

Exposure Assessment to Suggest the Cause of Sinusitis Developed in Grinding Operations Utilizing Soluble Metalworking Fluids

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Abstract

A worker who grinded the inner parts of camshafts for automobile engines using water-soluble metalworking fluid (MWF) for 14 years was diagnosed with sinusitis. We postulated that the outbreak of sinusitis could be associated with exposure to microbes contaminated in water-soluble MWF during the grinding operation. To suggest responsible agents for this outbreak, quantitative exposure assessment for chemical and biological agents and prevalence of work-related respiratory symptoms by questionnaire were studied. The exposure ranges of MWF mist (0.59 mg/m^3 to 2.12 mg/m^3) measured during grinding exceeded 0.5 mg/m^3 of the recommended exposure limit (REL). Grinder's exposures to bacteria, fungi and endotoxins were also generally higher than not only the proposed standards, but also those reported by several studies to identify the cause of respiratory effects. Statistical test indicated that the prevalence rate of reported symptoms related to nasal cavities showed no significant differences among the operations. Evaluation on grinding operation characteristics and quantitative exposure assessment indicated that repeated exposure to MWF mist including microbes contaminated from the use of water-soluble MWF may cause respiratory diseases like sinusitis or at least increase susceptibility to the development of sinusitis

Introduction

A grinding operation worker at an automobile engine plant was physician-diagnosed with sinusitis. His main job was to grind the inner parts of camshafts for automobile engines using water-soluble metalworking fluids (MWF). He has conducted only this work since he was employed on March 1988. He has no disease history including respiratory diseases.

Although exposure to MWFs is associated with respiratory diseases such as asthma and hypersensitivity pneumonitis (HP), no study has reported that sinusitis could be developed through exposure to MWF. Our study hypothesized that the outbreak of sinusitis might be associated with exposure to micro-biologically contaminated MWF mist generated during grinding operations. The ultimate goal of this study is to suggest the causative agent that can relate to the development of sinusitis based on industrial hygiene investigation. The specific objectives are 1) to assess exposure to chemical and biological agents that could associate with the development of sinusitis in grinding operations utilizing water-soluble MWF and 2) to compare the prevalence of the nasal cavity symptoms among operations.

Methods

The study plant manufactures cylinder linings (CL) and camshafts (CS) for automobile engines, and consists of casting and production lines where they are separated. The products cleaned in the casting line are sent to the production line located at another building. CL and CS are machined and grinded at grinding operations there where MWF are utilized.

Grinding operation and grinding Fluids

In grinding operation of production line, the inner outer part of CL and CS are grinded with MWF. The grinding fluids are straight MWF for the inner parts of the products, and water-soluble MWF for the outer parts of the products. One worker who was physician-diagnosed with sinusitis has handled water-soluble MWFs in grinding operation. The grinding operation of the production line was chosen as subjects for detailed evaluation of operation characteristics and quantitative exposure assessment because MWFs utilized is known to be associated with respiratory health effects.

MWF bulk collection and exposure assessment

Exposure to chemical agents (MWF mist, formaldehyde, metals and particulate) and biological agents (bacteria, fungi and endotoxin) were assessed from the breathing zone of the representative workers present at the production line including grinding operation. Area samples were collected where necessary. Bulk collection of and exposure to endotoxin, bacteria and fungi were conducted both 1st and 2nd round.

Chemical agents collected in the 1st round were all measured using the sampling and analytical methods recommended by National Institute for Occupational Safety and Health (NIOSH). The endotoxin concentrations were quantified using the Kinetic Turbidimetric Limulus Amoebocyte Lysate (LAL) method.

A collection and analysis of airborne micro-organisms, such as viable bacteria and fungi, was conducted using the CAMNEA method recommended by Palmgren et al.¹²⁾.

Questionnaire and study population

In contrast to exposure assessment that evaluated only grinding operation, a total of 232 workers who have worked in production line as well as office were invited to participate in the questionnaire and were completed with help of trained interviewers. Exposed group (N=75) was

defined as all workers at the grinding workshop who had been exposed to MWF (water-soluble or straight). The unexposed control group (N=157) consisted of subjects selected from other operations where MWF was not used and was further divided into three groups (casting, maintenance and office).

A Chi-square (χ^2) test was performed to examine the difference of dichotomous variables such as sex, smoking status, medical history and nasal cavity symptoms among operations.

Results

Exposure to MWF mist, formaldehyde, elements and particulate

Exposure to oil mists of workers who had handled only water-soluble MWFs ranged from 0.59 to 2.12 mg/m³ with an geometric mean (GM) of 1.09 mg/m³. In particular, two workers using water-soluble MWF in grinding operation were exposed to higher than 2 mg/m³. The MWF aerosol concentration measured in the area where the worker diagnosed with sinusitis was standing, was 8.4 mg/m³. The average exposure to MWF oil mist by workers using only water-soluble MWF was higher than that by workers handling straight MWF or both types of MWF. Most of MWF mist measured from this investigation exceeded both 0.5 mg/m³ of exposure limit recommended by NIOSH and 0.2 mg/m³ of threshold limit value (TLV) noticed as the intended change (NIC) by American Conference for Governmental Industrial Hygienists (ACGIH). Exposure to other chemical agents such as formaldehyde, elements and particulates were far lower than TLV of ACGIH. Therefore, substantial evidences that could adversely affect the respiratory systems of workers were not detected.

Exposure to bacteria, fungi and endotoxin

Exposure to bacteria, fungi and endotoxin evaluated in the 2nd round investigation were far higher than those in the first investigation as temperatures in sumps and air humidity increased. During a second round investigation, 13 workers using water-soluble MWF were exposed to bacteria in the range of 1.9×10² - 4.4×10³ CFU/m³. Exposure to endotoxins in the second investigation ranged from 1.9×10² EU/m³ to 1.2×10⁴ EU/m³ and showed an increase when compared to the first investigation.

Concentration of bacteria, fungi and endotoxin in sump

Like airborne concentration, microbe concentrations of sumps measured in the 2nd round were far higher than those in the 1st round due to the increased temperatures in sumps. Microbes and endotoxin concentration of this study were collected during winter with low temperature.

Questionnaire and medical examination results

The four operations did not differ with respect to their general characteristics except for smoking status (p=0.009) and disease history (p=0.008). The prevalence of reported symptoms related to nasal cavities also showed no significant differences among the operations. The prevalence rate of nasal obstruction and rhinorrhea was higher than those of other diseases. Based on the questionnaire, a Chi-square (χ^2) test found that the prevalence of paranasal sinusitis, or nasal polyps among operations was not significantly different.

Discussion

It could be very difficult work to identify the specific agents for a certain health effects like sinusitis because no one type of MWF or any specific component of MWF has been identified as the causal agent in MWF health effects. Our findings suggested that repeated exposure to MWF mist including generated in grinding operation utilizing water-soluble MWFs may cause respiratory diseases like sinusitis or at least may trigger the exacerbation of allergic rhinitis or rhinitis and paranasal sinusitis.

Conclusion

The range of personal exposure to MWF oil mist measured in grinding operation where one worker physician-diagnosed with sinusitis had grinded the inner parts of camshafts for automobile engines using water-soluble MWF for 14 years greatly exceeded 0.5 mg/m^3 of NIOSH-REL. Our findings suggested that repeated exposure to MWF mist including microbes in grinding operation may cause respiratory diseases like sinusitis or at least may increase to the development of sinusitis.