

Enhanced Depth Imaging Optical Coherence Tomography for Choroidal Tumors

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Enhanced depth imaging optical coherence tomography (EDI OCT) was first described by Spaide and associates¹ in 2008 as a technique for imaging the superficial and deep layers of the ocular fundus. The method involves placing a conventional optical coherence tomography (OCT) device closer to the eye and thereby producing an inverted image of both the retina and choroid.¹ Conventional OCT technology visualizes the retinal and retinal pigment epithelial (RPE) layers but little of the underlying choroidal tissue.² This novel method allows improved resolution of and sensitivity to deeper fundus structures such as the choroid and inner sclera using noncontact technology.²

A standard OCT device uses near infrared light at approximately 800 nm. This form of light allows visualization of the retina and subretinal space but becomes scattered by the RPE and choroidal structures. Moving the device closer to the eye allows the choroidal layers to receive a more focused stream of light, providing enhanced visualization of choroidal details. This development has facilitated descriptive findings of choroidal tumors and precision in measurement of choroidal tumor thickness.¹

CASE DESCRIPTION

A 61-year-old white woman was found to have a pigmented fundus lesion on routine eye examination. Visual acuity was 20/20 in each eye (OU). Intraocular pressures and anterior segments were normal OU. The left fundus was normal. The right fundus disclosed a lightly pigmented choroidal nevus temporal to the foveola measuring 6 x 5 mm at the base and 1.5 mm in thickness; overlying

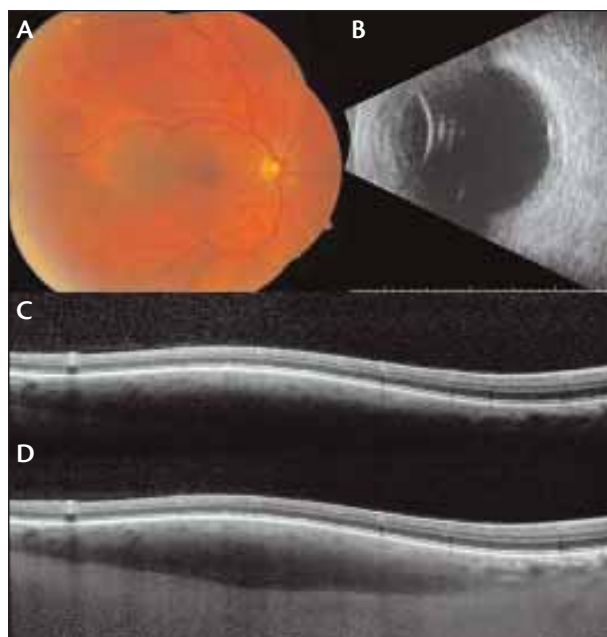


Figure 1. Color fundus photograph of right eye, showing a partially pigmented choroidal nevus with overlying drusen in the temporal macular region (A). B-scan ultrasonography demonstrating slightly elevated choroidal lesion corresponding to the nevus (B) with measurement of 1.5 mm thickness (retina plus choroid thickness). Standard OCT depicting the subtle choroidal elevation devoid of features but with excellent detail of overlying retina and retinal pigment epithelium (C). Enhanced depth imaging OCT showing full thickness of choroidal nevus with some degree of choroidal detail showing compression of the choriocapillaris overlying the deeper nevus; in this image, the nevus measured 660 µm in thickness (D).

drusen were noted (Figure 1A, 1B). Autofluorescence showed absence of orange pigment. Standard OCT depicted the slightly elevated choroidal mass with no details except for slight deep optical shadowing (Figure 1C). The overlying retina was attached, and there were micronodular changes at the level of the RPE consistent with drusen. EDI OCT confirmed the above findings but revealed more detail regarding the internal features of the choroidal nevus, demonstrating the location of the nevus in the outer choroid with compression of the choriocapillaris, intact scleral wall, and thickness of 660 μm (Figure 1D). A diagnosis of choroidal nevus was rendered, and observation was advised.

DISCUSSION

EDI OCT has played a vital role in the analysis of multiple ocular fundus conditions affecting the retina and the choroid. Fujiwara and associates³ utilized this technique to image highly myopic eyes in 31 patients. EDI OCT displayed significant choroidal thinning, and the investigators calculated that subfoveal choroidal thickness decreased by 8.7 μm per diopter of myopia and by 12.7 μm per decade of life. Spaide and associates⁴ studied age-related macular degeneration in 22 patients to

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explore the pathogenesis of related RPE detachment. EDI OCT imaging allowed visualization of choroidal neovascularization on the back surface of the detached RPE, possibly representing retinal vascular anastomosis and leading to RPE tears following contraction. Imamura and associates⁵ used EDI OCT to demonstrate the increase in choroidal thickness in 19 patients with central serous chorioretinopathy (CSC); the investigators suggested that accumulation of choroidal fluid or thickness with elevated hydrostatic pressure could be a step in the pathogenesis of CSC.

A recent PubMed search identified 2 reports of EDI OCT on choroidal tumors in the literature.

Basdekidou and associates⁶ presented a case report in which a choroidal nevus inaccessible to ultrasonography

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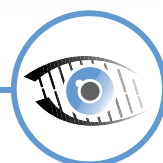
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was measured and evaluated in the superior macula using EDI OCT. Thickness was measured based on the hyper-reflectivity between the Bruch membrane and the inner scleral surface. The tumor was identified despite absence of RPE detachment and retinal photoreceptor damage.

Torres and coworkers² described the EDI OCT features of choroidal tumors less than 1 mm in thickness, which were previously unable to be identified using ultrasonography, in 23 patients. Various clinical features were identified on EDI OCT based on the tumor type. Amelanotic choroidal nevus showed a homogeneous appearance, with medium reflective band and visible intrinsic choroidal vessels. Melanotic choroidal nevus displayed a highly reflective band at the choriocapillaris layer with posterior optical shadowing. Choroidal melanoma displayed a highly reflective band anteriorly and did not allow visualization of choroidal vessels or sclera. EDI OCT was able to identify the anterior and lateral tumor boundaries using recognized landmarks of Bruch membrane, RPE, and surrounding normal choroid. However, the junction of the posterior boundary of the tumor with the inner scleral layer was visible only in tumors measuring less than 0.9 mm in thickness. Consequently, tumors with thickness greater than 1 mm in height or 9 mm in diameter could not be clearly identified from surrounding structures.

Shah and coworkers⁷ evaluated 104 patients with choroidal nevus to determine the optimal characteristics for EDI OCT imaging. Lesion and patient factors for ideal EDI OCT imaging included patient age less than 60 years (for best cooperation), nevus location within or close to macula (for most direct imaging), and small lesion diameter (for identification of landmark surrounding structures). The investigators evaluated retina and choroid in exquisite detail and reported that the most common findings for choroidal nevus imaged with EDI OCT included choroidal shadowing deep to the nevus (92%), choriocapillaris thinning overlying the nevus (94%), RPE atrophy (43%), RPE nodularity (8%), photoreceptor loss (43%), inner segment-outer segment irregularity or loss (43%), external limiting membrane irregularity (18%), outer nuclear and outer plexiform layer irregularity (8%), inner nuclear layer irregularity (6%), and subretinal fluid detected by EDI OCT (16%). The authors commented that EDI OCT measurement of a choroidal nevus at 0.66 mm was smaller than the ultrasound measurement of 1.5 mm. This probably relates to the more precise "choroid-only" measurement of the nevus and higher resolution of true anterior and posterior margins, but it could also represent miscalibration of either the OCT or the ultrasound unit.

CONCLUSION

EDI OCT enables improved examination of choroidal nevus and small melanoma, in comparison with standard OCT, by providing higher resolution of and sensitivity to choroidal detail and allowing precise measurement of intrachoroidal tumor thickness, which has historically often been possible only in thin amelanotic tumors. EDI OCT is an additional resource for tumor detection of inconspicuous flat tumors that might remain hidden from ultrasonography. As in the case presented here, EDI OCT can occasionally provide complete visualization of a choroidal tumor, which is critical for patient follow-up. ■

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