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Tear film secretion and stability in welders

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ABSTRACT

Purpose: Welders are prone to ocular injuries and ocular surface problems due to exposure to ultraviolet light. The aim of this study was to evaluate the tear film comprehensively and assess objective and subjective indices of dry eye in welders.

Methods: In this historical cohort, welders with at least 5 years of experience were compared with controls. A complete evaluation of ocular health was done for all participants. The Schirmer test (invasive and non-invasive) and Invasive Tear Break-Up Time (ITBUT) were applied for objective evaluation and the Ocular Surface Disease Index (OSDI) was used for subjective assessment of the tear film status. The results were compared between the two groups using the SPSS software.

Results: The results of 140 welders (mean age: 46.66 ± 13.01 years) and 172 controls (mean age: 45.05 ± 12.61) were analyzed. The values of the Schirmer test and ITBUT were significantly lower in welders than controls; the difference was more prominent for the Schirmer test as compared to TBUT (Schirmer difference = 4.98 mm, ITBUT difference = 2.23 s). OSDI values were also significantly lower in welders than controls ($P < 0.001$). Considering a cut-off point of 12, 81.2% of welders had degrees of dry eye which was severe in 46.2% while 35.5% of controls had dry eye.

Conclusion: The results indicate that the percentage of dry eye and tear problems is far higher in welders than non-welders. Most of the affected welders have severe dry eye. It seems that the main reason for dry eye in these people is aqueous deficiency.

1. Introduction

Many ocular diseases are associated with different professions and some authors believe that the most important point in diagnosis and treatment of ocular injuries is attention to the person's occupation [1,2]. In some occupations, the risk of certain ocular injuries is elevated [1,3]. For examples, the odds of foreign body in the eye are higher in metalworkers [1,4], or the risk of cataract is higher in glassworkers due to high exposure to infrared light [5,6].

Welding is a common and high-demand profession worldwide [7]. The process of welding, due to ultraviolet (UV) radiation from the electric arc, may damage the cornea and is therefore of significance in ophthalmology [8]. UV radiation may have different effects on eye tissues [7,9,10], including corneal opacity, melanoma, Squamous Cell Carcinoma (SCC), Basal Cell Carcinoma (BCC), pterygium, pinguecula. cataract, macular degenerative diseases, etc. Important factors in the effect of ionizing radiations on the eye include duration of radiation, radiation intensity, and its wavelength [11,12]. Therefore, different injuries may be reported in different occupations; for example, laboratory studies have shown endothelial damage following high dose radiation while common doses induce no endothelial damage [12].

Some previous studies evaluated ocular problems and diseases in welders. The most common problems in this occupational group are pinguecula, pterygium, corneal haze, cataract, and macular diseases [7,10,13,14]. Pinguecula has been reported to be the most common ocular surface problem in welders [7,14,15]. ocular surface problems have a close and bidirectional relationship with dry eye [16] as defects in each one may cause problems in the other [16,17]. Therefore, considering epithelial and conjunctival problems reported in welders, it is necessary to evaluate tear film changes and dry eye in these people comprehensively. The present study aimed at comprehensive assessment of subjective and qualitative tear film changes and subjective

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assessment of dry eye using a questionnaire in welders.

2. Materials and methods

2.1. Sampling and study design

This historical cohort was conducted in Iran in 2017. Two groups of welders and non-welders were selected as study groups. In this study, history of exposure to welding was considered as the main exposure, and people with no exposure to welding or its associated factors were excluded from the study. The only inclusion criterion was at least 5 years of experience in welding. Welders who did not work in the past three months and all people with a history of ocular surgery were excluded from the study. Individuals who no occupation related to welding and had a negative history of exposure to ultraviolet radiation were selected as the non-welder group, but those with a history of ocular surgery were excluded. To select welders, a list of all welders working in Tehran was obtained from their syndicate, and 170 welders were randomly selected from different parts of the city. All welders were invited via telephone; except for 15 welders who did not respond to telephone calls or had changed their workplace, 155 were invited to participate in the study. The non-welder group comprised people from the same parts of the city. Efforts were made to maintain the proportion of welders and non-welders in each part. Finally, 207 non-welders were selected and invited for the comparison group.

The tenets of the Declaration of Helsinki were observed in this study. The protocol of the study was approved by the Ethics Committee of Mashhad University of Medical Sciences, and informed written consent was obtained from all participants (to generalize the findings of the present study to all of the welders in city). The participants were also assured that their data were confidential and anonymous.

In the first stage, the demographic characteristics and work experience of the participants were evaluated. Then, an experienced member of the research team interviewed the participants to complete the Ocular Surface Disease Index (OSDI) questionnaire. Examinations were performed after completing the questionnaire.

2.2. Visual and ophthalmic examinations

All participants underwent optometric and ophthalmic examinations. First, an optometrist performed visual acuity and refraction measurement for both eyes. Then, the participants underwent slit lamp examination of the anterior segment including the cornea, conjunctiva and tear film.

First, ITBUT was measured with fluorescein. For this test, the patient was asked to sit at a slit lamp (TOPCON SL-6E, Japan). One drop of normal saline was instilled on a strip of fluorescein (Fluorescein, HAAG-STREIT AG, Switzerland). The strip was contacted with the superior bulbar conjunctiva as the subject was asked to look downwards. Then, the patient was asked to blink three or four times to distribute the fluorescein. After that, the patient was told to close his eyes and a broad beam of cobalt blue was illuminated with slit lamp set at a low magnification (6 X or 10 X). The subject was then asked to open his eyes slowly and the beam was focused on the cornea. The subject was instructed not blink, until told otherwise. A stop watch was used to record time between the last complete blink and the appearance of the first black or dark spot anywhere in the cornea. The test was performed three times for each person and the mean time was recorded as the ITBUT in seconds.

After ITBUT, a 30-min rest was applied for the tear status to return to normal and then the Schirmer test was performed invasively and non-invasively (the interval wash out time between invasive and non-invasive tests was 30 min). One drop of tetracaine was instilled in both eyes in the non-invasive test while no local anesthesia was applied in the invasive test. To do the Schirmer test, the Schirmer strip was placed in the conjunctival cul-de-sac (inferior fornix). The strip was removed after 5 min and the amount of moisture was measured in millimeter.

2.3. Definitions and diagnostic criteria

In the Schirmer test, moisture more than 10 mm, between 5–10 mm, and less than 5 mm was considered normal, borderline, and dry eye, respectively.

An ITBUT more than 15 s, 10–15 s, and under 10 s was considered normal, borderline, and dry eye, respectively.

To analyze the OSDI, the score of each subject was calculated multiplying the sum of scores of all questions answered by 25 and dividing the result by the total number of questions answered [18]. Similar to some studies, a score ≥ 23 was considered as dry eye symptom positive [18]. To show the severity of the symptoms, the OSDI was divided to four groups of normal (0–12), mild [1–22], moderate [1–32], and severe (≥ 33) [18.

All of the analysis in this study were analyzed by STATA V.12 software. Mean and standard deviation for the variables were reported and independent *t*-test were used to compare two groups. To adjust the effect of age, the multiple linear regression was used. To compare the percentage of abnormal subjects (who had abmormal test results) in each group, the logestic regression was performed.

3. Ethical issues

The Ethics Committee of Mashhad University of Medical Sciences approved the study protocol. Every stage of the study was conducted in accordance with the Tenets of the Helsinki Declaration. All parents signed a written informed consent.

4. Results

For this study, 155 welders and 207 non-welders were invited to participate, of whom 140 and 172 participated in the study or were eligible for analysis, respectively. The mean age of the welders and non-welders was 46.66 ± 13.01 (rang: 17–71) and 45.05 ± 12.61 (rang: 18–66) years, respectively (P = 0.266).

The correlation of the right and left eye for ITBUT, Schirmer test before drop instillation, and Schirmer test after drop instillation was 0.791, 0.736, and 0.764. The results showed that correlation of the right and left eye was 0.805, 0.929, and 0.801 in the control and 0.646, 0.694, and 0.684 in the case group, respectively.

The mean Schirmer was 12.81 ± 9.46 and 10.18 ± 8.49 mm before and after tetracaine instillation in the welder group and 17.79 ± 2.78 and 16.20 ± 0.45 before and after tetracaine instillation in the comparison group, respectively.

The results of the worse eye were used to analyze ITBUT, Schirmer without local anesthesia, and Schirmer after local anesthesia. Table 1 presents the mean ITBUT, Schirmer without local anesthesia, and Schirmer after local anesthesia in both groups.

According to *t*-test, the results of all the above tests were worse in welders (P < 0.001). Multiple linear regression, after adjustment for age, showed that all indexes were worse in welders (P < 0.001).

The results of the study showed that 45.7% of welders and 33.8% of

Table 1
The mean Tear breakup time, Schirmer without local anesthesia, Schirmer after local anesthesia and Ocular Surface Disease Index (OSDI) in both groups.

	Case n = 140	Control n = 172	p-value
Tear breakup time (mm)	10.61 ± 2.03	12.84 ± 4.85	< 0.001
Schirmer without tetracaine (mm)	10.59 ± 8.29	17.38 ± 3.03	< 0.001
Schirmer with tetracaine (mm)	8.83 ± 8.32	14.66 ± 8.17	< 0.001
OSDI	37.25 ± 28.25	12.31 ± 12.39	< 0.001