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Short Communication

Semen Quality and Reproductive Hormones among Welders —a Preliminary Study

S. KUMAR, S.S.A. ZAIDI, A.K. GAUTAM, L.M. DAVE and H.N. SAIYED

Division of Histochemistry & Reproductive Toxicology, National Institute of Occupational Health (ICMR), Ahmedabad, India

Abstract

Objectives: Welders are exposed to intense heat, toxic metals and their oxides and toxic gases during welding, and some of these substances reported to have adverse effects on reproductive organs. Thus, the present study was planned to investigate the sperm quality as well as reproductive hormones among welders exposed to a complex mixture of pollutants.

Methods: Seventeen welders aged 43.8±12.0 (mean±SD) years with welding exposure of 1 to 10 years or more participated in this study. They were performing arc and gas welding in a workshop. Blood (5–6 ml) and semen samples by masturbation were collected from them. Serum was separated and analyzed for reproductive hormones by RIA techniques. Semen was processed for microscopic examination.

Results: The results of this study indicated that sperm concentration was in the normal range (≥20 million/ml) in all seventeen welders, however, motility, morphology as well as Hypo Osmotic Swelling test (HOS) demonstrated impairment in few welders, indicating deterioration in sperm quality compared to the reported normal reference value. Compared with the normal value of hormones provided in diagnostic kits brochure, follicle stimulating hormone (FSH), leutinizing hormone (LH) and testosterone levels were in the normal range, except in two subjects who showed higher FSH and LH levels and one who showed a lower value of testosterone.

Conclusions: This study suggests that welding might have had some adverse effects on sperm motility, morphology and physiologic function even though sperm concentration was in the normal range. Hormonal changes did not show any definite pattern, indicating a need for further study.

Key words: welders, sperm concentration, HOS test, reproductive dysfunction, sperm motility, morphology, hormones

Introduction

Welding technology is an indispensable trade in modern society and has developed rapidly since the early 1940s world-wide. A large number of industrial workers and small shopkeepers doing welding jobs are exposed to toxic fumes during the process of welding operations. Deolate and Kulkarni (1) reported on the incidence of respiratory diseases, burn injuries, metal fumes fever and eye injury among workers in the welding industry in India.

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Reprint requests to: Sunil KUMAR
Deputy Director, National Institute of Occupational Health (ICMR), Meghani Nagar, Ahmedabad 380016, India
TEL: +91(79)2686351, 52, FAX: +91(79)2686110
E-mail: sunilnioh@yahoo.com
skumar@nioh.org

Pandya (2) studied the concentration of metals in the welding fumes and reported that the major components of fumes are iron, zinc and manganese while other metals like chromium, nickel, copper, cadmium and lead are present in trace quantities. Thus, welders are exposed to these metals as well as low doses of ultra violet radiation, intense heat and toxic gases such as carbon monoxide and nitrogen dioxide while welding. Thus, welders are exposed to a complex mixture of pollutants, which may disrupt normal reproductive functions. A preliminary studies carried out in our laboratory indicated the impairment of thyroid function in a few welders (3). As reviewed by Guldotti et al. (4) a welder may suffer from increased risk of ocular injury, burn irritation of throat and skin, musculoskeletal problems, renal, respiratory, reproductive and neuropsychiatric disorders, pneumonitis, leukemia and lung cancer.

The few studies on the reproductive systems of welders are contradictory. Some studies suggest that welding work may affect the male reproductive system (5–7) but these findings

have not been confirmed by other studies (8–9). However, positive findings encourage further study on this important aspect of human reproduction. Very recently, Hjollund et al. (10) noted the impact of welding in male mediated reproductive toxicity. Further, heavy metals such as lead and cadmium present in welding fumes are also known to affect reproductive function (11). A study on workers at a newspaper printing press was carried out at our institute and noted that the average sperm count was significantly lower and a lesser proportion of them were found to be motile as compared to controls. These changes were associated with the level of blood lead in these workers (12).

It is known that welders are exposed to intense heat and other toxicants during welding operations. The human testis is located outside the body cavity in the scrotum to reduce the intratesticular temperature. It is an established fact that active sperm production is dependent on an environment that is 3–4°C lower than the normal body temperature. There is growing evidence of the adverse effect of heat on sperm production in animals (13, 14) as well as in humans (15, 16). Bonde (17) studied seventeen manual metal arc alloyed steel welders with a moderate exposure to radiant heat but without substantial exposure to welding fumes toxicants, and he found a reversible decrease in semen quality. Sperm morphology also showed deterioration during six weeks of exposure and an increase after a break in the exposure. For these reasons we investigated the sperm quality as well as reproductive hormones among workers exposed to a complex mixture of pollutants and heat generated in welding operations.

Methods

Seventeen welders participated in this study. They were exposed for about 8 hours daily to welding fumes during welding operations. Routine medical examinations were conducted and symptom based questionnaires regarding reproductive function were administered and recorded on predesigned proforma. They were interviewed for their habits and duration of welding exposure, requested to donate blood and semen samples for the analysis. They were asked to clean the reproductive organ with tap water before semen collection. Semen samples were collected by masturbation. The appearance and physical characteristics of semen were noted. Blood samples (5–6 ml) were collected intravenously using sterilised syringe and needle. Serum was separated at room temperature and kept at −80°C for about eleven weeks until hormone analysis was carried out.

The semen samples were processed for various parameters such as sperm concentration, sperm motility, morphology and functional test such as HOS test. The sperm concentration was determined by diluting the semen with 19 parts physiological saline using positive pressure pipette and counts were made using a haemocytometer and expressed as million/ml. The sperm motility test was carried out by observing the movement of the sperm and was expressed as a percentage.

The Hypo Osmotic Swelling (HOS) test was carried out using the method of Jeyendran et al. (18). The coiled and straight tail were observed after adding the swelling solution (0.753 gm Sodium citrate+1.351 gm Fructose in 100 ml double distilled water). The basis of this assay is that when viable sperms are exposed to hypo osmotic medium the tail curls and bulges due to the influence of the fluid. The sperm showing curl tail is considered HOS positive.

Serum samples were brought to room temperature before analysis of LH, FSH, and Testosterone using RIA technique. The RIA kits were obtained from M/S Orion Diagnostica, Finland. The counts were taken on RIA gamma counter (Packard, USA). Control subjects were not willing to cooperate for semen analysis, therefore, results on sperm characteristic and hormonal levels were compared with the normal range reported by WHO (19) and in the diagnostic kit brochure, respectively.

Results

The subjects' characteristics and duration of welding exposure are presented in Table 1. Ten welders had more than ten years exposure to welding fumes and the rest had less than ten years exposure. Further, about 29% of welders were smokers and 12% were alcoholic.

The appearance of the semen was normal in all subjects. The results indicated that the sperm concentration was above 20 million/ml in the subject studied. The range of sperm concentration among welders was 33 to 203 million/ml in the semen of 17 welders studied, which was above the reported normal value i.e. ≥20 million/ml. The sperm motility data (included rapid and slow progressive) indicated that out of 17 subjects studied four-showed motility below 50%. The range of motility was 35.7–84.3% in this study. Deterioration of sperm morphology was also observed in some welders (about 43%). These welders showed less than thirty percent normal sperm, which is considered to be the abnormality.

The HOS test was carried out in all the samples and 11 showed HOS positive (indicating more than 60% sperms with curl tail in these welders). However, 6 showed less than 60%. Further analysis of data on the basis of exposure years (≤10 years and >10 years) indicated a significant change in HOS test as well as considerably low motility in the higher exposure group compared to the lower exposure group. However no considerable changes in sperm concentration and morphology were observed in either group (Table 2).

The data on reproductive hormones in 14 of the subjects are presented in Table 3. Blood samples could not be drawn from three subjects. The FSH data showed normal range in 12 cases. Two showed higher values of FSH, 12.9 and 13.2 IU/L.

Table 1 Subject characteristics and duration of welding exposure (n=17)

Sl. Nos	Subjects characteristics	
1	Age (mean±SD)	43.8±12.0 (Range 21–57 years)
2	Smokers (%)	29 (5 person)
3	Alcohol (%)	12 (2 person)
4	History of physical injury to reproductive organ	Nil
5	Welding exposure in years	1) ≤10 years—7 Subjects 2) >10 years—10 Subjects

Table 2 Sperm concentration, motility, normal morphology and HOS test (mean±S.E.) among welders

	Sperm concentration $\times 10^6$	Sperm motility %	Sperm morphology %	HOS test %
≤10 years				
Welding exposure	109.5±24	67.2±4.1	23.1±5.5	68.6±3.3
>10 years				
Welding exposure	101.9±22.6	56.7±4.8	27.3±2.3	54.6±3.9
	NS	NS	NS	p<0.02

NS—non significant

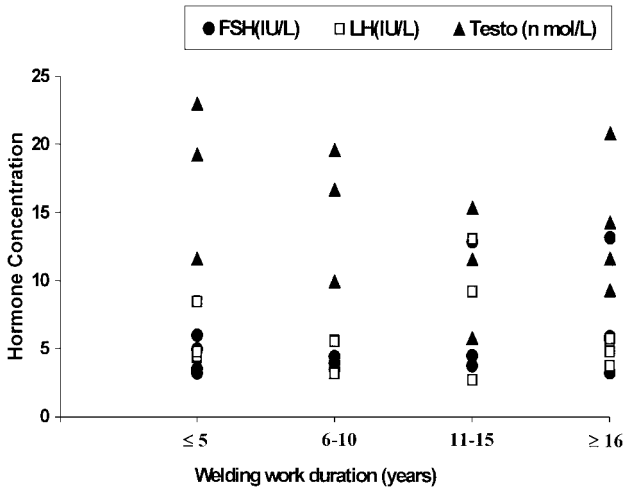

Fig. 1 Reproductive hormones among welders

Table 3 Reproductive hormone levels among welders

	FSH (IU/L)	LH (IU/L)	Testosterone (n mol/L)
Normal range provided with the kits	1.4–10.9	0.63–7.89	8.2–34.6
Range observed in the study	3.2–13.2*	2.7–13.1**	5.8–23.0***
≤10 years			
Welding exposure	4.2±0.4	5.2±0.6	17.6±1.9
>10 years			
Welding exposure	7.0±1.6@	6.4±1.3@	12.7±1.8@

* Two subjects showed higher levels i.e. 12.9 & 13.2
** Two subjects showed higher levels i.e. 9.2 & 13.1
*** One subject showed lower level i.e. 5.8
@ Statistically non significant with respect to low exposure group

LH was also higher, 9.2 and 13.1 IU/L, in two cases compared to the reported normal level provided in the kit (1.4–10.9 IU/L for FSH; 0.63–7.89 IU/L for LH). However, there was not a single sample, which showed a lower value for these two hormones. Testosterone level was 9.3–23.0 n mol/L in all but one subject, which is within normal range (8.2–34.6 n mol/L) (Fig 1). This subject showed a lower value than the reported lowest reference value provided in the diagnostic kit. In addition to this, considerably lower mean testosterone level (12.7 n mol/L) was observed in the high exposure group compared to the lower exposure group (17.6 n mol/L). However, FSH and LH levels were higher in the high exposure group in comparison to the low exposure group (Table 3).

Discussion

The present study indicates that welding exposure may not have an effect on the sperm concentration. All 17 subjects showed a concentration above 20 million/ml, which is the normal sperm concentration described by WHO (19). The concentration of sperm in this group of occupationally exposed workers was higher than that in workers exposed in chemical and pharmaceutical industries from this part of the world having the same ethnicity (20). Therefore, we inferred that this low level of exposure may not bring about drastic changes in the reproductive system on reduction in the sperm concentration. However, this low level of exposure may be responsible for the other deleterious changes observed in the present study. Parameters such as motility, morphology and HOS test clearly suggest that welding exposure may have some role in the deterioration of sperm quality, even though the sample size was small in the present study. Earlier, Zaidi et al. (3) also reported thyroid dysfunction in few welders compared to controls.

The mechanism by which these changes occur is not known. However, toxic metals present in the welding fumes, ultraviolet radiation, toxic gases as well as intense heat produced during welding operation may be responsible for the deterioration of the semen quality. Our study corroborates an earlier study of Bonde (21), who reported that the sperm count per ejaculate, the proportion of normal sperm count, the degree of sperm motility and the linear penetration rate of the sperm were significantly decreased. He also observed a dose response relation between total exposure to welding fumes and these sperm parameters (except sperm count). Further, Selevan et al. (22) reported alterations in sperm quality after exposure to periods of elevated air pollution without changes in sperm number. Thus we hypothesize that the low level of welding exposure may not be able to alter the sperm concentration but may have some effects on reproductive and endocrine systems, which may be responsible for the altered sperm quality in the present study.

In the present study two subjects showed higher values for serum FSH and LH levels as compared to reported normal values. However, no definite pattern was observed for the three hormones studied. Bonde (21) reported a borderline significant increase in concentration of FSH in serum of workers exposed during welding operations. In the present study, statistically insignificant elevation in FSH level was observed in the high exposure group (>10 years) as compared to the low exposure group (≤10 years). On the basis of available data, we subscribe to the hypothesis that the welding profession might affect human reproduction to some extent. However, there is a need to conduct a comprehensive cross sectional study among welders and their family members, as there are reports about the impact of welding through male mediated reproductive toxicity (10).

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