Real-time *in vivo* micromorphology and histopathology of choroidal osteoma using enhanced depth imaging

Rameez Hussain, Giridhar Anantharaman, Bindu Rajesh, Mahesh Gopalakrishnan

Choroidal osteoma is a usually unilateral benign tumor of the choroid composed of mature bone. Optical coherence tomography (OCT) has been used to image osteoma for several years. With the advent of enhanced depth imaging (EDI) feature of spectral-domain OCT (SD-OCT), better visualization of the morphology of choroidal lesions has been possible. Herein we present a case of choroidal osteoma in a 45-year-old woman, wherein *in vivo* morphology of the choroidal osteoma had been visualized using EDI technique of SD-OCT before and after performing photodynamic therapy. EDI OCT has proven to be a valuable noninvasive imaging modality, almost comparable to histopathological examination, for diagnosing choroidal osteomas and for providing an insight into the *in vivo* micromorphological changes occurring during the course of the disease.

Key words: Choroidal osteoma, enhanced depth imaging, morphology

Choroidal osteoma, first described by Gass *et al*.,[1] is a benign choroidal tumor composed of mature bone, typically observed in young females. It presents as a slightly, irregular elevated, yellowish white to orangish red lesion, usually juxta-or peripapillary in location, with well-defined geographic borders.[1]

Histopathological documentation of the tumor in literature is very scarce except for a single case report[2] which shows the tumor to be composed of dense, interconnected bony trabeculae with large cavernous vascular spaces and small capillary-like blood vessels filling the intratrabecular spaces. The bony trabeculae were shown to be composed of osteocytes and cement lines.[2]

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Choroidal osteomas have been imaged from the era of time-domain optical coherence tomography (OCT).[3] The advent of enhanced depth imaging (EDI) feature of OCT has provided better insight into the *in vivo* morphology of choroidal lesions.[4,5]

Herein, we present a case of choroidal osteoma wherein the EDI technology of spectral-domain OCT (SD-OCT) has enabled visualization similar to a histopathological examination.

Case Report

A 45-year-old woman, with gradually progressive defective vision in her left eye (LE) for 4 months, had a best corrected visual acuity of 20/20 in her right eye (RE) and 20/40 in the LE. Anterior segment examination was within normal limits. Fundus examination of the RE was normal, whereas the LE showed an irregular elevated, yellowish white choroidal lesion with well-defined geographic borders, involving the inferior macula. There were areas of subretinal hemorrhage at and above the fovea clinically suggestive of a choroidal osteoma with a subretinal neovascular membrane [Fig. 1a]. Fundus fluorescein angiography confirmed the presence of an active subretinal neovascular membrane [Fig. 1b-d]. EDI performed using a confocal scanning laser ophthalmoscope (Spectralis Heidelberg retina angiograph + OCT; Heidelberg Engineering, Heidelberg, Germany) showed a dense hyperreflective choroidal mass, almost continuous with the overlying retinal pigment epithelium (RPE) causing significant widening of the choroidal layer [Fig. 2a]. The hyperreflective choroidal lesion showed complete obliteration of the normal choriocapillaris and the Sattler's layer. The posterior border of the choroidal lesion could be well delineated with an intervening Haller's layer beneath the sclerochoroidal junction. The inner part of the choroidal lesion showed the presence of compactly packed multiple medium to highly hyperreflective layers suggestive of bone lamellae whereas the outer part showed the presence of multiple hyperreflective dots in a spongiform pattern. An area of pre-RPE hyperreflectivity was visualized corresponding to the active neovascular membrane [Fig. 2b]. The tumor details observed by EDI were found to be very similar to those of the only available histopathological report of choroidal osteoma [Fig. 3a and b]. Considering the nonresponsiveness of the lesion despite nine consecutive anti-vascular endothelial growth factor (VEGF); bevacizumab (1.25 mg/0.5 ml) injections, the patient was treated with full-fluence photodynamic therapy (PDT), followed by intravitreal triamcinolone acetonide (IVTA) injection (2 mg/0.05 ml) the next day. IVTA was administered to mainly counteract the inflammatory response that occasionally occurs after PDT and also considering the nonresponsiveness of the lesion to anti-VEGF. After PDT, gradual resolution of the subretinal fluid with involution of the neovascular membrane was observed [Fig. 4a and b]. The patient was reviewed periodically, and the visual acuity remained status quo at her last follow-up with no recurrence over a period of 1-year. EDI showed complete involution of the neovascular membrane with a reduction in the choroidal thickness. Though clinically the tumor size appeared the same [Fig. 5] a reduction was observed in the choroidal thickness as well as in the size of osteoma that could be better appreciated only on

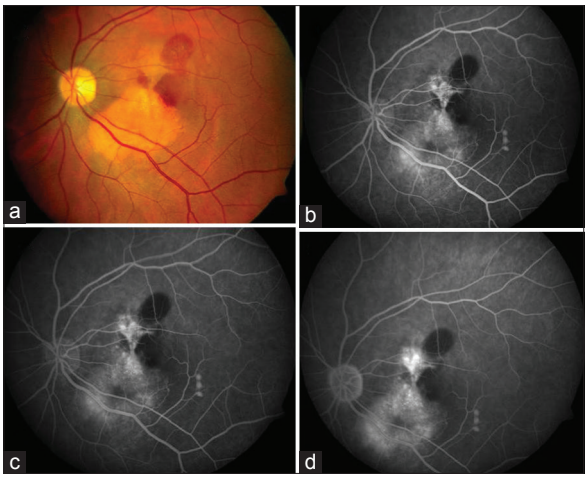

Figure 1: Color fundus photograph (a) of the left eye depicting a choroidal osteoma with areas of subretinal hemorrhage at and above the fovea. Fundus fluorescein angiography (b-d) showing early patchy hyperfluorescence with late diffuse staining corresponding to the choroidal osteoma. Areas of blocked choroidal fluorescence seen corresponding to the areas of subretinal hemorrhage along with an area of early hyperfluorescence and minimal late leakage in the upper part of the choroidal lesion suggestive of a subretinal neovascular membrane

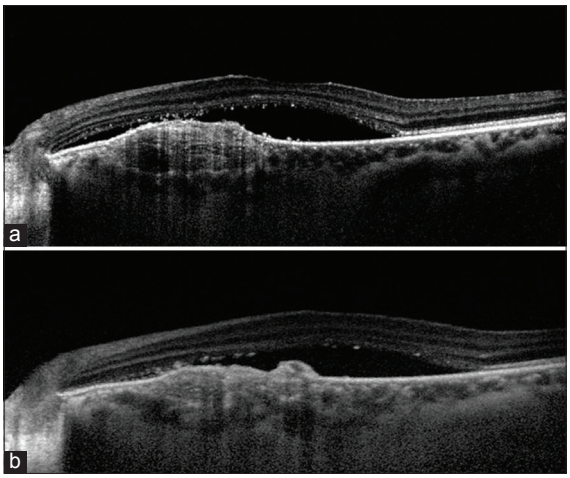

Figure 2: Enhanced depth imaging (a) depicting a well-defined choroidal lesion with hyperreflective layers in the inner part and spongiform pattern in the outer part. Focal areas of RPE thinning noted over the lesion. Overlying neurosensory detachment noted with hyperreflective dots in the outer retinal layers with focal photoreceptor layer disruptions. An area of pre-RPE hyperreflectivity can be visualized corresponding to the neovascular membrane (b)

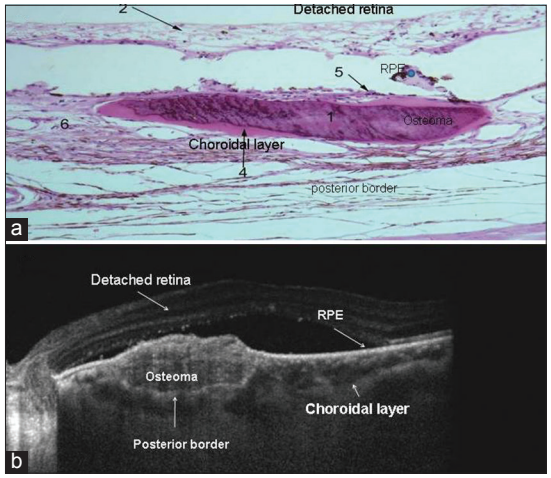

Figure 3: Comparison of the standard histopathology findings (a) described by Williams *et al*. with the features of the enhanced depth imaging (EDI) (b). EDI optical coherence tomography shows replacement of the normal choriocapillaris with a dense hyperreflective mass with distinct border and widening of choroidal space similar to that seen histopathologically. The main lesion is almost continuous with the overlying retinal pigment epithelium and overlying retinal detachment can also be visualized

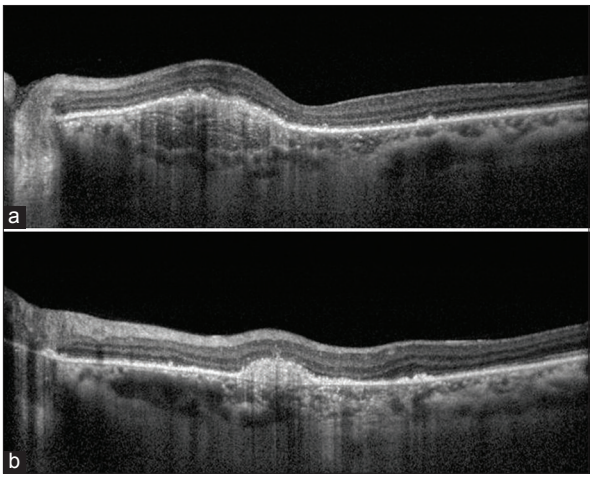

Figure 4: Enhanced depth imaging of the left eye (a) showing complete resolution of the subretinal fluid 2 months after photodynamic therapy with gradual involution of the neovascular membrane (b). Also noted focal areas of retinal pigment epithelium thinning with loss of overlying photoreceptor layers

EDI. Morphological changes in the form of replacement of the compact hyperreflective layers with more speckled appearance probably due to conversion to spongy trabecular or compact form of bone,could also be visualised.

Discussion

OCT has been used previously to study the morphological features of choroidal osteoma. Time-domain OCT initially gave information regarding the retinal architecture overlying the choroidal osteoma,[3] however, was not able to provide details regarding the choroidal tumor characteristics. In comparison, the advent of SD-OCT[6] enabled tumor characterization in terms of reflectivity as well as the surface topography. EDI feature of SD-OCT with deeper imaging capability allowed further in-depth visualization of the tumor morphology.

Enhanced depth imaging SD-OCT of our patient showed a mixed pattern consisting of horizontal lines and a spongiform pattern similar to the other reports.[4,5] Shields *et al*.[5] provided a detailed description and noted unique intrinsic tumor characteristics in the form of horizontal hyperreflective lamellar lines, denser lines, speckled tissue, and tubular channels. They have suggested that lamellar lines and the dense lines represent the bone lamella and the cement lines described

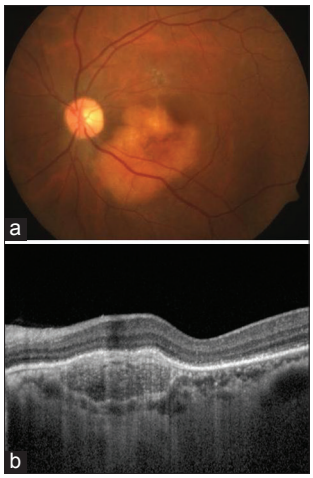

Figure 5: Color fundus photo of the left eye 1-year later (a) showing complete regression of the subretinal neovascular membrane. Enhanced depth imaging of the lesion (b) at 1-year follow-up depicting significant reduction in choroidal thickness as well as replacement of the inner compact hyperreflective layers with more of the speckled pattern

histopathologically.[2] According to them, Haversian canals or the vascular spaces are visible through EDI as horizontally or vertically oriented tubular channels.

Delineation of the posterior border of the tumor on EDI SD-OCT is a feature unique to choroidal osteoma, probably due to its transparent nature.[4,5] Though choroidal neovascular membranes secondary to choroidal osteoma are known to respond to anti-VEGF,[7] our patient seemed unresponsive despite multiple treatments. PDT as a successful treatment modality for choroidal neovascular membrane due to choroidal osteoma has been reported previously also.[8,9] Decrease in the choroidal thickness after the treatment as well as the change in the tumor characteristics on EDI further highlight its capability of an in-depth assessment of the pathological changes better than any other imaging modality.

Thus, EDI OCT has been proven to be a valuable noninvasive imaging modality for diagnosis and follow-up of choroidal osteomas and can provide an insight into the real-time *in vivo* micromorphology that is comparable to histopathological examination.

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