

# Persistence of Cloquet's Canal in Normal Healthy Eyes

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**PURPOSE:** Optic nerve head (ONH) structural imaging with state-of-the-art, high-speed, ultra-high-resolution optical coherence tomography (hsUHR-OCT).

**DESIGN:** Observational cohort study.

**METHODS:** ONH centered 3-dimensional (94,371,840 voxel measurements in a 6- × 6- × 1.4-mm tissue volume) hsUHR-OCT data were obtained in one eye from each of six males and nine females normal healthy volunteers (40 ± 9 years of age). The presence of structures projecting anteriorly from the disk into the vitreous was noted.

**RESULTS:** Structures were noted in 14 of 15 (93%) examined eyes, emanating from the rim of the ONH at the nasal inferior sector, presenting as thin tissue meandering into the vitreous.

**CONCLUSIONS:** Previous technologies provided limited visualization of ONH structures. The ability to scan the entire disk using 3-dimensional OCT (3D-OCT) in a high-density raster pattern reveals a high frequency of persistence of Cloquet's canal in the normal healthy eye. (Am J Ophthalmol 2006;142:862–864. © 2006 by Elsevier Inc. All rights reserved.)

CLOQUET'S CANAL (CC) SERVES AS A PERIVASCULAR sheath surrounding the hyaloid artery in the embryonic eye.<sup>1</sup> At birth, or soon thereafter, the hyaloid artery and associated vascular tree close, and their remnants are

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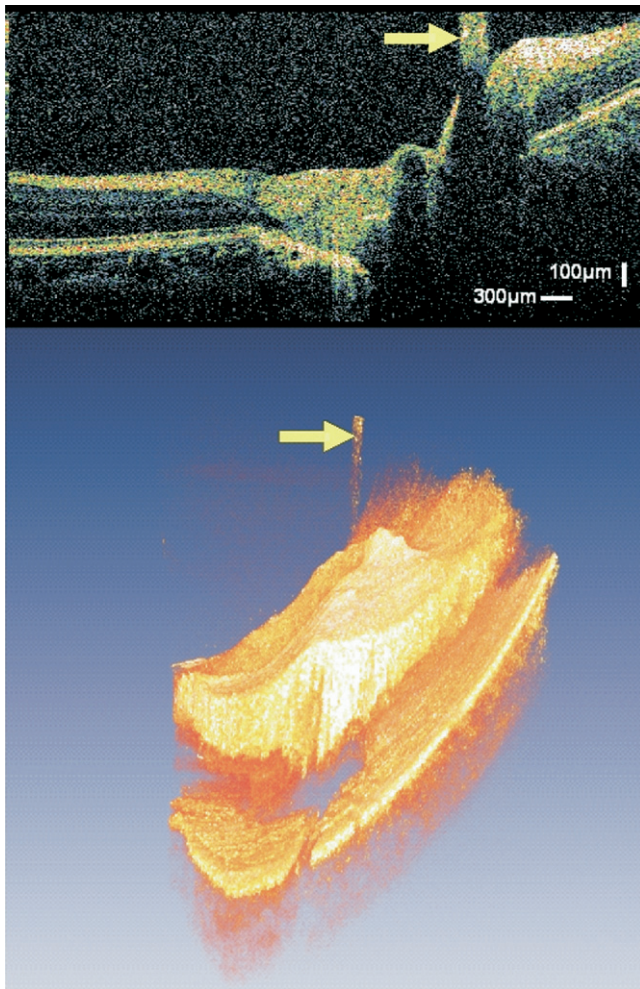
thought to be reabsorbed over time<sup>2</sup>; falling along the inferior surface of the lens and becoming “inconsequential” in the eye. In the mature eye, remnants of CC are evident in some eyes as Mittendorf's dot posterior to the lens and Bergmeister's papilla anterior to the optic nerve head (ONH),<sup>3</sup> with persistence of Bergmeister's papilla sufficiently common as to be considered an anatomic variant.<sup>1</sup>

Recent advances in high-speed, ultra-high-resolution optical coherence tomography (hsUHR-OCT) imaging using Fourier/spectral domain detection can enable dramatic improvements in resolution and imaging speed.<sup>4–6</sup> As with the commercially available Stratus OCT (Carl Zeiss Meditec, Dublin, California, USA), hsUHR-OCT allows noninvasive, in vivo, cross-sectional imaging of the retina. Our research prototype instrument has an axial resolution of 3.5 μm and an axial scan speed of ~24,000 scans per second, a factor of two to three times' finer resolution and 50 times' faster scan speed compared with the commercial instrument.<sup>5</sup> These high speeds enable 3-dimensional OCT (3D-OCT) imaging. We have imaged a number of normal and diseased ONH using 3D-OCT. We consistently observed a tissue structure extending anteriorly from the inferior nasal rim of the ONH, and extending into the vitreous of both healthy and glaucomatous subjects. Based on its origin and orientation, the authors believe this structure to be the remnants of CC. The purpose of this study was to provide pilot data describing the persistence of CC in the normal healthy adult eye.

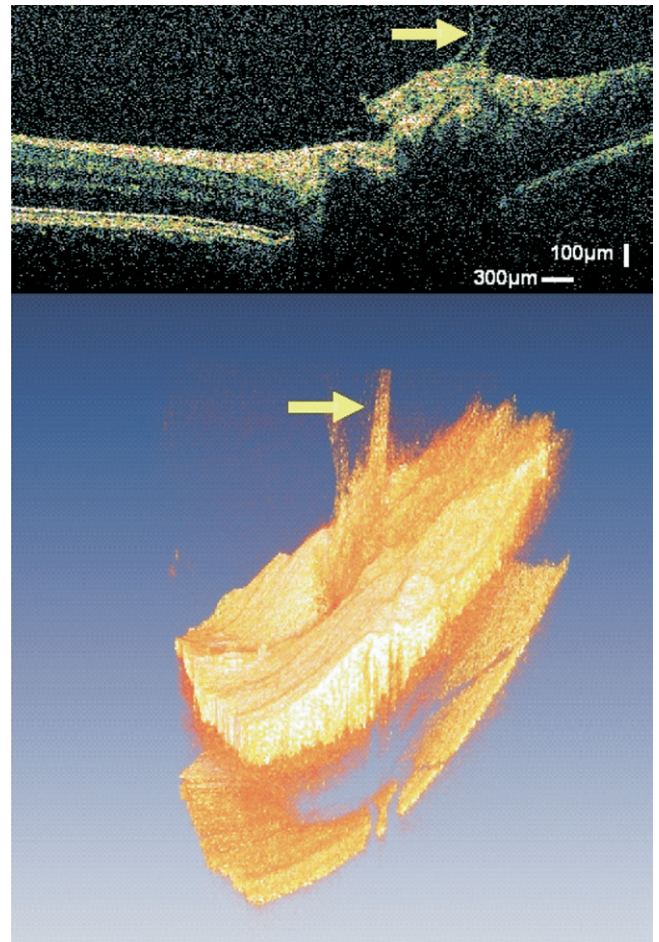
The study was approved by the institutional review board of the University of the Pittsburgh School of Medicine, and all subjects provided informed consent before imaging. The study was conducted in accord with Health Insurance Portability and Accountability Act (HIPAA) regulations.

hsUHR-OCT scanning has previously been described in detail.<sup>5,6</sup> Briefly, broadband (100-nm bandwidth, centered at 840 nm) light from a superluminescent diode light source (Broadlighter, Superlum Ltd, Moscow, Russia) is split and projected onto a stationary mirror and onto the retina. Reflected light is combined to form an interference pattern. Axial scan information is frequency encoded within the interference pattern. Reflections from different depths within the retina contribute to the interference pattern.

The 3D-hsUHR-OCT ONH centered data sets were obtained in one eye of each of 15 normal healthy subjects (six male, nine female, age 40 ± 9 years). Scans captured a 6 × 6 mm (512 lateral locations each within 180 vertical scans) slice of retinal tissue, with a slice thickness of approximately 1.4 mm (1024 axial samples/A-scan with a 3.5 μm resolution). Three-dimensional-OCT data were rendered using image processing software similar to that used in magnetic resonance imaging (Amira, Mercury Computer Systems, Inc, Chelmsford, Massachusetts, USA).



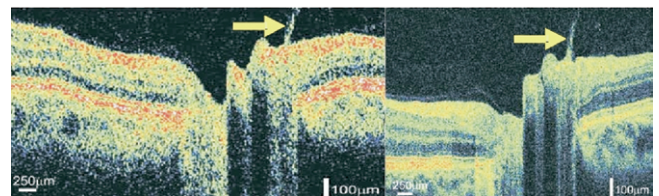
**FIGURE 1.** High-speed, ultra-high-resolution optical coherence tomography (hsUHR-OCT) images of remnants of Cloquet's canal (arrow) in Subject 1 presented as an optical cross-section ( $6 \text{ mm} \times 1.4 \text{ mm}$ ) (Top) and a 3D volumetric rendering ( $6 \times 6 \times 1.4 \text{ mm}$ ) of the nerve fiber layer and the photoreceptor outer segments and retinal pigment epithelial layer (Bottom).



**FIGURE 2.** High-speed, ultra-high-resolution optical coherence tomography (hsUHR-OCT) images of remnants of Cloquet's canal (arrow) in subject 2 presented as an optical cross-section ( $6 \text{ mm} \times 1.4 \text{ mm}$ ) (Top) and a 3D volumetric rendering ( $6 \times 6 \times 1.4 \text{ mm}$ ) of the nerve fiber layer and the photoreceptor outer segments and retinal pigment epithelial layer (Bottom).

The vitreous immediately anterior to the ONH was examined for reflective structural sources. A reflective structure extending anteriorly from the inferior-nasal ONH was visualized in 14 of 15 eyes (93%, [Figures 1 and 2](#)). In each case, the structure emanated from the inferior nasal quadrant rim of the ONH. The same structure was present in a previous publication by Wojtkowski M and associates describing the hsUHR-OCT technique ([Figure 3](#)).<sup>5</sup>

The finding of persistence of CC in 93% of healthy eyes demonstrates that the remnant of the hyaloid artery and its associated structures do not disappear completely in the majority of eyes. In fact, remnants of this structure may be detected in nearly every healthy eye we studied. This observation was made possible by advances in imaging technology; future discoveries may be enabled by further improvements in resolution and scan speed.



**FIGURE 3.** Remnants of Cloquet's canal (arrow) observed in both Stratus optical coherence tomography (OCT) and ultra-high-resolution optical coherence tomography (hsUHR-OCT). (Reprinted from Wojtkowski M, Srinivasan V, Fujimoto JG, et al., Three-dimensional retinal imaging with high-speed ultra-high-resolution optical coherence tomography. *Ophthalmology* 2005;112:1734–1746, with permission from *American Academy of Ophthalmology*).



The ability to assess the entire ONH structure using 3D-OCT with a high-density raster-scan reveals a high frequency of persistence of CC in the normal healthy eye. Supplemental Video available at [AJO.com](http://AJO.com)

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## Primary Orbital Melanoma Treated With Iodine-125 Plaque Radiotherapy

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**PURPOSE:** To report a case of primary orbital melanoma successfully managed by custom-designed iodine-125 plaque.

**DESIGN:** Case report.

**METHODS:** A 59-year-old man with no systemic or secondary melanocytic tumor was diagnosed with primary orbital melanoma after transconjunctival incisional biopsy. He was treated with unshielded iodine-125 plaque (90 Gy) that was sutured to the sclera. The radiation plan was calculated to safely target the initial tumor volume and any residual intrascleral or loose orbital melanoma cells that could have been disseminated to the surrounding orbital tissues during incisional biopsy.

RESULTS: After 66 months' follow-up, the patient was still alive with partial remission of his liver metastases. Routine orbital magnetic resonance imaging studies confirmed the lack of orbital recurrence.

CONCLUSIONS: Plaque radiotherapy appears to be a reasonable alternative to exenteration or external irradiation for orbital melanoma after biopsy confirmation. (*Am J Ophthalmol* 2006;142:864–866. © 2006 by Elsevier Inc. All rights reserved.)

ORBITAL PLAQUE RADIOTHERAPY HAS BEEN SUCCESSFULLY used for selected orbital malignancies after biopsy confirmation as an alternative treatment to exenteration and external irradiation.<sup>1</sup>

A 59-year-old Caucasian man was evaluated for left orbital discomfort without diplopia and visual disturbances over a six month period. Our initial examination (February 2000) revealed best-corrected visual acuity of 20/20 in both eyes. Anterior segment and fundus examination found both eyes to be within normal limits without periocular, facial, or scleral pigmentation. Orbital B-scan ultrasonography and magnetic resonance imaging studies demonstrated a  $7 \times 9 \times 13$  mm ( $0.82 \text{ cm}^3$ ) ovoid intraconal mass in the inferotemporal orbital quadrant (Figure 1).

Orbital incisional biopsy through an inferotemporal transconjunctival approach was performed on a poorly encapsulated amelanotic lesion that was firmly adherent to the sclera. Histopathological examination of the specimen ( $0.2 \text{ cm}^3$ ) revealed fascicular arrangements of neoplastic cells displaying large nuclei with prominent nucleoli and clear cytoplasm with rare brown pigments. Immunohistochemistry was strongly positive for HMB45 (Figure 2). Extensive systemic examination and thorough medical, dermatologic, urologic, and otorhinolaryngological examinations revealed no evidence of systemic primary or secondary melanocytic tumor.

An 18-mm-diameter unshielded iodine-125 plaque was designed to deliver approximately 90 Gy to the target tumor volume of  $0.82 \text{ cm}^3$  at 9 mm depth to cover any residual intrascleral or loose orbital melanoma cells surrounding the biopsy site. It was sutured to the inferotemporal scleral quadrant for 105 hours (Figure 3, Left). Radiation-induced cataract and retinopathy with retinal neovascularization developed after 16 months and were successfully treated with cataract surgery and panretinal photocoagulation. The final visual acuity of the affected left eye is counting fingers.

Diffuse liver metastases were diagnosed 22 months after orbital diagnosis, and intravenous chemotherapy (dacarbazine) was started. After 66 months' follow-up, the patient is still alive with partial remission of his liver metastases. Follow-up orbital magnetic resonance imaging studies performed every six months confirmed the

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