Original Article

Ocular Hazards Among Welders

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Purpose: The purpose of study was to analyze various ocular hazards which the welders come across in their working environments, their etiology and awareness of the welders about the safety measures and ocular hazards.

Material and Methods: A combined study on "Ocular Hazards Among Welders" was carried out simultaneously at Raza Eye Clinic Federal B Area and Al-Khidmet Hospital Orangi Town Karachi from June -December 2004. All the patients were welders collected randomly from the out patient departments when they attended the OPD for the complications they had suffered during their work. The level of knowledge about safety measures and ocular hazards was accessed. All the patients were examined thoroughly on slit lamp and detailed examination of anterior segment was done with special reference to conjunctiva, cornea and lens. X-ray orbits and B scans were done where there was a doubt of any intra ocular foreign body.

All the information gained from the examination and investigations was noted down on the performa.

Result: 70 patients were studied over period of 6 months. The most common ocular hazard found were metallic foreign bodies 58.57% which lead to corneal ulcers with or without hypopyon and corneal opacities as a result of unhygienic self removal trials by the workers themselves or their colleagues. These were followed by conjunctivitis due to smoke, irritant gases and fumes 18.57%, photo-keratoconjunctivitis 17.14%, hyphaema 2.85%, endophthalmitis 2.85%, lenticular changes 8.57% and old corneal opacities 37.5 l%. Most of the workers belonged to 20-30 years of age group. Although 72.85% welders were aware of the importance of the use of safety measures but only 35.7% were aware of the ocular hazards they could come across.

Conclusion: It was concluded that all these ocular hazards faced by the welders were almost preventable if the safety measures were used properly and regularly. Beginners in this profession should receive some basic training about the use of safety measures and first aid in case of emergency. The trends of self medication and treatment by quacks should be discouraged. The workers should seek immediate medical treatment as soon as possible to avoid miserable outcomes.

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Welding is one of the occupations which serves as a backbone for iron and steel industry of our country. Unfortunately workers of this field have to face a lot of ocular hazards perhaps due to their own ignorance illiteracy and lack of safety measures in their working environments. This also includes ignorance towards the safety measures even if they are provided. The sparks may look menacing, but welding causes almost no accidents when it is done in the right way with all the safety measures. One careless moment, though, can lead to serious injuries not to mention the occasional fire. Welders have to pay special attention to their eyes. Sparks and metal (either flying fragments or splatters of hot metal) can cause serious eye injuries, corneal foreign bodies, corneal ulcers and endophthalmitis. Welding "smoke" is a mixture of very fine particles (fumes) and gases. Many of the substances in welding smoke, such as chromium, nickel, arsenic, asbestos, manganese, silica, beryllium, cadmium, nitrogen oxides, phosgene, fluorine compounds, carbon monoxide,

nitrous oxide, cobalt, copper, lead, ozone, selenium, and zinc can be extremely toxic. Generally, welding fumes and gases come from:

- the base material being welded or the filler material that is used.
- coatings and paints on the metal being welded, or coatings covering the electrode.
- shielding gases supplied from cylinders.
- chemical reactions which result by the action of ultraviolet light from the arc and heat.
- processes and consumables used.
- contaminants in the air, for example vapors from cleaners and degreasers.

Use of substandard welding rods can produce fumes of poisonous gases, which can lead to chemical conjunctivitis. Especially to mention nitrogen monoxide and nitrogen dioxide also known as nitrous gases and nitric oxide are severely irritant to the eye.

Intense ultraviolet light from a welding arc can cause painful corneal burns called Welder's Flash, from even up to 50 feet away. Prolonged or repeated exposure to infrared light can cause cataracts as well as retinal burns.

Non-ionizing radiation (NIR) lies in the region of the electromagnetic spectrum (which includes the light spectrum) where the energies are less than needed to separate an electron from an atom (i.e., to ionize the atom). This region consists of energies with frequencies below 10^{16} Hz and includes (in order of decreasing frequency and energy) ultra-violet (UV), visible light (VL), and infra-red (IR).

Both flash keratoconjunctivitis and retinitis are injuries associated with over-exposures to certain types of NIR. Damage occurs in different parts of the eye and is caused by different types of NIR. Retinitis, however, should be more accurately described as photo retinitis, and while flash keratoconjunctivitis is more accurately described as photo keratoconjunctivitis[1].

Photo keratoconjunctivitis is caused by exposure to certain frequencies in the light spectrum. The symptoms range from irritation to severe pain of the eye and increased sensitivity to light. In most cases, symptoms are temporary, manifesting within 2 to 24 hours after exposure and subsiding within 1 to 5 days. "Flash" keratoconjunctivitis, refers specifically to the condition caused by excess exposure of the eye to ultra-violet light[2].

Photo keratoconjunctivitis occurs mainly at wavelengths between 220 to 310 nm (UV-B and UV-C), with peak sensitivity around 270 nm[3]. Ultra-Violet light is heavily absorbed by the cornea and lens of the eye but is greatly attenuated by the ocular fluids.

Therefore, UV damage (mainly photochemical) from excess exposure is generally limited to the anterior parts of the eye, such as the cornea and conjunctiva. Permanent corneal damage can occur with high intensity exposures or cumulative exposures over an extended period[4]. Retinitis can be caused by exposing the eye to excessive visible light and near infra-red radiation.

While ultra-violet light cannot be refracted, visible light and some infra-red radiation can be refracted and transmitted and focused on to the retina. Intense visible radiation can cause severe retinal damage by causing both thermal and photochemical changes. The blue-light region of the spectrum (near UV at wavelengths between 400 and 550 nm) is particularly hazardous to the retina because its intensity is too low to cause thermal damage, thus permitting long exposure that can lead to photochemical changes in retina. Both photo keratoconjunctivitis and photo retinitis have been commonly associated with metal welding and cutting, both common sources of intense ultra-violet radiation in the workplace. These processes are broadly divided into gas welding or torch cutting and arc welding/cutting.

MATERIALS AND METHODS

This was a combined study conducted simultaneously at Raza eye clinic Federal B area and Al-Khidmet Hospital Orangi Town Karachi. The study continued from June to December 2004 and included 70 patients and was an analytical observational study.

All the patients were welders collected randomly from the out patient departments when they attended the OPD for the complications they had suffered during their work. As the patients attended the OPD a performa was filled which included the information about their age, duration of their occupation and nature of the injury they had suffered as well as any history of self treatment if available. The level of knowledge about safety measures and ocular hazards was accessed.

All the patients were examined thoroughly on slit lamp and detailed examination of anterior segment was done with special reference to conjunctiva, cornea and lens. Fluorescien staining was done to outline the extent of corneal epithelial defects. Intraocular pressure was measured wherever possible. Fundus examination was done where possible to rule out the effects of radiation on retina.

X-ray orbits and B scans were done where there was a doubt of any intra ocular foreign body.

All the information gained from the examination and investigations was noted down on the performa. Patients were treated accordingly and final visual outcome was evaluated after three follow up visits mostly at interval of one week.

RESULTS

Out of the 70 patients studied during a period of 6 months the most commonly presented complication was corneal foreign bodies in 41 patients 58.57%. All were iron foreign bodies or their rust rings which were left in self-removal trials. Out of these 41 patients 29 (41.43%) developed corneal ulcers, 12 (17.14%) with hypopyon and 17 (24.28%) without hypopyon. 6 (8.57%) patients developed permanent corneal opacities after removal of foreign bodies. 6 (8.57%) patients had clear cornea 3 weeks after the removal of foreign body. 13 (18.57%) presented with conjunctivitis due to dust and smoke and irritant gases and substandard welding rods. 12 (17.1%) out of 70 patients showed up with photo kerato-conjunctivitis. 2 (2.85%) patients had hyphaema due to striking of projectile foreign bodies. Lenticular changes were seen in 6 (8.57%) patients. 2 (2.85%) patients presented with endophthalmitis which was the end result of unhygienic self removal trial of corneal foreign bodies. 25 (35.71%) out of 70 patients had old corneal opacities in the same or other eye which proved similar happenings in the past (Table 1). It was seen that young males of 20-30 years were mostly involved. This group makes 42.85% of the total followed by 10-20 years age group making up to 35.71% (Table 2). Final visual outcome up till 3rd follow up visit shows that 38 (54.28%) patients reached visual acuity of 6/6, 12 (17.14%) patients 6/9, and 8 (11.42%) patients reached 6/12 (Table 3). It was seen that only 19 (27.14%). out of 70 patients were partly aware about the safety measures. 51 (72.85%) patients were aware about the use of safety measures but 33 (47.14%) did not want to use the safety measures because of poor quality and fitting of safety equipment or hindrance in their work. 12 (17.14%) patients used safety measures regularly.

10 (14.28%) patients told that safety measures were not provided by their employers (Table 4).

Only 25 (35.71 %) patients were aware of the ocular hazards of their occupation, which is quite alarming (Table5).

It is obvious that 30% of the patients were involved in this occupation for last 5 years and 25.71% patients were involved since last 1 year. It could be seen that as duration of work increases the involvement of patients in various injuries decreases (Table 6).

DISCUSSION

In this study we found that the major ocular hazards among welders were corneal foreign bodies reaching up to 58.5% which lead to corneal ulcers with or without hypopyon due either to unhygienic self removal trials by the welders themselves or by their colleagues or due to non compliance and carelessness of the patients towards their injury. A similar study was carried out at department of Ophthalmology, Hvidovre Hospital, University of Copenhagen, Denmark, which showed the prevalence of ocular foreign bodies was 24% among the workers who had exposures of short duration and 42% in those who had prolonged exposures to welding works, which is somewhat closer to our study[10]. The patients with corneal foreign bodies suffer disastrous complications due to ignorance and illiteracy. Most of the time they try to remove these foreign bodies themselves with the help of new currency notes, toothpicks or even broomsticks. Sometimes their colleagues try to remove it by licking it with their tongue, which is the most unhygienic method. Most of the time these patients seek treatment from quacks who prescribe steroids in acutely infected cases. All these treatments usually lead to keratitis, corneal ulcers and hypopyon and sometimes when appropriate treatment is delayed endophthalmitis. Deep corneal foreign bodies lead to corneal opacities ranging from nebula, macula and leucoma, which lead to decreased visual acuity even after the treatment is completed. In the same study in Denmark the prevalence of welding light keratitis was 73%[10] while that in our study was 17.5%, which is markedly different. Probably, the reason for this marked difference is that there is a trend of self-treatment in welders in our country.

18.1% patients presented with conjunctivitis due to dust smoke and irritant gases. A study carried out in Institute of Medicine, Cattolica University, Italy where 49.8% welders presented with this type of conjunctivitis[11]. Reason for this marked difference is again that such patients usually don't seek medical advice in our setups.

Hyphaema was seen in 2.8%, which was the result of projectile foreign bodies striking the eyeball. 2.8% patients lost their eyes due to endophthalmitis. They presented very late and ended up in evisceration. 25% patients had old corneal opacities in same or the other eye which was the sign of same type of incidences in the past.

Table 1: Most common ocular complications seen during the study

S. No.	Complications seen	No. of cases n (%)
1.	Corneal foreign bodies	41 (58.57)
1a.	Corneal ulcers with hypopyon following removal of foreign body	12 (17.14)
1b.	Corneal ulcers without hypopyon following removal of foreign body	17 (24.28)
1c.	Developed corneal opacity following removal of foreign body	6 (8.57)
1d.	Cornea was clear after 3 weeks of removal of foreign body	6 (8.57)
2.	Conjunctivitis due to dust smoke and irritation gases from substandard welding rods	13 (18.57)
3.	Photokeratoconjunctivitis	12 (17.14)
4.	Hyphaema	2 (2.85)
5.	Lenticular changes	6 (8.57)
6.	Endophthalmitis	2 (2.85)
7.	Old corneal opacities in same or other eye	25 (35.71)

Table 2: Age distribution of patients

Age in years	No. of cases n (%)
1-10	2 (2.85)
10-20	25 (35.71)
20-30	30 (42.85)
30-40	8 (11.42)
40-50	3 (4.28)
50-60	2 (2.85)

It was seen in our study that most common age group, which suffered complications, was between 20-30 years of age. Patients of this young age group are usually the backbones of their families. If they suffer such injuries, which disrupt their visual capabilities, they suffer great economical and emotional setbacks. 2.85 %patients were below 10 years of age .If they suffer ocular injuries at such a young age we can well understand what their future could be?

Table 3: Final visual outcome

Visual Acuity on Snellen's chart	No. of cases n (%)
6/6	38 (54.28)
6/9	12 (17.14)
6/12	8 (11.42)
6/18	7 (10)
6/24	3 (4.28)
6/36	–
6/60	–
Endophthalmitis and evisceration	2 (2.85)

Table 4: Awareness of patients about importance of using safety measures

Awareness about safety measures e.g. Goggles, face masks shields and filters	No. of cases n (%)
Partly aware	19 (27.14)
Aware	51 (72.85)
Did not want to use safety measures because of either poor quality and fitting or hindrance in work (mostly torch or gas welders)	33 (47.14)
Used safety measures properly and regularly (mostly are welders)	12 (17.14)
Safety measures were not provided by the employers properly and regularly	10 (14.28)

It is obvious that 72.8% patients were aware of the importance of using safety measures then what is the reason for high rate of complications in spite of such awareness.

Table 5: Awareness about ocular hazards of their occupation

Awareness about ocular hazards	No. of cases n (%)
Not aware	6 (8.57)
Partly aware	39 (55.71)
Aware	25 (35.71)

Table 6: Duration for which the patients have been involved in welding

Duration of occupation in years	No. of cases n (%)
1	18 (25.71)
2	13 (18.57)
5	21 (30)
7	12 (17.14)
10	3 (4.28)
15	3 (4.28)

The reason may be that most of the workers do not want to use the safety equipments either because of their poor quality and fitting or due to the hindrance produced by them during their work. The goggles are very difficult to use in hot humid climatic conditions. Sometimes the protective measures are not provided by the employers. These practices are common among gas and torch welders as this type of welding is not very hazardous as far as irradiation is concerned but the risk of metallic corneal foreign bodies, corneal ulcers and hyphaema is increased due to direct exposure of the eyeball to the working environment. A survey in Alberta showed that, although 21% of the claims for eye injuries came from welders, over 70% of these injuries had no direct association with welding or thermal cutting but were caused by foreign particles entering the eye. In most of these cases, welders did not have their face shields in place[7]. It was noted that 35.7% patients were aware of the ocular hazards of their occupation while in a study carried out in Rawalpindi and Islamabad 29.3% patients were aware of their occupational hazards[12], which is quite closer to our study. It is interesting to note that number of patients presenting with there complains decreases as the duration of their occupation increases. This may be perhaps due to experience gained in the course of time. Most of the complications were seen in those patients who were in early years of their job.

Some international studies have also mentioned effect of radiation on retina and macula. Retinitis was also reported in some studies[13]. Some studies also mention the risk of ocular malignancies such as malignant melanoma of choroids[14]. But we have not found any case of retinitis or any ocular malignancy in our study.

CONCLUSIONS

It was concluded that most of these ocular complications were preventable if use of safety measures were made mandatory. So it is suggested that use of safety measures e.g. goggles, face masks, shields and filters should be made mandatory even in torch or gas welding to avoid accidental exposures.

Following are the safety equipments for the specific type of welding as suggested by the American Federation of Employees:

- Electric and arc welding requires welding helmet or shield with typical filter shades number: 10-4
- Gas welding requires welding goggles or face shield and typical filter shades numbers for gas welding are: 2-8, cutting: 3-6.
- Cutting, torch brazing, torch scolding requires spectacles or welding face shields and typical filter shades numbers are: 1.5-3.

It is advisable to start with a shade that is too dark to see the weld zone. Then go to a lighter shade, which gives sufficient view of the weld zone without going below the minimum. In ox fuel gas welding or cutting where the torch produces a high yellow light, it is desirable to use a filter lens that absorbs the yellow or sodium line in the visible light of the spectrum.

There should be some basic education for the beginners through media or in vocational institutes about safety measures and awareness about ocular hazards of their occupation and first aid in case of an emergency.

The trends of unhygienic self-removal of corneal foreign bodies and self medication and treatment by quacks should be extremely discouraged. It should be made possible for the workers to seek immediate medical treatment as soon as possible to avoid miserable outcomes of their injuries.

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