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# OCT detected optic nerve head remodeling in a young adult with early progressive myopia

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ABSTRACT

*Purpose:* To report a longitudinal OCT study of optic nerve head (ONH) neural canal remodeling in a young adult subject's eyes through the progression of early refractive myopia.

*Observations:* Deep ONH changes early in the progression of myopia included enlargement of the Bruch's membrane opening, progressive temporal displacement of BMO relative to the anterior scleral canal opening, choroidal border tissue remodeling and exposure of the temporal scleral flange within the ONH neural canal of both eyes.

*Conclusions and Importance:* Longitudinal OCT imaging of a young adult subject suggest that OCT is able to detect ONH neural canal remodeling early in the progression of refractive myopia that shares key features previously described only in more highly myopic eyes.

## 1. Introduction

The development of optic coherence tomography (OCT) has allowed a better understanding of the prelaminar ONH neural canal tissues, which extend from BMO through the choroidal border tissues of Elschnig, the anterior scleral canal opening (ASCO) and the deeper scleral flange.[1,2] While cross-sectional[3,4] and longitudinal[5,6] studies have detected temporal displacement and enlargement of BMO relative to ASCO in high myopia, the longitudinal studies to date have concentrated on childhood myopia in highly myopic eyes. This report is the first longitudinal OCT study of ONH neural canal remodeling in young adult eyes through the progression of early refractive myopia.

## 2. Case report

A 21-year-old woman sought ophthalmic evaluation for a family history of glaucoma. At presentation, she did not have any ophthalmic complaints and denied ocular surgeries or trauma. Her systemic and ophthalmic medical history were unremarkable. Her visual acuity was 20/20 in both eyes, with a refractive error of −1.50 D spherical equivalent OU, under cycloplegic refraction. Her biomicroscopy was unremarkable and her gonioscopies showed open angles bilaterally. Her central cornea thickness was 584 μm OD and 590 μm OS and intraocular pressures were 15 mmHg OU. Her fundus examination showed mild optic disc cup enlargement OU, with healthy rim tissues. No other abnormalities were identified.

ONH photographs were taken with the Canon CR2 retinal camera (Canon, Tochigiken, Japan) and OCT imaging was acquired with the Spectralis (Heidelberg Engineering, Heidelberg, Germany), for documentation. The OCT acquisition protocol consisted of 2 scan patterns: ONH (24 radial scans centered on the BMO) and peripapillary scans (3 concentric circle scans of 3.5, 4 and 4.5 mm in diameter). Both scans were acquired relative to the eye-specific FoBMO axis, which was determined before acquisition. OCT minimum rim width (MRW) measurements were within normal limits OU and peripapilary retinal nerve fiber layer thickness (RNFLT) measurements were within normal limits in the right eye and borderline in the temporal and superotemporal sectors of her left eye. Her visual fields showed generalized decreased sensitivity in both eyes. Axial length measurements were not obtained.

The patient was examined intermittently over a 5-year period of follow-up during which her visual acuity remained 20/20 OU while her refractive error changed from −1.50 D spherical equivalent to −3.00 D OU. Her intraocular pressures ranged from 14 to 16 mmHg OU in all visits. Her visual fields improved over time and were normal on her last visit. Serial fundus photography suggested progression peripapillary atrophy expansion and optic disc tilting OU (Fig. 1).

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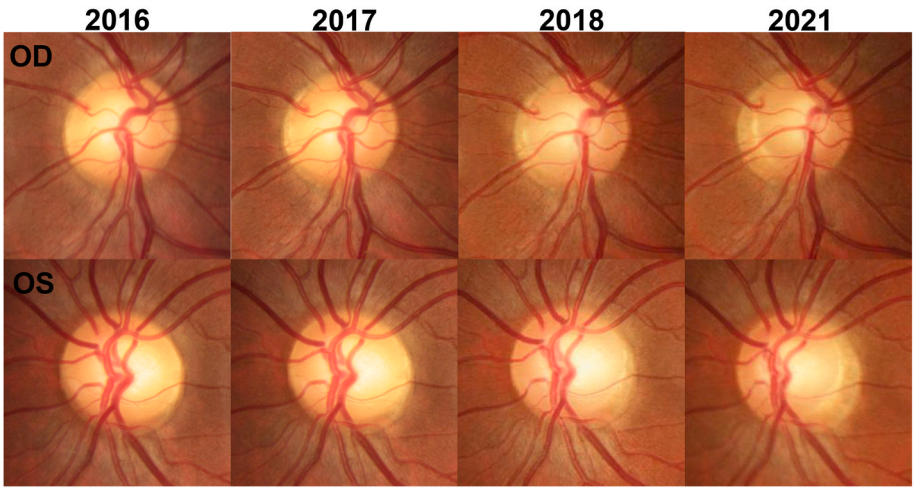


**Fig. 1.** Serial fundus photography from the right (top) and left (bottom) eyes suggesting enlargement of peripapillary atrophy and the onset of optic disc tilting in both eyes.

**Table 1**
Baseline and last follow up OCT Bruch's membrane opening (BMO) area, BMO minimum rim width (MRW) and peripapillary retinal nerve fiber layer thickness (RNFLT) measurements.

| | Right Eye | | Left Eye | |
|---|---|---|---|---|
| | Baseline | Follow-up | Baseline | Follow-up |
| **BMO area ($mm^2$)** | 2.82 | 2.90 | 3.11 | 3.27 |
| **RNFLT (μm)** | | | | |
| **Global** | 99 | 96 | 99 | 98 |
| **Superonasal** | 105 | 105 | 114 | 119 |
| **Nasal** | 94 | 88 | 91 | 87 |
| **Inferonasal** | 133 | 127 | 125 | 119 |
| **Superotemporal** | 113 | 115 | 114 | 116 |
| **Inferotemporal** | 144 | 146 | 160 | 156 |
| **Temporal** | 61 | 57 | 58 | 57 |
| **BMO Minimum Rim Width (μm)** | | | | |
| **Global** | 300 | 303 | 278 | 285 |
| **Superonasal** | 344 | 314 | 320 | 303 |
| **Nasal** | 284 | 285 | 248 | 248 |
| **Inferonasal** | 347 | 343 | 327 | 334 |
| **Superotemporal** | 316 | 313 | 298 | 306 |
| **Inferotemporal** | 311 | 327 | 332 | 352 |
| **Temporal** | 268 | 289 | 240 | 261 |

BMO Bruch's membrane Opening.

OCT imaging was repeated on her last visit using the Spectralis "*follow-up*" mode. Longitudinal changes in both eyes included enlargement of Bruch's membrane opening (BMO), from 2.82 $mm^2$ to 2.90 $mm^2$ in the right eye and from 3.11 to 3.27 $mm^2$ in the left eye (Table 1 and Fig. 2), accompanied by progressive temporal displacement of BMO relative to the anterior scleral canal opening (ASCO).

Previously externally oblique choroidal border tissues temporally became more so, and previously vertical choroidal border tissues nasally became internally oblique with slightly overhanging Bruch's membrane. As the choroidal border tissues remodeled to follow BMO temporally, they exposed the underlying scleral flange (Fig. 3). Peripapillary nerve fiber layer measurements did not change substantially in either eye. MRW measurements showed an increase in thickness in the temporal sectors OU and a decrease in thickness in the nasal superior sectors (Table 1).

On her final visit axial lengths were 23.88 mm OD and 23.81 mm OS, measured with IOL master (IOL mater 700, Carl Zeiss, Jena, Germany). Axial length measurements were not obtained prior to her final visit.

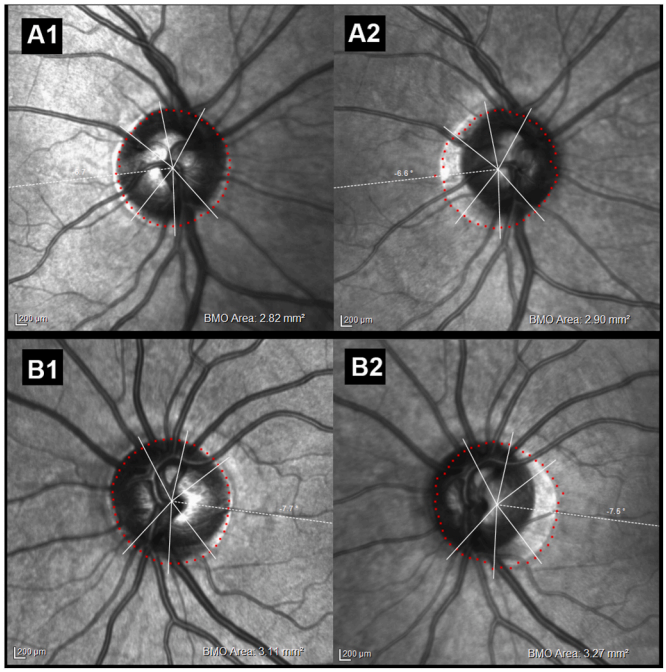


**Fig. 2. Baseline and follow up Optical Coherence Tomography (OCT) automated Bruch's membrane opening (BMO) segmentations (red dots) projected into the optic nerve head (ONH) infra-red image obtained at the time of OCT data set acquisition**. **A1** and **B1** are the right and left ONH baseline infra-red images, respectively, and **A2** and **B2** are the infra-red images from the from the last follow-up imaging session. When baseline and follow-up images are compared (A1 compared with A2 and B1 compared to B2), a qualitative enlargement of BMO area in both eyes and a temporal displacement (offset) of BMO relative to the clinical disc margin (not shown) can be appreciated. Nasally, BMO in the last follow up images, (A2 and B2) appears slightly inside of its baseline position (A1 and B2) which is the result of the transition to internally oblique border tissues that can be appreciated in Fig. 2 (see Fig. 2 legend). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

## 3. Discussion

This report is the first to longitudinally study ONH neural canal remodeling in a young adult through the progression of early refractive myopia. While its findings are compatible with previous cross-

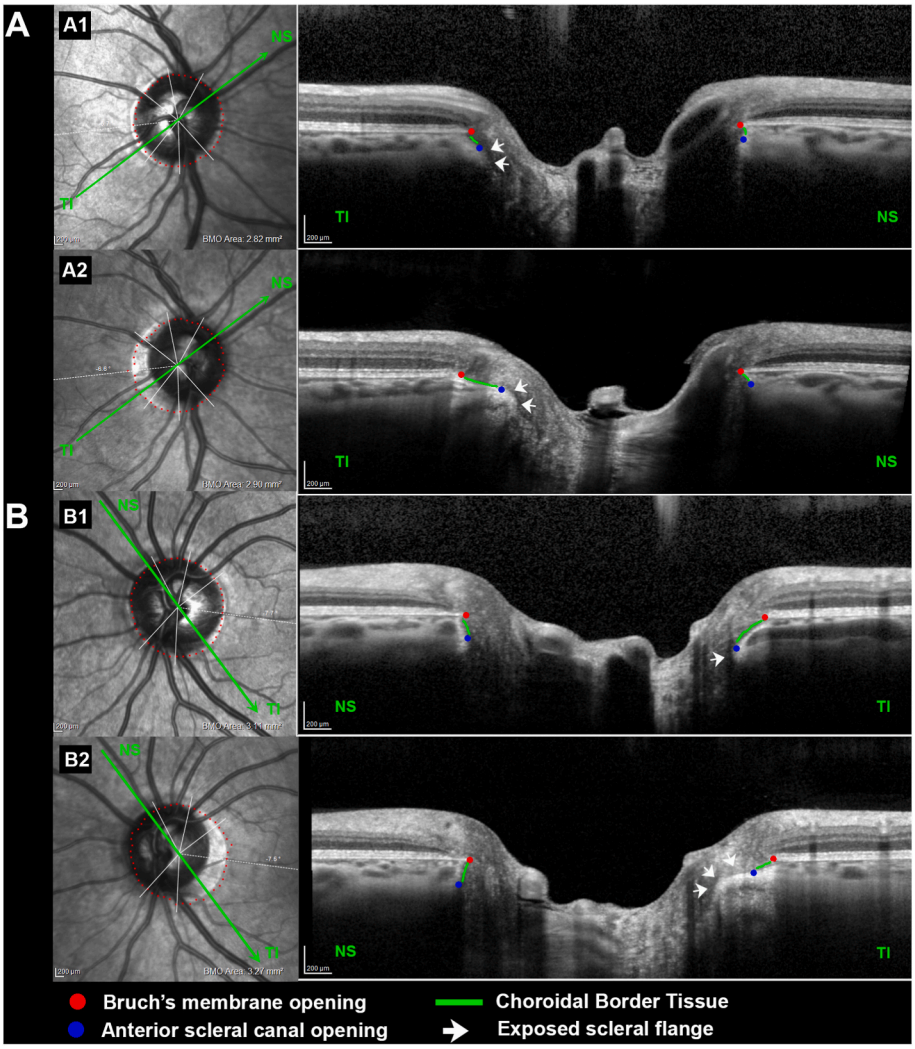


**Fig. 3. OCT ONH neural canal remodeling in the right (A) and left (B) eyes. (A1)** and **(B1)** Representative baseline OCT B scans in the right and left eye, respectively. Radial B scans, (right), are from the location depicted by the green line in the infrared image on the left. **(A2)** and **(B2)** OCT B scans acquired in the same position as A1 and B1, at the last follow-up visit. Comparing baseline and follow-up scans (A1 versus A2 and B1 versus B2) three important changes are evident: 1) a temporal shift and enlargement of Bruch's membrane opening (BMO, in red) relative to the anterior scleral canal opening (ASCO, in blue); 2) increased external obliqueness of the temporal choroidal border tissues (green delineations - TI) and increased "internal" obliqueness of the nasal choroidal border tissues (green delineations - NS);[1–3] and 3) choroidal border tissue remodeling has left the innermost portion of the temporal scleral flange more exposed (white arrows) (left eye more than the right). **NS** nasal superior; **TI** temporal inferior. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

sectional[3,4] and longitudinal[5,6] studies in highly myopic eyes, it differs from those studies in that the neural canal remodeling occurs in both eyes of a young adult subject that is experiencing the earliest changes of myopia.

Although most patients with myopia stabilize in the teenage years,[7] adult myopia onset and progression is not uncommon.[8,9] The young adult reported in this study was already mildly myopic at the beginning of follow-up and presented mild myopic refractive error progression over a 5-year period without a clear causative factor. However, the patient reported spending most of her time reading and doing near-work, which appear to be related with myopia progression.[9]

While it was assumed that an increase in ocular axial length occurred during the period of observation this cannot be confirmed as axial length was not measured at baseline. However, the longitudinal changes in ONH morphology and refraction suggest that OCT imaging is able to detect ONH neural canal remodeling early in the progression of myopia that shares key features previously described only in more highly myopic eyes. In so doing its findings additionally suggest that myopic ONH structural alterations in modest through high myopia may be a continuum that can be detected and parameterized at all stages of myopia using OCT.

## 4. Conclusions

Longitudinal OCT imaging of a young adult subject suggest that OCT is able to detect ONH neural canal remodeling early in the progression of refractive myopia that shares key features previously described only in more highly myopic eyes.

## Patient consent

Written informed consent was obtained from the patient for publishing this case report and any de-identified accompanying images.

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None.

## Financial Support

None.

## Additional contributions

We thank the patient for granting permission to publish this information.

## Authorship

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

## Declaration of competing interest

C. Zangalli: None.

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## References

1. Reis AS, Sharpe GP, Yang H, Nicolela MT, Burgoyne CF, Chauhan BC. Optic disc margin anatomy in patients with glaucoma and normal controls with spectral domain optical coherence tomography. *Ophthalmology*. 2012;119(4):738–747.
2. Hong S, Yang H, Gardiner SK, et al. Oct-detected optic nerve head neural canal direction, obliqueness, and minimum cross-sectional area in healthy eyes. *Am J Ophthalmol*. 2019;208:185–205.
3. Jeoung JW, Yang H, Gardiner S, et al. Optical coherence tomography optic nerve head morphology in myopia I: implications of anterior scleral canal opening versus Bruch membrane opening offset. *Am J Ophthalmol*. 2020;218:105–119.
4. Kim YC, Jung KI, Park HL, Park CK. Three-dimensional evaluation of posterior Pole and optic nerve head in myopes with glaucoma. *Sci Rep*. 2017;7(1):18001.
5. Kim M, Choung HK, Lee KM, Oh S, Kim SH. Longitudinal changes of optic nerve head and peripapillary structure during childhood myopia progression on OCT: boramae myopia cohort study report 1. *Ophthalmology*. 2018;125(8):1215–1223.
6. Kim YW, Choi JJ, Girard MJA, Mari JM, Choi DG, Park KH. Longitudinal observation of border tissue configuration during axial elongation in childhood. *Invest Ophthalmol Vis Sci*. 2021;62(4):10.
7. Group C. Myopia stabilization and associated factors among participants in the Correction of Myopia Evaluation Trial (COMET). *Invest Ophthalmol Vis Sci*. 2013;54 (13):7871–7884.
8. Bullimore MA, Jones LA, Moeschberger ML, Zadnik K, Payor RE. A retrospective study of myopia progression in adult contact lens wearers. *Invest Ophthalmol Vis Sci*. 2002;43(7):2110–2113.
9. Kinge B, Midelfart A, Jacobsen G, Rystad J. The influence of near-work on development of myopia among university students. A three-year longitudinal study among engineering students in Norway. *Acta Ophthalmol Scand*. 2000;78(1):26–29.