CASE REPORT

Maculopathy from an accidental exposure to welding arc

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SUMMARY

Welding light can cause photic retinal injury. We report binocular maculopathy induced by a brief exposure to electric arc welding light in a patient who could not be equipped with protective device because of narrow space. A 47-year-old man performed electric arc welding for approximately 10–15 min without wearing protective device because of narrow space and subsequently experienced eye discomfort and decreased visual acuity. At the initial visit, his best corrected visual acuity was 0.5. Fundus examination, optical coherence tomography (OCT) and multifocal electroretinogram (mfERG) were performed. OCT showed disruption in the ellipsoid zone, and mfERG amplitudes in the central 10° were markedly reduced in both eyes. The decrease in visual acuity had been noted for at least 18 months. Using the proper protective device is essential in welding, despite short time periods of work. For patients with welding-induced photokeratitis, doctors should also consider the possibility of photic retinal injury.

BACKGROUND

The welding process emits various spectrums and intensities of optical radiation, including infrared, visible and ultraviolet (UV) light.¹ Exposure to optical radiation can result in keratoconjunctivitis, cataracts and occasional retinal injuries.² The most frequent ocular damage from welding is photokeratitis, also known as 'Welder's eye.' Symptoms include foreign body sensation, pain and decreased visual acuity that onset about 6–12 hours after exposure to light radiation and fade 36–72 hours afterwards. However, in some case, phototoxic maculopathy may occur in addition to the corneal injury.³

Figure 1 Fundus photo of the left eye 5 days after photic injury. Yellowish spot in macula was seen in left eye (arrow).

Figure 2 Optical coherence tomography 11 days after photic injury. In both eyes, (A) right and (B) left, disruption of the ellipsoid zone within the central macula and a few microcystic lesions were seen along the ellipsoid disruption (arrow).

Unfortunately, most of the macular damage caused by welding is underestimated because such injuries are not commonly seen, and the damage can be masked by the severe irritation symptoms caused by corneal impairment, leading to misdiagnosis.⁴ Phototoxic retinal changes are typically subtle and uncommon, occurring in 0.14% of ophthalmologic patients. Moreover, the changes are difficult to clinically identify and document. Hence, studies covering a representative number of patients have been rare, and phototoxic maculopathy has been documented in casuistic reports only.⁵ There have been some case reports of retinopathy caused by welding arc.^{6–9} A case-control study with 40 participants reported that occupational welders have a higher risk of phototoxic maculopathy, and abnormalities in optical coherence tomography (OCT) could be detected earlier than visual symptoms.³ However, most of the previous welding-related maculopathy reports have not shown the results of follow-up examinations, and there still is not enough awareness of the importance of eye protection for welders. We report a case of bilateral maculopathy with prolonged decrease in visual acuity that was caused by short-duration electric arc welding and studied with OCT and multifocal

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electroretinogram (mfERG), along with a review of the associated literature.

CASE PRESENTATION

Patient information

A 47-year-old man visited a local ophthalmic clinic with acute decreased visual acuity in January 2015. He had performed electric arc welding for about 10–15 min without protective device 4 days before presentation. He mentioned that he could not wear protective device because the place of work was too narrow, but it was only brief exposure. After the welding work, he experienced eye discomfort and decreased visual acuity. However, he initially thought that his symptoms would improve and did not immediately go to the medical institute. At the initial visit, his best corrected visual acuity was 0.5 with a refraction of -1.50 sph in both eyes. Anterior segment examination and intraocular

pressure were normal. In fundus examination, a yellowish spot in the macula was seen in the left eye (figure 1). In the visual field test, the right eye showed constriction of the visual field, and the left eye showed multiple scattered defects. However, the reliability of the test was low.

OCT performed on the 11th day after the injury showed disruption in the ellipsoid zone and microcystic cavities near the fovea in both eyes (figure 2). A mfERG performed 1 month after the injury showed central loss of response density and remarkable reduction in the central 10° of the retina (figure 3). An OCT performed 10 months after the injury showed resolution of the microcystic lesions, attenuation of the outer retina and retinal pigment epithelium (RPE) with hyper-reflective deposits within the central macula (figure 4). His best corrected visual acuity had decreased to 15/100 in both eyes in June 2015, and remained at this level until October 2016, which was the date of the last follow-up examination.

Figure 3 Multifocal electroretinogram of both eyes 1 month after photic injury. Central loss of response density and remarkable reduction in the central 10° of the retina were observed. 2D, two-dimensional; 3D, three-dimensional.

Figure 4 Optical coherence tomography 10 months after photic injury. In both eyes, (A) right and (B) left, microcystic lesions were resolved. Attenuation of the outer retina and retinal pigment epithelium with hyper-reflective deposits (arrow) within the central macula were seen.

Medical history

In previous routine health check-ups, the patient was healthy without hypertension, dyslipidaemia or obesity. His best corrected visual acuity was 0.5 in 2014 and 0.9 in 2013. According to the National Health Insurance claims data from 2005 to 2015, he received treatment for a chalazion in 2006. Otherwise, nothing was found in his medical history that was associated with eye problems.

Family and social history

His brother and mother had liver cirrhosis. He denied any family history of eye problems. He had previously smoked 0.3 packs of cigarettes per day for 15 years and quit smoking 11 years prior. He consumed about 350 mL of beer two times per month. He has occasionally performed electric arc welding since 2013, although he had never welded prior to that time. He felt that his vision had been slightly deteriorating since he had started welding, but he was not bothered because it did not cause discomfort in daily life.

OUTCOME AND FOLLOW-UP

Workers' Compensation

The patient applied for industrial injury compensation to the Korea Workers' Compensation and Welfare Service in November 2015, and it was approved as an occupational accident at the end of 2016 after professional investigation and deliberation.

DISCUSSION

The high resolution OCT performed on our patient revealed disruption in the ellipsoid zone (inner segment/outer segment junction layer (IS/OS)) that correlated with decreased visual acuity. These findings are similar to a previous report on OCT findings in solar retinopathy.¹⁰ Cellini *et al* and Choi *et al* reported

no OCT findings in acute welding retinopathy, which may be related to differences in light intensity and protection.^{6 8} However, hyper-reflectivity in the external limiting membrane became apparent on OCT in their patients after 1 month.⁶ Other studies reported the OCT findings of chronic welding arc maculopathy as interruption in the IS/OS layer and the inner portion of the RPE.^{3 11 12} Saxena *et al* reported hyper-reflective material deposit in the disrupted region which may have resulted from reduced phagocytosis of RPE and increased accumulation of the cone OS.¹² Although the prognosis of welding-induced photic retinal injury is usually good, permanent complications are sometimes reported,⁹ and this difference in sequelae may reflect the severity of exposure and injury. Absence or disruption of the ellipsoid zone is known to be closely correlated with prognosis of visual acuity and disease severity.^{13 14} In solar retinopathy cases, decreased central foveal thickness and full-thickness disruption beneath the fovea observed on OCT could be associated with permanent visual acuity loss.¹⁵ In our case, decreased visual acuity continued for at least 18 months after diagnosis, and this could be associated with persistent disruption of the ellipsoid zone around the fovea. Thus, the impaired recovery of the ellipsoid zone integrity might indicate poor visual prognosis in welding arc maculopathy.

mfERG is a useful tool for detecting various retinal abnormalities that are not obvious in fundus examination.^{16–18} Initially, our patient showed slight anatomical disturbance in fundus examination and OCT, however, mfERG a month later identified significant abnormalities in macular function. Interestingly, an arc welding macular injury case in previous report showed slight reduction in amplitude of mfERG 5 days after injury and the reduction has been improved after 1 month.⁶ The marked reduction in amplitude of mfERG after a month in our case could be related to the severity of macular damage and subsequent poor visual prognosis. Therefore, the mfERG could play an important role in early diagnosis and prognostication in photic retinal injury.

Most UV light is absorbed by the cornea and lens, but sufficiently high intensity UV could also affect the retina. There are at least three types of retinal injury in this waveband—thermal, mechanical and photochemical.¹⁹ The type of retinal damage depends on wavelength, energy level, duration of exposure and degree of pigmentation.³ Light emitted during the use of welding tools is known to be a source of radiation resulting in phototoxic maculopathy that can also occur after overexposure to sunlight, halogen filaments and operation microscopes. Electrical welding arcs emit an intense and extended spectrum of radiation ranging from infrared to ultraviolet. Radiation, such as the visible light and infrared light (400–1400 nm) emissions from arc welding, penetrates deep into the eye and, if sufficient in intensity, may cause thermal or photochemical damage to the retina. When the welding radiation is focused on the macula by the refractive system, it causes thermal or photochemical damage to photoreceptors, RPE and other layers. The photochemical cascade of reactions may release free radicals, hyperoxide anions and hydrogen peroxide, and these by-products may react with tissue and membranes, inducing phototoxic injury.⁵ In animal experiments, retinal pigment epithelial damage was induced by light exposure in albino rabbits.²⁰ Retinal photochemical damage can result from only short exposure times without appropriate filters.²¹

Protective device containing appropriate lenses is essential to protect against retinal injury in welding labourers. Arend *et al* reported a case of a 26-year-old man with welding-induced maculopathy, despite using protective equipment at work.²² Examination of the lenses of his device revealed that he had used

lenses that allowed him the best visualisation of welding area, but these more transmitting lenses were inappropriate because they could only absorb light with a wavelength less than 380 nm. Thus, the infrared spectrum of emitted light was transmitted and resulted in thermal and photochemical macular damage. Yang *et al* suggested that a protective mask reduces a worker's field of vision, especially when working in dark and confined spaces; thus, welders prefer removing their protective equipment for simple welding.³ Similarly, the patient in our case was working in a narrow space, and he had only brief exposure to welding light without protective device. Although he soon recovered from photokeratitis, he developed and suffered from photic retinal injury. Therefore, the present case should be interpreted as a working accident and not as an occupational disease.

Conclusion

Welders must be educated about photic retinal injury and should wear the proper protective device to avoid potential retinal damage. In addition, when patients with welding-induced photokeratitis are encountered in the clinic, the doctor must be aware of the possibility of photic retinal injury and provide a relevant explanation for it. OCT and mfERG can be used as effective tools for early diagnosis and visual outcome predictor in phototoxic maculopathy.

Learning points

- ▶ A brief exposure to electric arc welding light in a patient who could not be equipped with protective device caused binocular maculopathy.
- ▶ Exposure to optical radiation during welding process can cause retinal injuries as well as keratoconjunctivitis.
- ▶ Visual impairment could be prolonged without extensive anatomic disturbance in macula.
- ▶ When patients with welding-induced photokeratitis visited the clinic, the doctor must be aware of the possibility of photic retinal injury and provide a relevant explanation for it; optical coherence tomography and multifocal electroretinogram could be useful tools in diagnosis and prognostication.

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Contributors SGL provide patient's information and clinical data. MSK and MYK collected, analysed and interpreted the data. JYK assessed clinical data. MSK and MYK authored the manuscript.

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