



ORIGINAL ARTICLE

Prevalence of color vision deficiency among arc welders

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KEYWORDS

Color vision deficiency;
Lanthony D-15 test;
Ultraviolet exposure;
Welding light

Abstract

Purpose: This study was performed to investigate whether occupationally related color vision deficiency can occur from welding.

Methods: A total of 50 male welders, who had been working as welders for at least 4 years, were randomly selected as case group, and 50 age matched non-welder men, who lived in the same area, were regarded as control group. Color vision was assessed using the Lanthony desaturated panel D-15 test. The test was performed under the daylight fluorescent lamp with a spectral distribution of energy with a color temperature of 6500 K and a color rendering index of 94 that provided 1000 lx on the work plane. The test was carried out monocularly and no time limit was imposed. All data analysis were performed using SPSS, version 22.

Results: The prevalence of dyschromatopsia among welders was 15% which was statistically higher than that of nonwelder group (2%) ($p=0.001$). Among welders with dyschromatopsia, color vision deficiency in 72.7% of cases was monocular. There was positive relationship between the employment length and color vision loss ($p=0.04$). Similarly, a significant correlation was found between the prevalence of color vision deficiency and average working hours of welding a day ($p=0.025$).

Conclusions: Chronic exposure to welding light may cause color vision deficiency. The damage depends on the exposure duration and the length of their employment as welders.

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PALABRAS CLAVE

Deficiencia de la visión del color;
Test D-15 de Lanthony;
Exposición a la luz ultravioleta;
Luz de soldadura

Prevalencia de la deficiencia de la visión del color entre los soldadores con arco eléctrico

Resumen

Objetivo: Este estudio se realizó para investigar si se puede producir una deficiencia de la visión del color relacionada con la profesión de soldador.

Métodos: Se seleccionó como grupo del caso a un total de 50 soldadores que habían ejercido la profesión durante un mínimo de cuatro años, y se les comparó con 50 varones no soldados que vivían en la misma zona, como grupo de control. Se evaluó la visión del color utilizando el test Lanthony D-15 desaturado. La prueba se llevó a cabo bajo la lámpara fluorescente de luz de día, con una distribución energética espectral con temperatura cromática de 6.500 K y un índice de representación de 94 que aportaba 1000 lux en el plano de trabajo. La prueba se realizó de forma monocular, no imponiéndose ningún límite de tiempo. Los análisis de los datos se realizaron utilizando el software SPSS, versión 22.

Resultados: La prevalencia de la discromatopsia entre los soldadores fue del 15%, lo cual fue estadísticamente superior al grupo de no soldados (2%) ($p=0,001$). Entre los soldadores con discromatopsia, la deficiencia de la visión del color en el 72,7% de los casos fue monocular. Se produjo una relación positiva entre la duración del empleo y la pérdida de la visión del color ($p=0,04$). De forma similar, hallamos una correlación entre la prevalencia de la deficiencia de la visión del color y la media de horas laborales de una jornada de soldadura ($p=0,025$).

Conclusiones: La exposición crónica a la luz de la soldadura puede causar una deficiencia de la visión del color. El daño depende de la duración de la exposición, y del tiempo en la profesión como soldadores.

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Introduction

Welding, a widely used industrial process, is one of the most intense artificial sources of invisible and visible optical radiation. Welding emits a wide spectrum of radiations ranging between 200 nm and 1400 nm. These radiations include ultraviolet rays (200–400 nm), Visible light (400–700 nm) and infra-red rays (700–1400 nm).¹ UV light is usually divided into 3 bands, including UVA (320–400 nm), UVB (290–320 nm) and UVC (100–290 nm).² Ultraviolet radiation can cause phototoxic retinal injury especially in children and young adults, because crystalline lens UVB retinal protection is deficient in these groups. In other word, there are UVB windows in the crystalline lens of children and adults under 30 years of age.^{3–6} In addition, visible light and near infra-red penetrate to the retina and may cause thermal or photochemical damage, which may be permanent and sight threatening, according to the intensity and duration of exposure.⁷ Retinal damage induced by arc welding is referred to as phototoxic maculopathy.⁸

Short wavelength light has two phototoxic effects. One is burnescence of the ocular lens from exposure to UVB, which reduce the amount of short wavelength light arriving at the retina.⁹ The other is direct selective damage to the short wavelength sensitive cones caused by UV and visible light.¹⁰ Both of these phototoxic effects can produce clinical blue yellow color vision defects.^{9,10}

On the other hand, according to AFSCME (2004), various gasses are emitted during welding and can cause ocular disorders.¹¹ Report of health effects from manganese in welding fume exposure have been relatively recent.¹²

Although there is a large body of literature on the association between occupational manganese exposure and ill health,¹³ vision was assessed in only two studies, and both found loss of color vision and changes in near visual contrast sensitivity.^{14,15}

Occupation-related color vision deficiency usually cause blue-yellow color discrimination loss or, less frequently, a combination of blue-yellow and red-green loss.¹⁶ The eyes may be unequally involved, and the course is variable depending on exposure and other factors.^{16,17} Occupational color vision loss is usually sub-clinical, and workers are unaware of any deficit. It can be assessed using sensitive tests, such as the Farnsworth-Munsell 100 Hue (FM-100) or the Lanthony D-15 desaturated panel (D-15 d).¹⁸

In the recent years, many studies have been carried out on the impairment of color vision. However, there are few studies that have specifically investigated the effect of arc welding on color discrimination.^{14,15,19,20} This study was performed to investigate whether occupationally related color vision deficiency can occur from welding and if so, is there any relationship between exposure duration and color vision defects? The issue that is not evaluated in previous studies.

Methods

A total of 50 male welders, who had been working as welders for at least 4 years, with a mean (\pm SD) age of 29.3 (\pm 6.36) were considered for inclusion in this study. Subjects were selected with simple random sampling method from the list of welders who lived in the welding park of Zahedan city. To

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