Case Report: Retinal Nerve Fiber Layer and Ganglion Cell Thinning on Spectral Domain Optical Coherence Tomography Following Multiple Strokes

Nicholas A. Froumis, BSc, OD
Chief of Optometry,
San Jose Service Area,
The Permanente
Medical Group,
San Jose, CA

Abstract

A 62-year-old Caucasian male presented for a routine exam with a history of a left middle cerebral artery (MCA) stroke suffered 5 years prior resulting in significant aphasia, but no sensory motor or initial visual deficits, followed by a convulsive episode requiring hospitalization 2 years later and multiple bilateral cortical and subcortical strokes revealed by subsequent MRI testing. At presentation, best correctable acuities were 20/20+ OU through mild hyperopic astigmatic correction. Visual field testing with frequency doubling technology revealed an incongruous left superior quandrantanopia. Anterior segments demonstrated mild bilateral mixed blepharitis, but were otherwise unremarkable. Dilated fundus examination revealed mild temporal disc pallor and moderate cupping OU. Spectral domain optical coherence tomography (OCT) revealed marked, symmetric inferior and temporal retinal nerve fiber layer (RNFL) thinning, as well as diffuse bilateral ganglion cell thinning. This case demonstrates how the detection of retrograde nerve fiber and ganglion cell loss by OCT may be more effective than visual field screening in revealing the extent of post-chiasmal pathology in the setting of multiple strokes.

KEY WORDS:
retinal nerve fiber layer (RNFL), ganglion cell, optical coherence tomography, quadrantanopia, stroke

INTRODUCTION

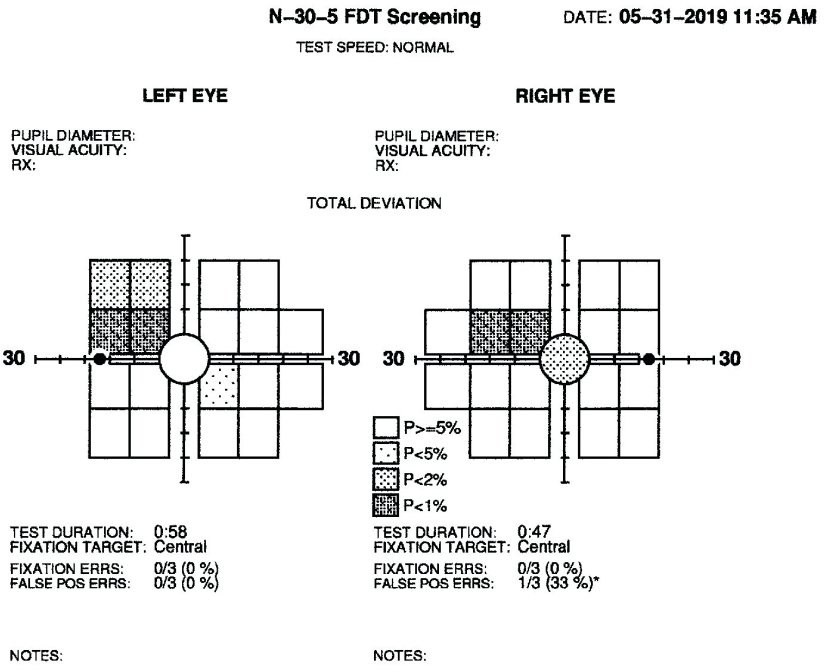
Lesions and vascular events affecting the post-chiasmal visual pathway have traditionally been discovered by automated visual fields during routine optometric examination. This can pose a diagnostic conundrum given the often high variability of subjective testing. Spectral-domain optical coherence tomography (SD-OCT) has already been proven to be an invaluable tool in glaucoma detection. This case demonstrates a further application of this versatile objective technology in a patient presenting with multiple previous cerebrovascular events and incongruous visual field findings.

CASE REPORT

A 62-year-old Caucasian male presented for a routine eye examination. His health history was significant for a stroke suffered 5 years prior while vacationing in France which resulted in aphasia requiring long-term speech rehabilitation, but no sensory motor or visual deficits. The patient was a poor historian due to limitations with speech and memory, but his wife indicated that he had suffered from a convulsive event 2 years after the initial stroke that required hospitalization and was subsequently diagnosed with "mini-strokes" on both sides of the brain. His current medications included adalimumab (Humira Pen), atorvastatin (Lipitor), pantoprazole (Protonix), metroprolol (Lopressor), ascorbic acid (Vitamin C Oral), coenzyme Q10 (Co Q-10), and baby aspirin.

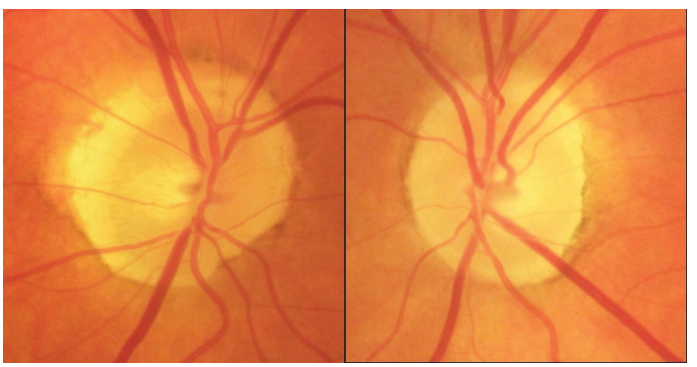
Examination revealed acuities correctable to OD 20/20+ and OS 20/20+ through mild hyperopic astigmatic correction. Extraocular motility was full, and pupils were equal, round, and reactive to light with no evidence of afferent defect. Screening visual fields with Frequency Doubling Technology (FDT) revealed an incongruous, left superior quadrantanopia (Figure 1). The anterior segments demonstrated mild mixed blepharitis OU, but were otherwise unremarkable. Intraocular pressure by non-contact tonometry measured 12/13 mm Hg.

Figure 1: *FDT Visual Fields*



Dilated fundus examination revealed moderate disc cupping with mild temporal disc pallor and mild peripapillary atrophy 360 degrees OU (Figure 2). Retinal vasculature demonstrated mild arterial attenuation OU. The maculae were flat and even, and the peripheral retinas were unremarkable OU. Disc and macular scans were ordered for further testing with SD-OCT (Zeiss Cirrus OCT).

Figure 2: *Optic Nerve Fundus Images*



The optic disc cube demonstrated marked symmetric inferior and temporal thinning on the Retinal Nerve Fiber Layer (RNFL) Deviation, Quadrant, and Clock Hour Maps (Figure 3). Ganglion cell analysis of the macular cube further demonstrated bilateral diffuse thinning of all sectors, with a slight relative inferior thinning OU (Figure 4). The degree of both temporal nerve fiber and ganglion cell thinning suggested a further pathological process preceding or following the initial stroke that targeted the papillomacular bundle. Previous records were obtained to gather more information regarding the

nature and location of the multiple reported strokes. The earliest record following the initial event 5 years prior indicated that the patient had first suffered a left middle cerebral artery (MCA) stroke, and CT angiography confirmed an infarct within the left basal ganglia. MRI testing performed 4 years later confirmed the presence of multiple bilateral cortical and subcortical lacunar strokes. The cortical infarctions were localized to the right posterior inferior temporal, right occipital, left posterior temporal, and left temporal lobes, while the subcortical infarctions were localized to the right caudate and bilateral cerebellar lacunes. The most recent MRI, performed 3 weeks prior, revealed right inferior temporo-occipital and left lateral temporo-occipital chronic infarctions. Screening lab results, obtained at the time of the latest MRI, were within the respective normal ranges for CBC, chemistry, B12, TSH, and thiamine. The etiology of the patient's high stroke burden remains unknown.

Figure 3: *OHN and RNFL Analysis*

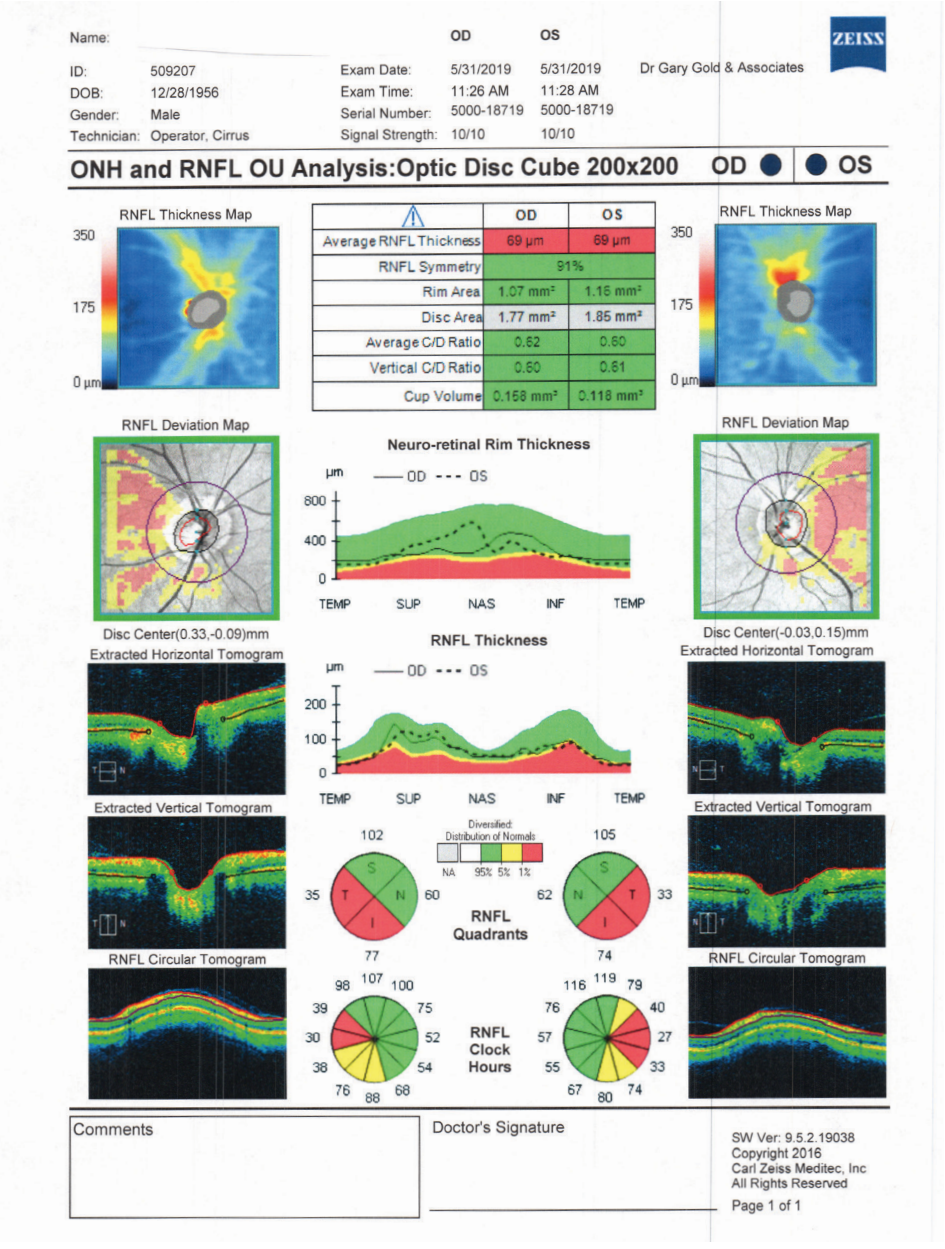
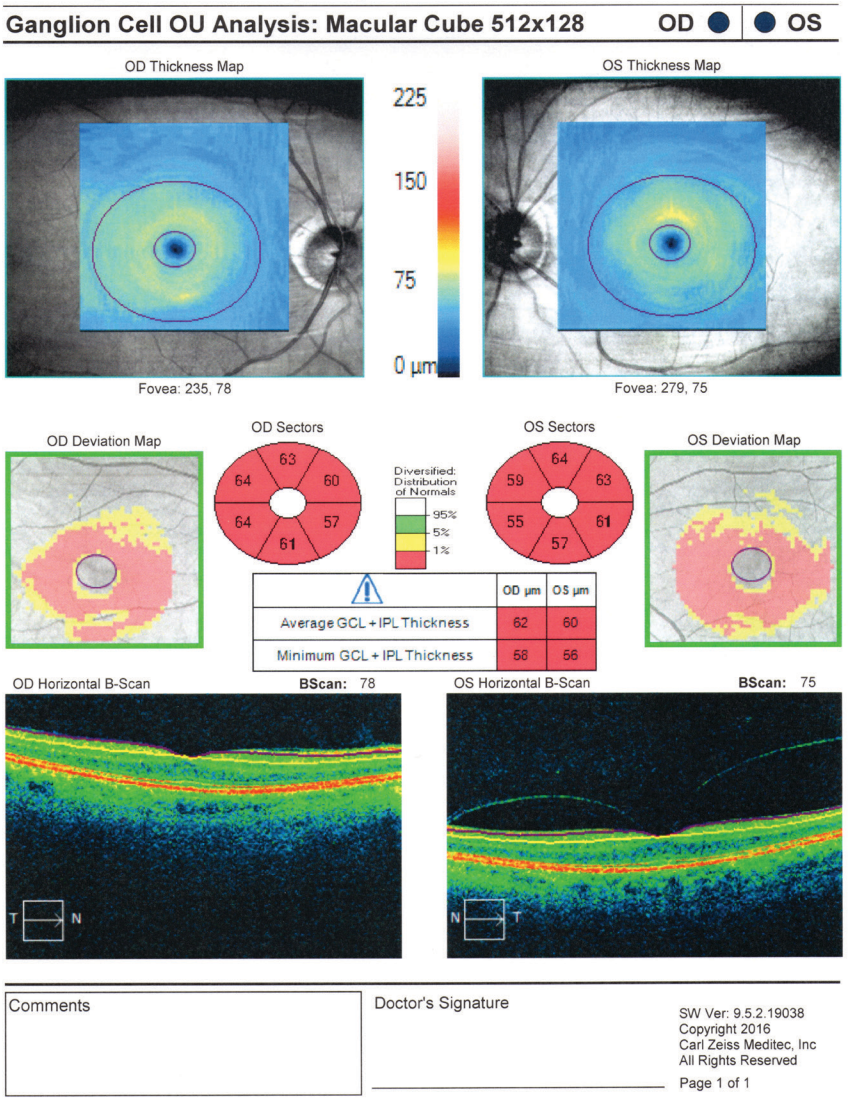


Figure 4: *Ganglion Cell Analysis*



DISCUSSION

The retro-chiasmal visual pathway involves the optic tracts first carrying fibers to the lateral geniculate nuclei. From there, the optic radiations divide into superior, inferior, and central fibers before ultimately terminating in the visual cortex of the occipital lobe. The inferior fibers (Meyer's loop) travel to the temporal lobe, while the superior and central fibers travel to the parietal lobe.[1] The "pie in the sky" superior left quadrantanopia observed in this patient suggested a stroke that affected the right temporal lobe and was likely the result of one of the multiple subsequent strokes, since the initial event occurred on the left side. The sub-cortical location of the initial stroke in the left basal ganglia may explain why a visual defect was not noted initially. Thinning of the inner RNFL following both congenital and acquired lesions of the retrogeniculate visual pathways has been confirmed by studies using time-domain, spectral domain, and swept-source optical coherence tomography.[2-4] This is also demonstrated in this case by the marked bilateral inferior NFL thinning on SD-OCT. Infarctions of the anterior choroidal artery can result in damage to Meyer's loop, causing seizures, memory deficits, and receptive aphasia, in addition to quadrantanopia.[1] This is consistent with the patient's presentation, as his wife reported a previous seizure, as well as memory and speech difficulties after his initial episode. What was unexpected in this case based on the relatively focalized field defects, was the marked bilateral temporal NFL thinning and overall diffuse bilateral pattern of thinning on the Ganglion Cell Analysis (GCA). Previous studies that have used OCT to analyze patients with homonymous hemianopia and quadrantanopia have demonstrated a high correlation of ganglion cell thinning on the side or sectors corresponding to the visual field defect.[4,5] The more diffuse pattern of ganglion cell loss in this patient suggests additional damage from some other previous or ongoing pathological process. Possible differentials for ganglion cell loss include early-stage glaucoma, other neurodegenerative disease (such as nutritional/toxic neuropathy, MS, Parkinson's, Huntington's or Alzheimer's),

ischemic optic neuropathy, and chronic cerebrovascular accidents. The slight bilateral disc pallor and significant symmetric temporal RNFL thinning suggest further pathology in the papillomacular bundles. In addition to toxic and nutritional optic neuropathies, both Parkinson's and Huntington's Disease have been shown to have a predilection for damage to the parvocellular cells, which is reflected by temporal RNFL thinning.[6] The lack of any movement difficulties in this patient ruled out Parkinson's and Huntington's disease as likely etiologies. Conversely, glaucoma and Alzheimer's tend to damage the magnocellular cells, leading to preferential RNFL thinning in the superior and inferior quadrants.[6] These latter two conditions are less likely with this patient, given the high overall symmetry and normal superior RNFL OU. Previous extensive neurology consultation, including blood labs and MRI testing, did not uncover the presence of plaques or a history of exposure to toxic substances, ruling out MS or nutritional/toxic etiologies. Further, ischemic optic neuropathy is unlikely given the absence of altitudinal visual defects. Occipital lobe infarctions have been shown to cause temporal ganglion cell thinning in the ipsilateral eye relative to the side of the infarction and nasal ganglion cell thinning in the contralateral eye.[7] The chronic, recurrent infarctions with a predilection for the temporal and occipital lobes were likely responsible for the diffuse ganglion cell thinning due to the additive effects of the bilateral presentation in this patient. Possible explanations for the less extensive field loss despite the diffuse pattern of ganglion cell loss include spontaneous recovery and neuroplasticity. Spontaneous recovery has been shown to occur to some degree in 50% of stroke patients and areas of the retina corresponding to recovered areas of the visual field also degenerate.[8]

In conclusion, SD-OCT has many applications for neurodegenerative disorders, including the detection of retrograde nerve fiber and ganglion cell loss following a stroke. While the macular cube scan for ganglion cell analysis has become a routine part of glaucoma testing, it is also useful in the investigation of homonymous visual field defects by providing objective data to support subjective findings. When ganglion cell loss exceeds the pattern predicted by the visual field findings, a further pathological process (or processes) should be considered. Clinicians can add disc and macular OCT technology to their diagnostic armamentarium when testing for suspected post-chiasmal pathology and refer for prompt work-up with neuroimaging in the absence of a previous contributing diagnosis. ●

CORRESPONDING AUTHOR
Nicholas A. Froumis, OD, nfroumisod@gmail.com

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