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Original Article

# Evaluation of quality of semen in male partner of infertile couple exposed to welding fumes

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ABSTRACT

Background: Exposure to high temperatures at the workplace can leads to deterioration of sperm concentration, morphology and impaired motility which may result in infertility. That's why present study was planned to investigate the sperm quality among welders exposed to welding fumes. Material and Methods: Seventy male partners in between age group of 20 to 40 years of infertile couple attending infertility laboratory including 35 as exposed to welding fumes and 35 as control were included in this case control prospective study. Semen samples were analyzed for sperm concentration, sperm motility, morphology and Hypo Osmotic swelling (HOS) test. Results: Mean sperm concentration and percentage of sperms motility were significantly higher in control group in comparison to exposed group ($p<0.01$). Grade III motility was predominant among exposed group while it was grade II in control group. Deterioration of sperm morphology was observed in some welders with less than thirty percent normal sperm count. Thirty cases from exposed group showed less than 60% HOS score. In control group, 31 cases showed HOS positive score ($P<0.01$). Conclusion: Welding can produce adverse impacts on sperm concentration, motility and morphology which might be responsible for infertility.



## 1. Introduction

Welders are exposed to intense heat, toxic metals and their oxides and toxic gases during welding. Some of these substances are reported to have adverse effects on reproductive organs like welding fumes and radiant heat are possible causal factors for male infertility since the testes are more vulnerable to heat and ionizing radiation in the body [1].

In industrialized countries 0.2-2% of the labor force is engaged in metal welding. The material most commonly welded is mild steel, but welding of stainless steel and high performance alloyed steel is also widely done. It is estimated that a large number of welders using the most common welding methods, manual metal arc (MMA) and metal active or inactive gas (MAG or MIG), are exposed to welding fumes at concentrations far exceeding the threshold limit values [2] proposed by the National Institute of Security and Health [3].

Stainless steel welding fumes have mutagenic and cytotoxic effects in vitro bioassay systems. These effects are mainly attributable to hexavalent chromium and partly to nickel in various solubility states. Because of the extensive and worldwide use of metal welding there is high possibility of risk of infertility due to reduced semen quality. Since the semen analysis provides readily obtainable information on testicular function the present study was planned to investigate the sperm quality among welders exposed to a complex mixture of pollutants due to welding work.

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## 2. Material and Method

The present case control study was conducted at the Infertility laboratory of department of physiology, Jawaharlal Nehru Medical College, Wardha India after obtaining permission from Institutional Ethical committee. Seventy male partners in between age group of 20 to 40 years of infertile couple attending infertility laboratory including 35 as exposed to welding fumes and 35 as control were included in the study after obtaining written informed consent.

Oligozoospermics and those persons who had an exposure to welding work for at least 1 year but not more than 10 years and exposed for about 8 hours daily to welding fumes during welding operations were included in the study. The controls were age-weight matched subjects not exposed to any kind of welding work or radiant heat at work. Azoospermics and all the subjects having any other conditions that can affect testicular function amounting to reduced sperm parameters were excluded from the study.

Semen analysis was done in 50 infertile males out of which 10 males had no sperms in their ejaculate and were classified as azoospermics. Thirty five males had a total sperm count less than 20 million sperms and were classified as oligozoospermic, 5 infertile males withdrawn from the study.

After general and systemic examination a symptom based questionnaires regarding reproductive function were asked and they were also interviewed for their habits and duration of welding exposure. All participants delivered three semen samples at monthly intervals. The semen samples were delivered by masturbation after preferably three days of abstinence.

All samples were analyzed within one hours of collection in accordance with the World Health Organization guidelines [4]. The semen samples were processed for various parameters such as sperm concentration, sperm motility, morphology and functional test such as Hypo Osmotic swelling test. Sperm concentration was determined by using a haemocytometer while morphology was analyzed using papanicolaous staining process. Sperm motility was expressed as percentage motility and grade of motility. Samples with more than 40% sperms with normal morphology were considered as normal.

T he Hypo Osmotic Swelling (HOS) test was carried out using the method of Jeyendran et al [5]. The basis of this test is that when viable sperms are exposed to hypo osmotic medium the tail coils and bulges due to the influence of the fluid. The sperm showing coiled tail is considered HOS positive. The percentage of coiled sperms before and after subjecting to hypoosmotic solution was observed and HOS score was calculated by using the formula; Total coiling % — Initial coiling % = HOS score. HOS score of > 60% was considered asnormal. Data was analyzed by applying paired t test using SPSS software.

## 3. Results

Mean age group of exposed as well as control group was between 31.37-31.46 years. 29 subjects were exposed to welding fumes for more than 5 years while 6 subjects exposed for less than 5 years (Table-1).

Appearance of the semen was normal in all the subjects. The mean seminal volume was 2.63+ 0.490 ml in exposed group and 2.00 + 0.00 ml in control group. Sperm concentration in exposed group was below the boundary line (normal value i.e. ≥ 20 million/ml) and in control group it was more than normal. Sperm concentration was better in control group as compared with exposed group ($p<0.01$). The mean percentage of sperms motility were significantly lower in exposed group as compared to control group ($P<0.01$). Deterioration of sperm morphology was also observed in some welder, these welders showed less than 30% normal sperm, which is considered to be the abnormality. Observed head defect was more than the tail and midpiece defect in exposed group than the control group. The most predominant abnormality was thick coiled tail (37.6%) followed by amorphous head (25.6%) of the sperms (Table-2).

Among all the subjects, 5 cases showed HOS positive score indicating more than 60% sperms with curl tail in these welders. However, 30 subject showed less than 60% in exposed group as compared to control group in which 31 showed HOS positive score while 04 showed HOS negative score ($P<0.01$).

**Table- 1. Characteristics and duration of welding exposure**

| Characteristics | Exposed Group | Control Group |
|---|---|---|
| Age (Mean + SD) | 31.37 + 4.90 | 31.46 + 4.71 |
| H/O physical injury to reproductive organs | Nil | Nil |
| Years of exposure to welding fumes | <5 Years 6 Cases | Nil |
| | >5 Years 29 Cases | Nil |

**Table- 2. Semen parameters**

| Semen parameters | Exposed Group Mean + SD | Control Group Mean + SD |
|---|---|---|
| Volume (ml) | 2.76 + -0.35 | 2.00 + 0.00a |
| Sperm concentration (ml/million) | 16.06 + 3.91 | 30.14 + 11.85[a] |
| Motile sperm percentage | 40.29 + 24.55 | 69.43 + 14.54[a] |
| Normal morphology percentage | 33.71 + 13.30 | 51.71 + 9.73[a] |
| HOS score percentage | 34.74 + 13.14 | 65.94 + 9.26[a] |

**a= p<0.01***

## 4. Discussion

It is known that welders are exposed to intense heat and other toxicants during welding operations. Functional and fully differentiated Sertoli cells are critical for development of quantitatively and qualitatively normal spermatogenesis. They also provide structural and functional support to the developing and differentiating germ cells [6]. High testicular temperature damages the Sertoli cells and their number decreases impairing spermatogenesis [7].

There is growing evidence of the adverse effect of heat on sperm production in animals [8, 9] as well as in humans [10, 11]. Our study corroborates an earlier study of Bonde [12] 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 after the infertile males had exposure to high temperature at their work place as compare to control. It is possible that in these men exposure of testes to high environmental temperature led to an elevation of intratesticular temperature. This elevation of intratesticular temperature might have impaired spermatogenesis and led to production of morphologically abnormal sperms with impaired motility.

Bedford [13] proposed that cauda epididymis is sensitive to high temperature. High scrotal temperature causes rapid disruption of absorptive and secretory function of cauda epithelium thereby changing protein composition of cauda fluid and causing reduction of its storage capacity. One of the well known mechanisms to explain spermatogenic impairment due to hyperthermia is activation of p53, a tumour suppressor gene which is expressed in testes [14, 15]. Its level of expression is highest in pachytene spermatocyte [16]. High scrotal temperatures cause condensation of nuclear chromatin which causes p53 activation which leads to cell cycle arrest. This prevents colonial proliferation of germ cells with damaged DNA.

In present study we found that 85.72% sperms had abnormal morphology and only 14% exposed cases had normal morphology. Wang et al. (1997) explained that elevated testiculoepididymal temperature decreases the synthesis of sperm membrane coating protein which in turn results in the production of morphologically abnormal sperms [17].

Increase in number of morphologically abnormal sperms results in impaired motility as normal intact sperm morphology is prerequisite for linear progressive motility [18, 19]. In our study majority of sperms had impaired motility, only 30% sperms showed linear progressive motility. Majority (70%) of sperms had impaired motility (grade III and IV) in exposed group while in control group 85.72% showed linear progressive motility (grade II) and only 14.3% (grade III and grade IV) had impaired motility. Gandini et al postulated that sperm function is strictly correlated with sperm morphology and that sperm motility is the best predictor of fertility potential in man [9].

**5. Conclusion**

We conclude that welders who are exposed for longer period to intense heat, toxic metals and their oxides and toxic gases during welding have higher risk of infertility. Welding can produce adverse impacts on sperm concentration, motility and morphology which might be responsible for infertility in these persons.

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