Macular choroidal thickness and volume in normal subjects measured by swept-source optical coherence tomography.

Hirata M, Tsujikawa A, Matsumoto A, Hangai M, Ooto S, Yamashiro K, Akiba M, Yoshimura N.

Department of Ophthalmology and Visual Sciences, Kyoto University Graduate School of Medicine, Sakyo-ku, Kyoto, Japan.

PURPOSE: To study the choroidal thickness in healthy subjects by swept-source optical coherence tomography (SS-OCT) at longer wavelength.

METHODS: The macular area of 31 eyes (31 healthy volunteers) was studied with an SS-OCT prototype system, which uses a tunable laser as a light source operated at 100,000 Hz A scan repetition rate in the 1-μm wavelength region. Three-dimensional volumetric measurement comprised of 512 × 128 A scans was acquired in 0.8 second. From a series of OCT images, a choroidal thickness map of the macular area was created by manual segmentation. To evaluate interoperator reproducibility, the choroidal thickness in each section from 10 subjects was determined independently by two observers.

RESULTS: SS-OCT at the 1-μm wavelength region allowed visualization of the fine structure of the choroid as well as that of the retina. Mean choroidal thickness and volume in the macula area were, respectively, 191.5 ± 74.2 μm and 5.411 ± 2.097 mm³. The mean choroidal thickness of the outer nasal area was significantly thinner than that of all other areas (P < 0.05). The measurements by the two independent observers were significantly identical; the intraclass correlation coefficient in mean choroidal thickness was between 0.945 and 0.980 in each area. The macular choroidal thickness was significantly correlated with axial length after adjustment for age (P < 0.001), and with age after adjustment for axial length (P < 0.001).

CONCLUSIONS: SS-OCT system at 1 μm provides macular choroidal thickness maps and allows one to evaluate the choroidal thickness more accurately.
Imaging Retrobulbar Subarachnoid Space around Optic Nerve by Swept-Source Optical Coherence Tomography in Eyes with Pathologic Myopia.

Ohno-Matsui K, Akiba M, Moriyama M, Ishibashi T, Tokoro T, Spaide RF.

Department of Ophthalmology and Visual Science, Tokyo Medical and Dental University, Tokyo, Japan;

PURPOSE: To examine the subarachnoid space (SAS) of eyes with pathologic myopia and analyze the characteristics of the SAS and the surrounding tissues by swept-source optical coherence tomography (OCT).

METHODS: One hundred thirty-three eyes of 76 patients with pathologic myopia (spherical equivalent refractive error of >-8.00 diopters (D) or an axial length >26.5 mm) and 32 eyes of 32 subjects with emmetropia were enrolled. The eyes in both groups were not tested to determine whether glaucoma was present. The papillary and peripapillary areas were examined with a swept-source OCT prototype system that uses a wavelength sweeping laser operated at 100,000 Hz A-scan repetition rate in 1-μm wavelength.

RESULTS: In the B-scan images, the arachnoid trabeculae inside the SAS were clearly observed as a pattern of reticular lines and dots interspersed with hyporeflective zones consistent with fluid, whereas orbital fat had more uniform features with gray intervening spaces. The SAS was triangular, with the base toward the eye surrounding the optic nerve in the region of the scleral flange. An SAS was found in 124 highly myopic eyes (93.2%) but not in the emmetropic eyes. The shortest distance between the inner surface of lamina cribrosa and SAS was 252.4 ± 110.9 μm, and the thinnest region of peripapillary sclera above SAS (scleral flange thickness) was 190.6 ± 51.2 μm. In one myopic patient, there appeared to be direct communication between the intraocular cavity and SAS through pitlike pores.

CONCLUSIONS: Optic SAS is seen in 93% of highly myopic eyes, and the SAS appears to be dilated in highly myopic eyes. The expanded area of exposure to CSF pressure along with thinning of the posterior eye wall may influence staphyloma formation and the way in which certain diseases, such as glaucoma, are manifested.
Evaluation of peripapillary intrachoroidal cavitation with swept source and enhanced depth imaging optical coherence tomography.

Spaide RF, Akiba M, Ohno-Matsui K.

*Vitreous, Retina, Macula Consultants of New York and the LuEsther T. Mertz Retina Research Center, Manhattan Eye, Ear and Throat Hospital, New York †Topcon Corporation, Tokyo, Japan ‡Department of Ophthalmology and Visual Science, Tokyo Medical and Dental University, Tokyo, Japan.

PURPOSE: To investigate the anatomic characteristics of peripapillary intrachoroidal cavitation using optical coherence tomography methodologies that are capable of deeper tissue penetration and consider pathophysiologic mechanisms of disease on the basis of the derived imaging information.

METHODS: Consecutive eyes with peripapillary intrachoroidal cavitation were imaged with swept source optical coherence tomography with a 1-mm light source and in one eye with enhanced depth imaging spectral domain optical coherence tomography and 3-dimensional rendering. The anatomic layers were identified, and the induced abnormalities were evaluated.

RESULTS: There were 16 eyes of 13 patients who had a mean age of 50.3 years and a mean spherical refraction of -12.5 diopters in the affected eyes. The lesion appeared as a yellowish-orange lobular region, usually inferior to the optic nerve, which was invariably tilted. The sclera was bowed posteriorly under the region of the intrachoroidal cavitation, while the overlying retina-retinal pigment epithelium-Bruch membrane complex showed little, if any, deformation. Full-thickness defects in the retina at the inferior border of the conus were seen in four eyes and were associated with prominent cavitation within the choroid with marked posterior bowing of the sclera, but negligible deformation of the overlying retina inferior to the nerve.

CONCLUSION: Newer imaging modalities provided information about deeper structures in the eye not available in older studies that were performed with time-domain optical coherence tomography. This study demonstrated posterior deformation of the sclera in regions previously thinned by the ocular expansion that occurs in high myopia and imaged the resultant effects on the involved choroid.
Ophthalmology. 2012 Apr 9. [Epub ahead of print]

Acquired Optic Nerve and Peripapillary Pits in Pathologic Myopia.

Ohno-Matsui K, Akiba M, Moriyama M, Shimada N, Ishibashi T, Tokoro T, Spaide RF.

Department of Ophthalmology and Visual Science, Tokyo Medical and Dental University, Tokyo, Japan.

PURPOSE: To examine the incidence and characteristics of pit-like structures around the optic disc and myopic conus in eyes with high myopia.

DESIGN: Prospective, observational case series. PARTICIPANTS: We evaluated 198 eyes of 119 patients with pathologic myopia (spherical equivalent >-8 diopters [D]). We also evaluated 32 eyes of 32 subjects with emmetropia (refractive error ≤±3 D) as controls.

METHODS: The papillary and peripapillary areas were examined with a prototype swept-source optical coherence tomography (OCT) system with a center wavelength of 1050 nm. We studied the structural characteristics of pit-like changes.

MAIN OUTCOME MEASURES: The incidence and characteristics of the optic nerve (ON) pits in eyes with high myopia. RESULTS: Pit-like clefts were found at the outer border of the ON or within the adjacent scleral crescent in 32 of 198 highly myopic eyes (16.2%) but in none of the emmetropic eyes. The eyes with these pits were more myopic, had significantly longer axial lengths, and had significantly larger optic discs than the highly myopic eyes without pits. The pits were located in the optic disc area (optic disc pits) in 11 of 32 eyes and in the area of the conus outside the optic disc (conus pits) in 22 of 32 eyes. One eye had both optic disc pits and conus pits. The optic disc pits existed in the superior or inferior border of the optic disc. All but 1 eye with conus pits had a type IX staphyloma, and the location of the conus pits were present nasal to the scleral ridge or outside the ridge temporal to the nerve. The optic disc pits were associated with discontinuities of the lamina cribrosa, whereas the conus pits appeared to develop from a scleral stretch-associated schisis or to emissary openings for the short posterior ciliary arteries in the sclera. The nerve fiber tissue overlying the pits was discontinuous at the site of the pits.

CONCLUSIONS: Optic nerve pits are common in highly myopic eyes. The ON pits are barely visible ophthalmoscopically but can be demonstrated by using swept-source OCT.

FINANCIAL DISCLOSURE(S): Proprietary or commercial disclosure may be found after the references.
Assessment of Macular Choroidal Thickness by Optical Coherence Tomography and Angiographic Changes in Central Serous Chorioretinopathy.


Department of Ophthalmology and Visual Sciences, Kyoto University Graduate School of Medicine, Kyoto, Japan; Department of Ophthalmology, Faculty of Medicine, Prince of Songkla University, Songkhla, Thailand.

OBJECTIVE: To investigate the relationship between macular choroidal thickness measured by high-penetrating swept-source optical coherence tomography (SS-OCT) and angiographic findings in central serous chorioretinopathy (CSC).

DESIGN: Prospective cross-sectional case series.

PARTICIPANTS AND CONTROLS: Thirty-four patients with CSC (44 eyes) and 17 volunteer subjects (17 normal eyes).

METHODS: All subjects underwent a comprehensive ophthalmologic and SS-OCT prototype examination. All patients with CSC also underwent simultaneous fluorescein angiography (FA) and indocyanine green angiography (IA). Mean regional choroidal thickness measurements on the Early Treatment Diabetic Retinopathy Study (ETDRS) layout and squared sector grids were obtained by 3-dimensional raster scanning using SS-OCT.

MAIN OUTCOME MEASURES: Macular choroidal thickness and angiographic abnormalities.

RESULTS: Mean whole macular choroidal thickness in eyes with CSC (total, 329.3±83.0 μm; classic CSC, 326.9±83.1 μm; chronic CSC, 325.4±93.3 μm; and multifocal posterior pigment epitheliopathy, 359.0±15.5 μm) was greater than that in normal eyes (233.0±67.0 μm) (P < 0.001). In unilateral cases, mean whole macular choroidal thickness was greater in eyes with unilateral CSC than in unaffected fellow eyes (P=0.021). There was no significant difference in choroidal thickness between active eyes and resolved eyes in any of the ETDRS sectors. Mean choroidal thickness was greater in areas with leakage on FA than in areas without leakage (P=0.001). Mean choroidal thickness was greater in areas with choroidal vascular hyperpermeability and in areas with punctate hyperfluorescent spots on IA than in unaffected areas (P<0.001 for both).

CONCLUSIONS: Increased choroidal thickness was observed in the whole macular area of eyes with any of the CSC subtypes. Choroidal thickness was related to leakage from the retinal pigment epithelium, choroidal vascular hyperpermeability, and punctate hyperfluorescent lesions. These findings provide evidence that CSC may be caused by focally increased hydrostatic pressure in the choroid.

FINANCIAL DISCLOSURE(S): Proprietary or commercial disclosure may be found after the references.
Abstracts DRI OCT-1


Intrachoroidal Cavitation in Macular Area of Eyes With Pathologic Myopia.


Department of Ophthalmology and Visual Science, Tokyo Medical and Dental University, Tokyo, Japan.

PURPOSE: To determine the incidence and characteristics of intrachoroidal cavitations in the macular area of eyes with high myopia.

DESIGN: Prospective, noninterventional case series.

METHODS: We evaluated 56 eyes of 44 patients with pathologic myopia (myopic spherical equivalent >8 diopters) and with patchy chorioretinal atrophy using a swept-source optical coherence tomographic (OCT) system with a center wavelength of 1050 nm. We focused on the changes in the scleral curvature in the area of patchy atrophy. The relationship of the macular intrachoroidal cavitation and retinoschisis was also analyzed. Sixty-eight consecutive patients with pathologic myopia but without patchy atrophy were analyzed as controls.

RESULTS: In 31 of 56 eyes (55.4%) with patchy atrophy, the swept-source OCT images showed that the sclera was bowed posteriorly in and around the patchy atrophy compared to neighboring sclera, whereas none of the 68 patients without patchy atrophy showed this finding. Macular intrachoroidal cavitation had OCT features similar to peripapillary intrachoroidal cavitation; the choroid in the macular intrachoroidal cavitation area appeared thickened and the retina was caved into the cavitation. There was a direct communication between the vitreous and intrachoroidal cavitation in 3 eyes. Retinoschisis was observed significantly more frequently in or around the patchy atrophy in eyes with macular intrachoroidal cavitation than in those without cavitation.

CONCLUSIONS: These findings suggest that patchy atrophy affects the scleral contour within posterior staphyloma beyond the funduscopically identified patchy atrophy by macular intrachoroidal cavitation. Such deformation of sclera may facilitate the development of retinoschisis in and around the patchy atrophy.
Macular choroidal thickness and volume in eyes with angioid streaks measured by swept source optical coherence tomography.


Department of Ophthalmology and Visual Sciences, Kyoto University Graduate School of Medicine, Kyoto, Japan.

PURPOSE: To study the mean choroidal thickness and volume of the macula in eyes with angioid streaks using swept source optical coherence tomography (OCT) in the 1050-nm wavelength range.

DESIGN: Prospective case series.

METHODS: The macular area of 39 eyes of 23 patients with angioid streaks and of 20 normal eyes of 20 matched controls (Group 1) was studied with a swept source OCT prototype system. Eyes with angioid streaks were classified into 1 of 4 groups: those without choroidal neovascularization (CNV) (Group 2); those with CNV that had no history of treatment (Group 3); those with CNV that had previously received only anti-vascular endothelial growth factor treatments (Group 4); and those with CNV that had previously received photodynamic therapy (Group 5). Using a raster scan protocol with 512 × 128 A-scans, we produced a macular choroidal thickness map (6 × 6 mm(2)).

RESULTS: There were no significant differences in age, axial length, or refractive error among the 5 groups. Mean choroidal thickness of the macula in Group 2 (218.9 ± 46.8 μm) was as great as that in Group 1 (218.8 ± 69.2 μm). However, the macular choroidal thickness in Group 3 (119.7 ± 49.2 μm), Group 4 (140.1 ± 64.9 μm), and Group 5 (144.0 ± 52.6 μm) was significantly less than that of Group 1 (P < .05). There were no statistical differences between Groups 3 through 5. In each group, the choroid of the nasal quadrant was significantly thinner compared to that in other quadrants (P < .05).

CONCLUSIONS: The choroid in eyes with angioid streaks without CNV was as thick as that in normal controls, but was significantly thinner in eyes with angioid streaks that had developed CNV
Retinal and Choroidal Thickness measured by Swept-source Optical Coherence Tomography in the Population-based Rotterdam Study

Caroline C. Klaver1A, Gabriëlle H. Buitendijk1A, Virginie J. Verhoeven1A, Henriët Springelkamp1A, Nomdo M. Jansonius1B,2, Johannes R. Vingerling1A. 1Ophthalmology and Epidemiology, 2Epidemiology, 1Erasmus Medical Center, Rotterdam, The Netherlands; 2Ophthalmology, University of Groningen, University Medical Center Groningen, Groningen, The Netherlands.

PURPOSE: To study the retinal and choroidal thickness by swept-source optical coherence tomography (SS-OCT) at 1050 nm wavelength in persons from a general elderly population.

METHODS: Participants (55+ yrs) of the population-based Rotterdam Study underwent multiple extensive ophthalmic examinations including fundus photography and OCT. A subset (n=220 eyes of 111 participants) was imaged using the new swept-source OCT prototype system (DRI-OCT-1, Topcon Corp, Japan) at 100 kHz A-scan repetition rate with 100nm sweeping range, yielding 8 μm axial resolution in tissue. Retinal and choroidal thickness maps of the fovea were created by automated segmentation with manual correction. Associations with common denominators were investigated using Pearson correlation and linear regression models.

RESULTS: Scan time of each three dimensional image was 0.8 seconds; 93% (n=205) of scans were of high-quality. Mean (standard deviation) retinal and choroidal thickness of the right eyes (n= 103) were 219.57 (41.3) and 212.5 (36.0) μm, respectively. The correlation between left and right eyes was 0.762 (Pearson correlation p<0.0001). We observed a significant association between choroidal thickness and age (-5.592 μm per year; p<0.0001); not between retinal thickness and age, nor between retinal or choroidal thickness and gender. Choroidal thickness (-13.670 μm per mm; P=0.003), but not retinal thickness, was significantly associated with axial length.

CONCLUSIONS: The new SS-OCT system at 1 μm is a fast and relatively easy means to evaluate retinal and choroidal thickness in large studies, providing new opportunities for retinal research.