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DNA-damage in blood of welders occupationally exposed to welding fume using comet assay

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ABSTRACT

Welding workers exposed to various risks resulting in different harms, hazard health effects, and even, sometimes, death. Moreover, air pollution that results from welding operation leads to consequent human hurts. Therefore, this study comes to investigate the potential DNA damage as an indicator of health problems in welding workers. In this study, blood samples of forty welders and twenty non-welders were collected, and Oxiselect comet assay kit was used. The results showed that there were a significant change in low, and high comet percentage of control compared to welders, while there was no significant difference in medium comet percentage between control and welders.

Keywords: Comet assay, Welders, DNA-damage.
Article type: Short Communication.

INTRODUCTION

The American Welding Society describes welding as "a process of metal joining in which coalescence is achieved by heating at acceptable temperatures or by using pressure with or without filler metal" (American Welding Society 2009; Akca & Gursel 2016). In several industries and workplaces, welding is a very common process. Depend on some reports, 0.2 - 2.0 % of the workers in industrialized countries are related to activities of welding (Golbabaei & Khadem 2015). Widespread, over than five million of workers performing welding as a part-time or full-time duty (Erdely *et al*. 2012). Welding workers exposed to various risks resulting in different harms, hazard health effects, and even, sometimes, death. While others near the workplace where the welding operations are done could be affected via the hazards generated with it (Gonser *et al*. 2011). In general, welding hazards could be classified as physical or chemical. Radiation, electricity, heat, fire, flames, explosion, welding fumes, some kind of solvents, noise, fuel gases, gas mixtures, and inert gases are some of the risks associated with welding processes (Golbabaei & Khadem 2015). The common hazards of chemical materials could include particulates (such as: Ni, Pb, Zn, Fe_2O_3, Cd, CuF_2, Mn, and Cr) and gases (include: CO, NO_x, and O_3; Masoudi *et al.* 2019; Alhesnawi *et al.* 2022). Newly, nanoparticles (NPs) released via welding processes are considered as an air pollutant substantial group and there is a need to evaluate the particle size and distribution behaviours when a hazardous assessment is achieved. There are some specific forms of welding, each of them could have a number of subgroups (Kopeliovich 2012). The most commonly used and recognized forms of soldering includes: Shielded Metal Arc Welding (SMAW; Golbabaei *et al*. 2012), Gas Metal Arc Welding (GMAW; Weman 2003; Kopeliovich 2012), Gas Tungsten Arc Welding (GTAW; Kopeliovich 2012), Submerged Arc welding (SAW; Kopeliovich, 2012; Welding guide 2020), Plasma Arc Welding (PAW; Welding guide 2020), and Flux Core Arc Welding (FCAW; Weman 2003; Kopeliovich 2012). Many factors could affect welding fume emissions like current (Pires *et al*. 2006; Matusiak & Wyciślik 2010; Sajedifar *et al*. 2018), voltage (Mert 2017; Jilla 2019), base-

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metal (Jilla 2019), electrode (Brown 1997), electrode diameter (Spear 2004), shielding gas composition (Albert, 1996), speed of welding (Kathersan *et al*. 2012), and contact work distance **(**Nadzam *et al*. 2014) and electrode angle (Jilla 2019). The welding fume particles contain a large part of the nanoparticle size (McNeilly *et al*. 2004; Abdallah & Abdulhay 2017), harmful, and toxic agents. These particles could easily penetrate deeply in the respiratory tract and could be held to the interior portion of the welder body and might lead to chronic and acute diseases (Mistry 2015). Exposures can vary depending on where the welding is done (on board, in confined space, laboratory, or outdoor; Kopeliovich 2012). This fume mostly be potential in causing damage to DNA and reactive oxygen species (Mccarrick *et al*. 2019). Iarmarcovia *et al*. (2005) used the analysis of DNA damage and biological fluids to assess the risk of welding fumes and heavy metals by comet and cytokinesis assays. They discovered that there were statistically significant differences of comet-assay and revealed that the welders had a significant increase in the olive tail moment (OTM) distribution at the end of a work week compared to the beginning, as well as a significant induction of DNA strand breaks. Furthermore the welder group showed greater prevalence of chromosomal damage than the controls. Botta *et al*. (2006) used the alkaline comet assay to look for welder's DNA damage, when comparing welders' lymphocytes to controls, reporting that they had higher amounts of DNA damage than the controls and there was a positive connection between the blood Al, Co, Ni, and Pb concentrations and the DNA damage levels. Also, there was a negative association between DNA damage and Mn in blood, however a positive correlation between urine Mn concentration and DNA damage. These findings suggest that occupational exposure to welding fumes causes increased DNA damage in lymphocytes. The present study investigates the adverse effects of welding fumes of Shielded Metal Arc Welding (SMAW) wire, which is more public used in Iraq, and a potential effect on the genetic material of workers exposed to welding fumes using comet assay. This project is very important to consider because of the reality that welding workers have been registered to suffer many illnesses after inhalation of their fumes.

MATERIALS AND METHODS

Five to eight mL blood samples were collected from forty welding workers (working as welders in the Najaf and Kufa Industrial districts, Iraq) and twenty persons with no exposure to the fume of welding (working in Kufa University as control group) using 10-mL disposable syringe and using gel tube. Then, these samples were preserved in a cooling box until arriving to the lab of Advance Ecology in Faculty of Science-University of Kufa. To the comet test, using an Oxiselect comet assay kit (De Boeck *et al*. 2000). The analysis of variance (ANOVA), F test, LSD, median, standard deviation, minimum, maximum, and correlations statistics were used to find the significance among the study variances using SPSS statistical program software (version 17). For creation the plots and tables, we used Microsoft excel.

RESULTS AND DISCUSSION

The discovery of DNA damage using single cell gel is very interested to explain the double and single strand breaks, alkali-labile sites, imperfect repair sites, cross links and repair in individual cells (Azqueta & Collins 2013). Occupational exposure to welding fumes may improve the genetic system frequency in humans and damage to DNA among workers who are exposed to the occupation (Manikantan *et al*. 2010). As shown in Table 1, there are significant change (LSD; $p \leq 0.05$) in low and high comet percentage (Figs. 1a and 1b, respectively) of control group compared to welders, while there was no significant difference in medium comet percentage (Fig. 1c) between control and welders. This results were in agreement with Iarmarcovai *et al*. (2005) who studied the risk assessment of welders using analyses of eight metals by ICP-MS in blood and urine and also DNA damage evaluation by the comet and micronucleus assays; influence of X-ray repairs cross complementing protein 1 and 3 (XRCC1 and XRCC3) polymorphisms. DNA lesions and cytogenetic abnormalities in lymphocytes are surrogate endpoints in surrogate cells that are thought to indicate genetic changes involved in target tissue carcinogenesis. Individual susceptibility variables such as genetic variation influencing genomic stability (DNA repair, folate metabolism) and carcinogen metabolism may also explain the outcomes of genotoxic endpoints (Norppa 2004). Aksu *et al*. (2019) evaluated the damage of DNA in the whole blood of welders and controls using the comet assay, and concluded that high comet assay of DNA damage in blood were found in workers compared to control groups.In the blood of welder in this study, high concentrations of heavy metals such as Pb, Cr, Cd, etc. were observed, and the accumulation of these metals could cause DNA damage and tail length (Iarmarcovai *et al*. 2005; Botta *et al*. 2006; AL-*Amier et al*. 2019; Aksu *et al*. 2019).

Workplace exposure to welding fumes may induce genotoxic damage which may lead to significant occupational health issues. In order to provide an evaluation of the health risk in the welding sector, further epidemiological research should be undertaken.

Table 1. The frequency (%) of DNA fragmentation in welder and control groups using comet assay.

Parameter	Low comet (%)	Medium comet (%)	High comet (%)	LSD
Controls	58.8 ± 11.5%[a]	36.5 ± 13.4% [a]	4.8 ± 4% [a]	-54*
Exposures	23.4 ± 12.1% [b]	39.4 ± 9.3% [a]	37.2 ± 14% [b]	-16.06*
LSD value	35.4*	-2.96	-32.42*	

*($p \leq 0.05$)

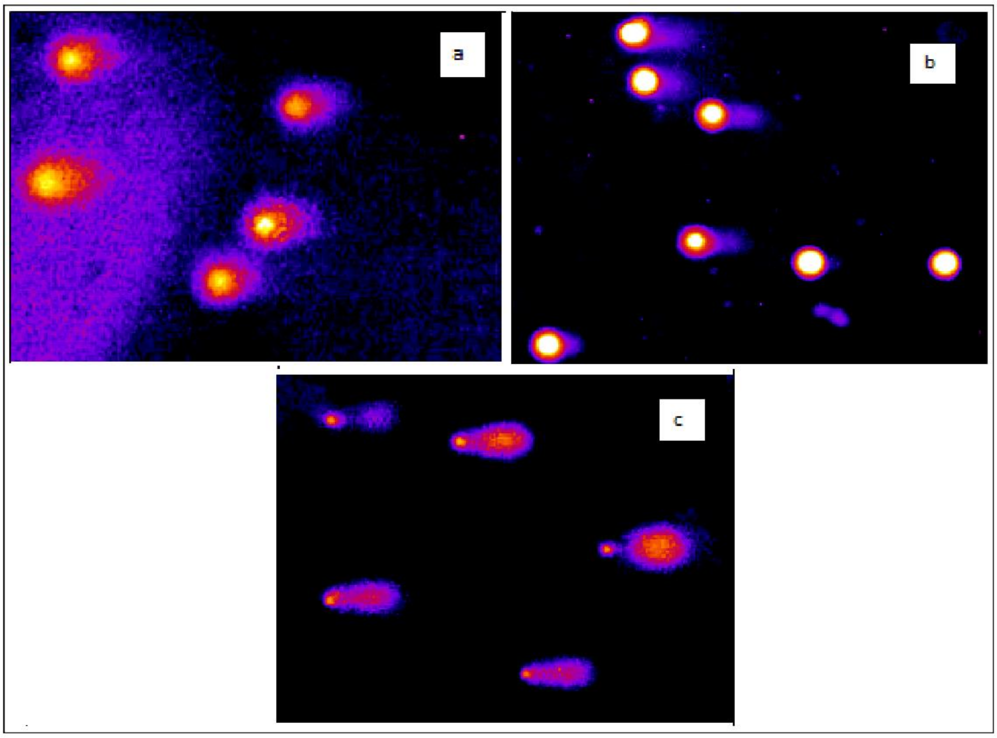

Fig. 1. Comet image analysis by comet score software, scoring categories for comet assay; a: normal to low DNA damage, b: medium DNA damage, c: high DNA damage.

CONCLUSION

This study concluded that there were a significant changes in low (%), and high (%) comet percentage of control compared to welders, and accumulation of metals in blood could causes DNA damage and tail length. Also, we recommended to conduct further in-depth research into welder DNA damage and studying more parameters related to DNA damage of welders.

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