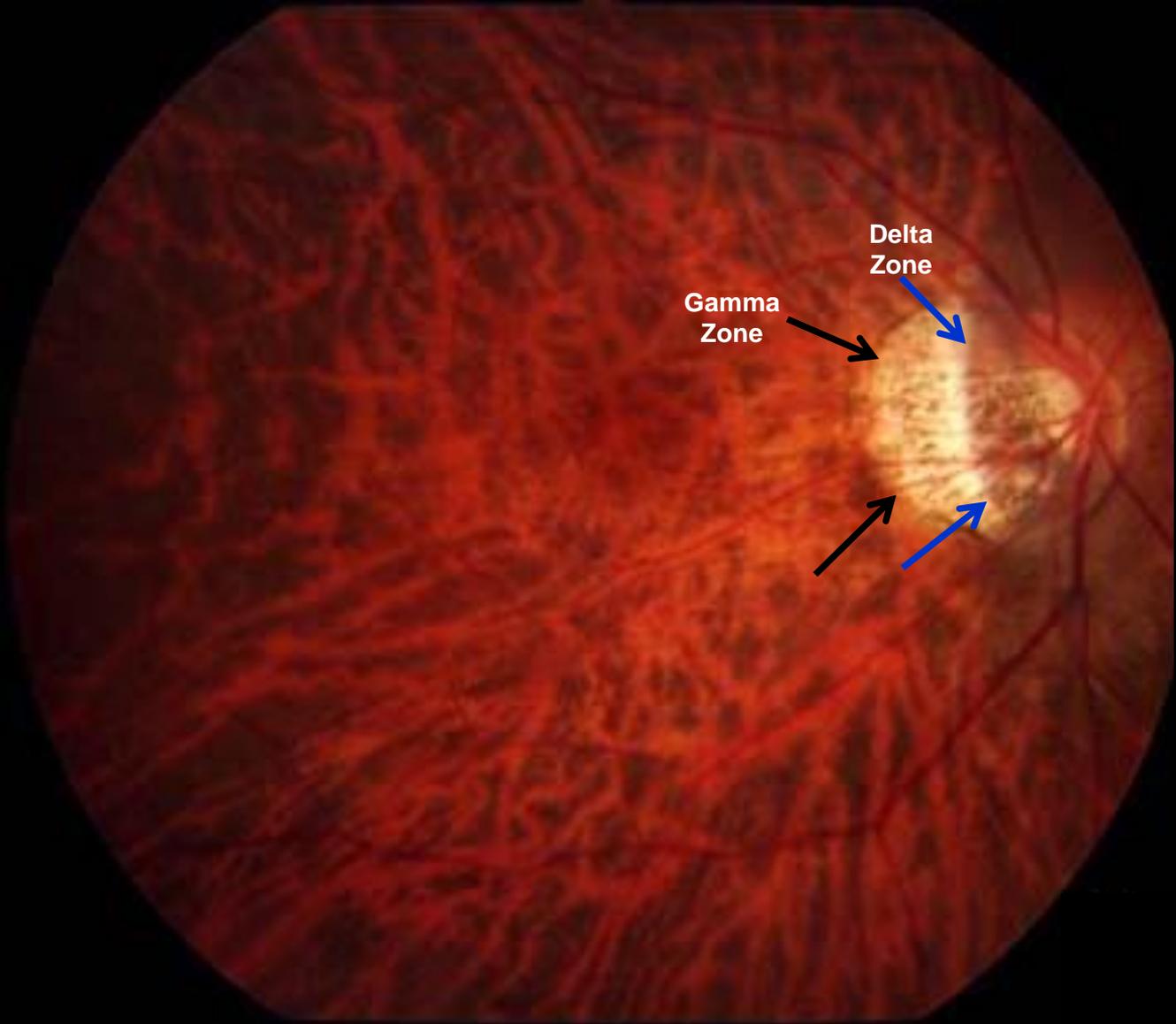
Gamma Zone of Parapapillary Region



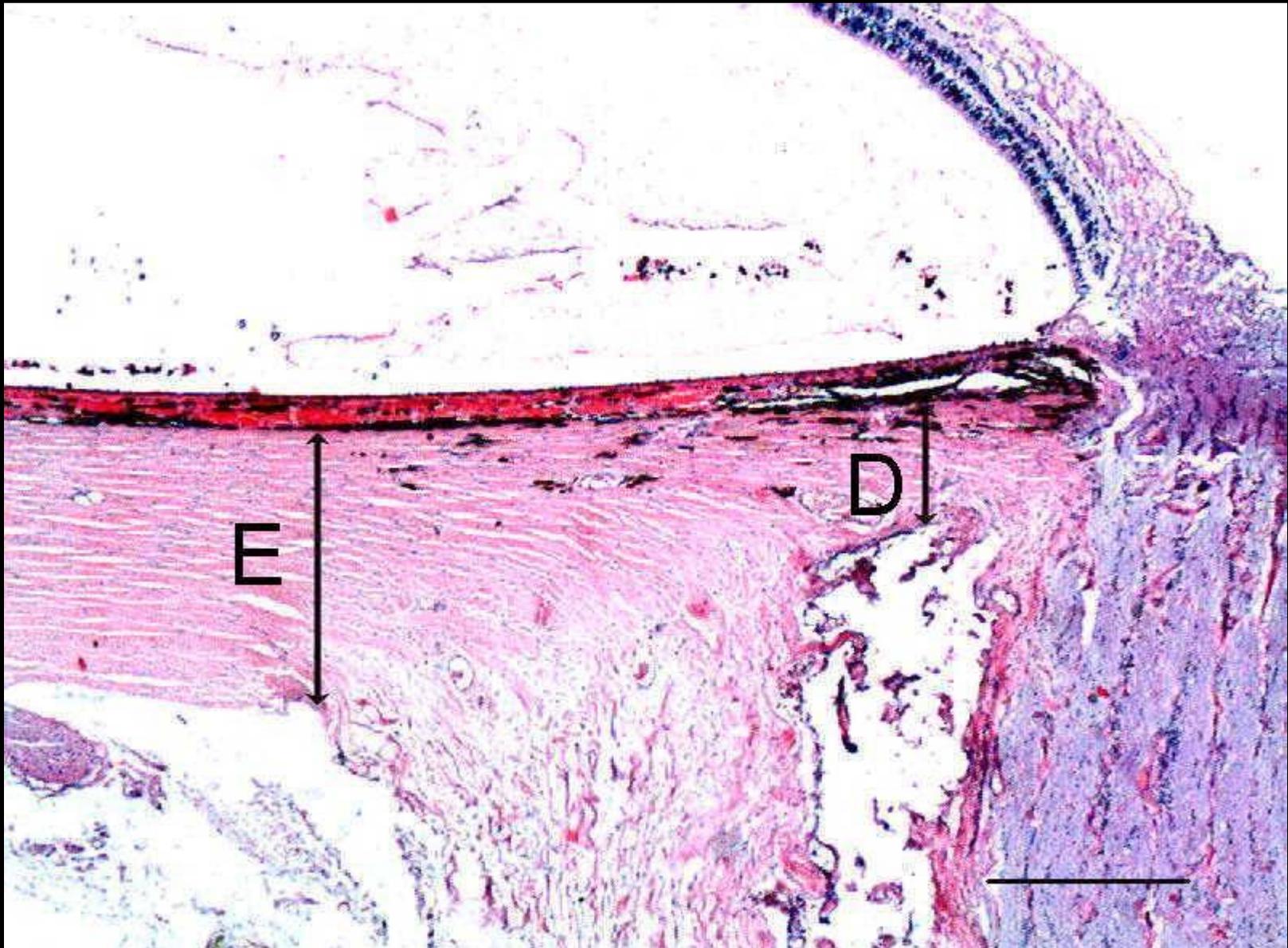
Beta / Gamma Zone of Parapapillary Region



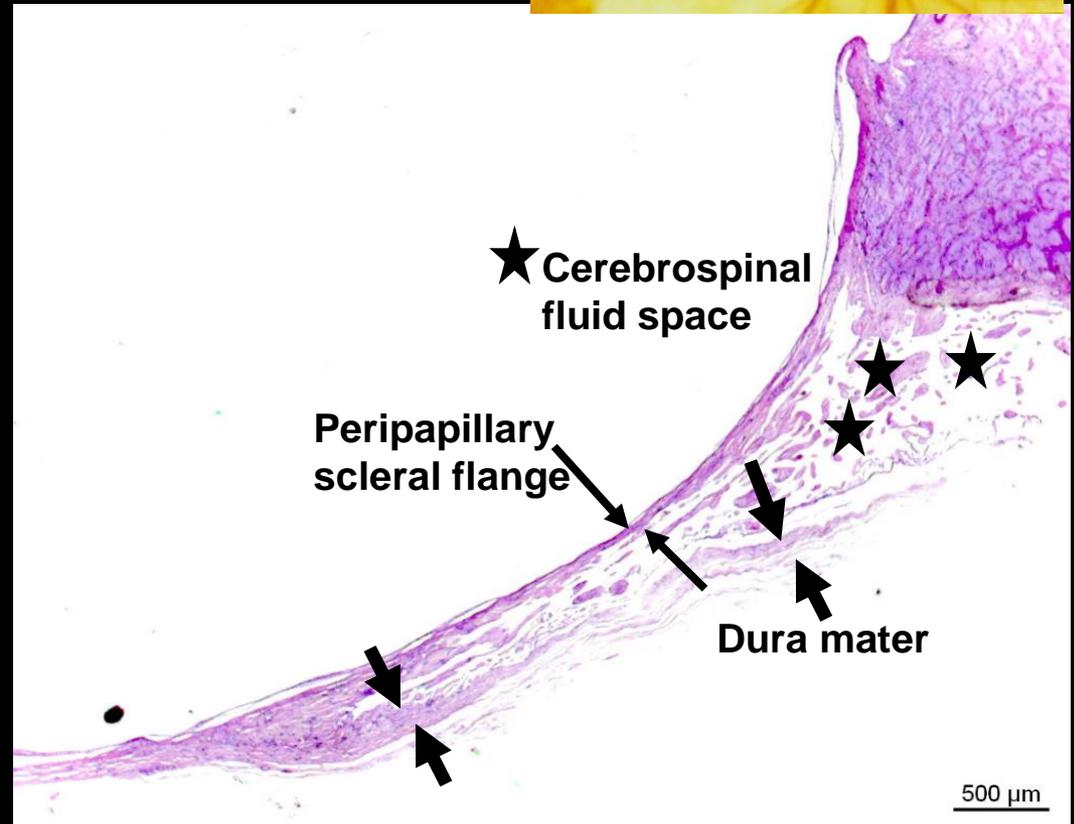
Parapapillary Gamma Zone and Delta Zone



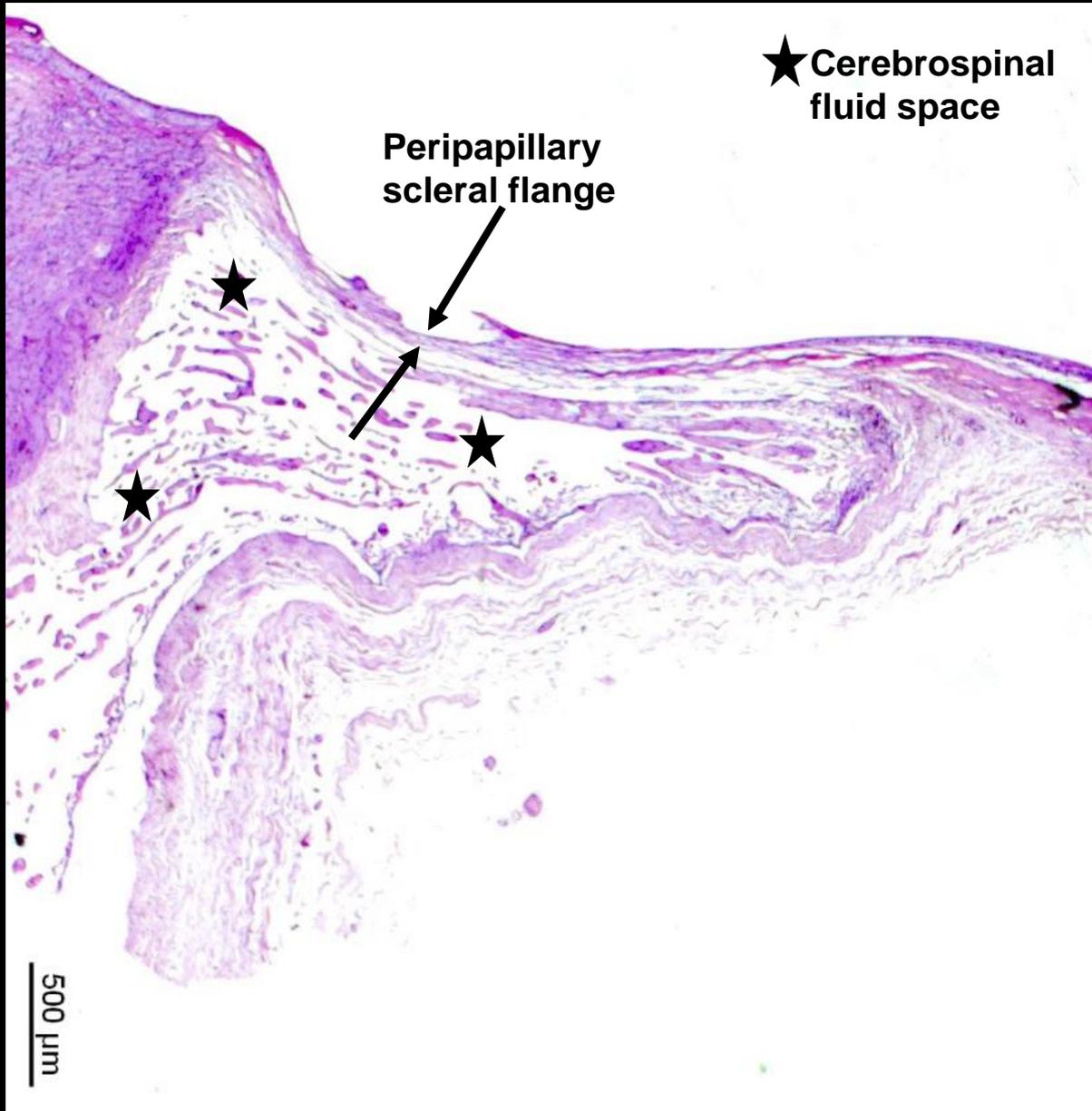
Peripapillary Scleral Flange = 50% of Posterior Sclera



Thinning of the Peripapillary Sclera in Highly Myopic Eyes

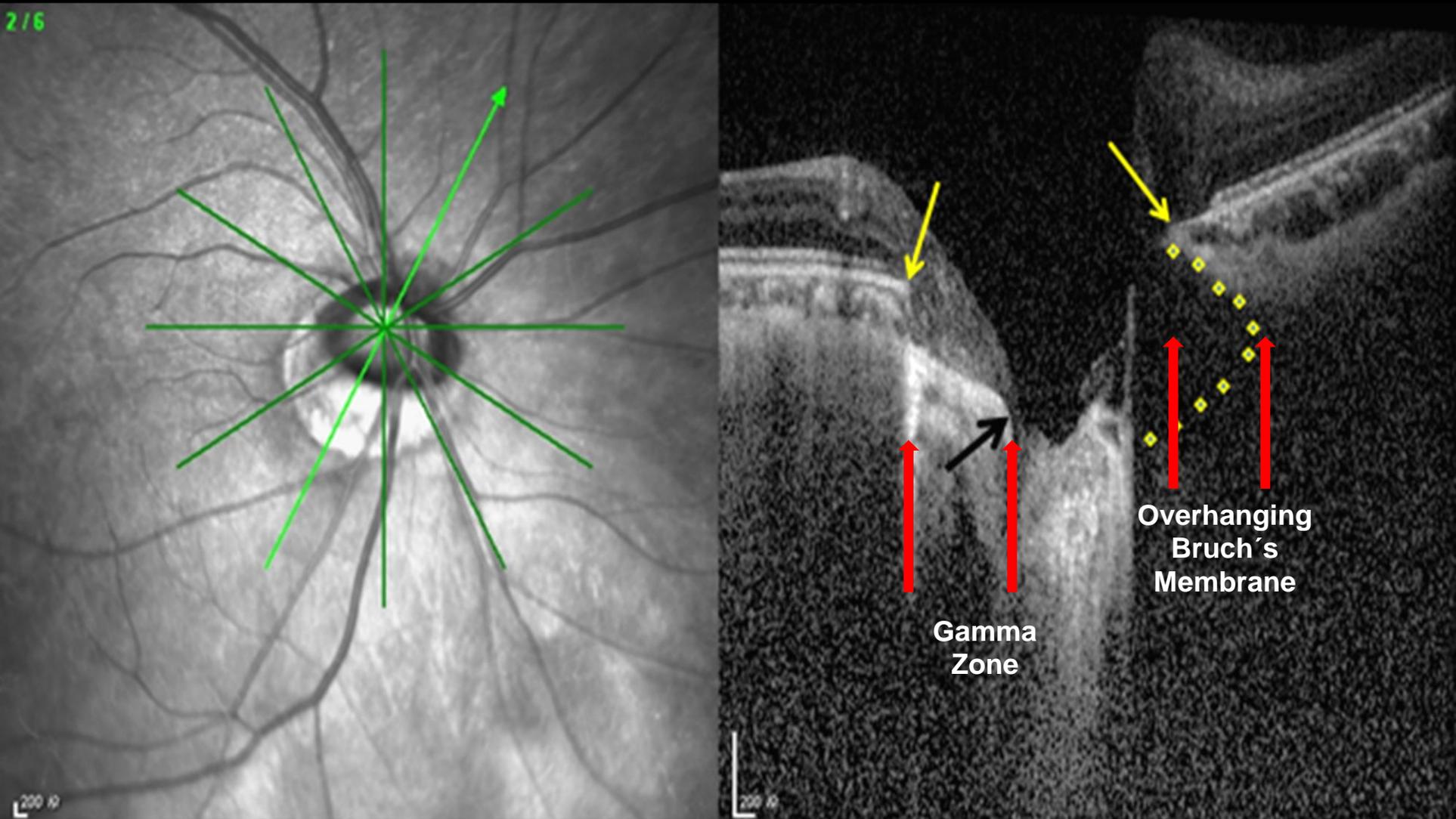


Parapapillary Delta Zone: Peripapillary Scleral Flange in High Myopia

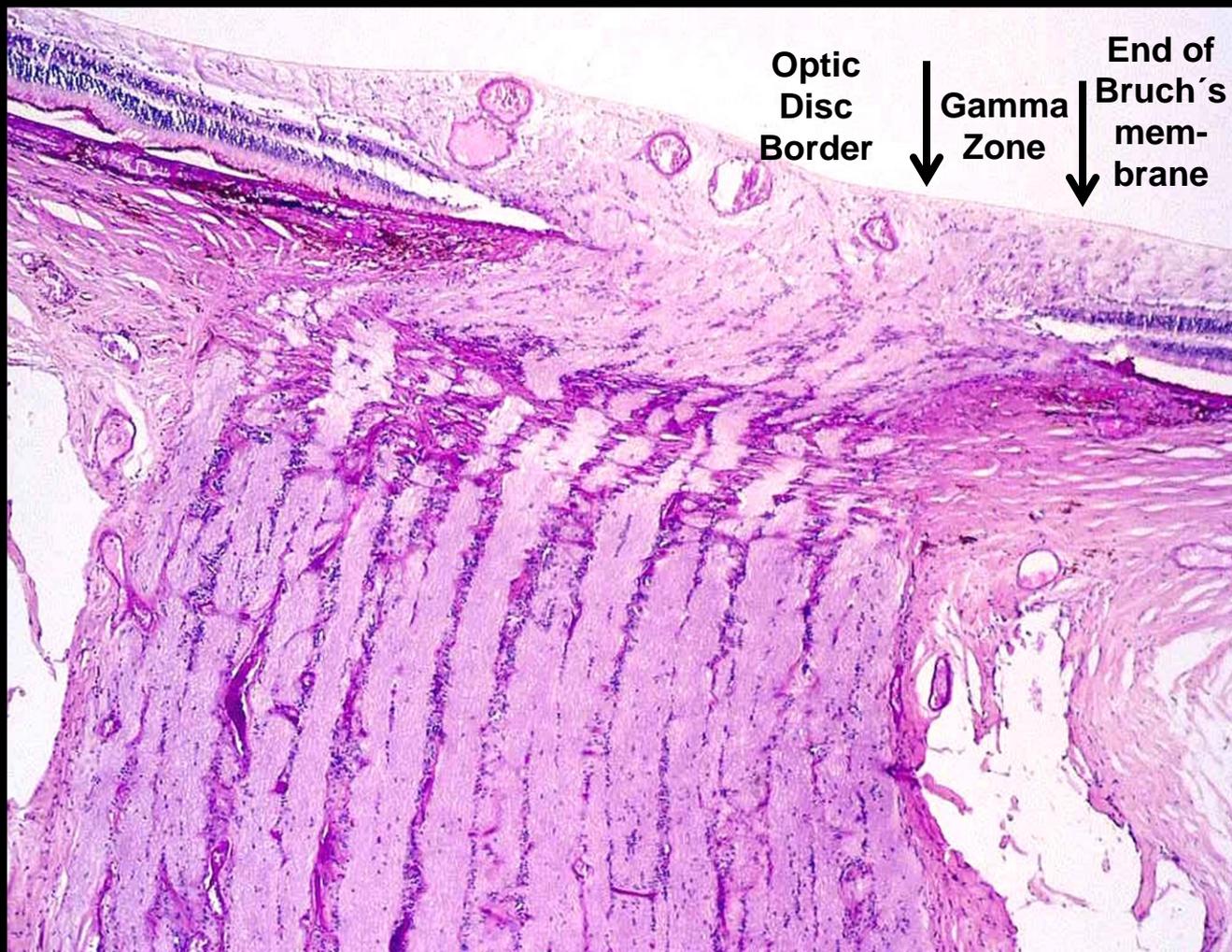




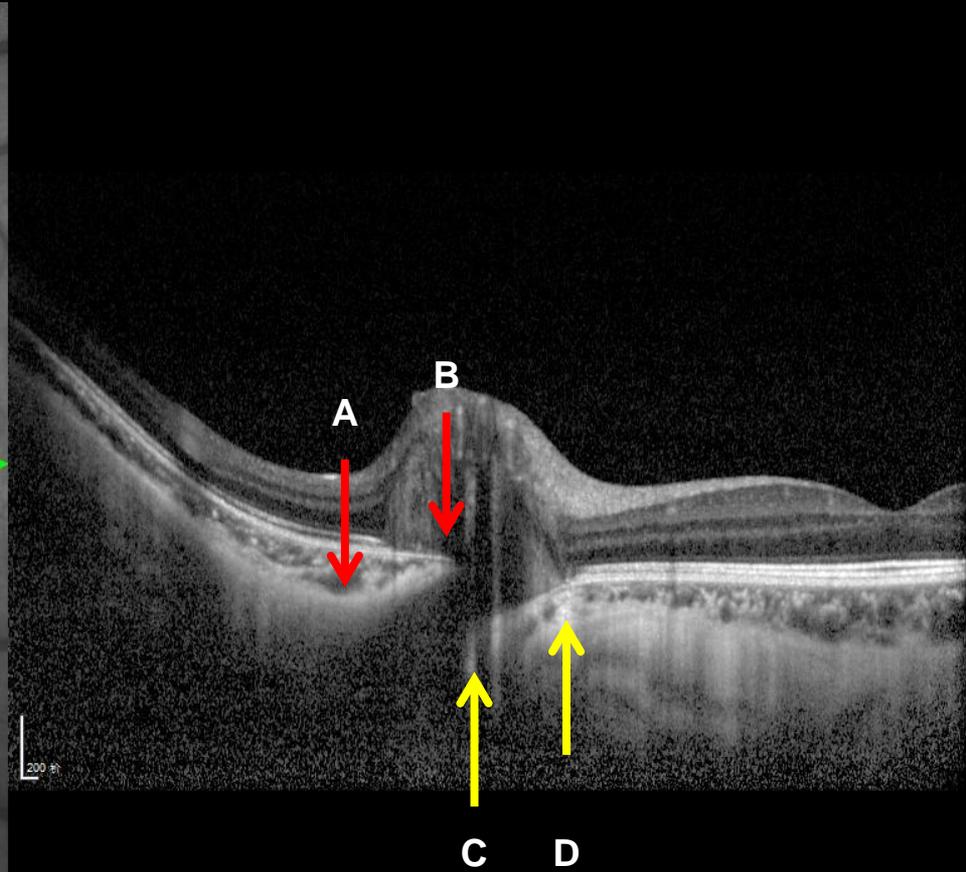
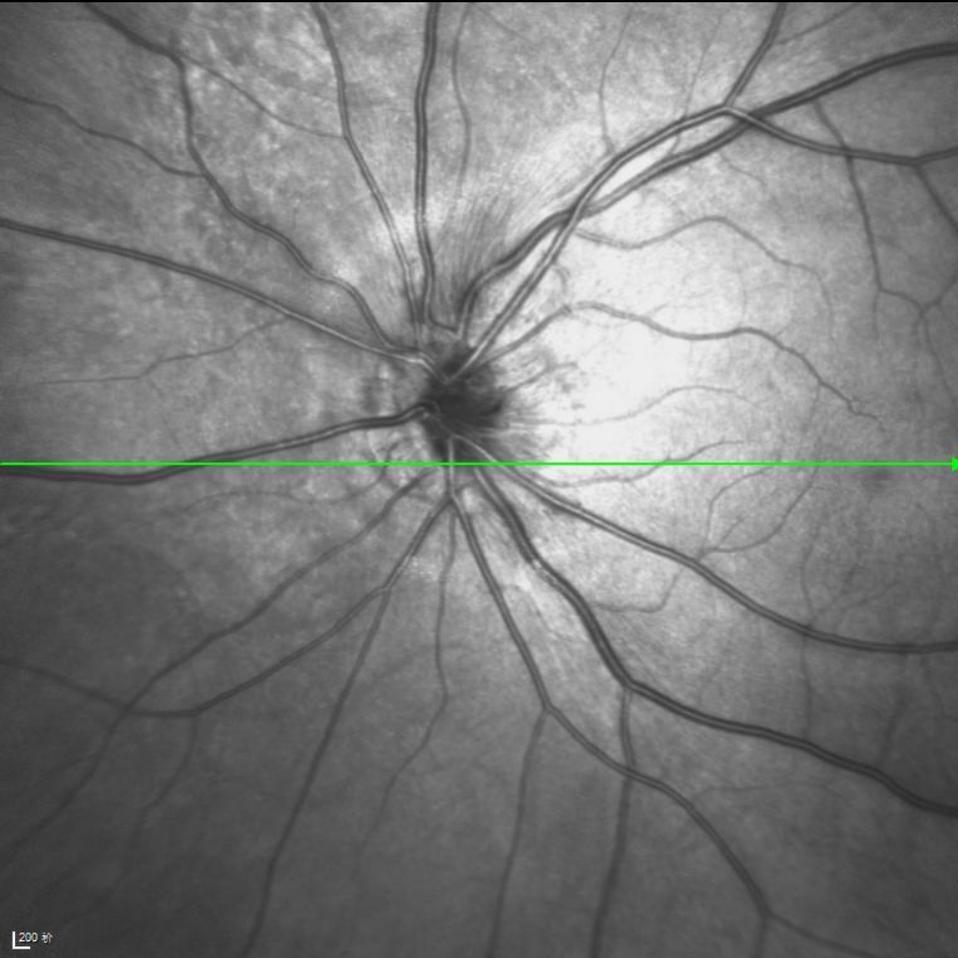
Bruch's Membrane Opening



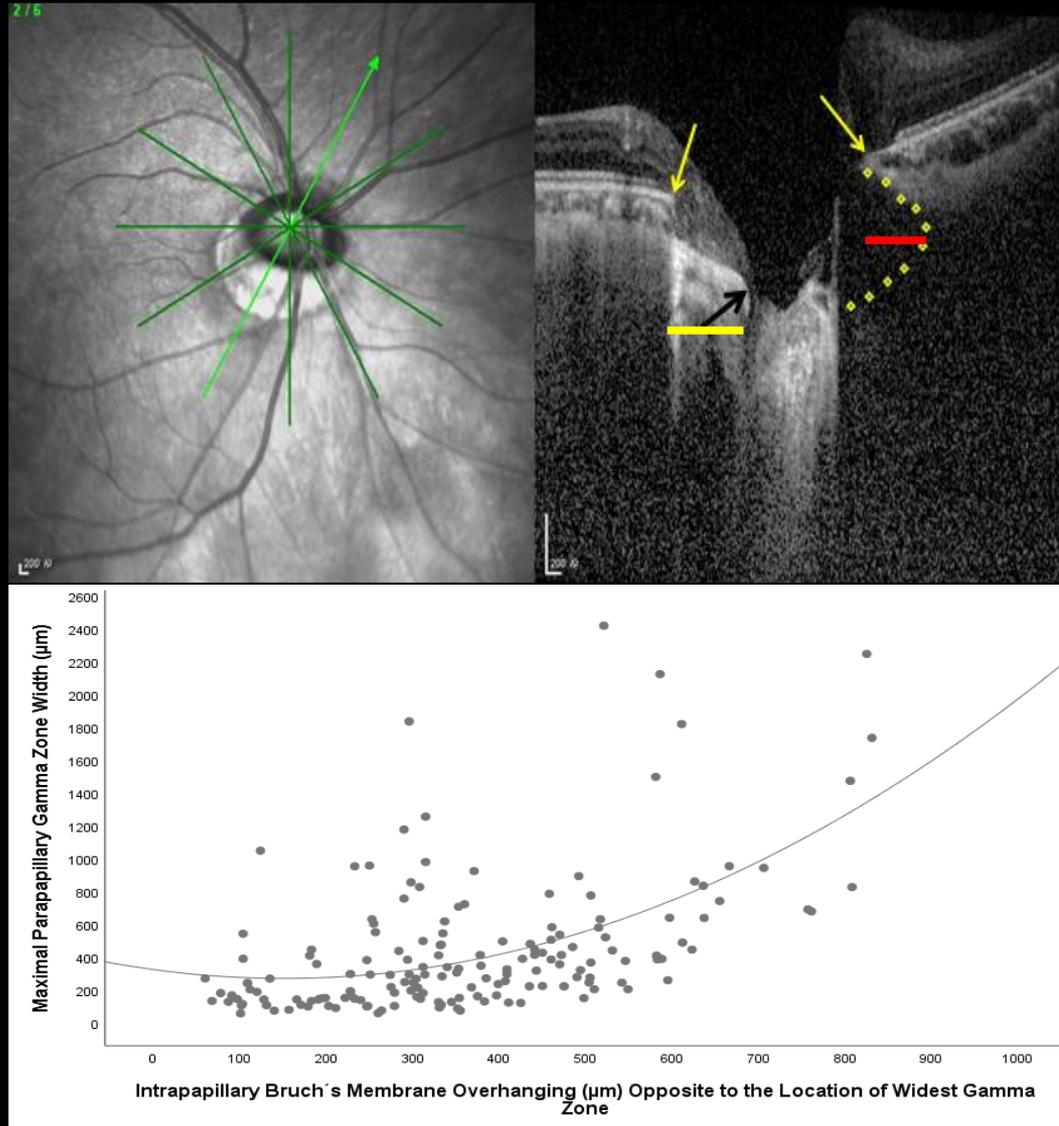
Mechanism of Process of Emmetropization (Myopization) Temporal Shift of BM-Opening and Oblique Orientation of the Optic Nerve Head



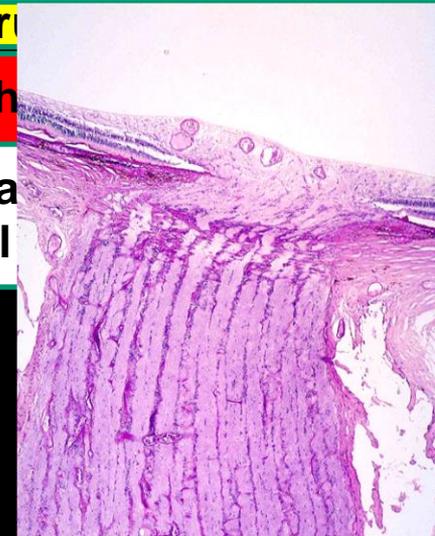
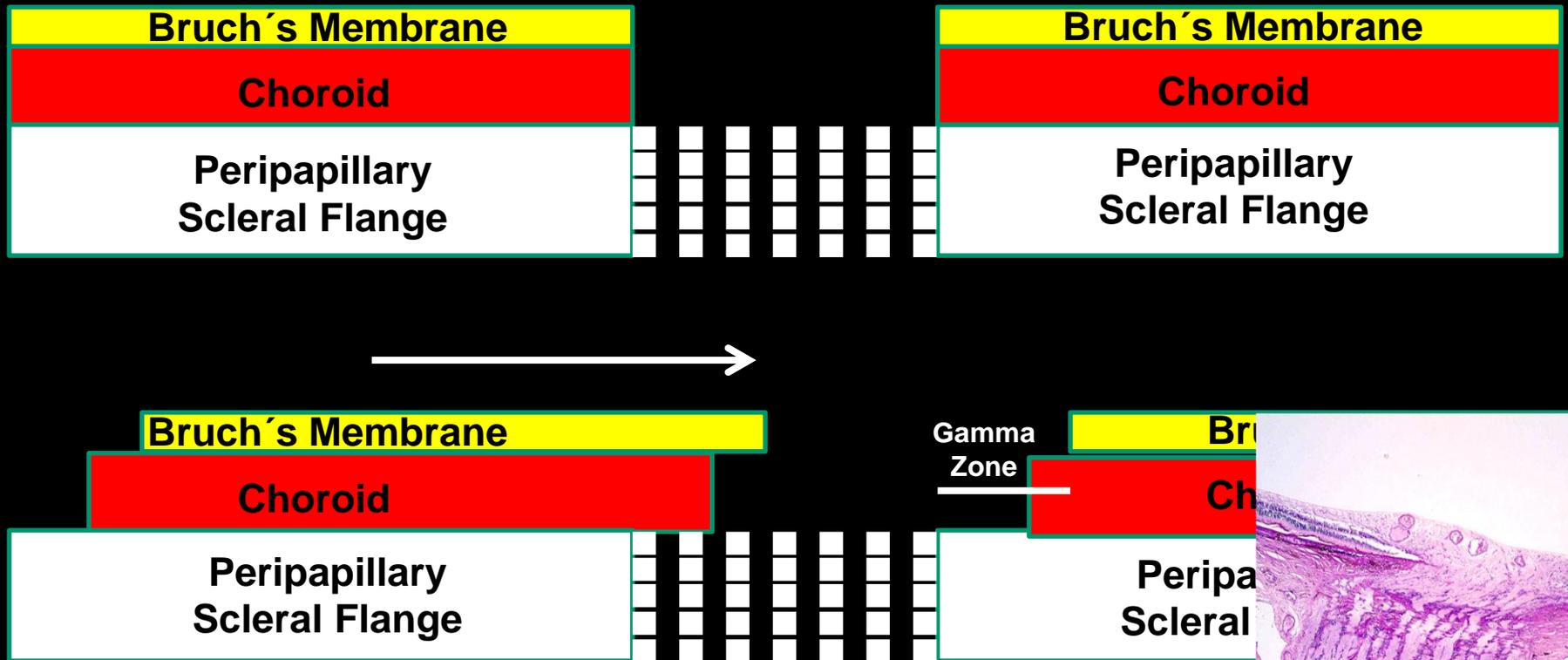
Oblique Optic Nerve Head Channel



Bruch's Membrane Opening

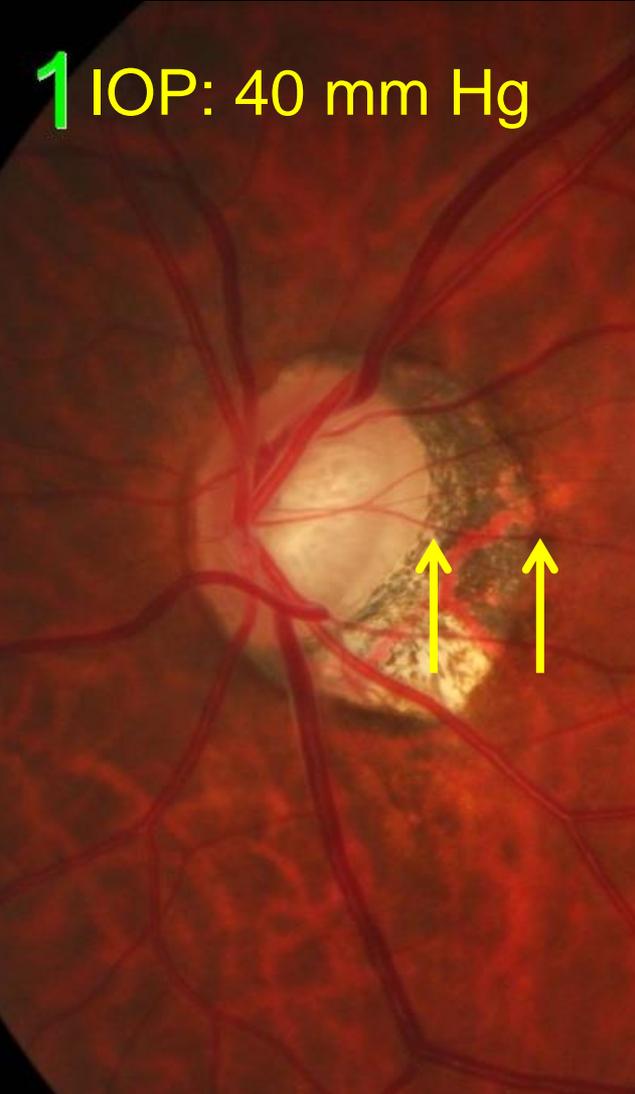


Parapapillary Gamma Zone and Bruch's Membrane Opening: Optic Nerve Head as Three-Layered Hole

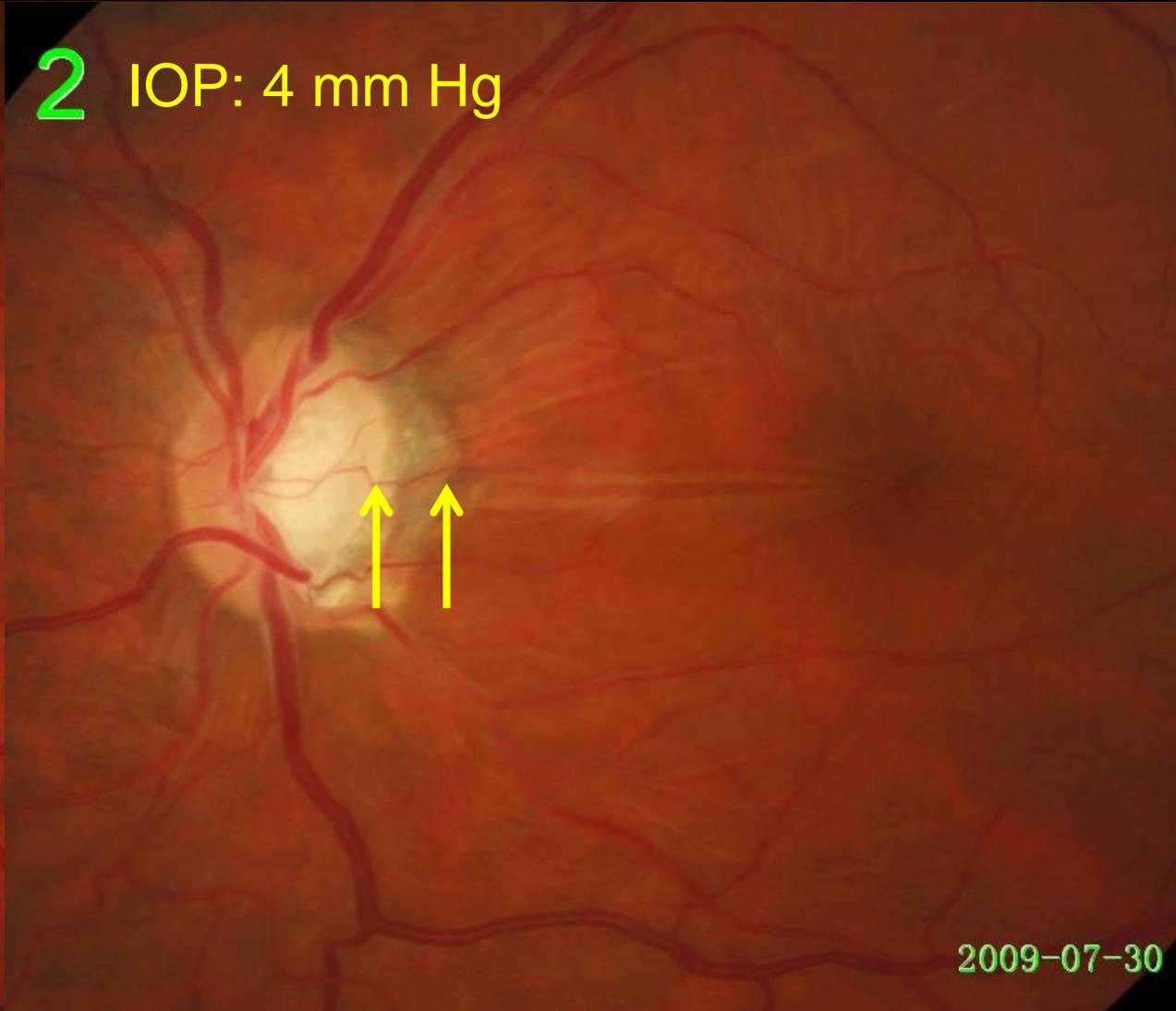


Etiology of Gamma Zone: Bruch's Membrane Opening: Sliding of Bruch's Membrane

1 IOP: 40 mm Hg

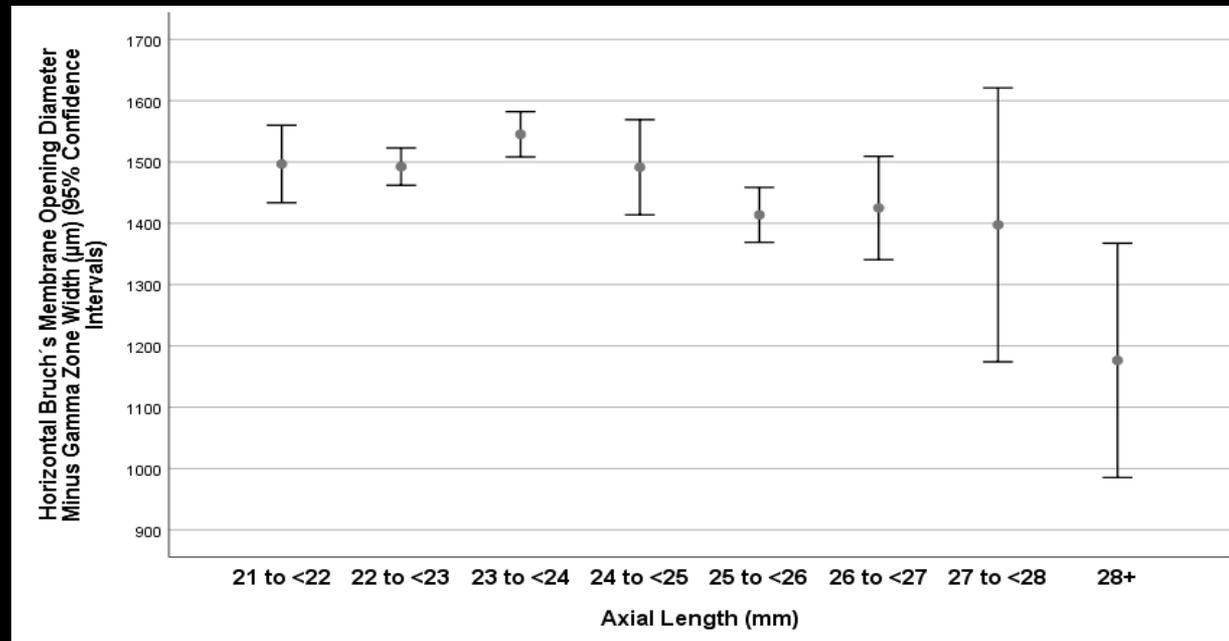
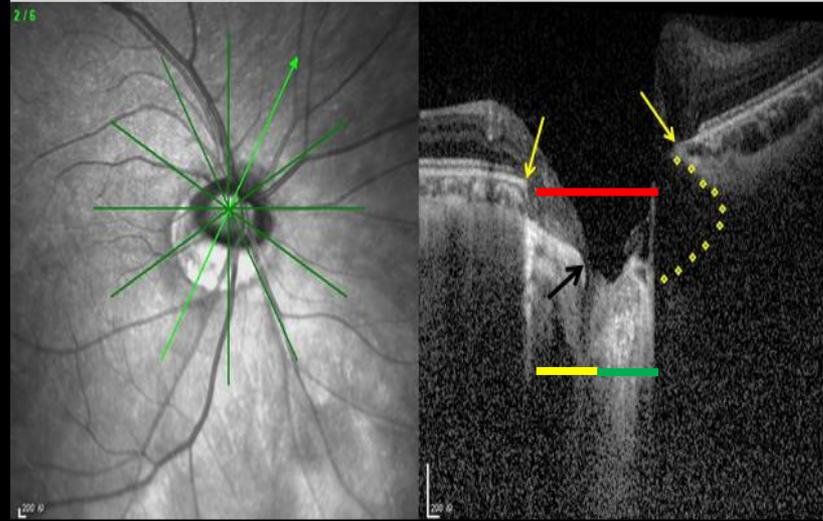


2 IOP: 4 mm Hg

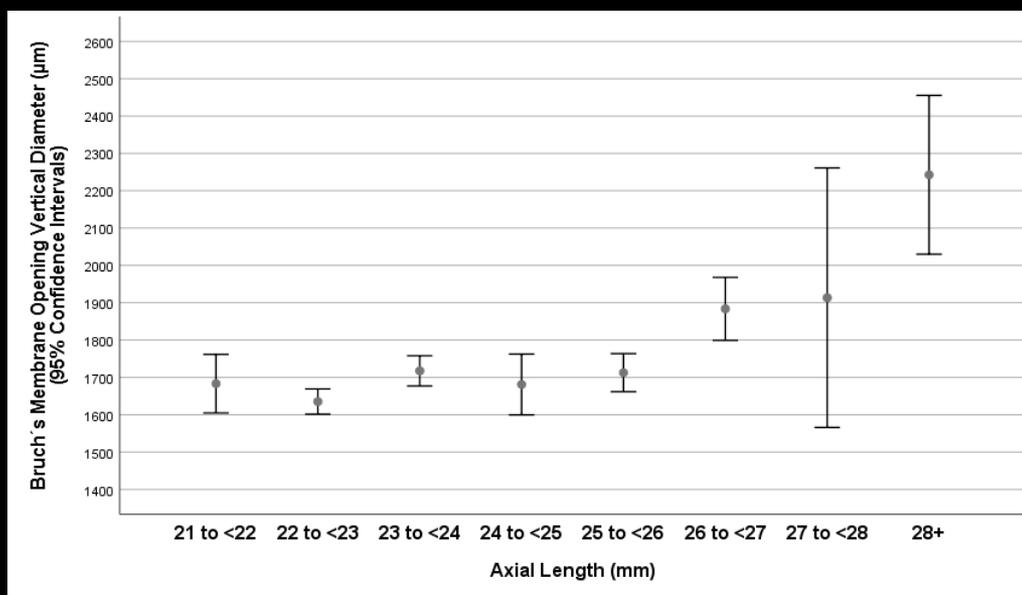
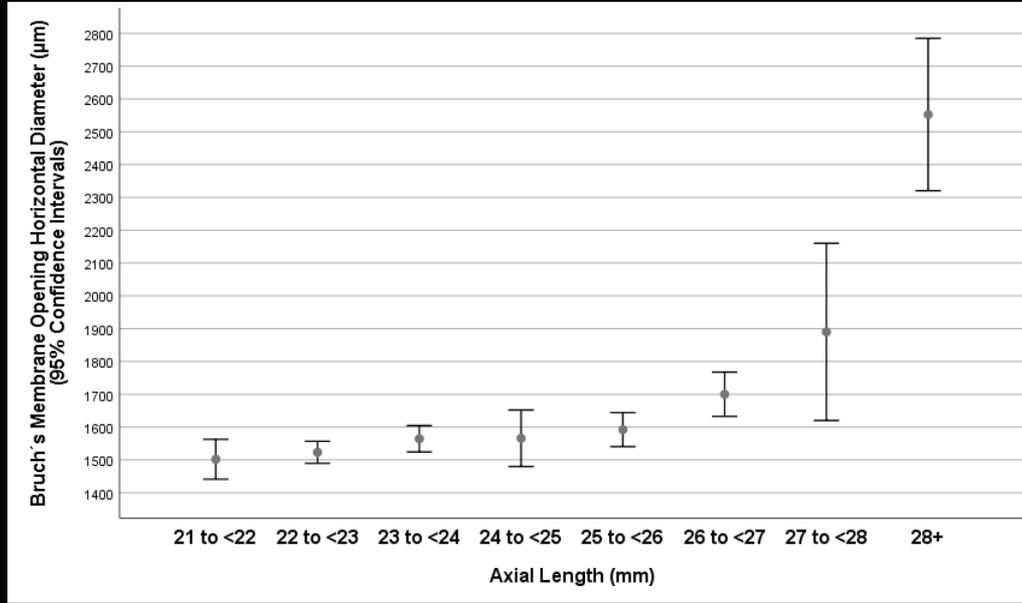


2009-07-30

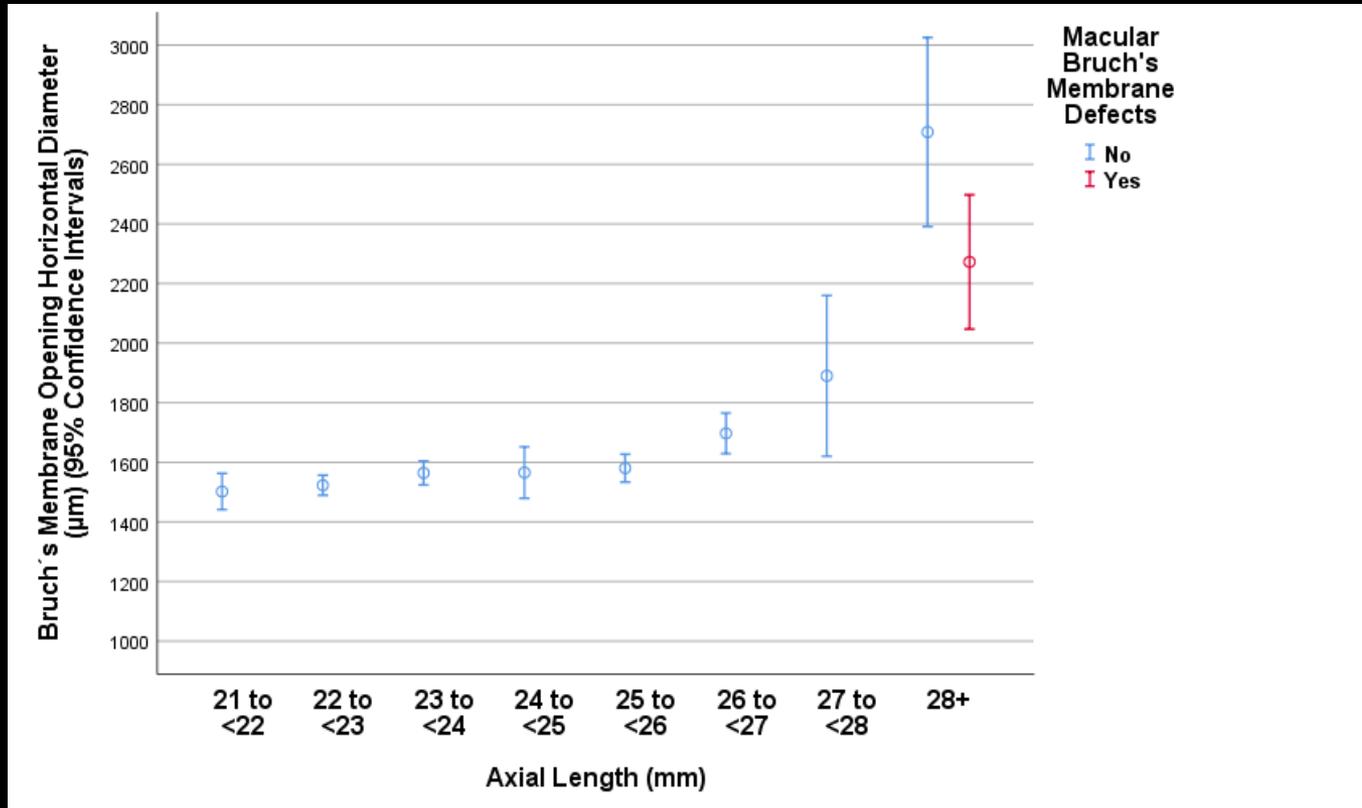
Bruch's Membrane Opening



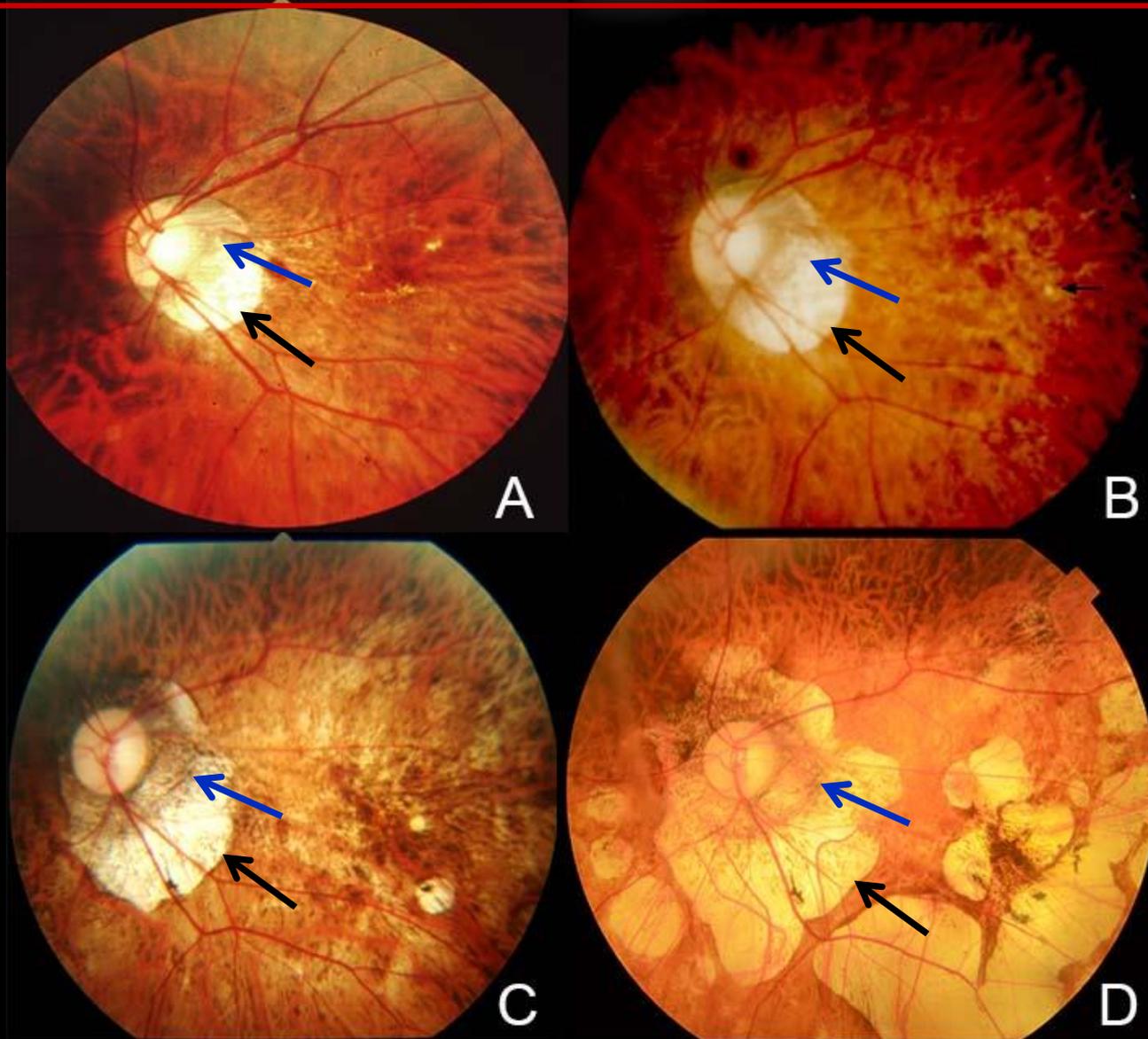
Bruch's Membrane Opening



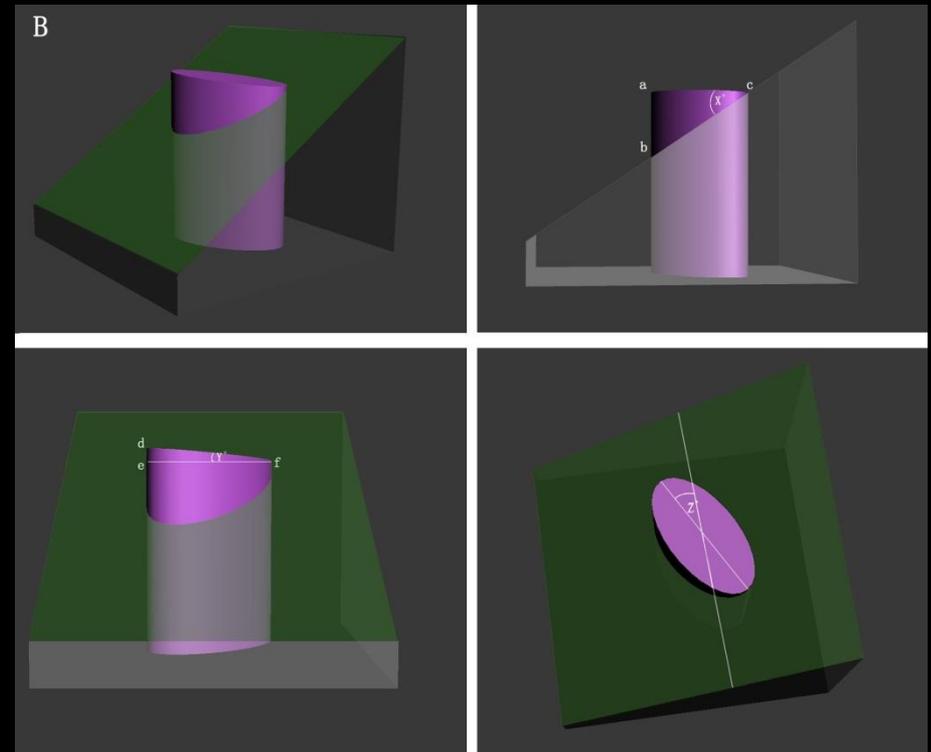
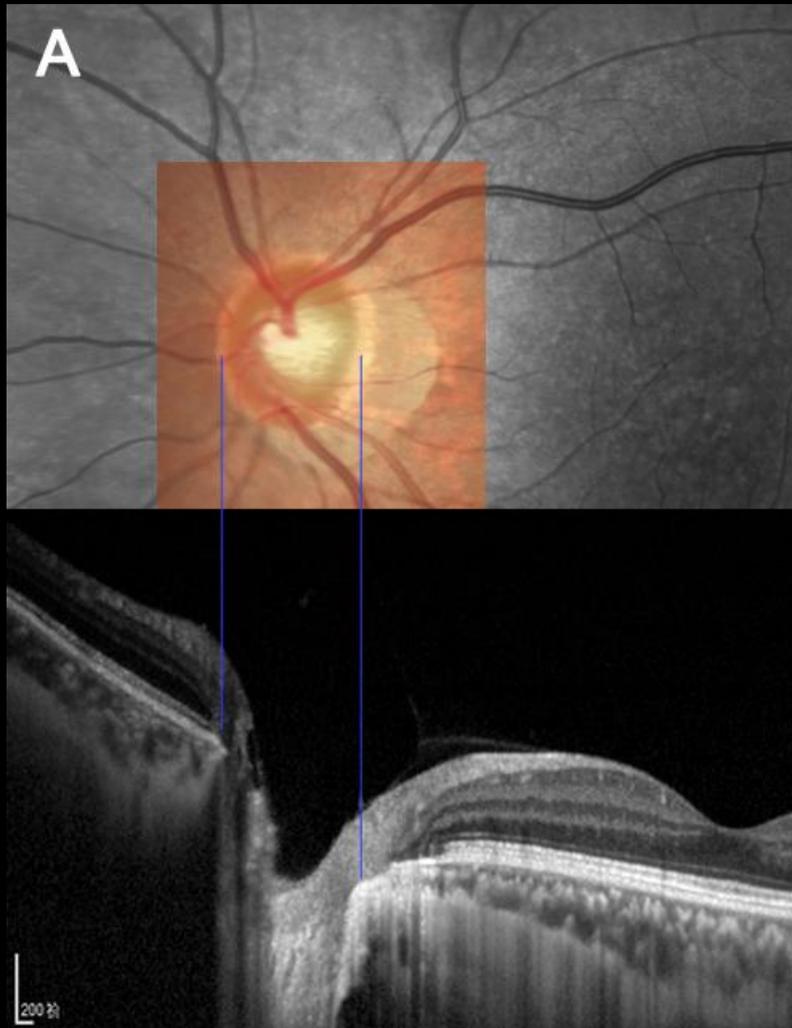
Bruch's Membrane Opening

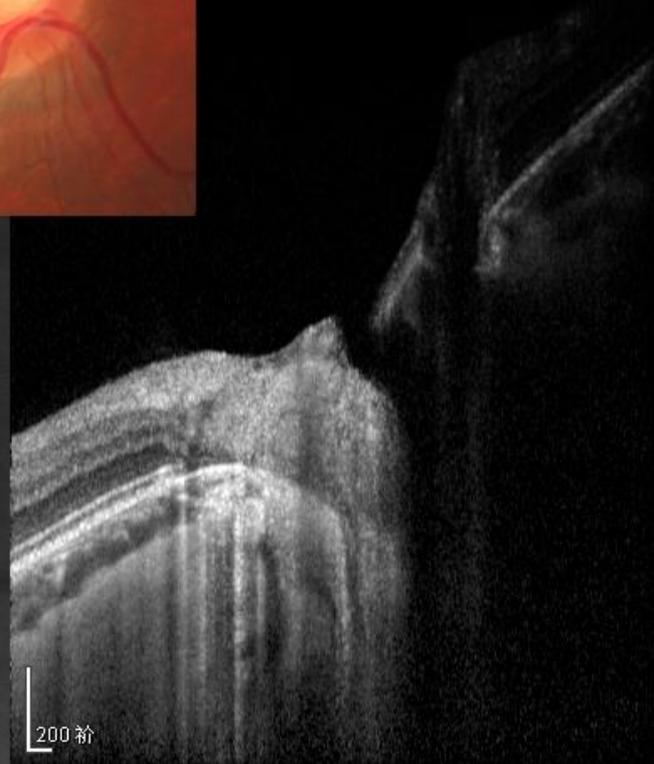
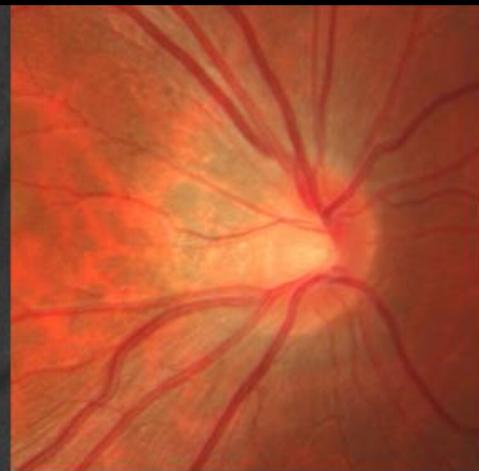
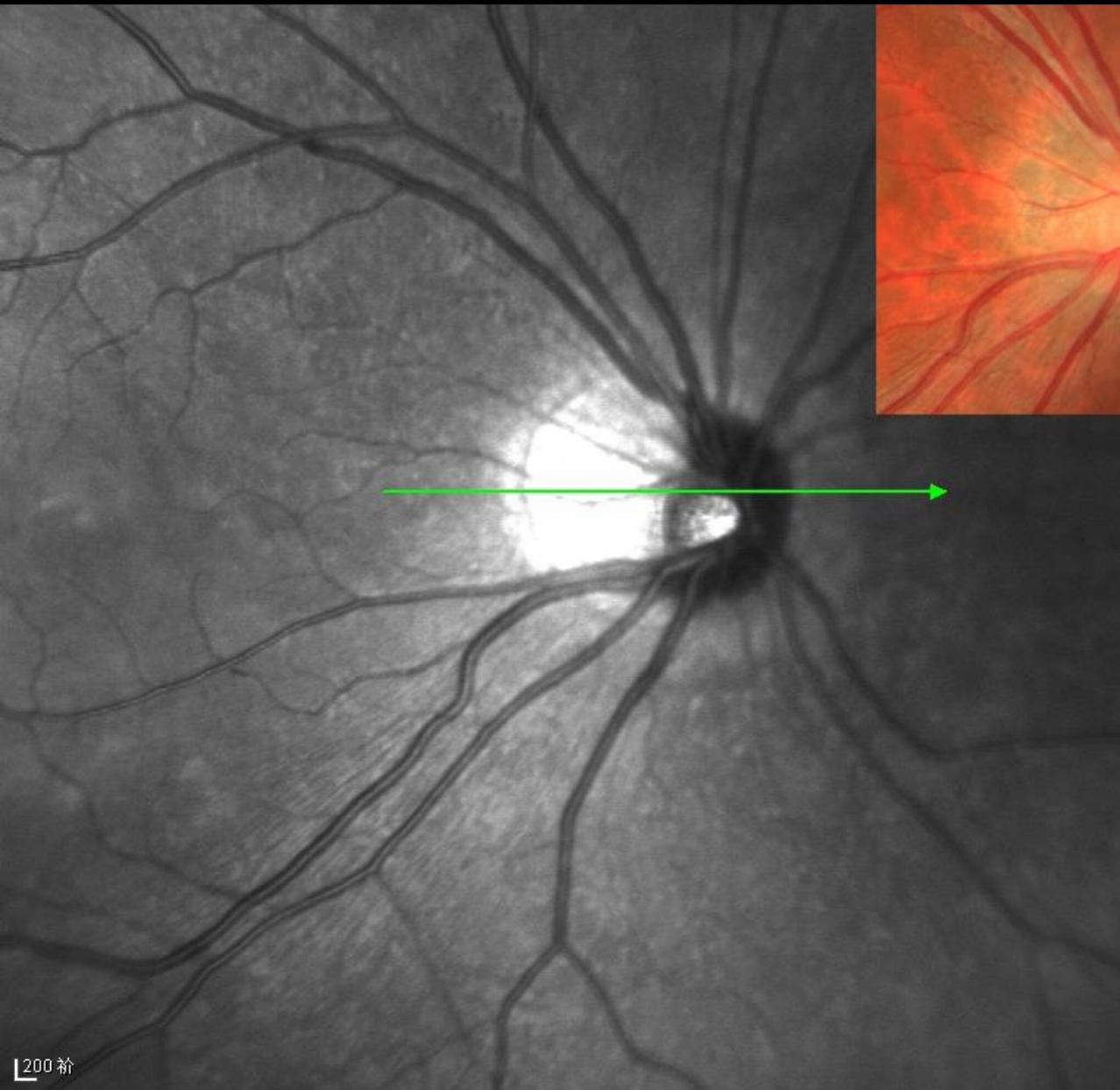


Progression of Myopic Maculopathy During 18-Year Follow-Up



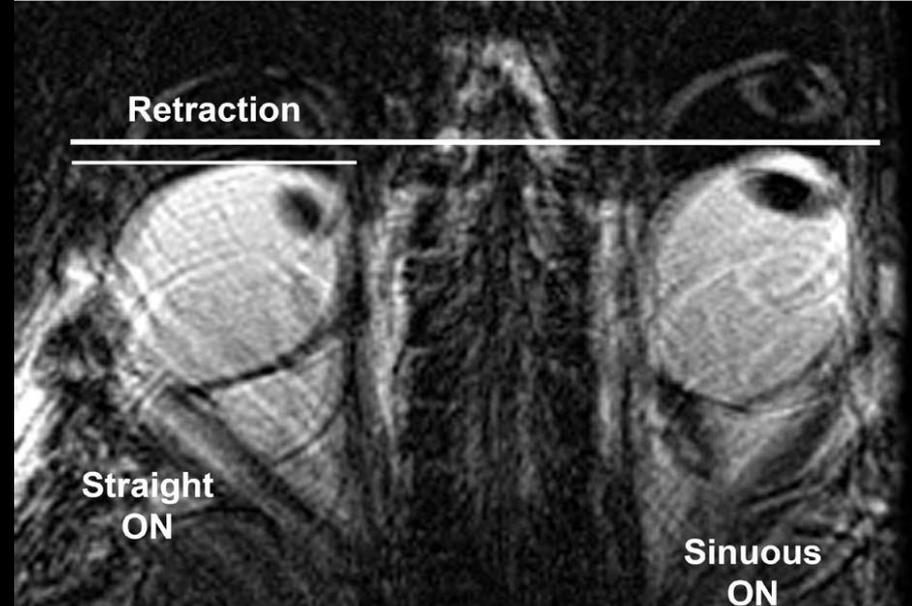
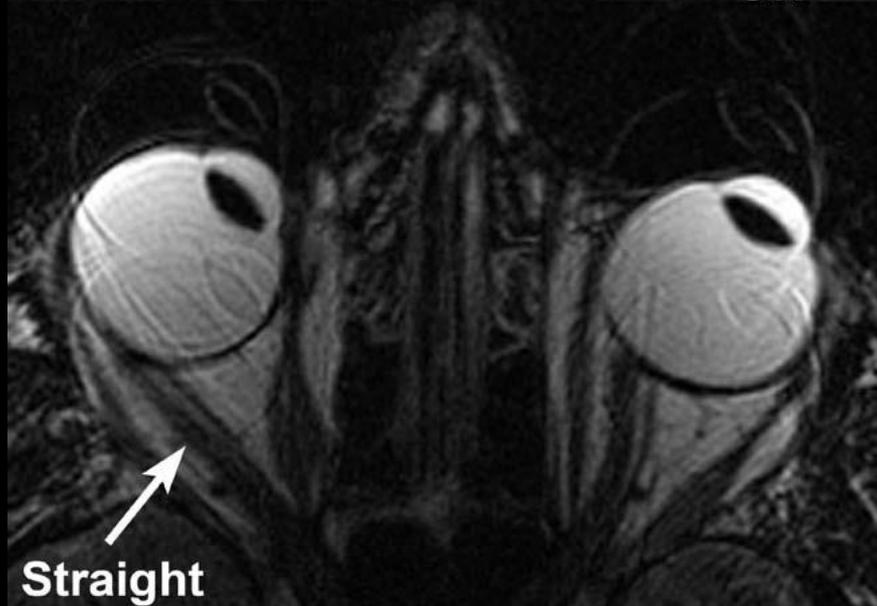
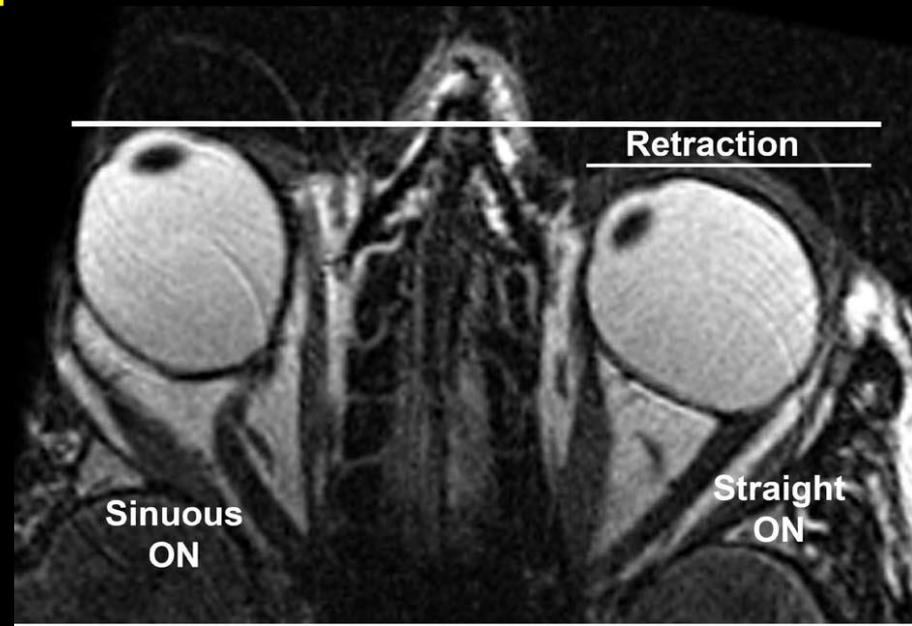
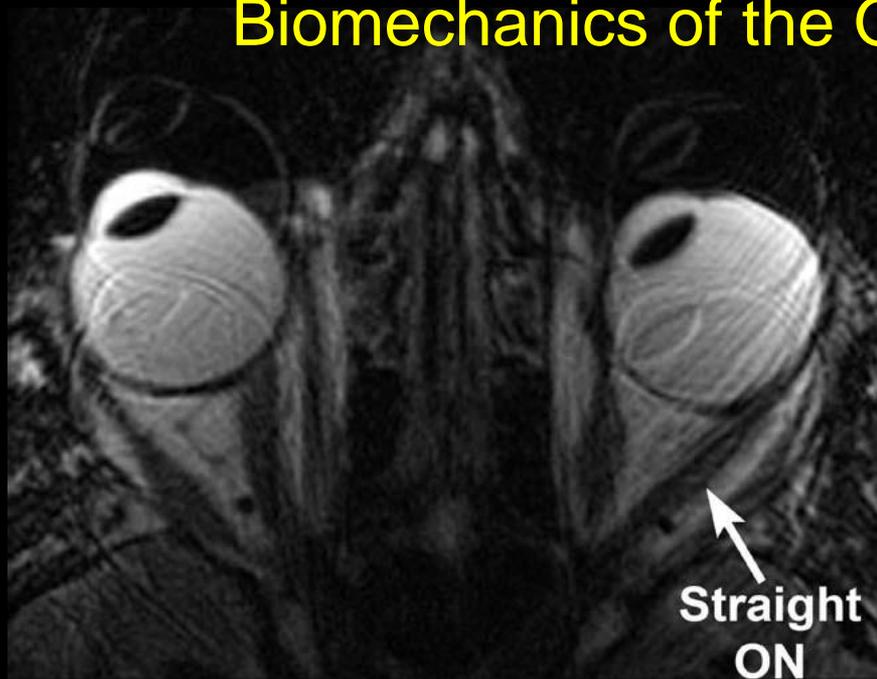
Ophthalmoscopic-Perspectively Distorted Optic Disc Diameters and Real Disc Diameters





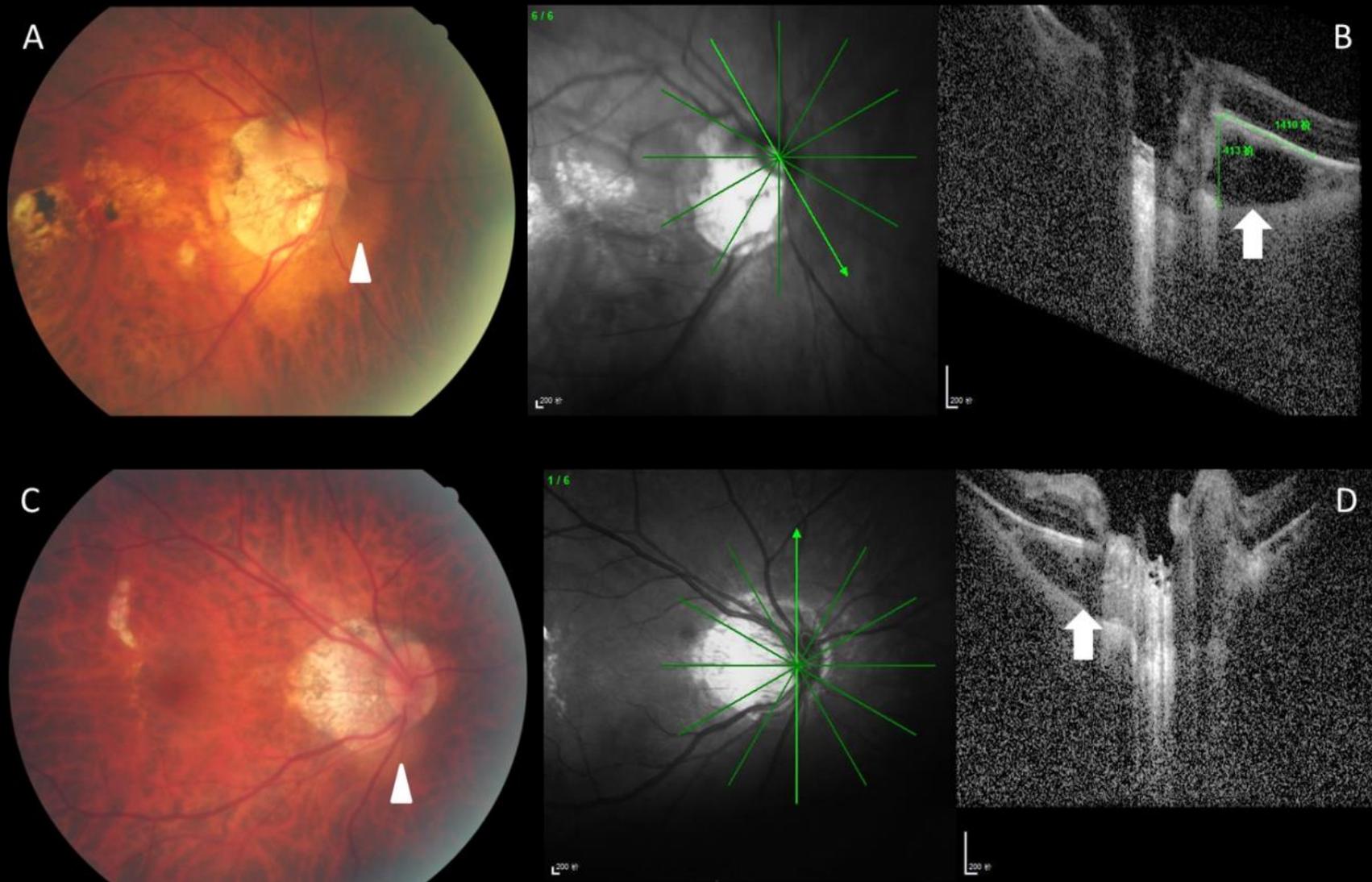
-4.5D

Biomechanics of the Optic Nerve Dura Mater

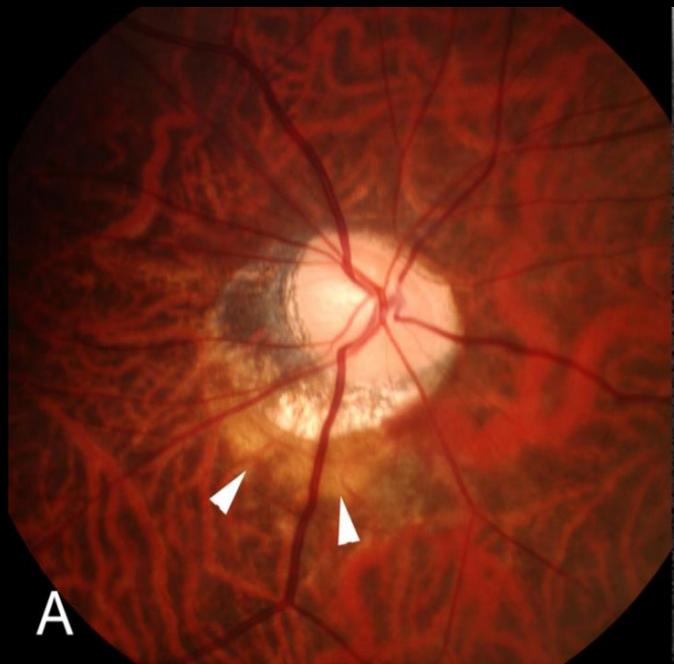


Wang X, Rumpel H, Lim WE, et al. Finite element analysis predicts large optic nerve head strains during horizontal eye movements. Invest Ophthalmol Vis Sci. 2016;57:2452-62.

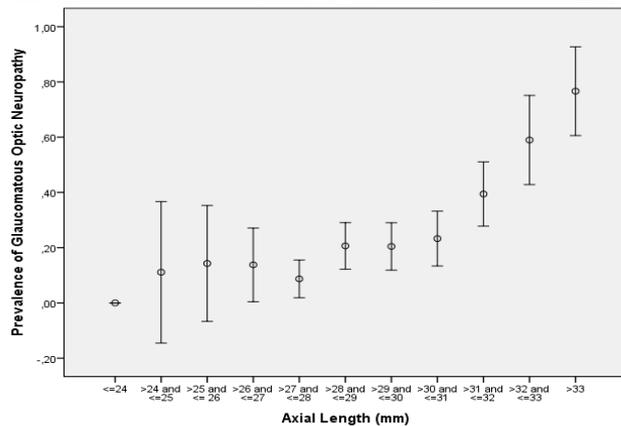
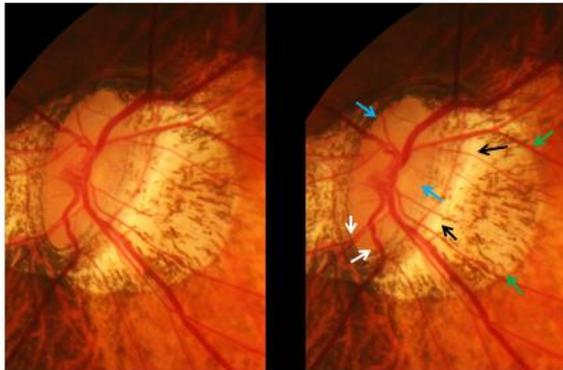
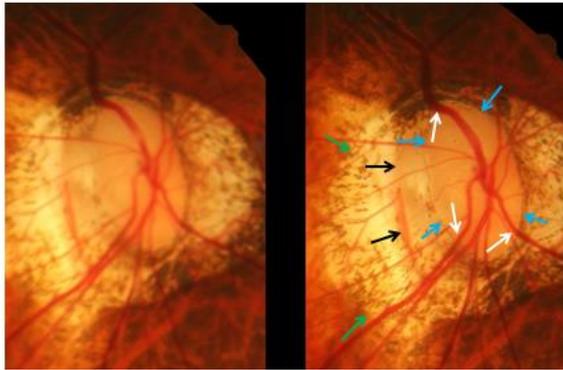
Peripapillary Suprachoroidal Cavitations. The Beijing Eye Study



Peripapillary Suprachoroidal Cavitations. The Beijing Eye Study



Glaucoma in High Myopia and Parapapillary Delta Zone

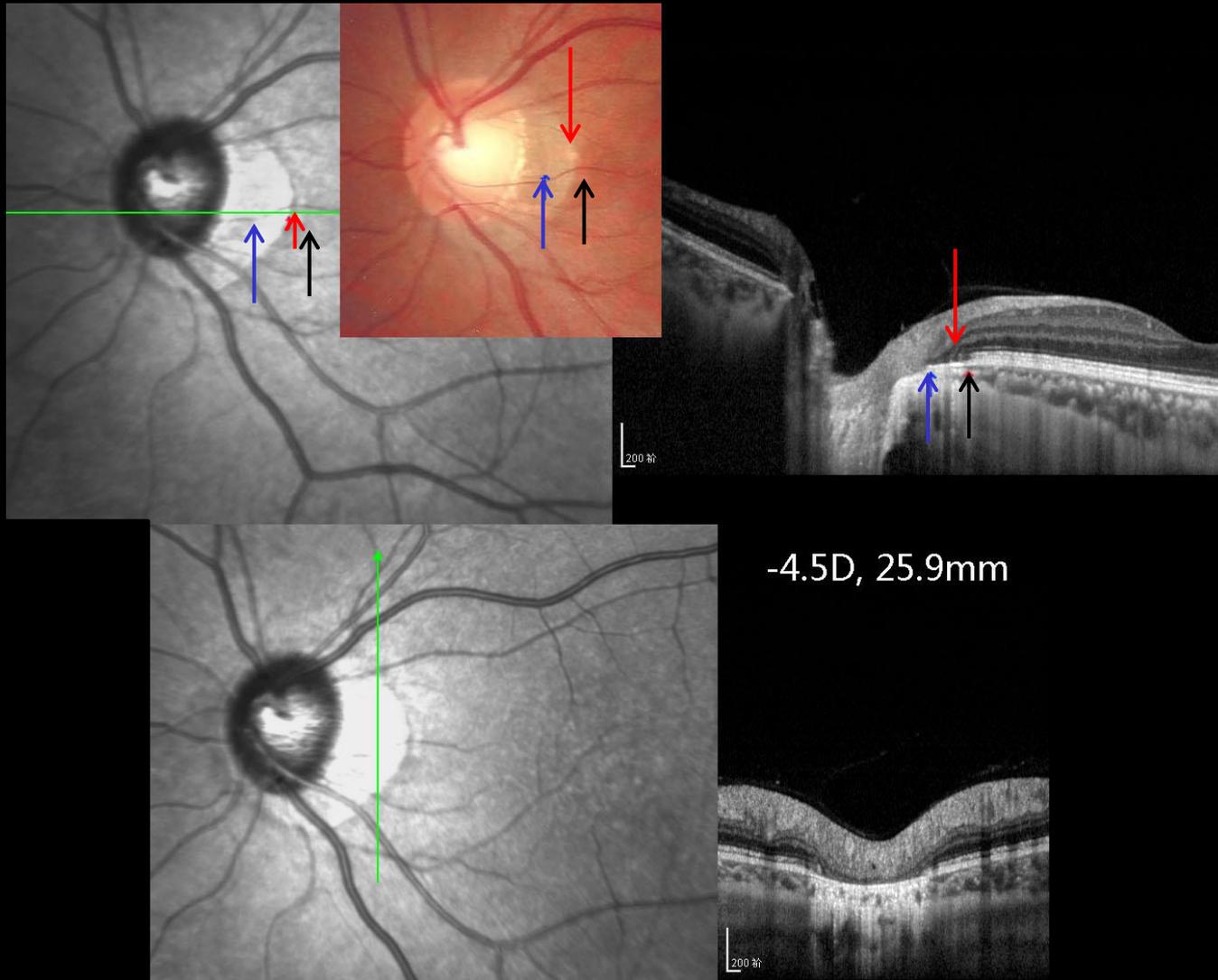


- 519 eyes (axial length: 29.5 ± 2.2 mm); GON present in 141 (27.2%) eyes.
- Prevalence of GON increased from 12.2% (1.7, 22.7) in eyes with an axial length of <26.5 mm to 42.1% (35.5, 48.8) in eyes with an axial length of ≥ 30 mm.
- In multivariate analysis, higher GON prevalence was associated (Nagelkerke r^2 : 0.28) with **larger parapapillary delta zone** diameter ($P < 0.001$; OR:1.86), **longer axial length** ($P < 0.001$; OR:1.45;7) and **older age** ($P = 0.01$).
- If parapapillary delta zone width was replaced by the **vertical disc diameter**, higher GON prevalence was associated with larger vertical optic disc diameter ($P = 0.04$; OR:1.70)

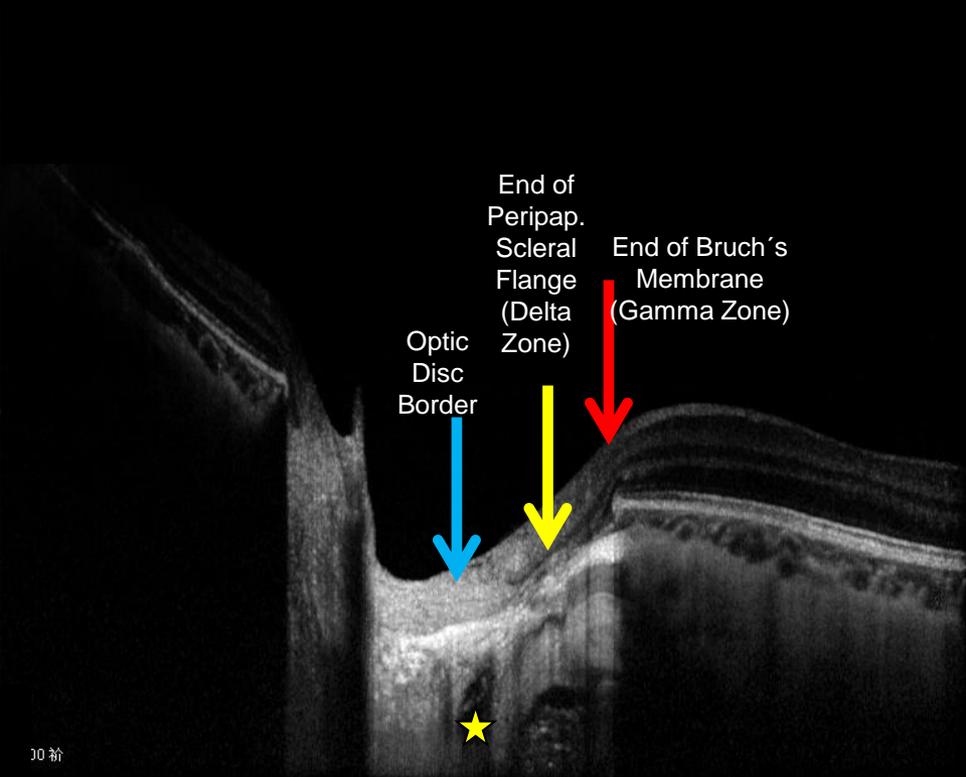
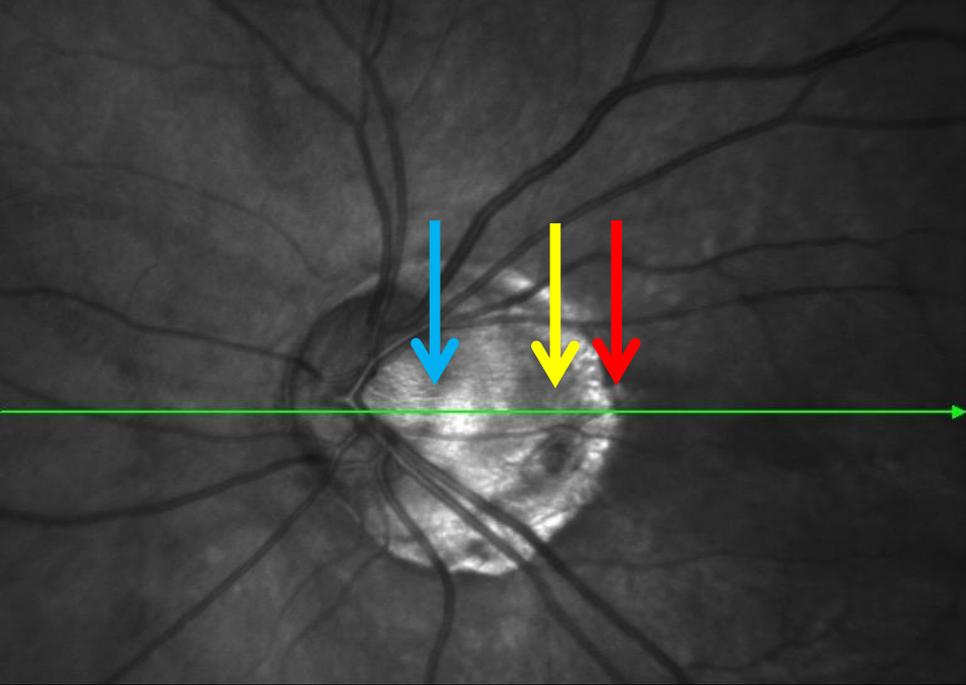
Alpha, Beta, Gamma, Delta Zone

- Alpha Zone: Bruch's membrane present, RPE > irregularly structured
- Beta Zone: Bruch's membrane present, no RPE, no photoreceptors (plus choriocapillaris occluded); associated with glaucoma; not associated with myopia
- Gamma Zone: No Bruch's membrane, therefore no photoreceptors, no RPE, no choriocapillaris; associated with myopia; not associated with glaucoma
- Delta Zone: elongated (and thinned) peripapillary scleral flange in highly myopic eyes; bordering the orbital cerebrospinal fluid space

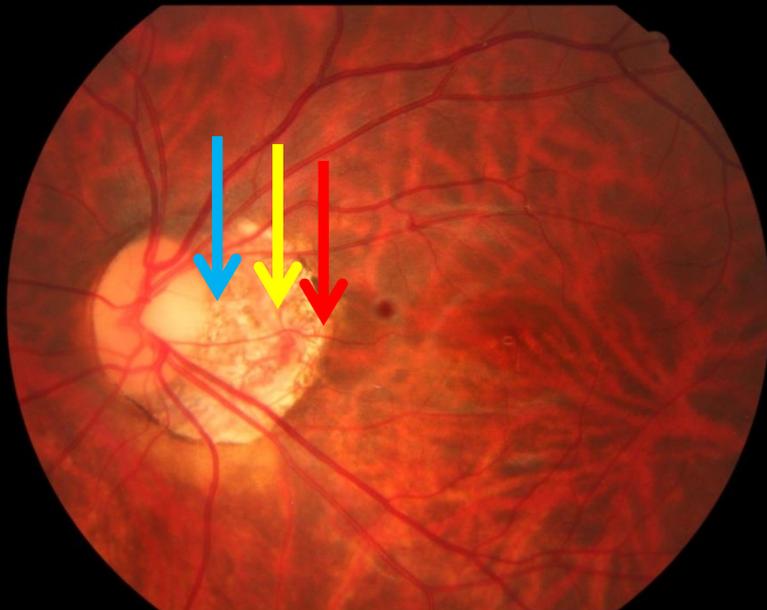
OCT Correlate of Parapapillary Region



Parapapillary Delta Zone: Peripapillary Scleral Flange in High Myopia



10 µm

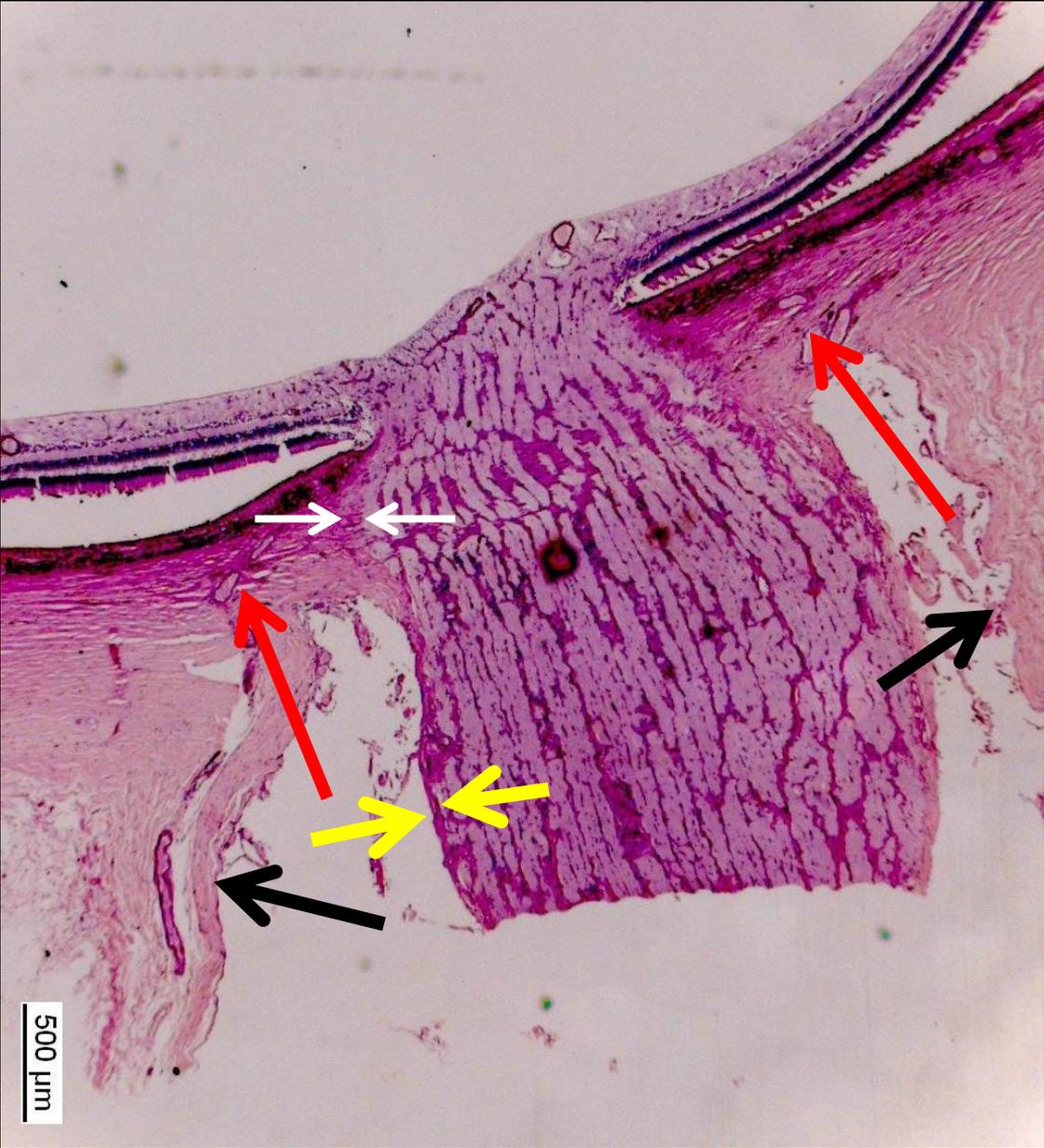


Optic Nerve Pia Mater
Optic Nerve Dura Mater

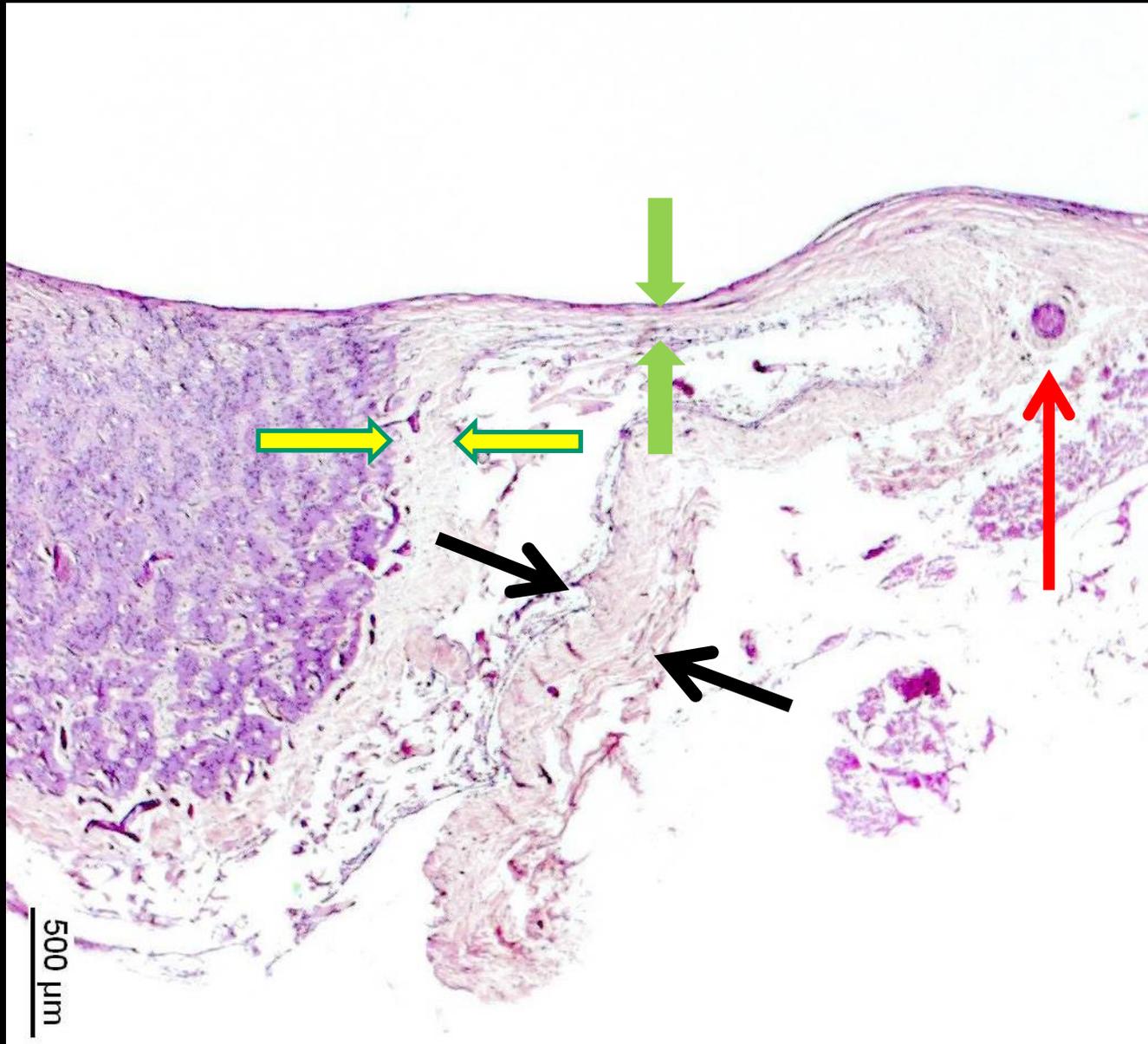
Parapapillary Delta Zone: Peripapillary Scleral Flange in High Myopia



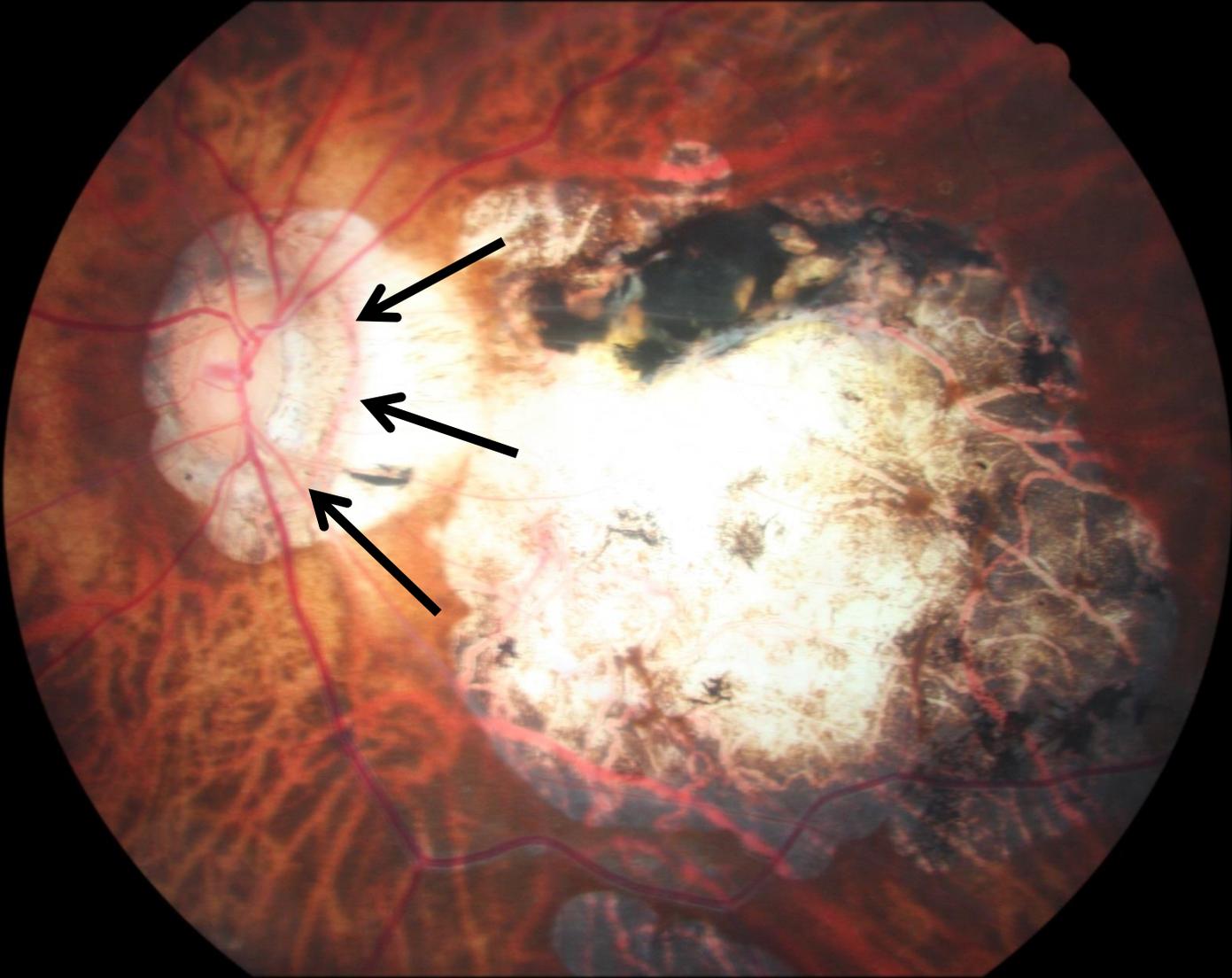
Circular Peripapillary Arterial Ring of Zinn-Haller



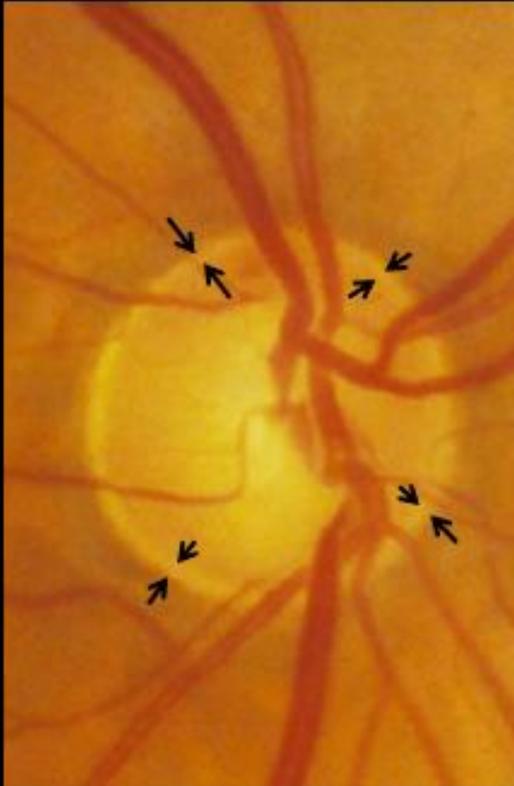
Circular Peripapillary Arterial Ring of Zinn-Haller



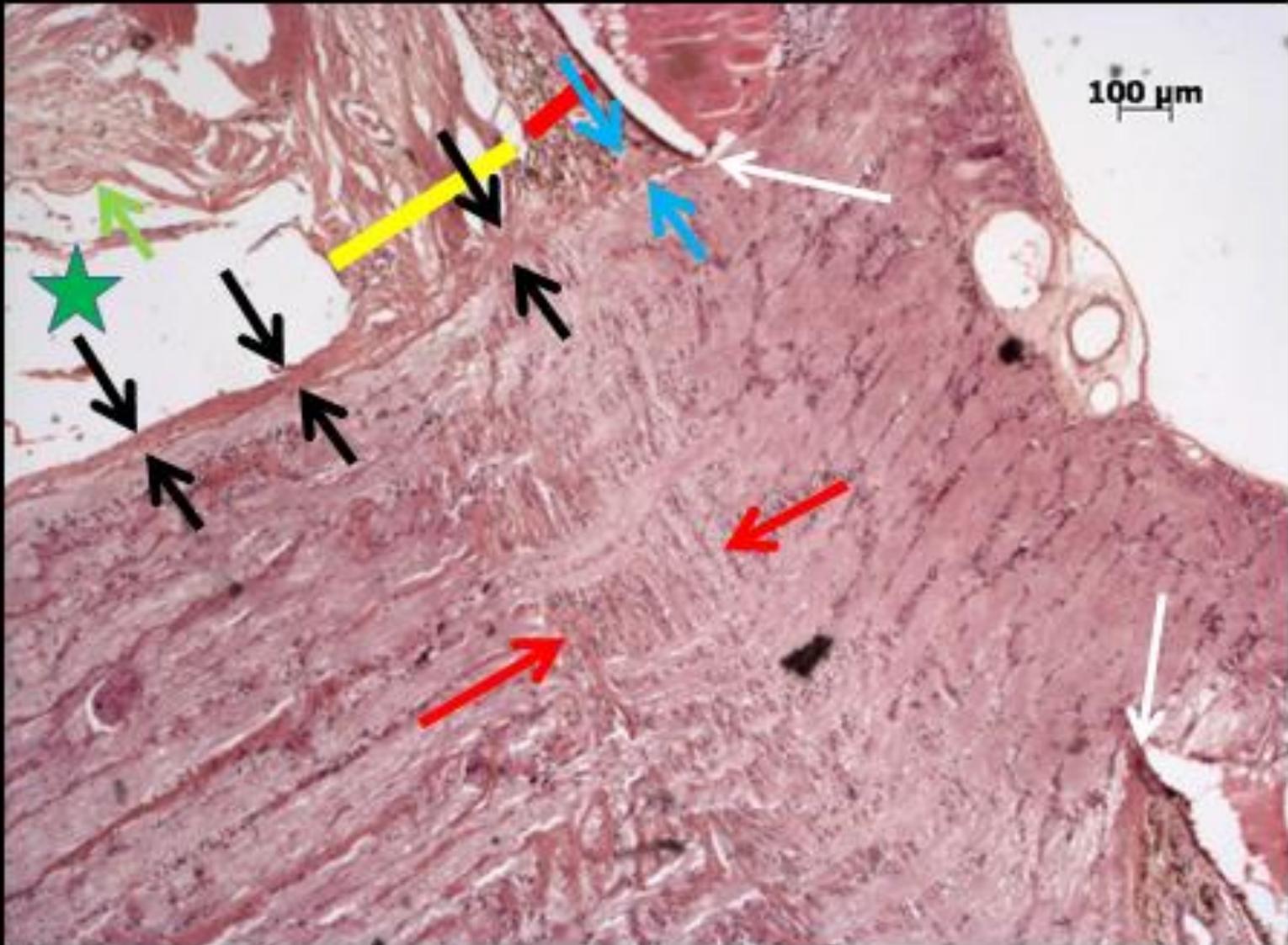
Circular Peripapillary Arterial Ring of Zinn-Haller

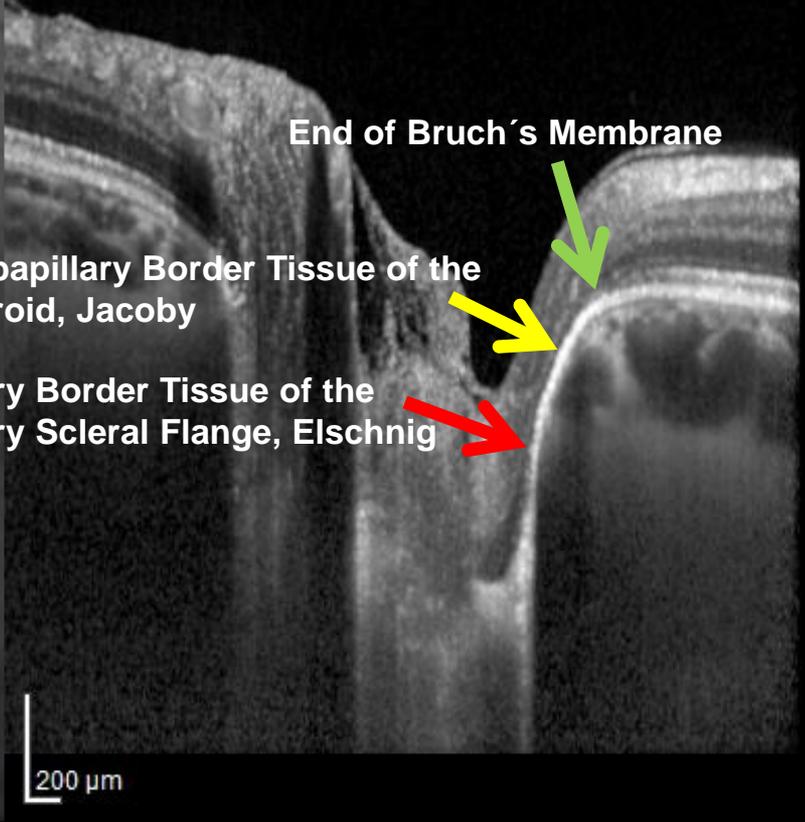
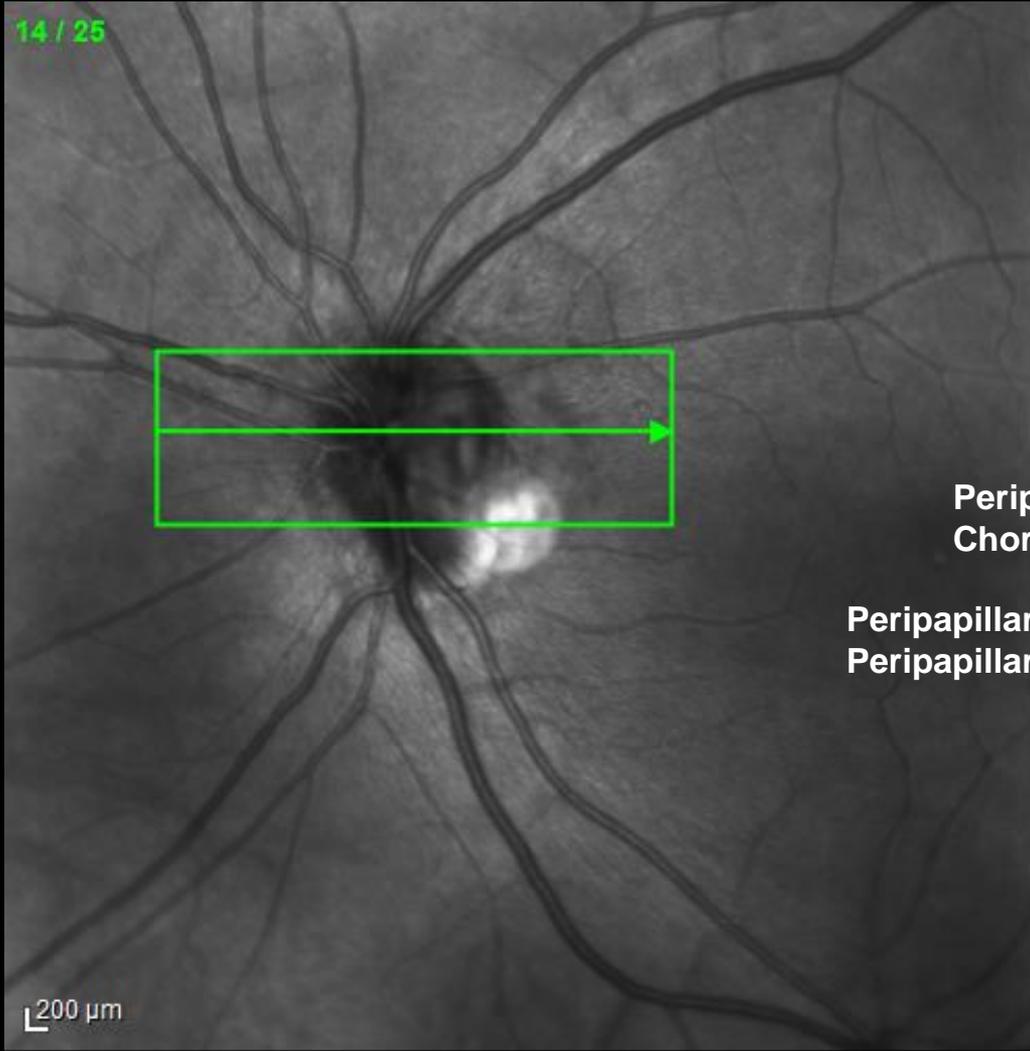


Peripapillary Ring



Peripapillary Ring





End of Bruch's Membrane

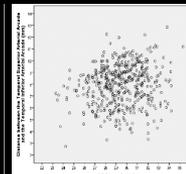
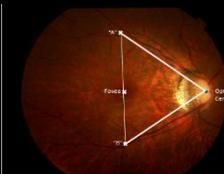
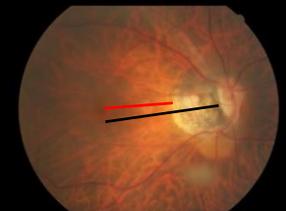
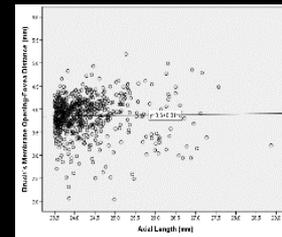
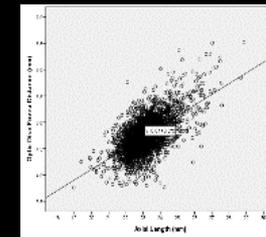
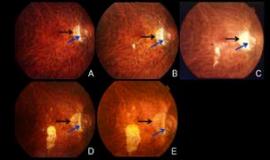
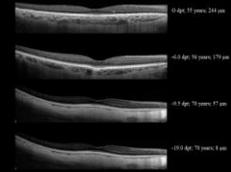
Peripapillary Border Tissue of the Choroid, Jacoby

Peripapillary Border Tissue of the Peripapillary Scleral Flange, Elschnig

Ophthalmoscopical Features of Axial Myopia

Macula:

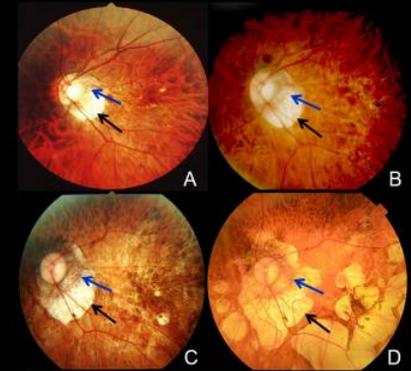
- Fundus tessellation with thinning of the posterior choroid (leptochoroid)
- Lacquer cracks
- Patchy atrophies (Bruch's membrane defects)
- Macular atrophy (Bruch's membrane defects)
- Choroidal neovascularization
- Retinoschisis
- Macula ridge
- Dome-Shaped macula
- Scleral staphyloma
- Disc-Fovea distance increases with longer axial length
- Length of (horizontal) macular Bruch's membrane (Disc-fovea distance minus parapapillary gamma zone width) is not related with axial length (if > 24 mm)
- Length of (vertical) macular Bruch's membrane (distance temp. arterial arcade) is not significantly related with axial length, so that the angle kappa decreases in myopia



Ophthalmoscopical Features of Axial Myopia

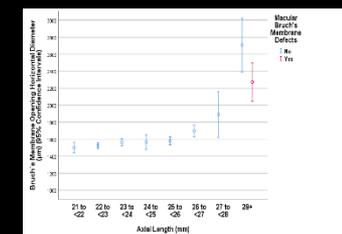
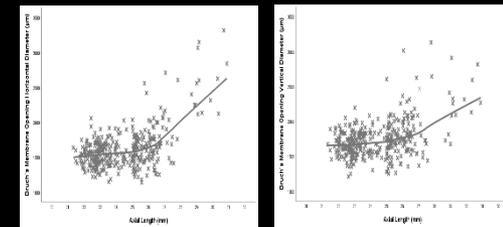
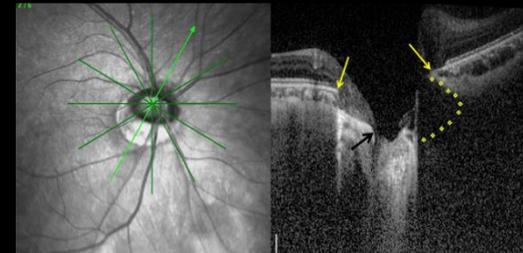
Optic nerve head:

- Parapapillary gamma zone enlargement temporal by a temporal shift of the Bruch's membrane opening
- Gamma Zone enlargement circular
- Delta zone enlargement (elongation of peripapillary scleral flange)
- Optic disc (lamina cribrosa) enlargement



Histology:

- Shift of Bruch's membrane in temporal direction leading to BM overhanging nasally and lack of BM temporally (gamma zone)
- Elongation and thinning of the lamina cribrosa (decrease in distance between intravitreal cavity and retrobulbar compartment)
- BM-free zone temporally (gamma zone) and eventually circularly
- Elongation and thinning of the peripapillary scleral flange (delta zone)

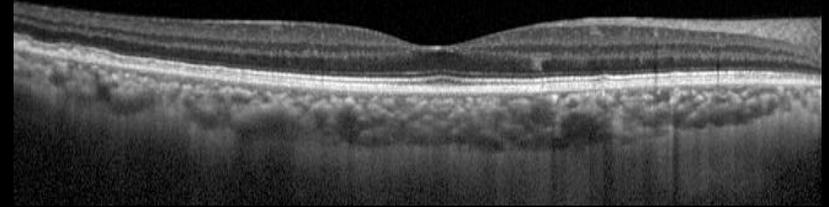


Mechanism of Process of Emmetropization (Myopization)

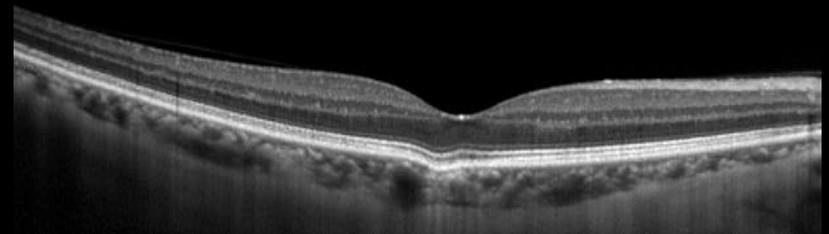
Addressing the question about the driving force to elongate the eye in myopia, one may, in contrast to the common belief, not consider the sclera but Bruch's membrane (BM) as the primary driver elongating the globe, since:

- If the sclera was the primary moving structure in axial elongation, the choroidal space would widen.

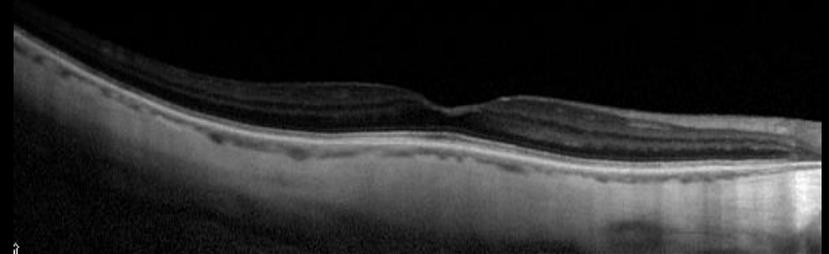
0 dpt; 55 years; 244 μm



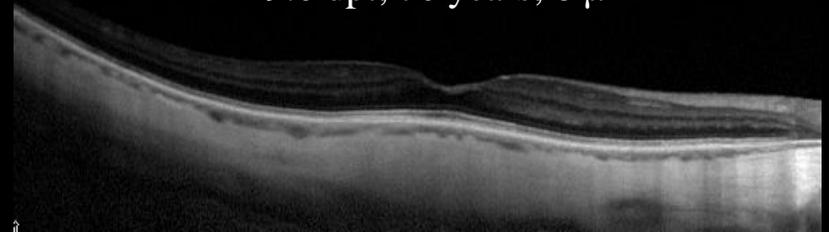
-6.0 dpt; 56 years; 179 μm



-9.5 dpt; 70 years; 57 μm

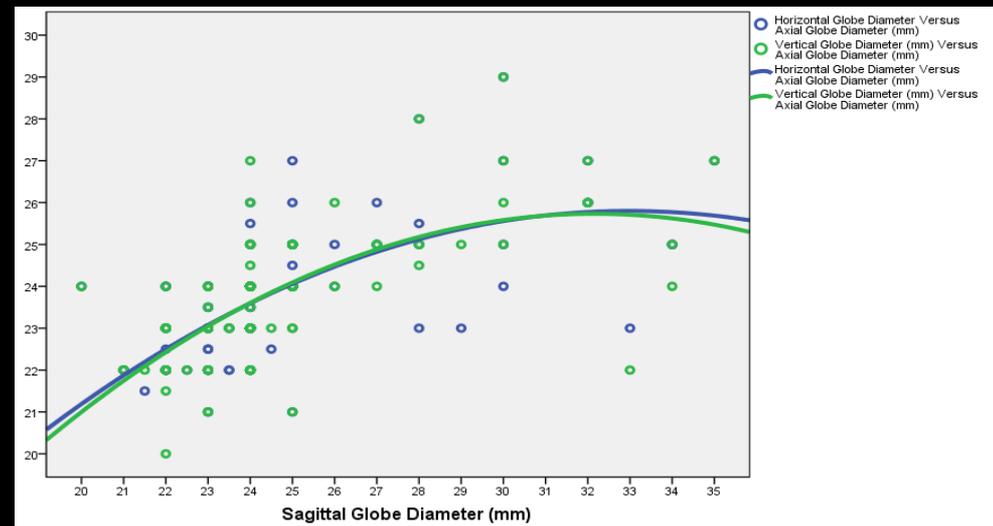
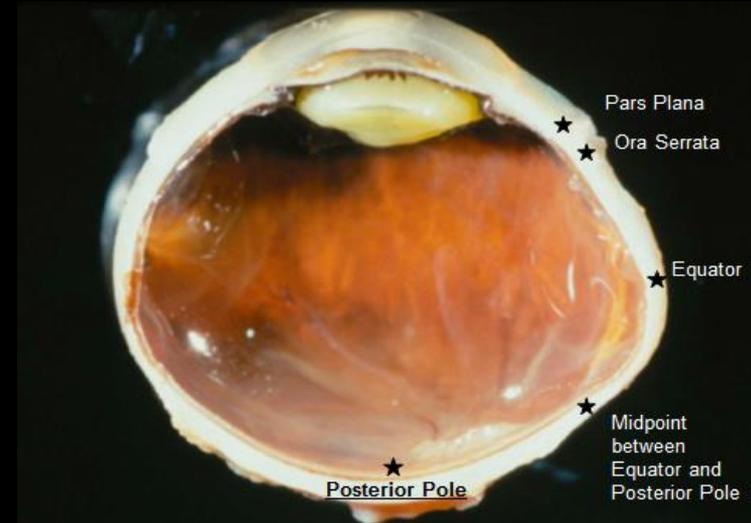


-19.0 dpt; 70 years; 8 μm



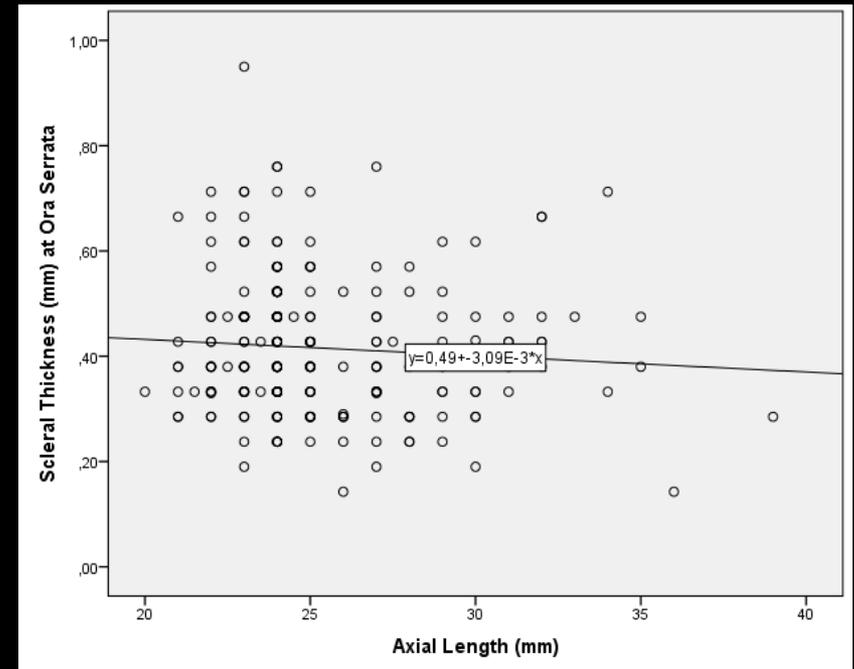
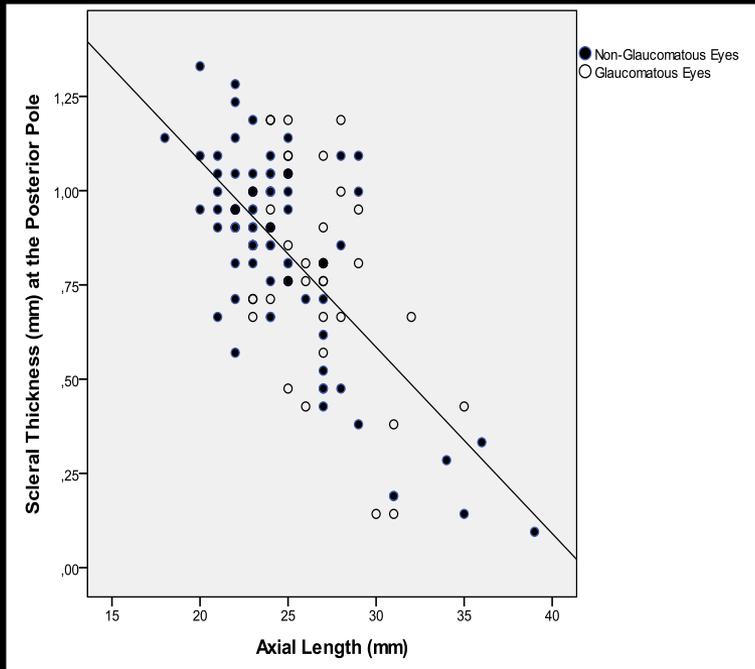
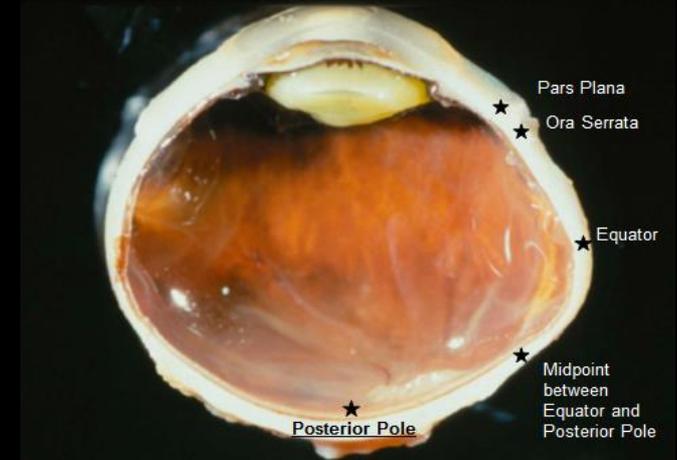
Mechanism of Process of Emmetropization (Myopization) Bruch's Membrane as Biomechanically Supporting Structure

- **Globe Diameters:**
 - Axial length >24 mm, the horizontal and vertical globe diameter increases by 0.19mm and 0.21mm, respectively, for each mm increase in axial diameter
 - It suggests an elongation of the eye walls in regions close to the equator.



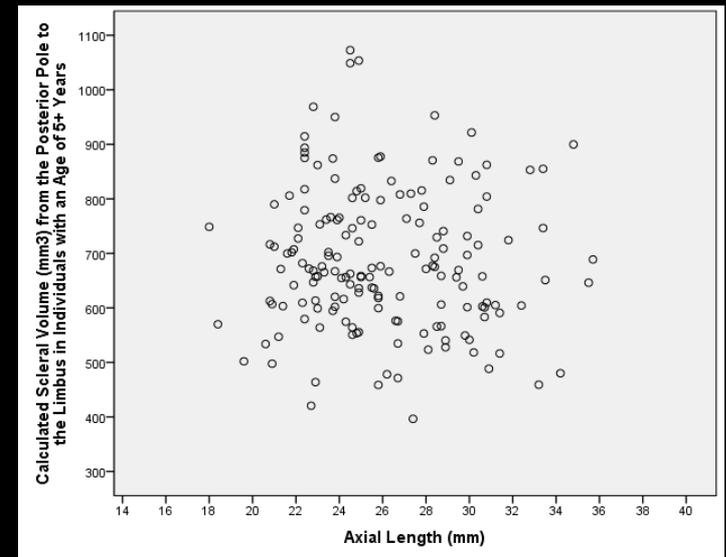
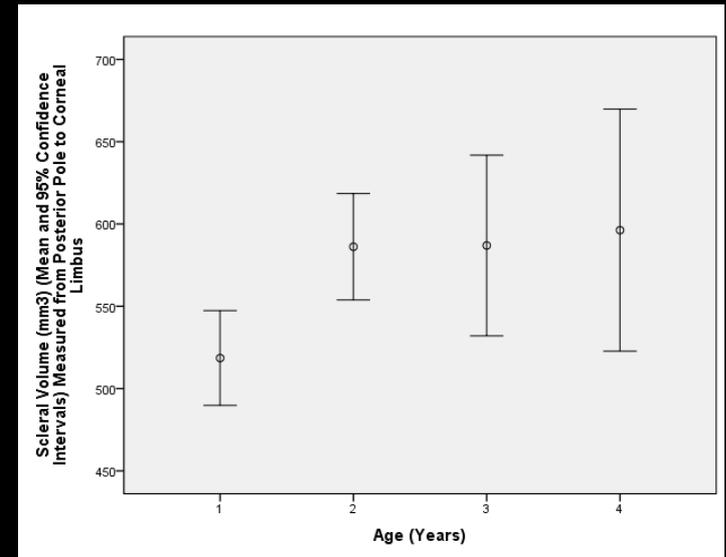
Mechanism of Process of Emmetropization (Myopization) Bruch's Membrane as Biomechanically Supporting Structure

- Scleral thickness:
 - Decreases with longer axial length, most marked at the posterior pole, least marked in pars plana region



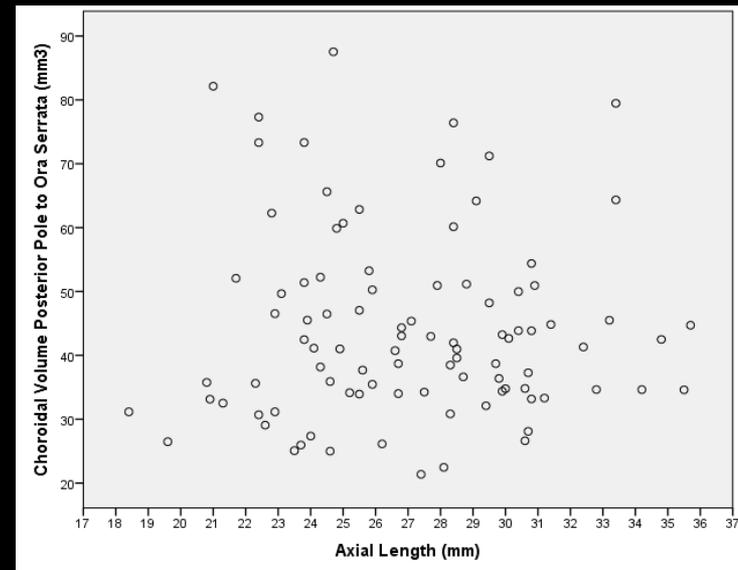
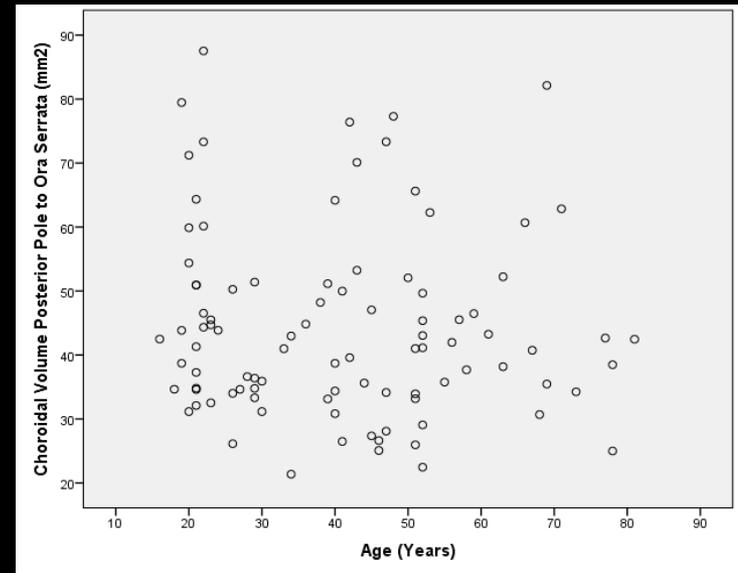
Mechanism of Process of Emmetropization (Myopization) Bruch's Membrane as Biomechanically Supporting Structure

- Scleral Volume:
 - Increases up to the end of the second year of life, and remains then constant
 - In individuals aged ≥ 5 years, scleral volume is not significantly associated with axial length ($P=0.70$)
 - There is no active scleral growth



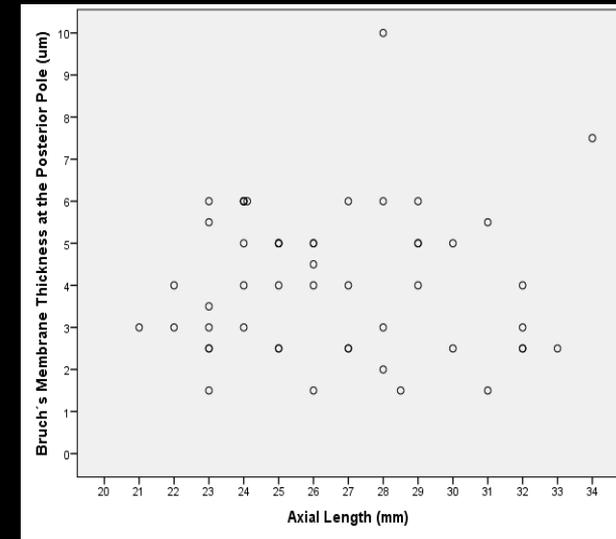
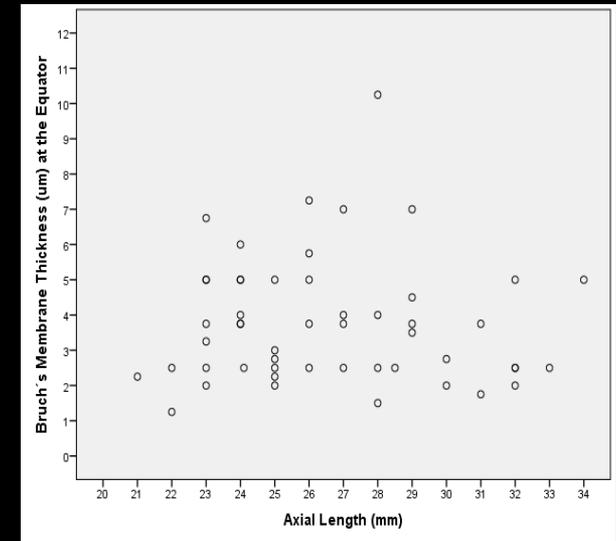
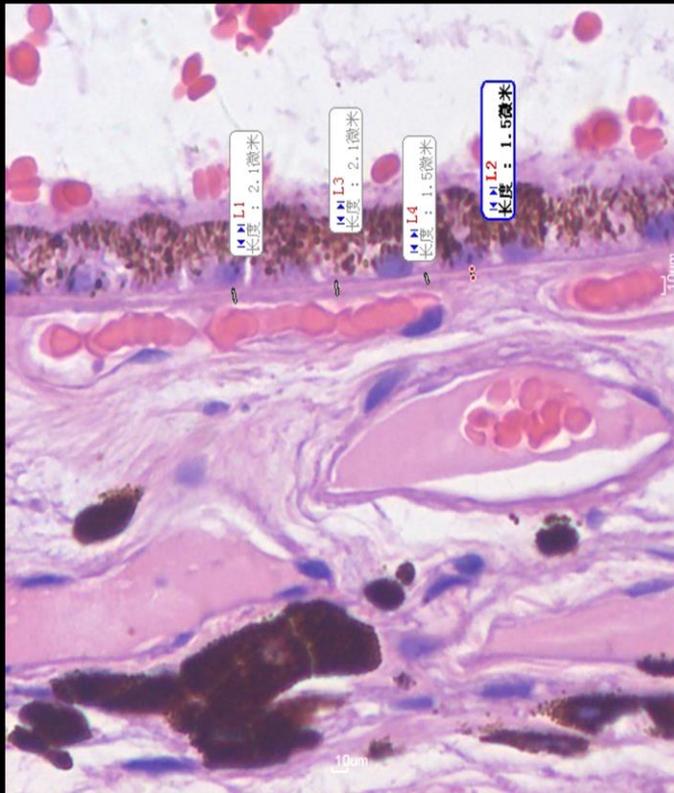
Mechanism of Process of Emmetropization (Myopization) Bruch's Membrane as Biomechanically Supporting Structure

- Choroidal Volume:
 - Not significantly associated with age ($P=0.47$) or axial length ($P=0.83$) in individuals aged 16+ years.
 - There is no active choroidal growth



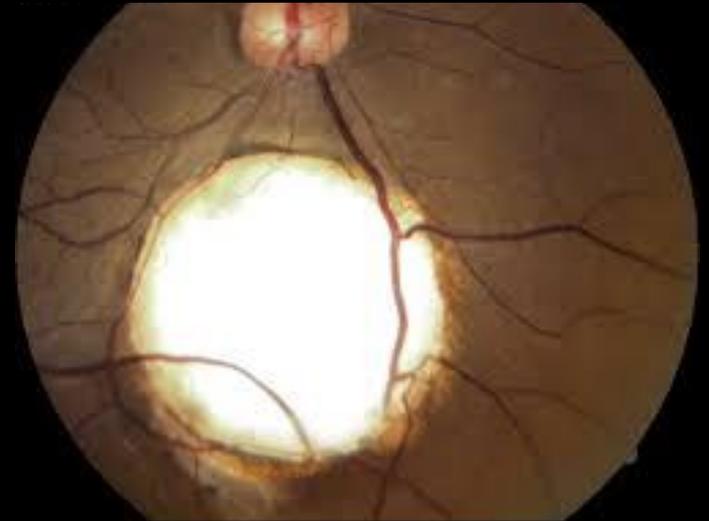
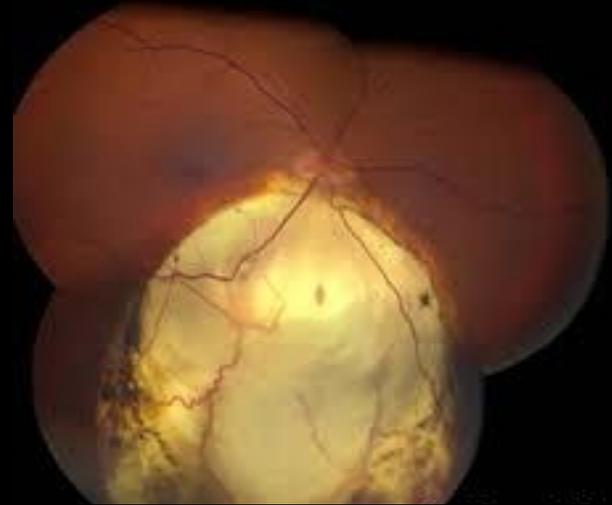
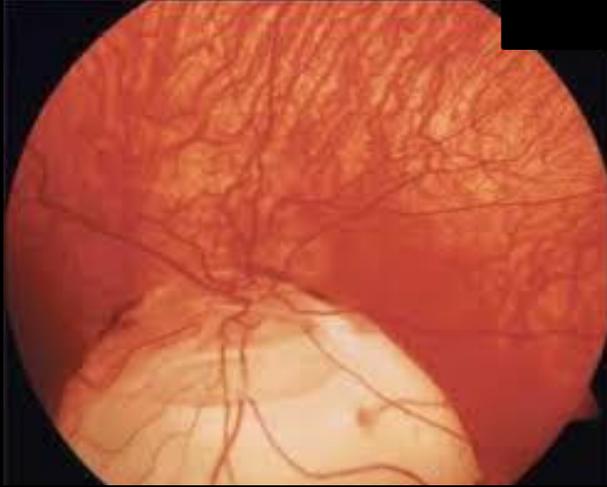
Mechanism of Process of Emmetropization (Myopization) Bruch's Membrane as Biomechanically Supporting Structure

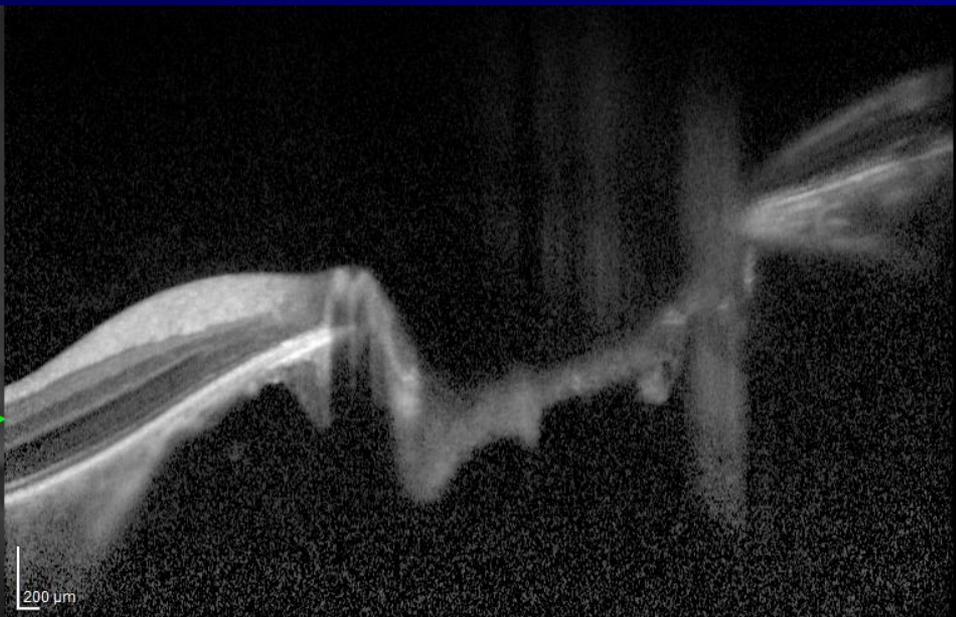
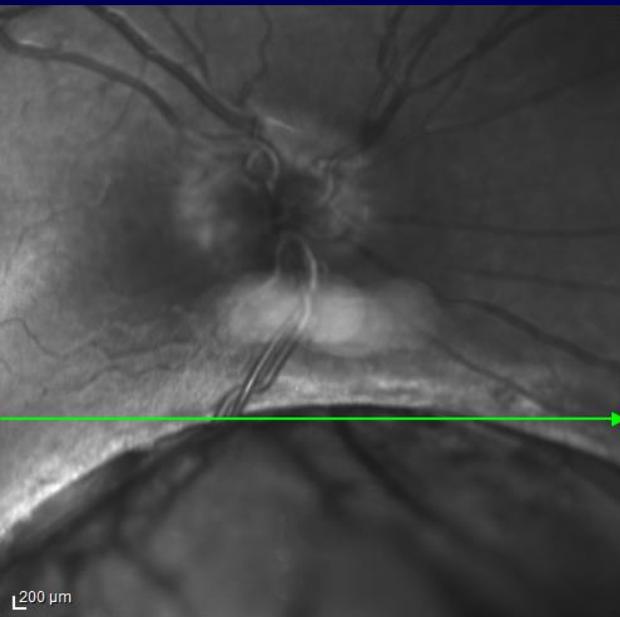
- In contrast to sclera and choroid, BM thickness at any location is not (all $P > 0.45$) related with axial length.
- BM increases in volume with axial length



Mechanism of Process of Emmetropization (Myopization) Bruch's Membrane as Biomechanically Supporting Structure

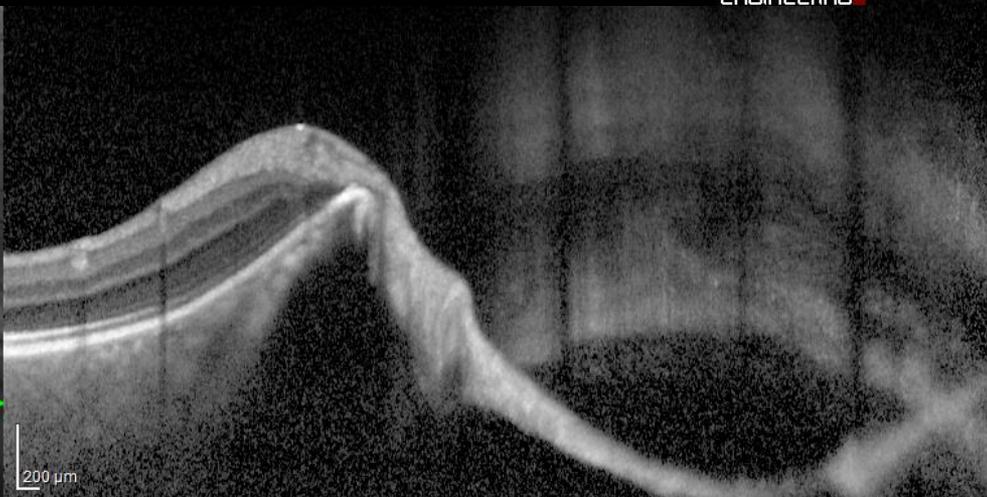
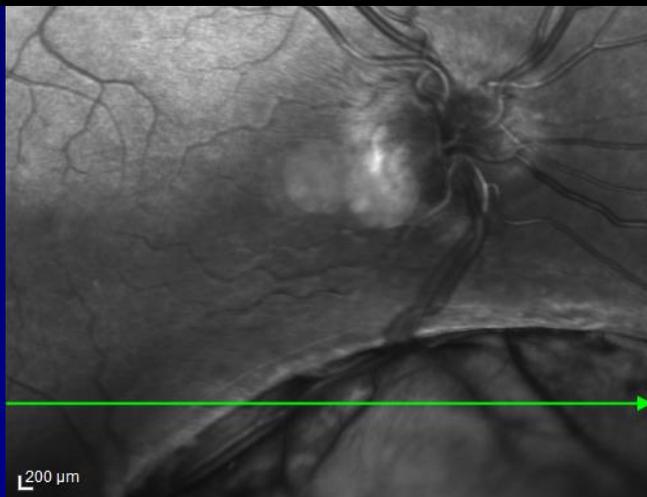
- Primary Bruch's membrane defects in congenital colobomata are associated with scleral staphyloma





04.12.2020, OD
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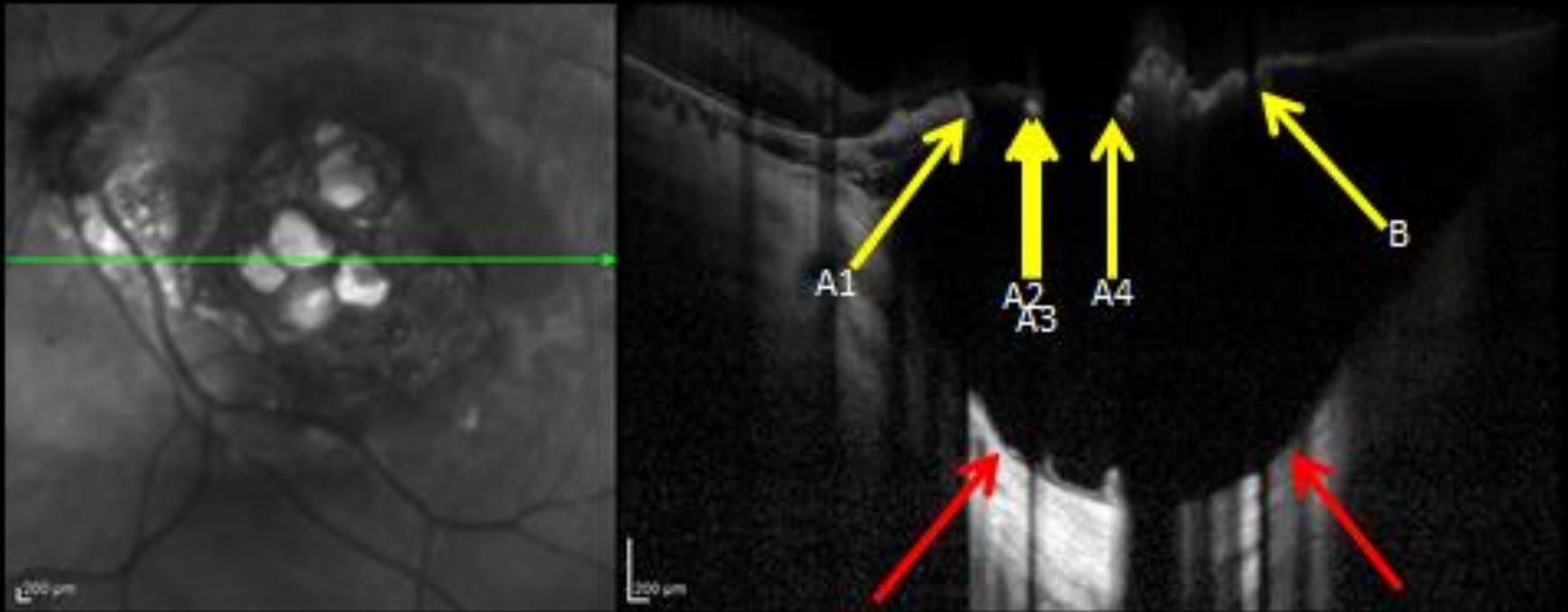
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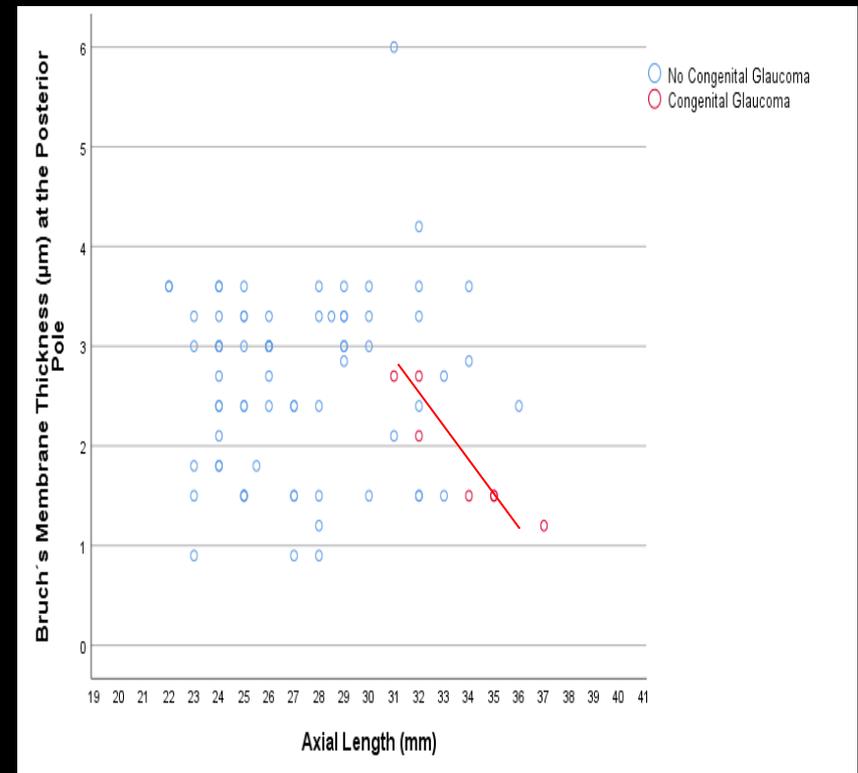
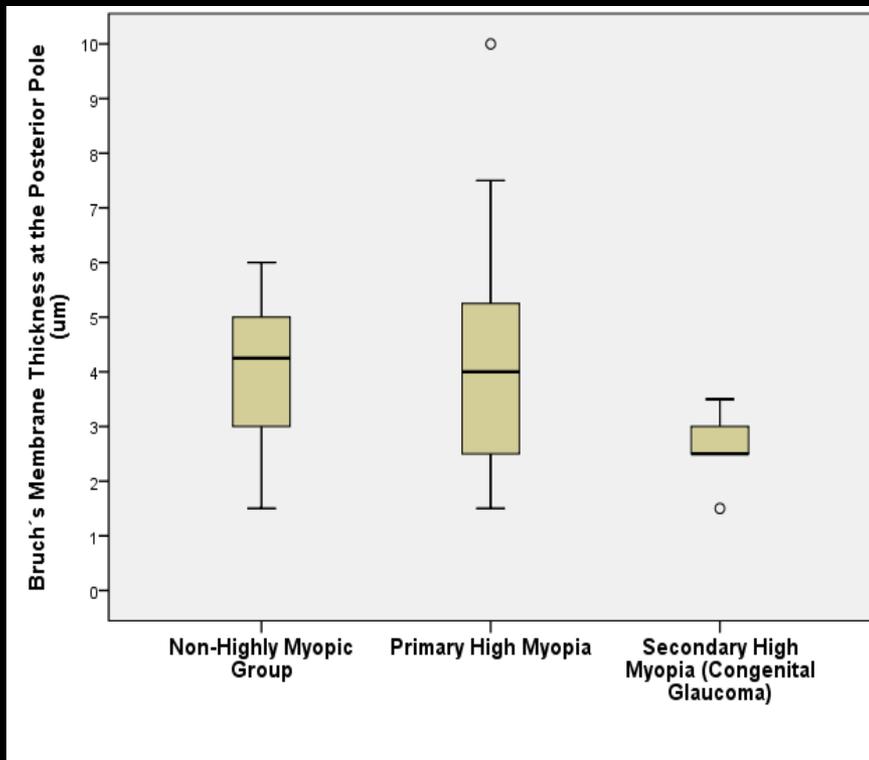
Mechanism of Process of Emmetropization (Myopization) Bruch's Membrane as Biomechanically Supporting Structure

- Secondary Bruch's Membrane defects are associated with collateral scleral staphyloma (toxoplasmotic scars)



Mechanism of Process of Emmetropization (Myopization) Bruch's Membrane as Biomechanically Supporting Structure

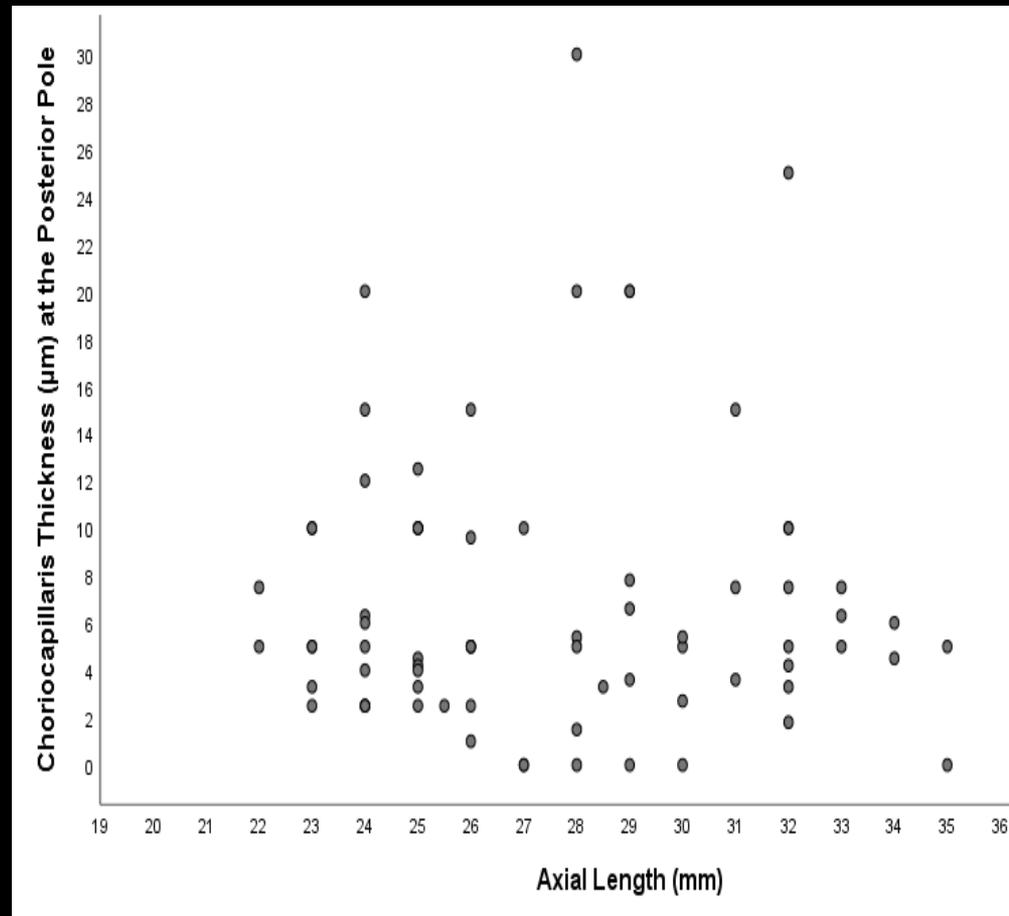
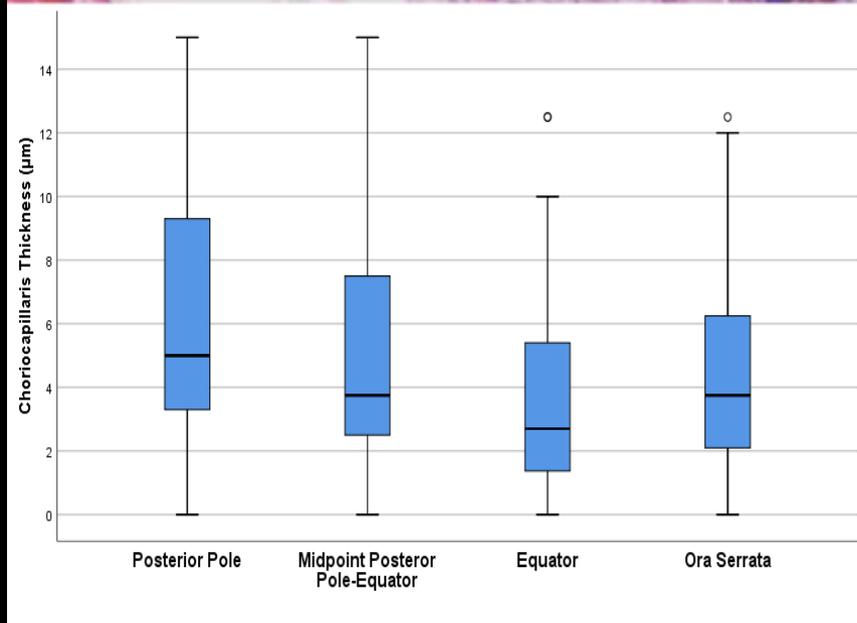
- In secondary high myopia due to congenital glaucoma, Bruch's membrane is thinner than in primary high myopia or emmetropia, and decreases with longer axial length



Jonas JB, Holbach L, Panda-Jonas S. Histologic differences between primary high myopia and secondary high myopia due to congenital glaucoma. *Acta Ophthalmol* 2016;94:147-153

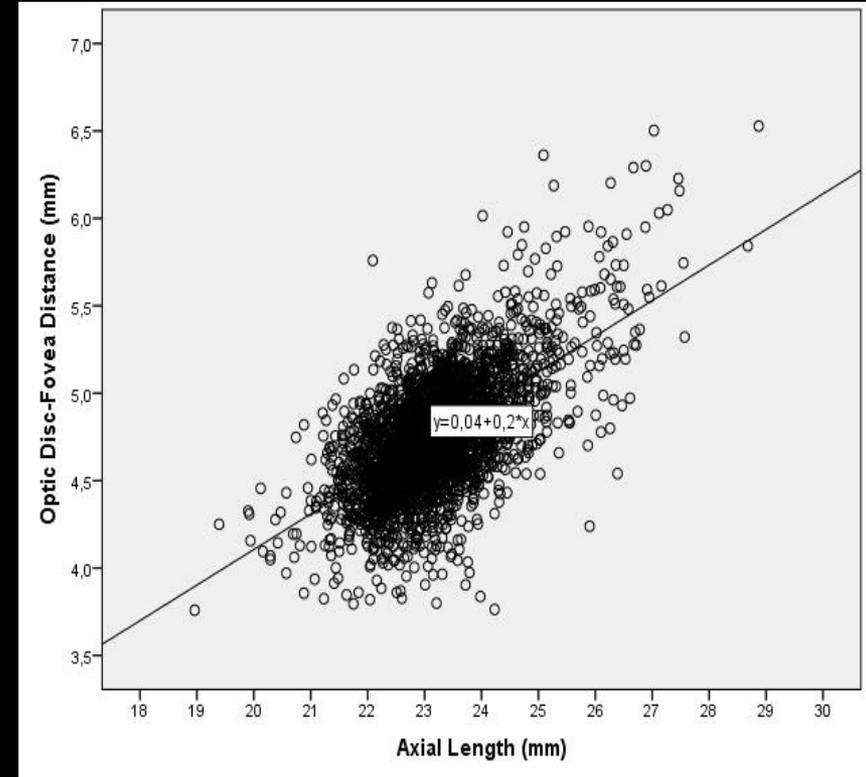
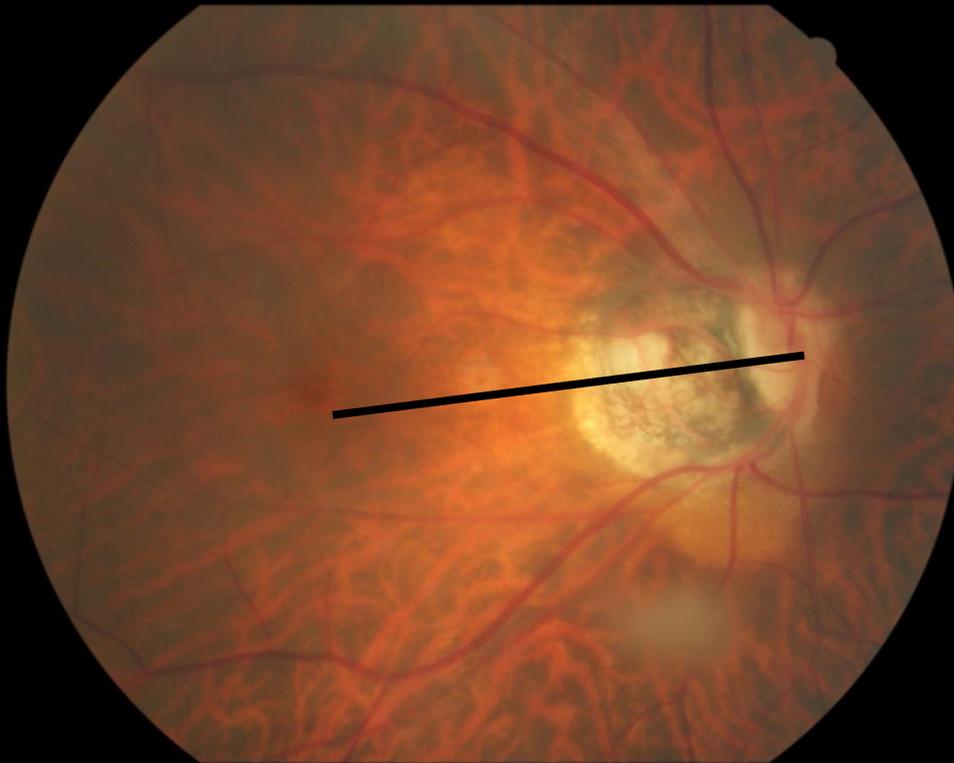
Jonas JB, Dong L, Holbach L, Panda-Jonas S. Retinal pigment epithelium cell density and Bruch's membrane thickness in secondary versus primary high myopia and emmetropia. Submitted

Choriocapillaris Thickness and Density in High Myopia



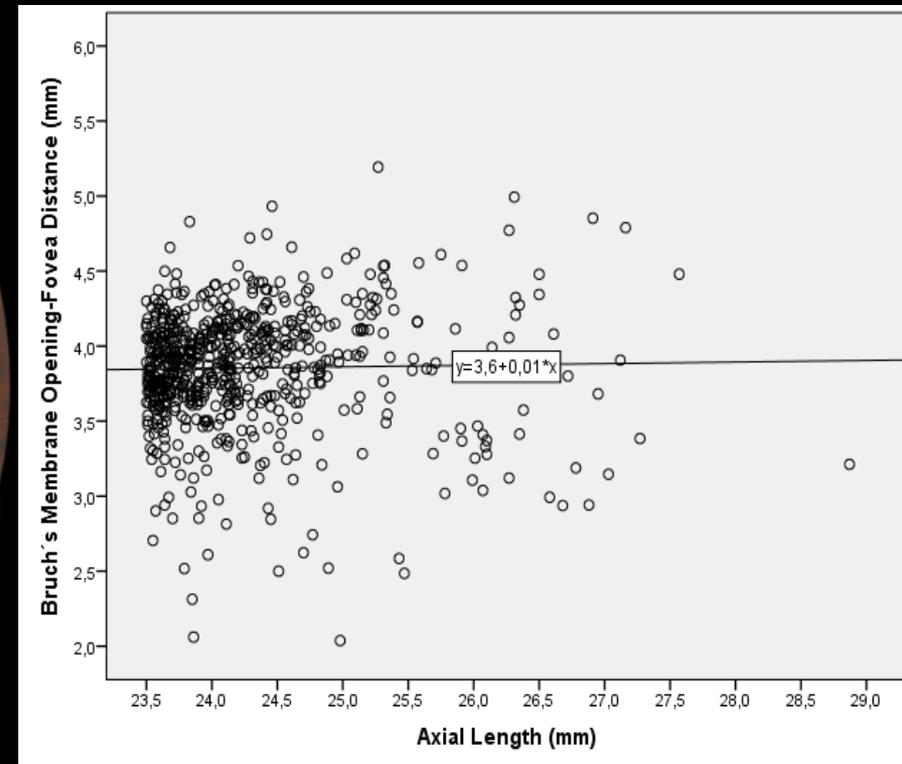
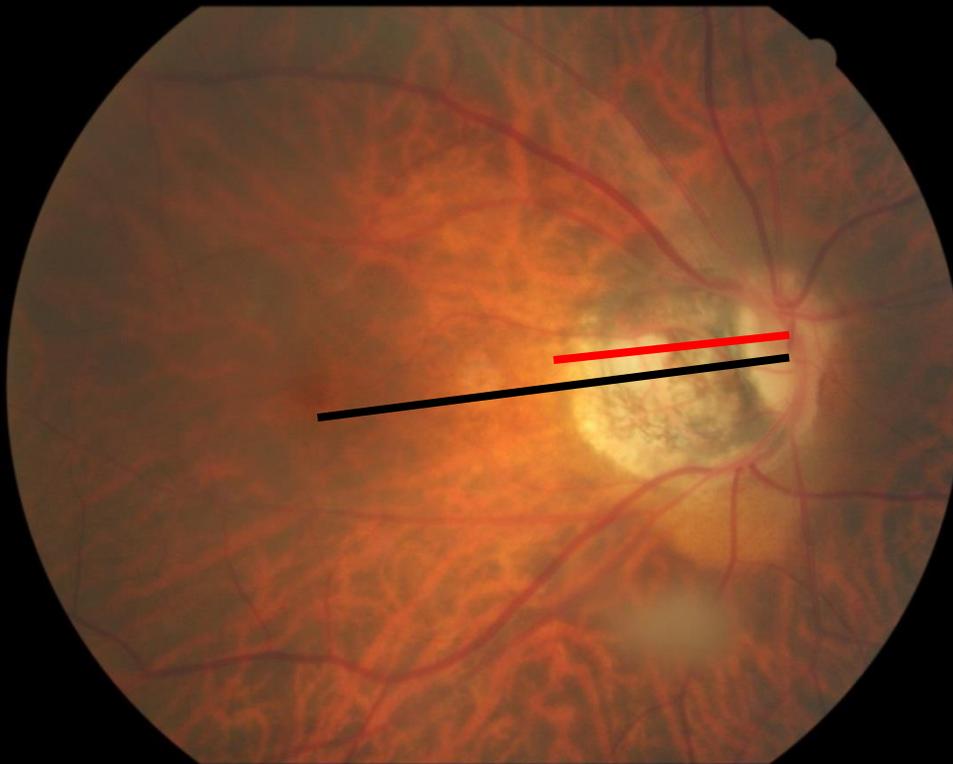
Mechanism of Process of Emmetropization (Myopization) Bruch's Membrane as Biomechanically Supporting Structure

- Optic disc-fovea distance increased with longer axial length



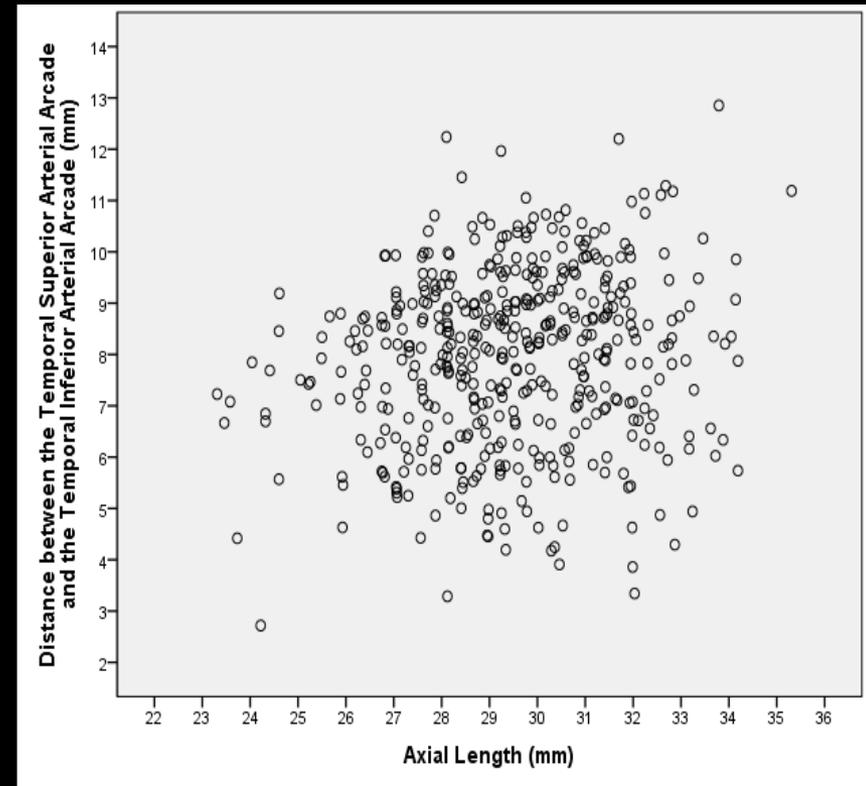
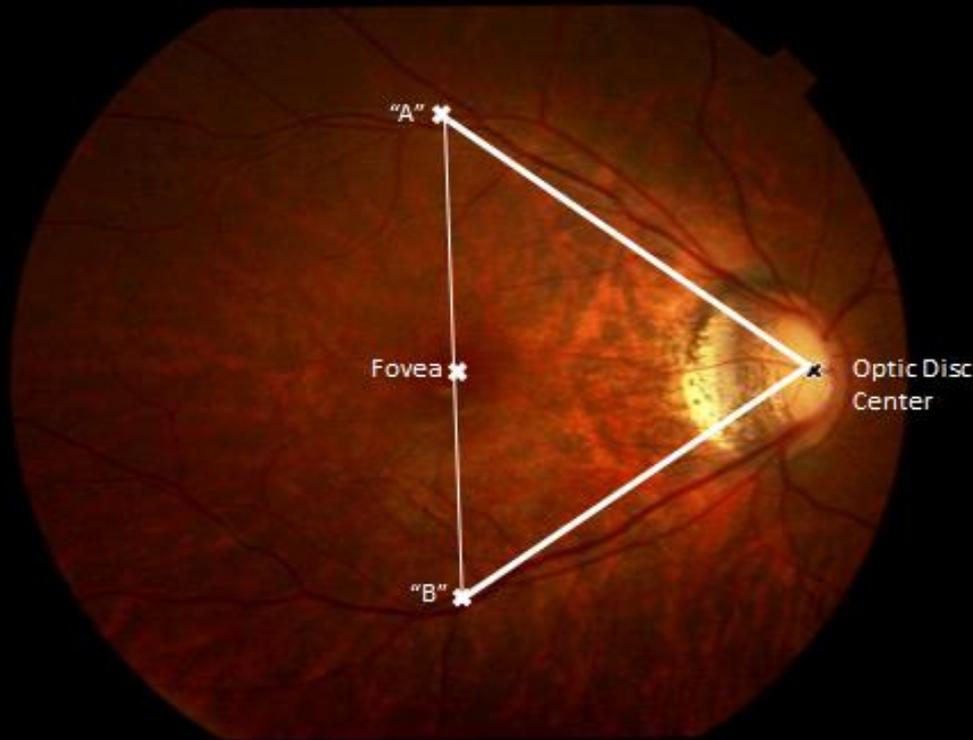
Mechanism of Process of Emmetropization (Myopization) Bruch's Membrane Biomechanically Supporting Structure

- Length of (horizontal) macular Bruch's membrane (Disc-fovea distance minus parapapillary gamma zone width) is not related with axial length (if > 24 mm)



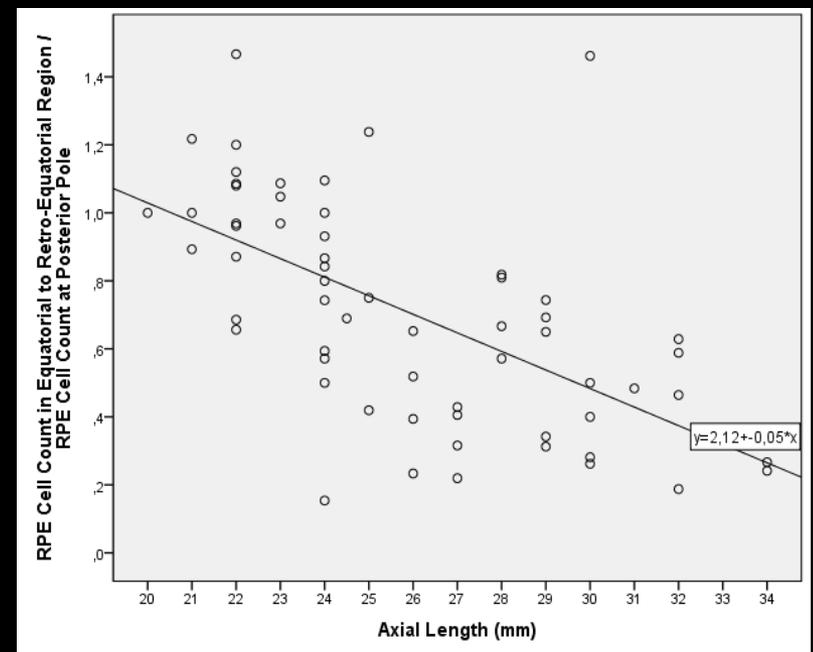
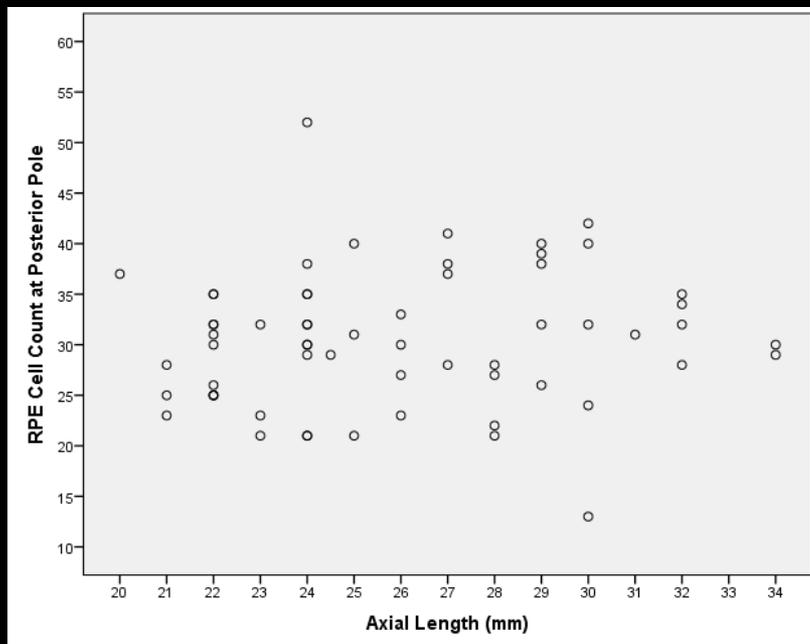
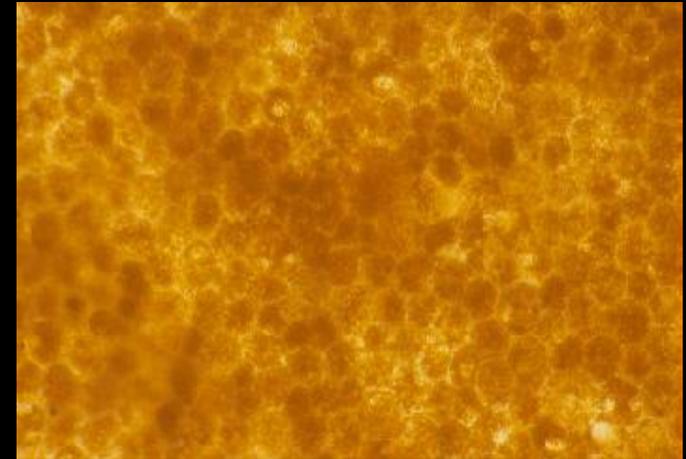
Mechanism of Process of Emmetropization (Myopization) Bruch's Membrane as Biomechanically Supporting Structure

- Length of (vertical) macular Bruch's membrane (distance temp. arterial arcade) is not significantly related with axial length, so that the angle kappa decreases in myopia



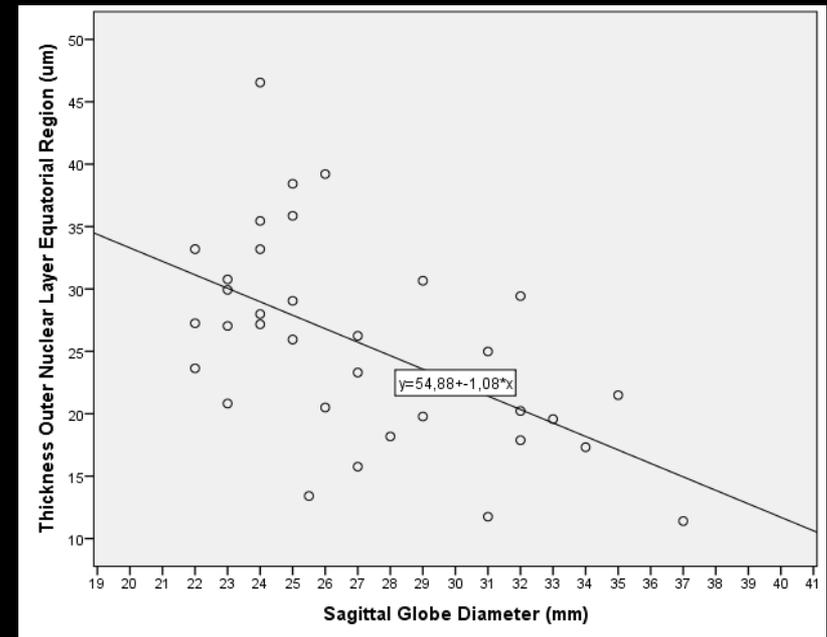
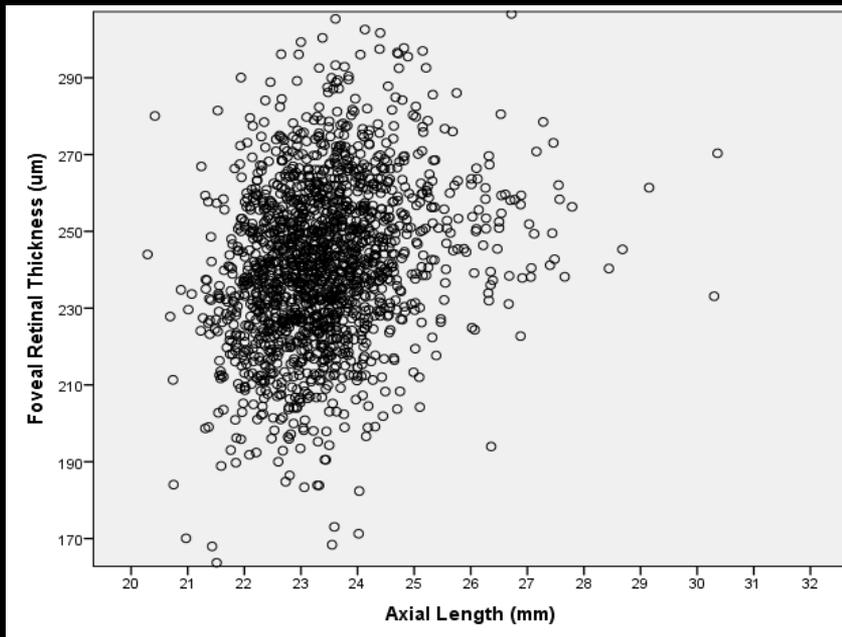
Mechanism of Process of Emmetropization (Myopization) Bruch's Membrane as Biomechanically Supporting Structure

- Retinal pigment epithelium cell density is independent of axial length at the posterior pole and ora serrata, while
- It decreases with longer axial length in the equatorial to retro-equatorial region, where presumable the feedback mechanism of emmetropization is located.



Mechanism of Process of Emmetropization (Myopization) Bruch's Membrane as Biomechanically Supporting Structure

- Retinal thickness is independent of axial length in the macula, while
- It decreases with longer axial length in the equatorial to retro-equatorial region.
- Correspondingly, best corrected visual acuity is independent of axial length

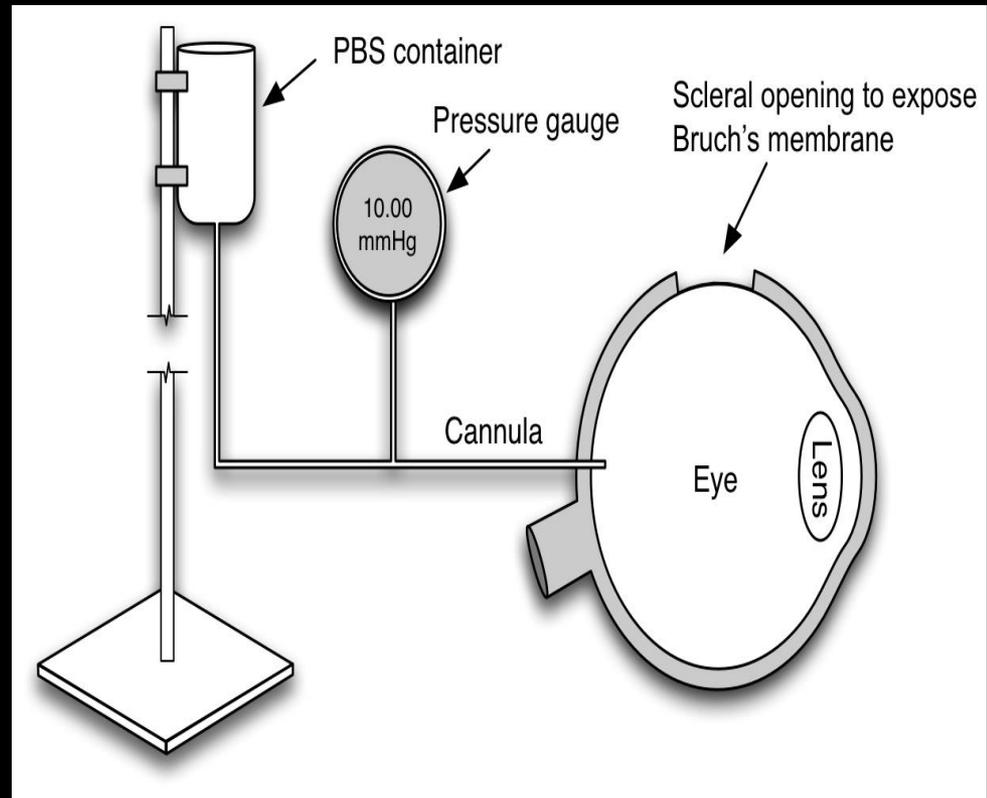


Potential Mechanism of Process of Emmetropization (Myopization)

- Up to second year of life, globe increases spherically with increase in scleral volume
- Beyond that age, process of emmetropization: Fine-tuning of optical axis length to the optical characteristics of lens and cornea
- Axial elongation by production and elongation of Bruch's membrane in the equatorial region: Sagittal enlargement (1 mm in length to 0.2 mm in vertical / horizontal direction)
- Explains decrease in RPE density and retinal thinning at the equator
- Fovea primarily unaffected: Retinal thickness, RPE density, choriocapillaris thickness and best corrected visual acuity normal
- Increase in disc-fovea distance due to parapapillary gamma zone
- Enlargement of Bruch's membrane opening and development of macular BM defects due to tension in BM in coronal direction
- BM as primary driver of axial elongation leads to choroidal compression (thinning)
- Also: The optical axis ends at the photoreceptor outer segments in close proximity to the RPE and BM
- The sclera is separated from the photoreceptor outer segments by the spongy and variable choroid.

Mechanism of Process of Emmetropization (Myopization) Bruch's Membrane as Biomechanically Supporting Structure

- Biomechanical strength of Bruch's membrane: Pressure required to burst BM: 82 mmHg (range: 39-147 mmHg)



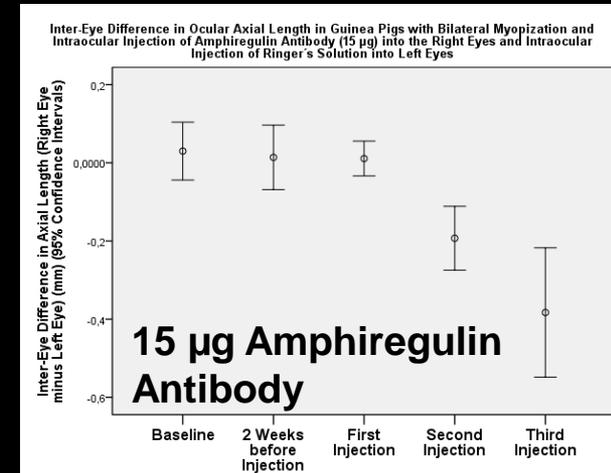
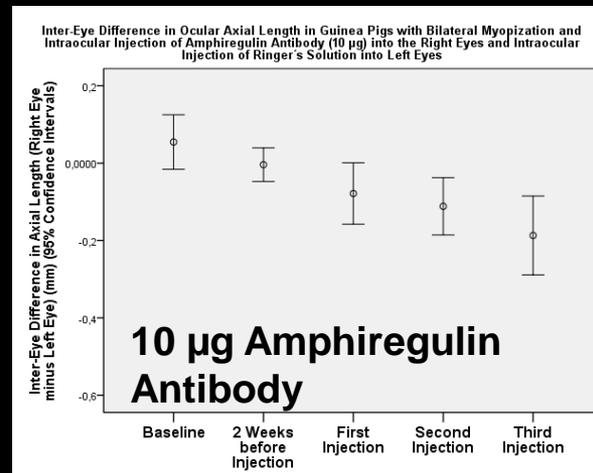
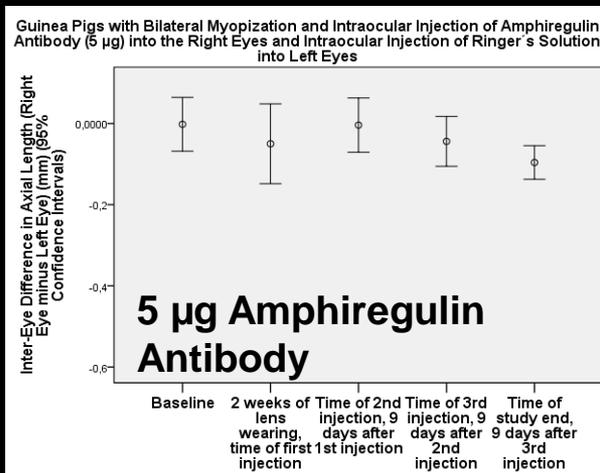
Mechanism of Process of Emmetropization (Myopization) Bruch's Membrane as Biomechanically Supporting Structure

- Experimental Myopia: Guinea pigs received unilateral intraocular injections of amphiregulin antibody (doses: 5, 10, or 15 μ g) three times in intervals of 9 days



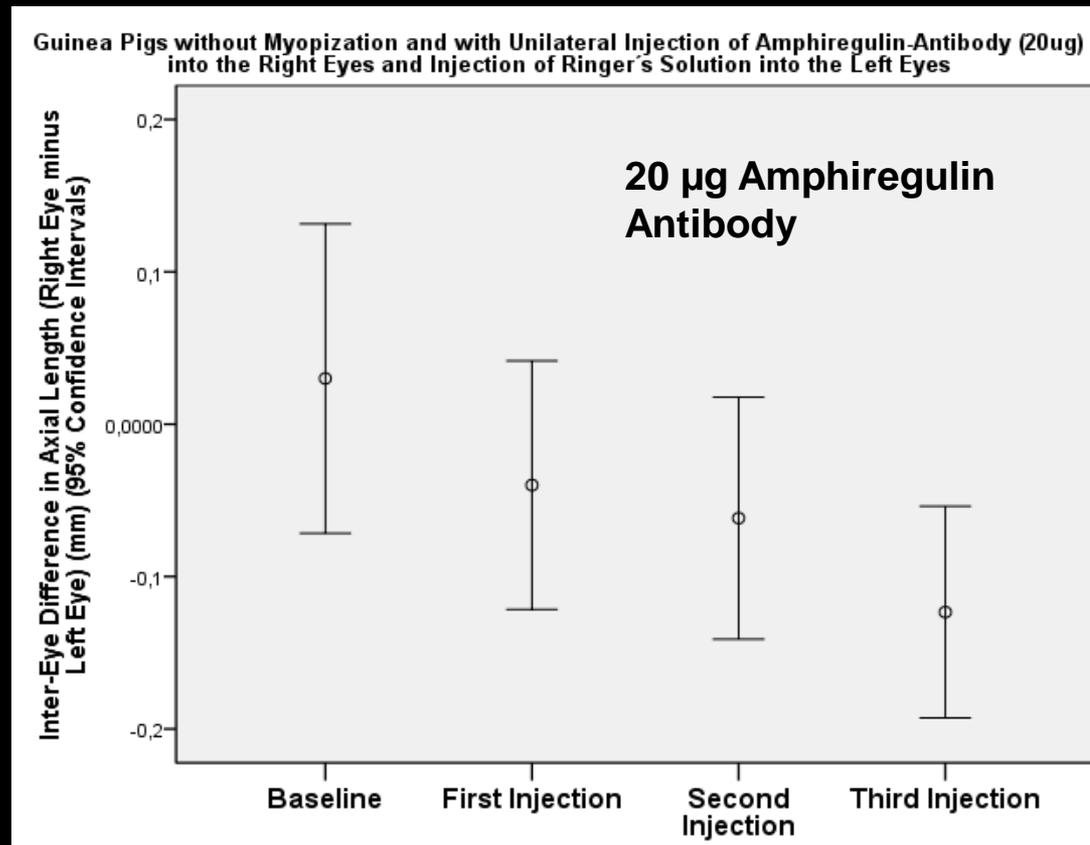
Mechanism of Process of Emmetropization (Myopization) Bruch's Membrane as Biomechanically Supporting Structure

- In an intra-animal inter-eye comparison and intra-eye follow-up comparison, study eyes with amphiregulin antibody showed a dose-dependent reduction in axial elongation.

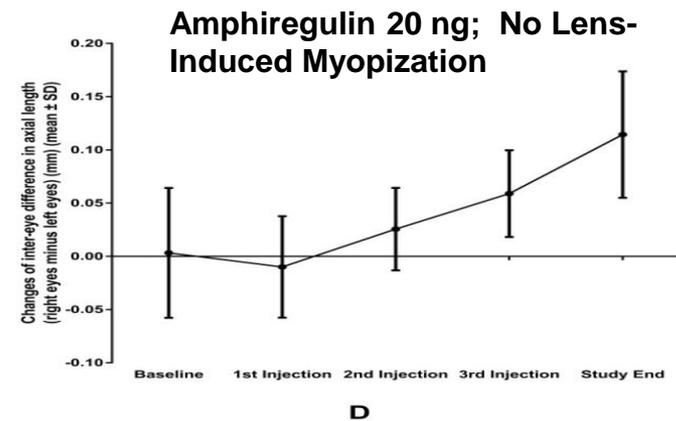
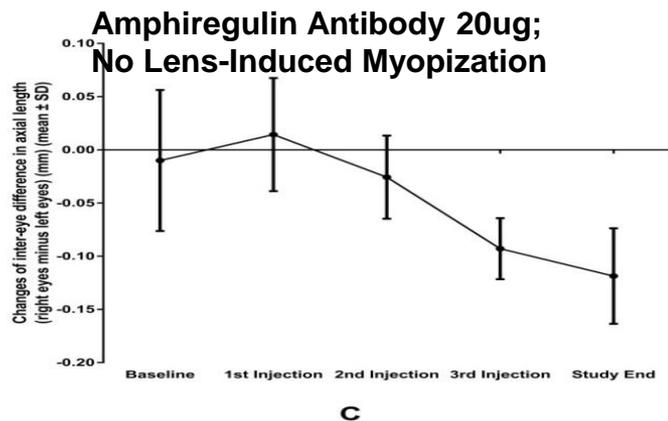
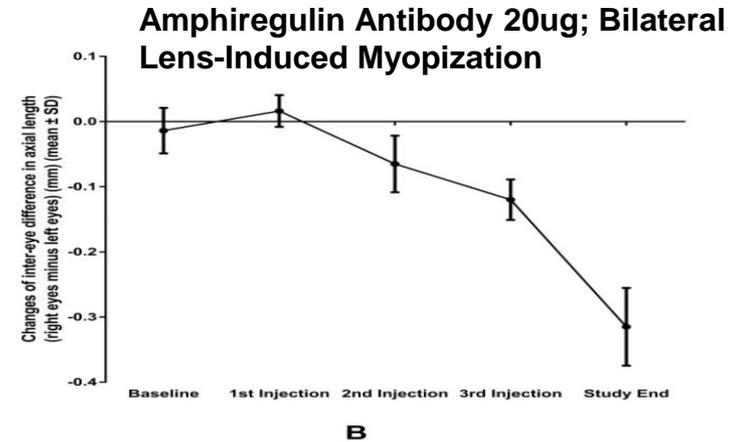
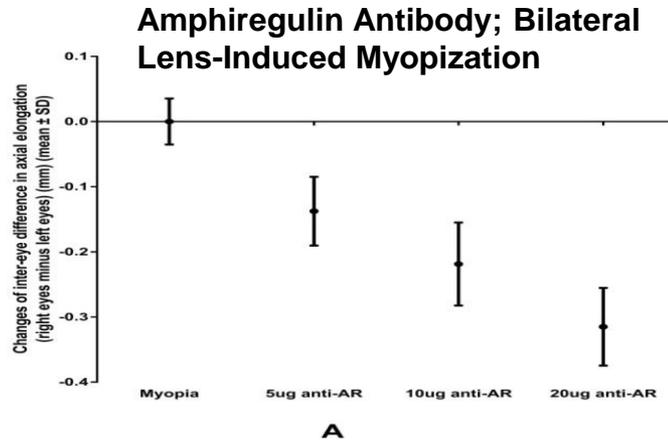


Mechanism of Process of Emmetropization (Myopization) Bruch's Membrane as Biomechanically Supporting Structure

- Guinea pigs without myopization showed shorter axial length in the injected eyes (amphiregulin antibody 20 μg)

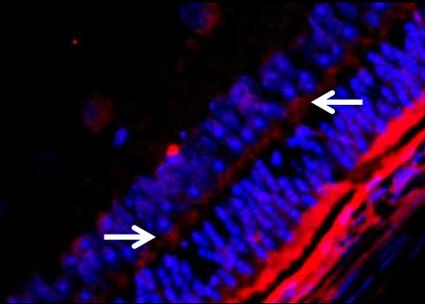


Mechanism of Process of Emmetropization (Myopization) Bruch's Membrane as Biomechanically Supporting Structure

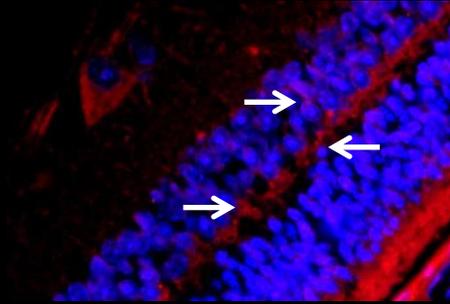


Mechanism of Process of Emmetropization (Myopization) Bruch's Membrane as Biomechanically Supporting Structure

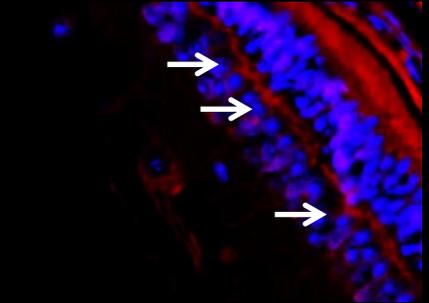
Equator



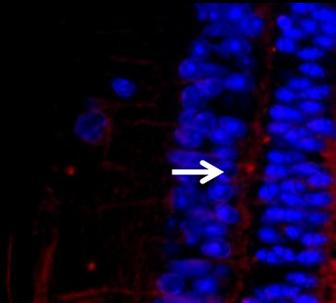
Normal



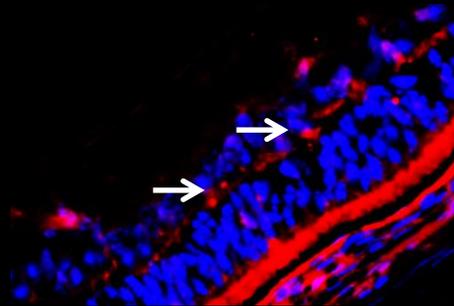
Myopia



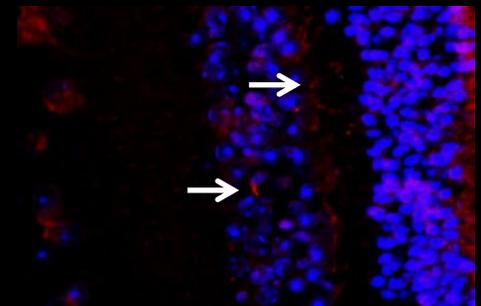
Myopia Plus PBS



Myopia + 5ug Anti-Amphiregulin



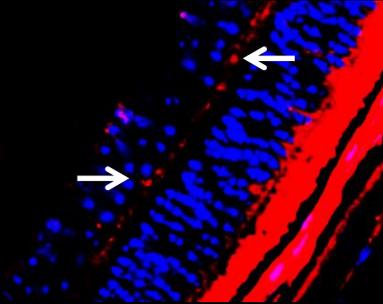
Myopia + 10ug Anti-Amphiregulin



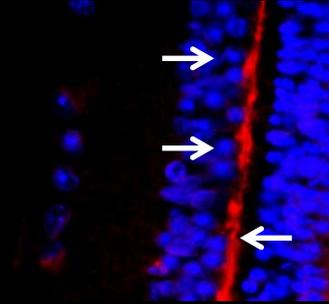
Myopia + 20ug Anti-Amphiregulin

Mechanism of Process of Emmetropization (Myopization) Bruch's Membrane as Biomechanically Supporting Structure

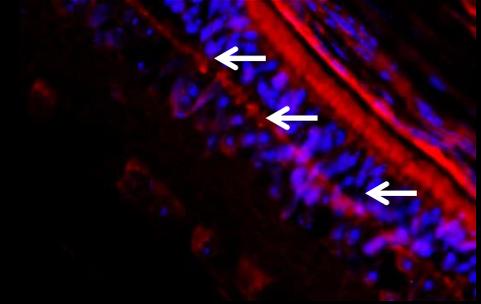
Midpoint Between Equator and Posterior Pole



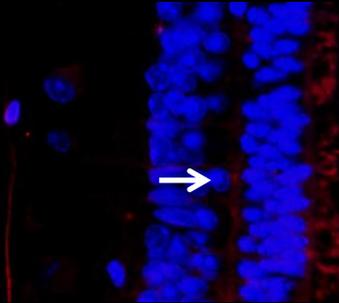
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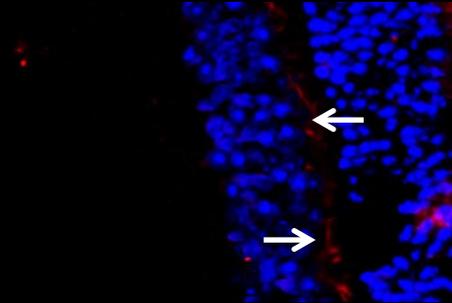
Myopia



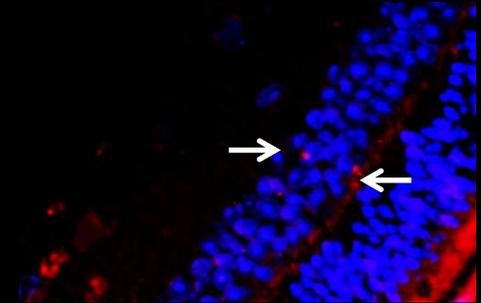
Myopia Plus PBS



Myopia + 5ug Anti-Amphiregulin



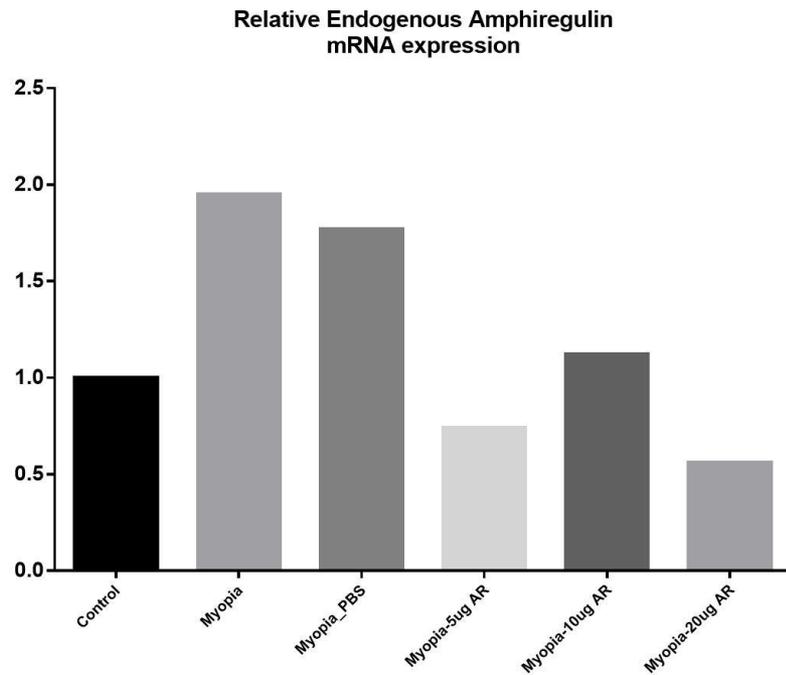
Myopia + 10ug Anti-Amphiregulin



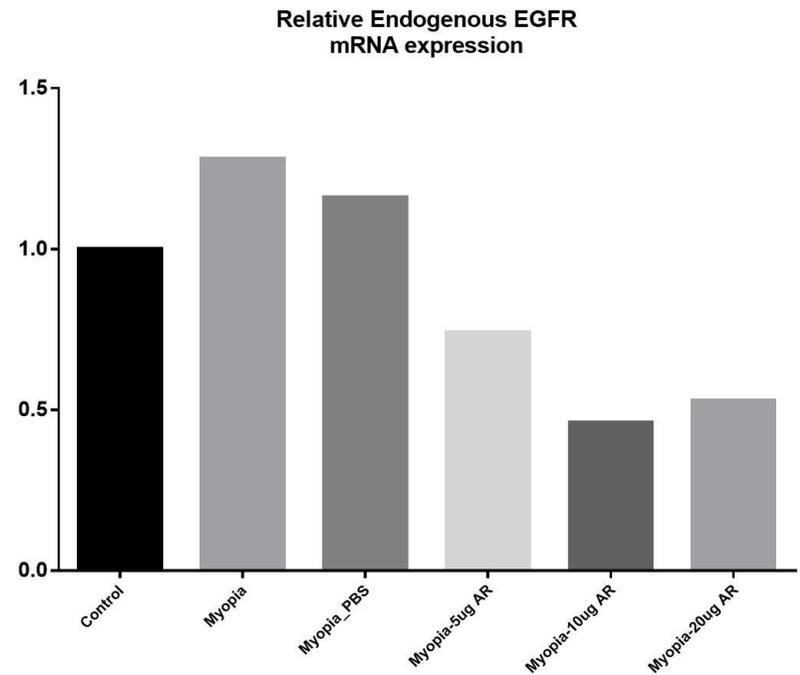
Myopia + 20ug Anti-Amphiregulin

Mechanism of Process of Emmetropization (Myopization) Bruch's Membrane as Biomechanically Supporting Structure

Relative Endogenous Amphiregulin mRNA Expression

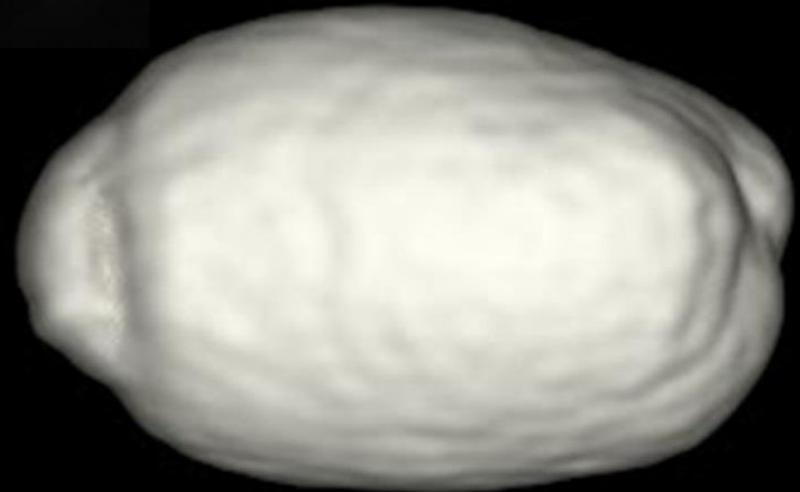
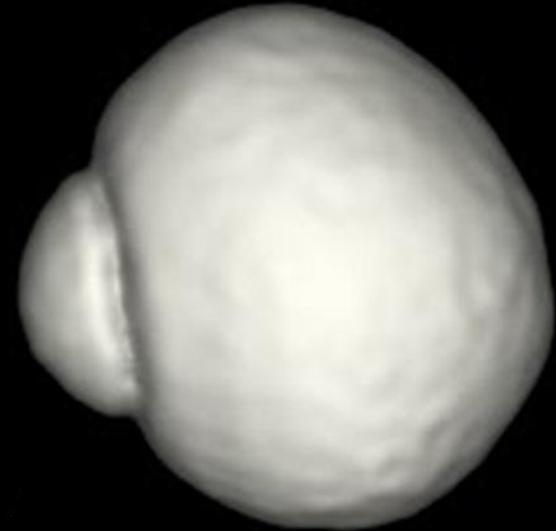
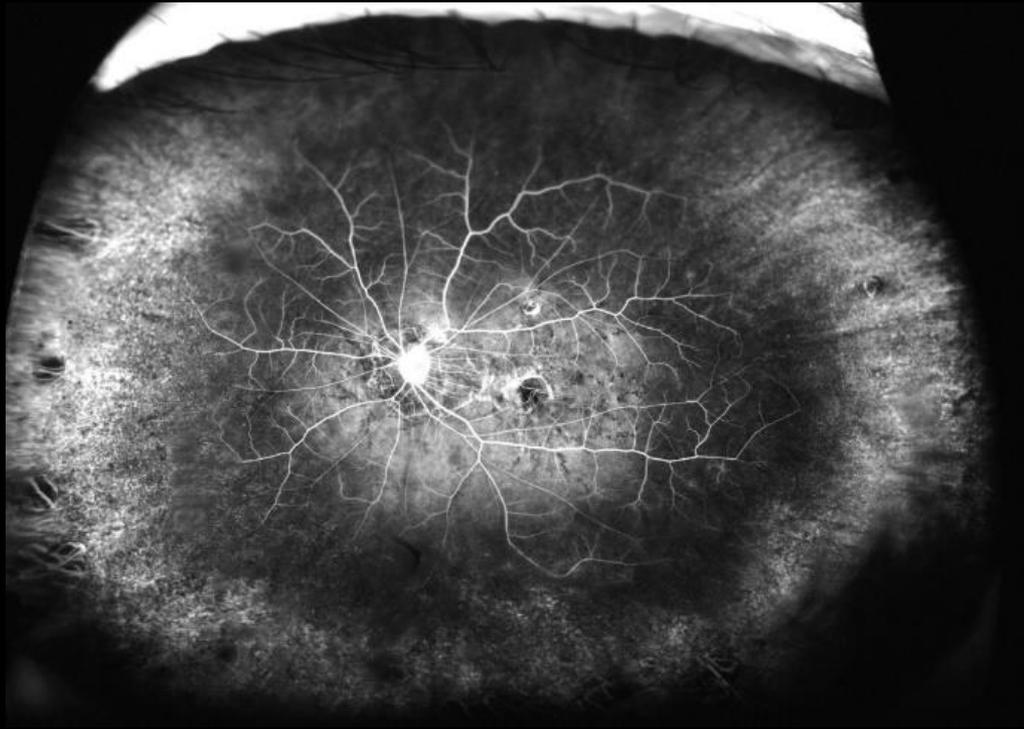


A



B

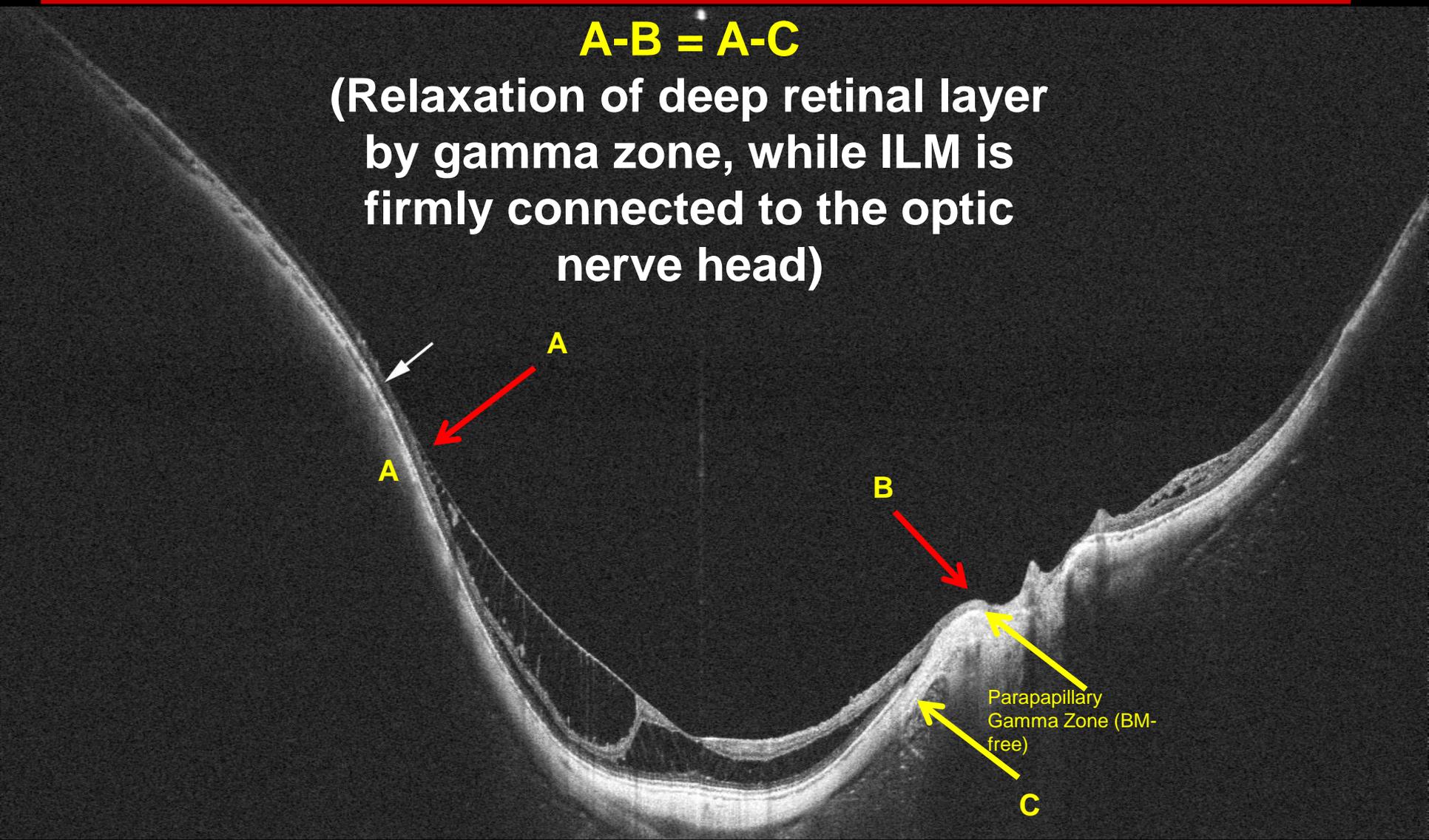
Dependence of the angle between light rays, traveling from the end of the retinal vascular region through the pupil, on axial length: Concentric visual field constriction?



Ultra Wide-Field Optical Coherence Tomography of Myopic Macular Retinoschisis and Posterior Staphylomas

A-B = A-C

(Relaxation of deep retinal layer by gamma zone, while ILM is firmly connected to the optic nerve head)



Conclusions

Bruch's membrane may be more than just an almost invisible double basal membrane with some collagen and elastin in between

