CASE REPORT

Three-dimensional spectral domain optical coherence tomography in chronic exposure to welding arc

Sandeep Saxena,¹ Nibha Mishra,² Carsten H Meyer³

¹Department of Ophthalmology, CSM Medical University, Lucknow, Uttar Pradesh, India

²Department of Ophthalmology, King George's Medical University, Lucknow, Uttar Pradesh, India

³Department of Ophthalmology, Pallas Klinik, Olten, Switzerland

Correspondence to
Professor Sandeep Saxena,
sandeepsaxena2020@yahoo.com

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SUMMARY

Three-dimensional spectral domain optical coherence tomography was performed in a 26-year-old man with chronic exposure to welding arc. Advanced macular visualisation provided significant findings of inner segment-ellipsoid zone disruption with the presence of cystoid changes and hyper-reflective material in the area of disruption. The external limiting membrane was intact in both the eyes. C-scan retinal pigment epithelium fit map of the left eye revealed a well-delineated defect whereas the right eye showed a poorly delineated smaller defect. The hyper-reflective material can be hypothesised to originate from the disrupted photoreceptor layer. The hyper-reflective material was more evident in the left eye which could be correlated with more marked diminution of vision and a prominent yellow lesion at the fovea.

BACKGROUND

Light emitted during the use of welding tools is known to be a source of injury to various structures of the eye including retina, primarily affecting the macula.^{1 2}

We report changes in the retinal layers on chronic exposure to welding arc using three-dimensional spectral domain optical coherence tomography (SD-OCT). It provided us with an unparalleled understanding of the macular damage along with possible explanation to the clinical findings.

CASE PRESENTATION

A 26-year-old man presented at our tertiary care centre with complaint of diminution of vision in both eyes since 2 years. He is a welder by profession for 8 years, which involves indoor work with a history of irregular use of protective glasses. The patient had the habit of performing welding usually winking his right eye. He and his family gave no history of him witnessing a solar eclipse, not even in his childhood. He has no history of undergoing any ocular surgery. He neither had a history of any mental illness nor of any substance abuse. His best corrected visual acuity in the right eye was 20/80 and 20/200 in the left eye. Anterior segment was unremarkable and showed no signs of any surgical intervention. Fundus examination revealed presence of abnormal foveal reflex in both the eyes. A round yellow lesion was seen at the fovea in both the eyes, more prominent in the left eye ([figure 1](#)). On fluorescein angiography the left eye showed ring-shaped hyperfluorescence at the fovea but the right eye was unremarkable ([figure 2](#)).

Advanced macular visualisation, on three-dimensional SD-OCT, in both the eyes showed disruption of the Inner Segment-ellipsoid zone (ISel)^{3 4} in the subfoveal area. Presence of cystoid changes at the photoreceptor layer in the right eye, along with hyper-reflective material in the area of disruption was observed ([figure 3A, B](#)). Hyper-reflective material between the ISel and external limiting membrane in the area of photoreceptor

Figure 1 Coloured fundus photograph of the right eye showing an abnormal foveal reflex with a small yellowish lesion at the fovea which is more prominent in the left eye (white arrow).

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Figure 2 Fluorescein angiography of the right eye showing no significant finding while in the left eye a ring-shaped hyperfluorescent area is noted in the foveal area (white arrow).

Figure 3 (A and B) Advanced macular visualisation of the right eye showing an area of disruption in the inner segment-ellipsoid zone with cystoid changes with some hyper-reflective material in the area of defect (white arrow). Cystoid changes can be well appreciated in the magnified view of the fovea (B).

Figure 4 (A and B) Advanced macular visualisation of the left eye showing disruption of the inner segment-ellipsoid zone with presence of hyper-reflective material in the area of defect. The hyper-reflective material is more prominent in the left eye which can be appreciated in the magnified visualisation of the fovea (B).

Figure 5 C-scan retinal pigment epithelium fit map of the right eye reveals poorly delineated defect measuring $351 \times 386 \mu\text{m}$ (A). However, the left eye showing a well-delineated defect measuring $234 \times 323 \mu\text{m}$ (B).

disruption was more prominent in the left eye (figure 4A, B). The external limiting membrane and the retinal pigment epithelium was intact in both the eyes. C-scan retinal pigment epithelium (RPE) fit map of the left eye revealed a well-delineated defect measuring $351 \times 386 \mu\text{m}$ whereas the right eye showed a poorly delineated smaller defect measuring $234 \times 323 \mu\text{m}$ (figure 5). Three-dimensional imaging further highlighted, in an unparallel manner, the presence of difference in hyper-reflective material in the area of photoreceptor disruption between both the eyes (figures 6 and 7 and video 1).

INVESTIGATIONS

- Fundus photography
- Fluorescein angiography
- Three-dimensional SD-OCT (Cirrus high-definition OCT (Carl Zeiss Meditec Inc), California, USA)

Figure 6 Advanced three-dimensional analyses exquisitely showing disruption of the inner segment-ellipsoid zone with few specks of hyper-reflective material.

DISCUSSION

Cellini *et al*⁵ reported subfoveal external limiting membrane hyper-reflectivity in a case of acute exposure to welding arc. Choi *et al*⁶ reported acute welding arc injury with diminution of vision without any retinal changes on SD-OCT. Vedantham⁷ reported, in chronic welder arc exposure, presence of a hypore- flective space between the two retinal outer hyper-reflective layers.

Chronic changes observed in photic injury by welding arc, solar retinopathy and distant lightning strike are similar. Solar radiation is responsible for reduced lipofuscin content of the retinal pigment epithelium cells resulting from reduced phago- cytosis of photoreceptor outer segment.^{8 9}

In the present case, the patient gave a history of exposure to welding arc for the past 8 years with on and off use of protec- tive glasses. Corneal and lenticular opacity was not observed on slit-lamp biomicroscopic examination. Similar findings have been observed in a recent study by Yang *et al*¹⁰ in which the

Figure 7 The left eye on advanced three-dimensional analyses showing defect in the inner segment-ellipsoid zone with significant hyper-reflective material in the area of disruption.

Video 1 Advanced three dimensional visualisation of the left eye shows disruption of the inner segment-ellipsoid zone with presence of hyper reflective material in the area of defect.

anterior segment was found to be unremarkable in 40 welders from a manufacturing enterprise. The crystalline lens is known to filter out hazardous ultraviolet light in the elderly. However, the clear crystalline lens in young is an inefficient filter of the short wavelength.¹¹ In the present case, the patient had been exposed to high levels of ultraviolet light for a long period of time at a very vulnerable period of life time causing more photic injury to the macula.

In the present case disruption of the ISEL, in the subfoveal region, was noted on SD-OCT. The external limiting membrane and retinal pigment epithelium in both the eyes were intact suggesting that the main area of damage in photic injury by chronic exposure to the welding arc is the photoreceptors. Three-dimensional imaging in our case, highlighted for the first time, the global visualisation of ISEL disruption and hyper-reflective material in the area of disruption providing an improved understanding of the area of damage. Presence of hyper-reflective material between ISEL and retinal pigment epithelium was more pronounced in the left eye which could be correlated with associated functionally with marked diminution of vision and structurally with a prominent yellow lesion at the fovea. Besides, the left eye revealed a well-delineated larger defect on C-scan. Photic injury to the macula by solar radiations leads to abnormal processing of cone outer segments.⁹ This results in increased accumulation of outer segments in the outer retina and subretinal space. In the present case, the hyper-reflective material in the area of photodisruption of ISEL may also result from increased accumulation of cone outer segments as seen in solar maculopathy. The presence of this hyper-reflective material in the welder's arc maculopathy suggests localised involvement of the photoreceptor layer and defective phagocytic function of RPE.

Three-dimensional SD-OCT provides comprehensive pathogenic insight into the in vivo histology of the retina in chronic exposure to welding arc.

Learning points

- ▶ Chronic exposure to welding arc leads to significant retinal damage.
- ▶ Inner segment-ellipsoid disruption occurs on chronic exposure to welding arc but the external limiting membrane remains intact.
- ▶ Three-dimensional spectral domain optical coherence tomography revealed hyper-reflective material in the area of photoreceptor disruption providing definitive proof of localised involvement of photoreceptors with defective retinal pigment epithelium functioning.
- ▶ Young patients are more prone to photic injury due to ultraviolet rays as the crystalline lens is known to filter out much of the hazardous ultraviolet light in the elderly; however, the lens of young people is an inefficient filter of the short wavelength.

Competing interests None.

Patient consent Obtained.

Provenance and peer review Not commissioned; externally peer reviewed.

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