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Levels of methylmethacrylate, formaldehyde, and asbestos in dental workroom air

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Abstract – The levels of methylmethacrylate and formaldehyde in workroom air of a dental laboratory following finishing and polishing a pour type denture base resin have been measured. The levels of these compounds did not exceed the respective hygienic threshold limit values in the general workroom air or in breathing air close to workpiece. The content of asbestos fibers in breathing air released during dismantling molds from gold casting was measured. During the dismantling procedure the fiber content in the air could exceed threshold limit values by up to about 12 times. However, about 10 min after terminating this process the fiber content had declined to a level below the established requirements.

Key words: asbestos; dental hygiene; dental laboratories; dental materials; formaldehyde; methylmethacrylate.

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In workroom air of dental laboratories dust levels following handling of chromium–cobalt alloys, amalgam dies, porcelain or gypsum models could attain values markedly in excess of hygienic requirements (2, 3).

In the finishing and polishing procedure for denture base material, particulate matter as well as fumes are released to the ambient breathing air. The particulate matter is composed of polymers as well as particles of abrasives from the tools, i.e. wheels and stones. In a comparison of the levels of this kind of particulate matter with inert mineral dust, the hygienic threshold limit value was not exceeded (3).

Release of formaldehyde from denture base material has previously been studied by RUYTER (5). He observed that formaldehyde could be released in quantities of about 1–10 mg/m² from surfaces of polymers exposed to water for 3 d.

During preparation of denture base materials methylmethacrylate vapors can be transferred to the workroom air due to release of unreacted monomers as well as due to depolymerization of the polymer matrix (6).

In various casting procedures an asbestos liner is used to allow expansion. During the heat treatment at a temperature of about 850°C the asbestos liner becomes brittle. Consequently, asbestos fibers will be released to breathing air during dismantling the mold.

The present measurements of the levels of methylmethacrylate, formaldehyde and asbestos fibers in dental workroom air are part of a general survey of the internal environment of dental laboratories (2, 3).

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Material and methods

Methylmethacrylate – During finishing and polishing a pour type denture base resin (Swe Flow. Svedia Dental-Industri AB, Sweden), air was collected in the breathing position about 30 cm away from the workpiece using suction into a 2-liter bag constructed of polyethylene and aluminum laminate. This bag was selected for gas collection because of negligible adsorption of methylmethacrylate to the walls of the bag (1).

The air sample was then sucked through a column containing about 2 mg active carbon in order to adsorb methylmethacrylate before the gas was injected into a gas chromatograph (Model 3920, Perkin Elmer Corp., C.T., U.S.A.) for quantitative chemical analysis. The analysis was carried out at Central Institute of Industrial Research, Oslo.

Formaldehyde – Formaldehyde released during finishing and polishing of the pour type denture base resin (same as above) was collected in breathing air at a distance of about 30 cm from the workpiece. The air was sucked into a solution of sodium bisulfite retaining formaldehyde. Formaldehyde was then quantitatively assayed by means of the chromotropic acid technique comprising a colorimetric measurement (4).

It is known that the capacity of the sodium bisulfite solution for fixing formaldehyde will decrease during suction of air through the solution due to oxidation of bisulfite to sulfate (4). For this reason standards of formaldehyde in the range 25–150 µl 0.01 M HCHO were injected into a 1-l bulb filled with either nitrogen or air. The gases were then sucked through the bisulfite solution. The chemical recovery of formaldehyde was then determined by means of the chromotropic acid technique (4). The recovery was expressed in terms of extinction referring to absorption at the wavelength of 580 nm (4). The recovery curve for formaldehyde standards in nitrogen atmosphere served as reference.

Asbestos – The release of asbestos fibers to breathing air during dismantling a mold containing a Pennwald liner (Jelenko, New Rochelle, NY, U.S.A. was measured in a laboratory which was not equipped with local ventilation. Asbestos fibers were collected on a membrane filter installed about 30 cm away from the workpiece. Samples were collected during dismantling the mold as well as during two periods after terminating the procedure.

The asbestos fibers were counted using light microscopy at the Institute of Occupational Health, Oslo.

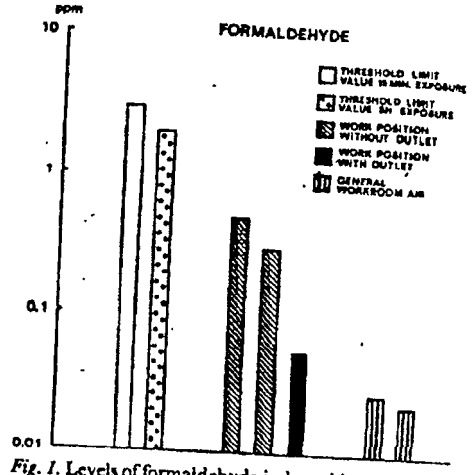


Fig. 1. Levels of formaldehyde in breathing air close to workpiece as well as in general workroom air of a dental laboratory during finishing and polishing denture base resin.

Results and discussion

The contents of formaldehyde and methylmethacrylate vapors in breathing air in a dental workroom following finishing and polishing a

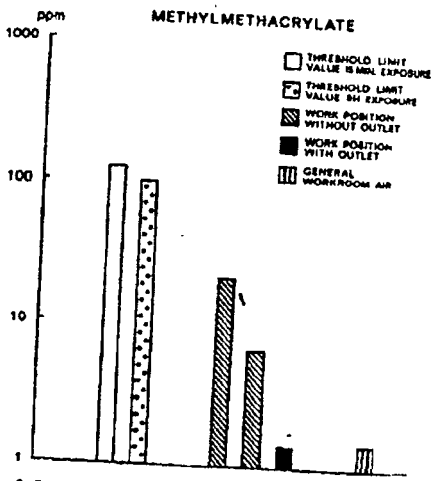


Fig. 2. Levels of methylmethacrylate in breathing air close to workpiece as well as in general workroom air of a dental laboratory during finishing and polishing denture base resin.

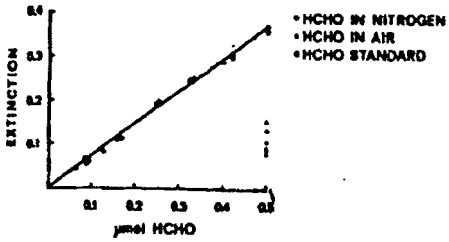


Fig. 3. Recovery of formaldehyde in sodium bisulfite solution in air and nitrogen atmosphere. Recovery is expressed in terms of extinction referring to the chromotropic acid technique (4).

denture base resin are presented in Figs. 1 and 2, respectively. Hygienic threshold limit values referring to 15 min and 8 h daily exposure (8) are included on the illustrations.

According to the present findings neither methylmethacrylate nor formaldehyde were found to exceed the respective hygienic threshold limit values even in cases with no ventilation. Local ventilation resulted in a strong decrease of the levels of these vapors (Figs. 1 and 2).

Fig. 3 presents the recovery of formaldehyde from nitrogen or air atmosphere accomplished through fixation in sodium bisulfite solution followed with the chromotropic acid colorimetric measurement (4). According to Fig. 3 formaldehyde is quantitatively retained in nitrogen atmosphere whereas anomalies appear when the gas is present in air. However, when formaldehyde was present in air at low levels, a quantitative uptake was also demonstrated (Fig. 3).

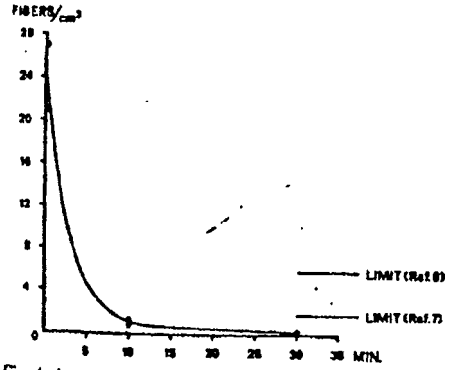


Fig. 4. Amount of asbestos fibers in breathing air close to workpiece following demolishing a mold in a dental laboratory. Levels of threshold limit values according to U.S. and Norwegian regulations are indicated.

The present study involves the analysis of formaldehyde at low concentrations in air in the dental laboratory. The linear relationship of the yield curve in Fig. 3 was consequently used in the quantitative assay of formaldehyde.

Fig. 4 presents the number of asbestos fibers/cm³ in breathing air released during dismantling molds. In two experiments values of 21 and 27 fibers/cm³ were measured during the dismantling procedure. According to Norwegian regulations concerning limits of pollutant levels in the working environment, asbestos should not exceed two fibers/cm³ (7).

According to American threshold limit values for chemical substances in workroom air the asbestos fiber content should not exceed 5 fibers/cm³ (8). Consequently, the asbestos levels in dental laboratories could exceed threshold limit requirements up to 12 times in short-time intervals. The dismantling procedure may account for a time of about 5 min. However, about 10 min after terminating the procedure the asbestos fiber content had declined to levels lower than 2 fibers/cm³.

In the present laboratory no access to local ventilation was available. With a good local ventilation system the asbestos fiber content would most likely be reduced to levels lower than two fibers/cm³ even during the dismantling procedure. Efficiencies of local ventilation for purifying polluted dental workroom air may attain values close to 99% (3).

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