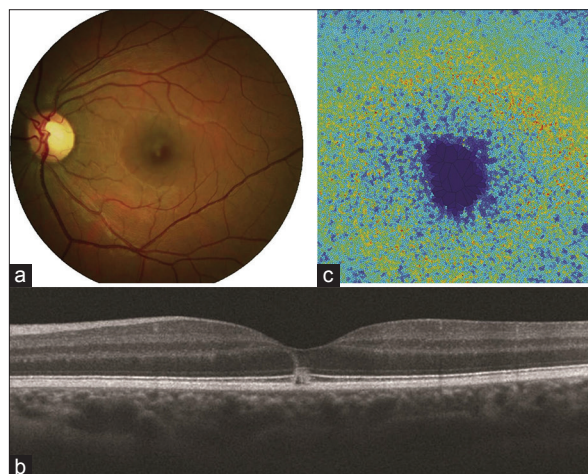


## Adaptive optics study of photoreceptors layer damage from presumed sun exposure: A case report

Sir,

In the present study, we described a case of solar retinopathy studied by means of adaptive optics (AO). Solar retinopathy consists in a photooxidative retinal injury following a prolonged exposition to high-energy light. Histopathological studies have confirmed that both the retinal pigment epithelium (RPE) layer and the outer segments of the photoreceptors layers are susceptible to be damaged.<sup>[1]</sup> Several diagnostic tools are used to evaluate solar retinopathy, including fundus autofluorescence (FAF), fluorescein angiography, multifocal electroretinography, and optical coherence tomography (OCT).<sup>[2,3]</sup> AO fundus imaging is a reliable technique for assessing and quantifying the changes in the photoreceptors layer. AO works by measuring and correcting ocular aberrations in real time, achieving a lateral resolution of 2  $\mu\text{m}$ .<sup>[4]</sup>

We studied a case of a 25-year-old woman complaining decreased visual acuity (20/200 OU), central scotoma, chromatopsia, and photophobia after a mountain walk over the snow in a sunny day and without sunglasses protection. Other causes of macular phototoxicity, including welding arc, exposure to microscope light, laser pointer were excluded from this study. Although she denied it, we cannot exclude she had direct sun gazing. Ophthalmoscopic examination, fundus photography, FAF, spectral domain OCT (SD-OCT), and AO examination were performed to study *in vivo* retinal damage at cellular level.

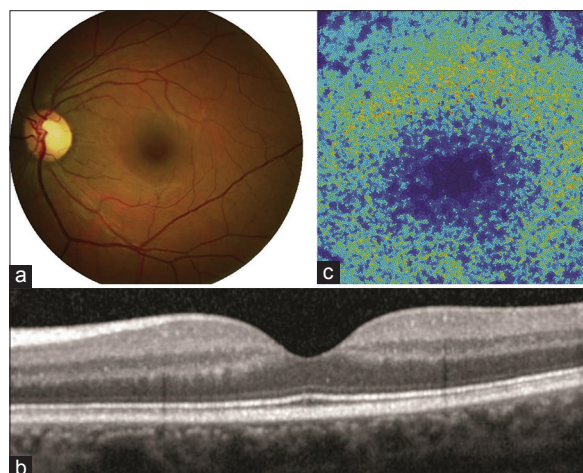


**Figure 1:** Multimodal imaging of a 25-year-old woman with acute solar retinopathy in the left eye. (a) Fundus photography showed a foveal yellowish-white spot with surrounding gray, granular pigmentation. (b) Spectral domain optical coherence tomography detected increased foveal rod-shaped full-thickness hyperreflectivity that extended from the outer segments of the photoreceptors and the retinal pigment epithelium to the inner layer of the retina. (c) Adaptive optics cone density map is based on a color scale expressed in thousands of cones/ $\text{mm}^2$  and shows heterogeneous disruption of the cone photoreceptor mosaic with cone density reduction

All clinical features were suggestive for solar retinopathy. Ophthalmoscopic examination revealed foveal small yellowish-white spot with surrounding gray, granular pigmentation [Fig. 1a]. SD-OCT showed full-thickness rod-shaped foveal hyper-reflectivity extended from the outer segments of the photoreceptors and RPE to the inner layer of the retina, and a slight interruption of the external limiting membrane and the ellipsoid zones with disorganized material [Fig. 1b]. AO examination was obtained using the Rtx1 AO retinal flood-illumination camera (Rtx1, Imagine Eyes, Orsay, France). Each image was obtained by an average of forty frames of a  $4^\circ \times 4^\circ$  retinal area. Cone cells density was then calculated using proprietary software. AO imaging revealed disruption of the cone mosaic, and cone density extended reduction beyond the limit of the lesion visualized by both FAF and SD-OCT [Fig. 1c and Supplementary Fig. 1a, 2a].

A progressive resolution of clinical and anatomical signs was shown on ophthalmoscopy, SD-OCT, and FAF with a near-complete restoration of the ellipsoidal and interdigitation zones during follow-up [Fig. 2a, b and Supplementary Fig. 1b]. Microperimetry was also performed after 24 months follow-up, showing normal retinal sensitivity [Supplementary Fig. 3]. Visual acuity improved to 20/20 OU, although central scotoma persisted in both eyes. AO revealed a progressive but incomplete improvement in cone mosaic distribution and density during follow-up [Fig. 2c and Supplementary Fig. 2b].

Several reports describe a multimodal approach to visualize RPE and photoreceptors layers.<sup>[2,3]</sup> AO imaging was more sensitive than combined FAF and SD-OCT to detect and follow photoreceptors damage on solar retinopathy. Cone loss was consistent with continued central scotoma as reported by our patient. The question is whether the lack of cone visualization showed in AO images was really related to a cone loss or rather to an optical shadowing. A previous study



**Figure 2:** Multimodal imaging 24 months later. (a) The solar retinopathy lesion was barely detectable in the fundus photography image in the left eye. (b) Spectral domain optical coherence tomography detected a complete restoration of the ellipsoid and interdigitation zones. (c) Adaptive optics revealed incomplete recovery of the cone mosaic, with persistent cone photoreceptor loss at the level of the solar retinopathy lesion

demonstrates disappearance of the normal cone mosaic on AO images of the macular area co-localized with a disruption of the interdigitation zone on OCT in different pathologies. Conversely, a normalization of the normal cone mosaic was related to concomitant restoration of the interdigitation zone on OCT.<sup>[5]</sup>

We suppose that a real cone damage event occurred in our patient, and succeeding photoreceptor recovery demonstrates neuronal reconstitution, reorganization, and plasticity *in vivo* at cellular level. AO are an excellent tool for documenting photoreceptor damage and recovery in solar retinopathy, showing higher sensitivity in photoreceptor damage detection than both SD-OCT and FAF.

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Nil.

#### Conflicts of interest

There are no conflicts of interest.

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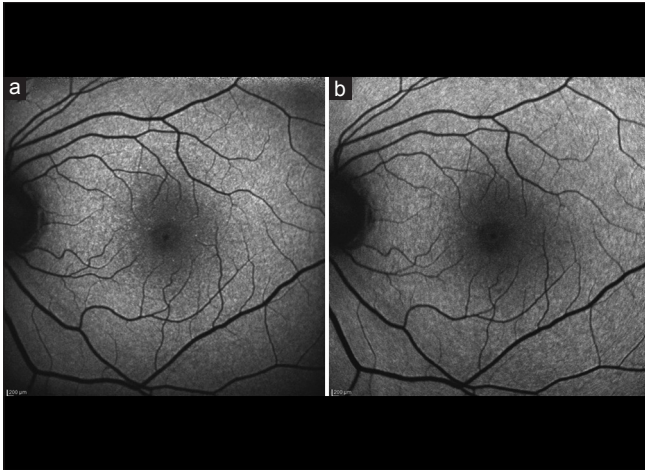
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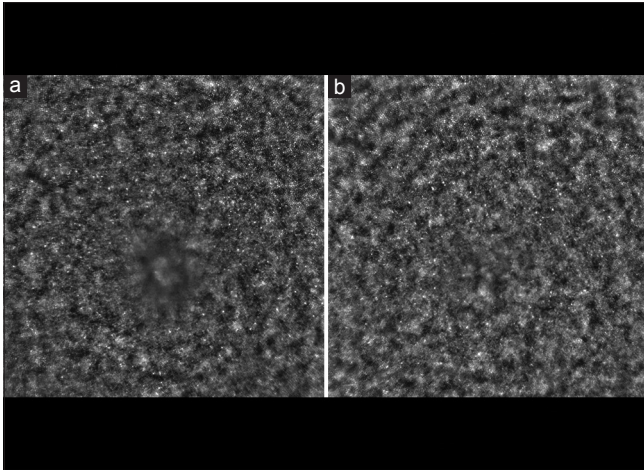
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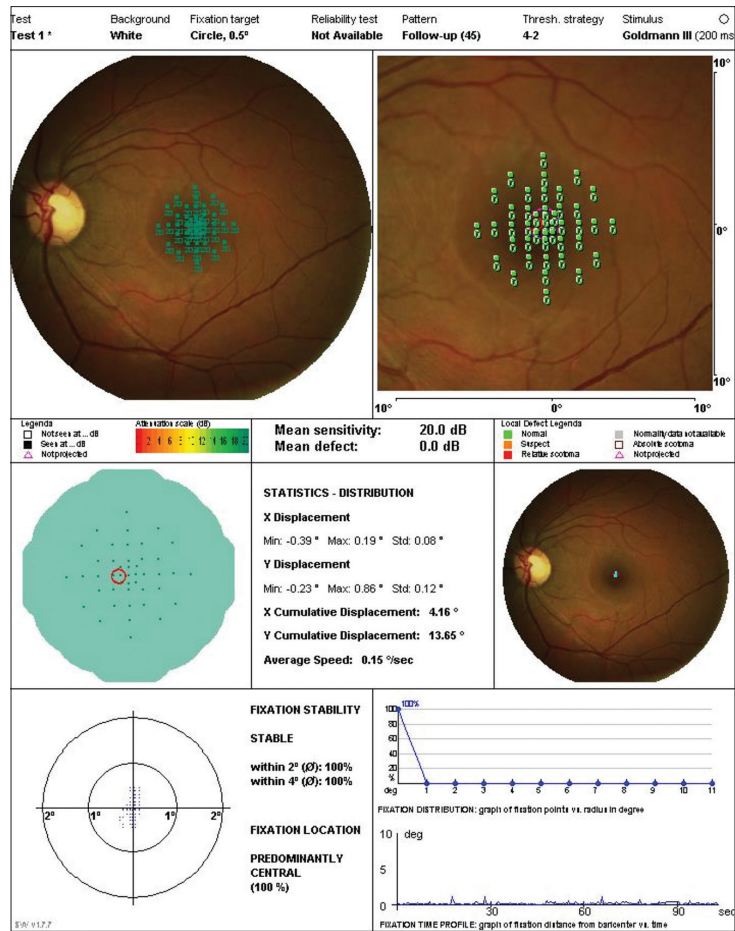
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**Supplementary Figure 1:** (a) Autofluorescence image showed solar retinopathy lesion as a hypofluorescent spot surrounded by an irregular hyperautofluorescence ring in the left eye. (b) After 24 months follow-up, the solar retinopathy lesion was barely detectable in the autofluorescence image in the left eye



**Supplementary Figure 2:** (a) Adaptive optics  $4^\circ \times 4^\circ$  retinal area scan revealed heterogeneous disruption of the cone photoreceptor mosaic with cone density reduction in the left eye. (b) After 24 months follow-up, adaptive optics revealed incomplete recovery of the cone mosaic, with persistent cone photoreceptor loss at the level of the solar retinopathy lesion in the left eye



Supplementary Figure 3: Microperimetry was performed after 24 months follow-up, showing normal retinal sensitivity in the left eye