Optic nerve cavitations in glaucoma suspect and glaucoma patients

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ABSTRACT

Purpose: Glaucoma is associated with structural changes of the optic nerve head such as deformation, lamina cribosa defects, prelaminar schisis, and peripapillary retinal schisis. We describe optic nerve cavitations that were detected by routine spectral domain optical coherence tomography (OCT).

Observations: OCT imaging showed cavitations in 5 eyes of 4 patients with an initial diagnosis of glaucoma or glaucoma suspect. The cavitations were seen as hyporeflective spaces that are sharply delineated from surrounding tissue. They were centered inferonasally, anterior to the lamina cribosa, and at least partially within the Bruch’s membrane opening (BMO). They extended from 3 to 6 clock hours.

Conclusion: AND IMPORTANCE: We describe a new OCT finding in patients with a diagnosis of glaucoma and glaucoma suspect. While previous reports describe cavitations in the choroid in patients with pathological myopia, our patients had minimal refractive error and the cavitations were located within the optic nerve. We will examine these patients over time to determine the impact of this finding on longitudinal changes in structure and function.

1. Introduction

Glaucoma includes well-known structural changes of the optic nerve head, which reflect deformation and remodeling of load-bearing tissues, primarily the lamina cribosa and peripapillary sclera. Optical coherence tomography (OCT) provides quantitative measurements of the optic nerve head structure that clinicians use for clinical diagnosis and management of glaucoma. It has also revealed other retinal and optic nerve structural abnormalities (such as peripapillary retinal schisis and prelaminar schisis) associated with glaucoma that were previously not visible to clinicians using clinical ophthalmoscopy. Lee et al. found that patients with a diagnosis of glaucoma and peripapillary retinoschisis were more likely to have corresponding temporal lamina cribosa defects. Fortune et al. found that patients with a diagnosis of glaucoma with peripapillary retinoschisis had faster visual field progression and retinal nerve fiber layer (RNFL) thinning than those who did not. Lowry et al. demonstrated that eyes with prelaminar optic nerve head schisis had thinner minimum rim width and a deeper cup than age-matched controls.

Here, we describe optic nerve cavitations that were detected via routine spectral domain OCT imaging (Spectralis, Heidelberg Engineering, Heidelberg, Germany). A previous report described intrachoroidal cavitations (ICC) in patients with pathological myopia, which have a similar appearance on OCT. However, our patients had minimal refractive error and the cavitations occurred within the optic nerve. Structural optic nerve head abnormalities may provide insight into the progression and pathophysiology of glaucoma.

2. Findings

The Legacy Health Institutional Review Board (Portland, Oregon, USA) approved the reporting of this de-identified retrospective case series.

Routine spectral domain optical coherence tomography (SD-OCT) imaging showed optic nerve cavitations in 4 eyes with a diagnosis of glaucoma and 1 eye with a diagnosis of glaucoma suspect. The SD-OCT images (Fig. 1) demonstrated hyporeflective spaces that are sharply delineated from surrounding tissue. The spaces were centered in the inferonasal quadrant, anterior to the lamina cribosa, and at least partially within the Bruch’s membrane opening (BMO). Cases 1, 3, 4 had a unilateral presentation, while case 2 was bilateral. Cases 1, 2, and 3 had the center of the cavitation located under the BMO, while case 4 had cavitation centered more laterally. The cavitations extended 3 clock hours radially in cases 1 and 4, and almost 6 clock hours in cases 2 (both...
eyes) and 3. Table 1 summarizes the demographic and ocular information of the case series. Of note, the spherical equivalent (sphere \( + \frac{1}{2} \) cylinder) refractive error was \(-1.1 \pm 1.7\) (range \(-4.0\) to \(+0.3\) diopters and axially lengths were largely normal without extreme axial myopia. The optic discs ranged from severe cupping to largely normal. We tested visual field sensitivity with the Humphrey Field Analyzer (Zeiss Humphrey, California, USA) using the Swedish Interactive Threshold Algorithm (SITA) standard 24-2 and 30-2 protocols. The visual fields ranged from normal to severe depression. Further clinical details are below.

2.1. Case 1

Case 1 is a 66 year old white female with a diagnosis of low tension glaucoma. At the time of presentation, she had advanced cupping (0.9 cup to disc ratio) of both optic nerves. Baseline visual fields showed advanced disease in the right eye (center involving superior and inferior arcuate defects) and moderate disease in the left eye (center sparing inferior arcuate defect). During 14 years of follow-up, her intraocular pressures (IOP) have remained mostly stable at 11 mmHg in both eyes, maintained by daily timolol and latanoprost. In 2007, her IOP was found to be 15 mmHg OD and a disc hemorrhage was noted concurrently. Laser trabeculoplasty decreased her IOP to 12 mmHg. She had bilateral cataract surgery with visual acuity maintained at 20/20 in both eyes. Expansion of the visual field defects was suspected at the latest follow up visit. SD-OCT retinal nerve fiber layer (RNFL) thickness data is available for 3 years, which showed superior and inferior measurements outside normal limits (<1%) bilaterally.

2.2. Case 2

Case 2 is a 78 year old white female. She presented as a glaucoma suspect, with a family history of glaucoma, elevated eye pressures of 22 mmHg in both eyes (OU), and normal appearing optic discs (0.2 cup to disc ratio) in both eyes. No intervention was undertaken for 14 years until her IOP increased to 27 mmHg in both eyes on two consecutive occasions. A SITA Standard 30-2 visual field was performed which was normal in the right eye, but showed an early superior nasal step in the left with a mean deviation of \(-0.85\) dB. Her ophthalmologist started a prostaglandin eye drop in both eyes, as well as additional treatment over time with a combination carbonic anhydrase inhibitor and beta-adrenergic antagonist eye drop, and laser trabeculoplasty. She subsequently developed cataracts, and combined cataract surgery with goniotomy was performed in both eyes. Over 34 years of follow-up, she had progressive optic disc cupping and stable early visual field loss. SD-OCT RNFL thickness data is available for 3 years which showed outside normal limits (<1%) for the superior and inferior quadrants in the right eye, and outside normal limits for the inferior quadrant of the left eye with no evidence of progressive thinning. Both eyes had optic nerve cavitation. She developed wet macular degeneration that was thought to be unrelated to the cavitation.

2.3. Case 3

Case 3 is a 76 year old white female who has been followed for 22 years. She originally presented as a glaucoma suspect with a family history of glaucoma. Her IOP was 22 mmHg in both eyes and her optic nerve appearance showed inferior thinning in both eyes. Her cup-to-disc ratio was 0.5 OD and 0.6 OS and she was started on a prostaglandin eye drop. Over 22 years of follow-up, she had progressive optic disc cupping and stable early visual field loss. SD-OCT RNFL thickness data is available for 3 years which showed outside normal limits (<1%) bilaterally.
2.4. Case 4

Case 4 is an 80 year old Asian male with a diagnosis of low tension glaucoma, who has been followed for 5 years. He presented with intraocular pressures of 14 mmHg OD and 15 mmHg OS, and with cup to disc ratios of 0.8 OD and 0.7 OS and extensive peripapillary atrophy. While the optic disc appearance did not change throughout follow-up, a series of unreliable and fluctuating visual fields suggested worsening of glaucoma. He was treated with a prostaglandin and beta-adrenergic antagonist eye drop with IOP 12 mmHg in both eyes. OCT RNFL data is available for 5 years. The right eye (with the cavitation) had inferior temporal thinning, which was non-progressive. The left eye had normal RNFL thickness with no progression.

3. Discussion

This case series of optic nerve cavitation included diagnoses of primary open glaucoma, low tension glaucoma, and glaucoma suspect. The refractive error was slightly myopic to normal with largely normal axially lengths. The optic discs and visual fields ranged from abnormal to normal. The range of follow up for the visual fields were 7 years–34 years, while the range of follow up for the OCT RNFL ranged from 2 years to 5 years. Cases 1 and 4 had visual field progression while cases 2 and 3 had very stable fields. The appearance of the cavitations on OCT RNFL remained stable throughout the range of follow up of 2–5 years.

One may confuse acquired pits of the optic nerve (APON) with our findings of optic nerve cavitations. However, APONS have distinct features including: 1) inferotemporal location, 2) a break or disinsertion of the lamina cribosa, 3) associated RNFL loss, and 4) progressive visual field loss. In this study all of the cases were centered inferonasally and were located between the anterior lamina cribosa and the BMO. No breaks in the anterior lamina cribosa were observed. Cases 1 and 3 had RNFL change of −1.5μm/yr and −1.0μm/yr while Cases 2 and 4 had minimal RNFL change. Aside from the progressing macular degeneration in Case 2, the other patients did not develop any retinal pathology. Progressive field loss was noted in Case 1 and Case 4 only. Another feature common to APON is herniation of retinal tissue. Herniation of retinal tissue. Herniation of retina was not observed in this small case study. In summary, there were relatively few features in these cases that is consistent with those of an acquired pit of the optic nerve.

4. Conclusion

We describe optic nerve cavitations, and are unaware of these being previously described in the context of glaucoma. While previous reports describe cavitations in the choroid associated with pathological myopia, our patients had minimal refractive error and the cavitations were located within the optic nerve. We do not know whether these finding are acquired (from glaucoma) and whether they are associated with changes in structure, or function when compared to glaucoma patients without this finding.

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Research ethics

We further confirm that any aspect of the work covered in this manuscript that has involved human patients has been conducted with the ethical approval of all relevant bodies and that such approvals are acknowledged within the manuscript.

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Conflicts of interest

No conflict of interest exists.

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