Phototoxic maculopathy induced by quartz infrared heat lamp
A clinical case report

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Abstract
Rationale: A large proportion of the output of quartz infrared heat lamps is emitted as infrared radiation (IR). Retinal damage induced by IR-A and visible light on arc welders has been reported. However, case reports of retinal damage caused by quartz infrared heat lamps are rare. To the best of our knowledge, this is the first reported case of phototoxic maculopathy induced by quartz infrared heat lamps.

Patient concerns: We report a female with a 1-month history of progressive blurred vision and dysmorphopsia in her right eye after improper staring at the tubes of a quartz infrared heater. Her best corrected visual acuity of the right eye was 20/32. Optical coherence tomography revealed a defect from the ellipsoid zone to retinal pigment epithelium (RPE)/Bruch’s complex layer with a diameter of 360mm at its widest. P1 amplitudes in the two central concentric rings were reduced as assessed by multifocal electroretinography.

Diagnoses: The patient was diagnosed with phototoxic maculopathy.

Interventions: The patient was advised to cease all exposure to the infrared heater and was treated with peribulbar injections of methylprednisolone, oral Pancreatic Kininogenase, and oral Mecobalamin.

Outcomes: Ten months later, her BCVA improved to 20/20. All examination results returned to normal except for a small residual defect in the interdigitation zone and RPE/Bruch’s complex layer in her optical coherence tomography.

Lessons: Light emitted by quartz infrared heat lamps may cause damage to the retina through photothermal and photochemical means. The public is insufficiently aware of the hazard potential of infrared heat lamps and other IR-A sources on human retina.

Abbreviations: BCVA = best corrected visual acuity, ICNIRP = The International Commission on Non-ionizing Radiation Protection, IR = infrared radiation, NRPB = The National Radiological Protection Board, OCT = optical coherence tomography.

Keywords: maculopathy, phototoxicity, quartz infrared heat lamp

1. Introduction
Quartz infrared heat lamps are of wide use in many households for heating.1,2 A large proportion of the output of quartz infrared heat lamps is emitted as infrared radiation (IR).3,4 Retinal damage induced by IR-A and visible light on arc welders has been reported.5–9 However, case reports of retinal damage caused by quartz infrared heat lamps are rare. In this case report, we described a phototoxic maculopathy induced by quartz infrared heat lamps.

2. Case presentation
In March 2015, a 41-year-old female presented to our clinic with a 1-month history of progressive blurred vision and dysmorphopsia in her right eye. She had previously been healthy and had no relevant medical history such as high myopia, toxic exposure, laser exposure, solar exposure, known parasitic infection, or trauma. Blurred vision with dysmorphopsia is associated with maculopathy and retinopathy or choroidopathy located near the macula, such as central serous chorioretinopathy, age-related macular degeneration, macular hole, epimacular membrane, or macular pigmentary degeneration.

Further questioning revealed that she had been intentionally staring at the tubes of a quartz infrared heater (NSB-80, huaju; Yiwu, China), which was operating 0.5 to 0.8 meter away on her right side at her workplace. According to its manufacture factory, the heater had a power of 800 W. It measured about 220 W/m² in irradiance and about 180 lux in illuminance under her using conditions. During work breaks, she would stare at the tubes while warming her hands. She would also stare at the tubes while daydreaming. This intermittent exposure accumulated to an estimated 2 hours per day for 2 months.
Her best corrected visual acuity (BCVA) of the right eye was 20/32. Optical coherence tomography (OCT)—an imaging technique that uses light to capture micrometer-resolution images of the anterior segment of the eye and the retina—revealed a defect from the ellipsoid zone to retinal pigment epithelium (RPE)/Bruch’s complex layer with a diameter of 360 μm at its widest. There was a pigment disorder in adjacent areas from the external limiting membrane to RPE/Bruch’s complex layer (Fig. 1). The color fundus photograph demonstrated a light-yellow lesion with obscure boundaries at the inferior nasal region of the fovea. Fundus autofluorescence revealed mottled hypofluorescence in the inferior nasal fovea, consistent with fundus fluorescein angiography demonstrating mottled hyperfluorescence in the same location. There was no fluorescence leakage. Visual field analysis was unremarkable. P1 amplitudes in the 2 central concentric rings were reduced as assessed by multifocal electroretinography (Fig. 2). Intraocular pressure was 14.3 mm Hg. Examination of her left eye was normal with BCVA of 20/20 and intraocular pressure of 16.2 mm Hg.

Based on the history and examination results, the patient was diagnosed with phototoxic maculopathy. She was advised to cease all exposure to the infrared heater. She was treated with 2 peribulbar injections of 20 mg methylprednisolone 5-days apart, in addition to oral Pancreatic Kininogenase (240 u t.i.d.) and oral Mecobalamin (0.5 mg t.i.d.) for 1 month.

In follow-up at 1 month, 3 months, and 7 months, her examination showed continual improvement. OCT scans demonstrated that the diameter of the defect gradually shrank from 313 μm to 274 μm to 232 μm, respectively. The pigment disorder abated. A small round lump of high signal appeared in the layer of outer segments of the photoreceptors. Ten months later, at the last visit, her BCVA improved to 20/20. All examination results returned to normal except for a 152 μm residual defect in the interdigitation zone and RPE/Bruch’s complex layer in her OCT (Fig. 3).

3. Discussion

The design of the quartz infrared heat lamp consists of a satin milky-white quartz glass tube with an electrical resistance...
and almost no ultraviolet (UV).

The National Radiological Protection Board (NRPB) in the UK reported that 56.0% of the total radiant output is IR-B (770–1400 nm), 2.0% visible light (400–770 nm), and almost no ultraviolet (<400 nm).

According to tissue optics of the human eye, IR-B and IR-C are almost entirely absorbed by the vitreous gel, so the radiation reaching the retina is almost entirely within the IR-A and visible bands.

Case reports of retinal damage caused by quartz infrared heat lamps are rare. Retinal damage induced by IR-A and visible light has been reported. The arc welding process emits a wide spectrum of radiation, with strong visible light and IR-A radiation penetrating to the retina.

Arc welding light-induced macular lesions present with characteristics similar to our case.

Light can cause damage to the retina through photothermal, photomechanical, and photochemical means. Photothermal damage may have played a role in our patient’s pathogenesis. When exposed to radiant energy from light with wavelengths at the upper end of the visible spectrum, as well as IR-A, molecules in the tissue tend to gain both rotational and vibrational energies, causing molecular collisions and rising tissue temperature.

On a cellular and molecular level, temperature elevation causes protein denaturation and membrane fluidization and then cell necrocytosis appears and tissue lesions are induced. Melanin, the most effective absorber of photothermal energy is located primarily in the RPE; thus, the RPE will more readily absorb photothermal energy and get damaged. This is consistent with the fact that the retinal defect was mainly located at the RPE in this case.

Photomechanical damage is probably not involved in this case, because it is caused by high irradiances in the range of megawatts or terawatts per cm squared and exposure times in the range of nanoseconds to picoseconds.

The lesion was unilateral in this case. Some arc-welding-induced phototoxic maculopathy cases are also unilateral. Here, it likely results from the location of the heater on the right side of her office table, and therefore her right eye suffered from more light exposure.

The International Commission on Non-ionizing Radiation Protection (ICNIRP) statement on far infrared radiation exposure provides safety guidance and criteria for infrared heat lamps and other IR-A sources. ICNIRP recommendations may be overly conservative, as the brightness of a lamp is sufficient to reduce the pupil size from that assumed for ICNIRP calculations. Additionally, the high aspect ratio of the filament image will cause less temperature rise than the circular image assumed in the ICNIRP calculation methodology. To our knowledge, there is an absence of controlled clinical trials or prospective epidemiological studies concerning the influence of commercially available quartz infrared heat lamps on the human retina. The public is insufficiently aware of this issue.

4. Conclusion

We reported a case with progressive blurred vision and dysmorphopsia after improper use of quartz infrared heat lamps. IR-A and visible light emitted by quartz infrared heat lamps may cause phototoxic maculopathy through photothermal and photochemical means. The public should be more aware of the hazard potential of infrared heat lamps and other IR-A sources on human retina.

5. Consent

This study adhered to the tenets of the Declaration of Helsinki, and the ethics committee of the First Affiliated Hospital of Nanjing Medical University approved the study. Informed consent was obtained from the patient for publication of this report and its related images.
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