NATIONAL BUREAU OF STANDARDS REPORT

10 377

Progress Report

on

POOR MERCURY HYGIENE FROM ULTRASONIC AMALGAM CONDENSATION

U.S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

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POOR MERCURY HYGIENE FROM ULTRASONIC AMALGAM CONDENSATION

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ABSTRACT

There is a potential hazard of mercury poisoning in using an ultrasonic device for amalgam condensation. A cloud of mercury droplets and alloy particles was emitted from the soft amalgam at the working tip of the instrument. Mercury vapor levels as recorded by a vapor detector held 30 cm from the working tip were 20% of the allowable threshold limit value (0.1 mg Hg/m^3 of air) and probably do not represent unsafe levels.

The continued long-time use of the ultrasonic instrument would result in the deposition of a great many mercury droplets throughout a dental operatory and could thereby cause higher mercury vapor levels especially in poorly ventilated spaces. In addition, the inhalation of the emitted material by the patient and the dental health personnel cannot be considered good hygiene. Therefore, the use of this instrument for amalgam condensation is contraindicated until such time as the safety of the instrument for this purpose is firmly established.

Introduction

The potential hazard of mercury poisoning of dental health personnel and dental patients has been studied by many investigators.[1-8] Souder and Sweeney[1] found that the amount of mercury vapor emitted from dental restorations of silver amalgams was undetectable and that there was little danger from the ingestion of mercury in solution from these restorations. Nixon and Smith[2] found that the amount of mercury in the fingernails and in the hair of dental workers was often many times that of a control group.

Mercury vapor levels in dental offices are increased during periods of manipulation of mercury and the mixed amalgam. Airaksinen[3] analyzed the air in dental offices and concluded there were safe levels of mercury vapor in all cases. Highest levels were found during mixing but he considered the dangerof poisoning to be slight. Nossek[4] determined the mercury vapor content in the air following ultrasonic amalgam condensation and observed no increase in mercury vapor over that produced by hand condensation in spite of macroscopically visible spraying of plastic amalgam.

Meyer[5] determined that the threshold limit value of 0.1 mg mercury per cubic meter of air[6] was exceeded by 2 to 4 times during such procedures as amalgam carving and removal of old amalgams but these concentrations existed for only short durations.

Most investigators, including Grossman[7] and Frykholm[8], agree that if recommended precautions are followed the mercury vapor concentration is maintained well below the threshold limit[6]. But it is also agreed that the effects of long periods of exposure to even minimal amounts of mercury vapor is not well known and therefore, such exposure should be kept at a minimum.

A preliminary investigation in this laboratory designed to study the effects of ultrasonic condensation on the properties of dental amalgam, revealed that when the ultrasonic instrument was being used, significant amounts of material were emitted from the working area in the form of a cloud, Figure 1. The nature of this cloud and the amount of mercury vapor in the surrounding area while condensing dental amalgam with the ultrasonic device were determined.

Materials and methods*

The ultrasonic device used in this study is reported to develop 25,000 mechanical strokes per second at the working tip with a stroke length of 0.001 inch.** An amalgam condensing insert was used with maximum water cooling and a power setting of 2 (medium). The temperature of the plashy amalgam after removal from the mechanical mixer and during compacting with the ultrasonic plugger was about 35°C as recorded with a 36 gauge (B and S) Type T thermocouple. During compaction occasional transient peaks of 55 to 60°C were recorded. Other inserts and power settings and in one case an ultrasonic instrument of the same brand in a different operatory produced essentially the same type of cloud.

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* Certain commercial materials and equipment are identified in this paper to specify adequately the experimental procedure. In no instance does such identification imply recommendation or endorsement by the National Bureau of Standards or that the material or equipment identified is necessarily the best available for the purpose.

** The frequency and amplitude were measured and found to be 24,850 ± 150 hz and 0.9 ± 0.1 thousandths of an inch, respectively.

Amalgam mixes were prepared with commercially available alloys at 1:1 mercury-to-alloy ratio.

To collect a sample of material from the aerosol cloud, a suction device containing an in-line filter (maximum opening 0.2 μm) was held 7 cm above the operating area. This distance from the working tip was used for the collection of particles whereas with the vapor detector the intake hose opening was held 30 cm from the working tip. The material gathered on the filter was examined and photographed with a metallographic microscope.

Mercury vapor levels were determined with an Instantaneous Vapor Detector (General Electric Catalog #9790339G1). The instrument functions on a principle of ultraviolet light absorption as it passes through an atmosphere containing mercury vapor. Vapor levels between 0.01 and 3.0 mg per cubic meter of air are detectable.[9]

The intake hose of the detector was placed 30 cm from the tip of the condenser to simulate operator-to-tooth working distance. The position of the intake hose was adjusted so that it was approximately in line with the air currents in the immediate working area. For comparison purposes, identical tests were run using hand condensation and two mechanical condensers.*

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* Hollenback condenser, Clev-Dent, Cleveland, Ohio
Vibrapak, Superba Dental Products, San Diego, California

The amalgam mixes for vapor detection were condensed for three minutes in a steel die containing a 4 x 8 mm cylindrical mold. The amalgam cylinder without having any excess removed from its top surface was undisturbed for three minutes before removing to another room.

Results and discussion

Figure 1 shows the aerosol dispersed from the area of the tip of the ultrasonic condenser. In some cases the cloud could be seen to rise as high as 60 to 90 cm. This cloud is carried by air currents similar to cigarette smoke and the particles settle in the 60 to 90 cm radius from the working area. The operator, assistant and patient could inhale and or ingest the emitted material during amalgam condensation. Higher power settings and mixes containing more mercury resulted in the emission of more material than when a low power setting and less mercury was used. However, the same phenomena occurred even at the lowest power setting and in mixes squeezed with pliers (as recommended by the manufacturer of the condenser) containing as low as 45.5%

mercury. The greatest cloud formation occurred when the tip of the instrument touched the wall of the cavity prepared in an extracted or porcelain tooth or the side of the steel die.

Figure 2 is a photograph of the material collected on the filter as viewed through a metallographic microscope. The material was composed of ~1 to 100 μm size spheres of mercury and a great many alloy particles. The percentage of particles penetrating the pulmonary air spaces rises from essentially zero at 10 μm to a maximum at and below 1 μm, where it equals the fraction of tidal air which reaches the lungs.[10] It is assumed that the spheres of mercury contained some dissolved alloy and that the alloy particles were partially reacted with mercury. Souder[1] analyzed the liquid squeezed from an amalgam mix before crystallization had caused it to harden. He reported 1.07% tin and 0.13% silver, therefore, presumably these mercury droplets would be 98+% mercury.

Tests for mercury vapor revealed very little vapor in the air drawn into the intake hose of the detector when the opening was 30 cm away from the working area. The highest reading obtained at 30 cm was 0.02 mg Hg/m^3 of air during ultrasonic condensation. This represents 20% of the threshold limit value of 0.1 mg Hg/m^3 of air as established by the American Conference of Governmental Industrial Hygienists.[8] The vapor levels were about zero when using hand and mechanical methods of condensation, other than ultrasonic. It was necessary to move the intake hose of the detector to within 7 cm of the working area to obtain vapor levels above the threshold limit value.

When condensation was stopped, the vapor levels returned to near zero within approximately 3 to 4 minutes even when the condensed alloy and excess plashy amalgam was allowed to remain in place.

Shepherd et al[11] determined that the levels of mercury vapor present in scientific laboratories was

primarily dependent on the amount of ventilation in the rooms. Other important factors were the number and types of sources and the degree to which these sources were disturbed.

The low levels of vapor found in the present study may have been due to good air ventilation in the operatory (10 cubic meters of air per minute in a room containing approximately 50 cubic meters) but reducing the air circulation by blocking the intake and exhaust vents did not produce significantly higher levels.

Figure 3 is a photograph of a porcelain tooth and the surrounding operating field after condensation of three amalgam mixes into the tooth. From viewing the mercury droplets deposited in the field it is evident that there is a considerable surface area for the evaporation of relatively large amounts of mercury vapor. Since these droplets contain dissolved tin and a slight amount of silver the evaporation of mercury may be reduced. Extended use of the ultrasonic device

would ultimately result in a great number of fine droplets of mercury being deposited throughout a dental operatory which in turn could cause a high level of vapor, especially if the mercury droplets were disturbed. Whether toxic levels could be achieved is not known but certainly awareness of the potential hazard is one of the primary factors in prevention.

No quantitative value of the amount of mercury and alloy particles that are dispersed are given because the amount dispersed for any one operation is subject to the following and probably other variables: the mercury-alloy proportions, the size and shape of the instrument tips, the size and shape of the restoration, the power adjustments on the instrument, the length of time the instrument tip is in contact with the amalgam mix and the length of time the tip of the instrument is in contact with the walls of the cavity.

In any event the dispersion of mercury droplets and fine partially amalgamated alloy particles in the area

of operation when amalgam is condensed by ultrasonic means is undesirable. Some of the debris will be swallowed and some inhaled by the patient and the operating team.

Summary and conclusions

Amalgam condensation with an ultrasonic device resulted in the emission of a cloud of material from the area of the working tip. This aerosol was composed of mercury droplets and alloy particles. Mercury vapor levels of 0.02 mg Hg/m^3 of air were found 30 cm from the condensing point. This value represents 20% of the current (July 1970) threshold limit value for mercury vapor and, in itself, probably does not represent a poison hazard. However, the additive effect of introducing this technic into an office having safe levels of mercury vapor may be sufficient to develop hazardous concentrations. The inhaling and swallowing of alloy particles and mercury droplets cannot be considered good practice in any case and may represent a health hazard even though they apparently are not producing excessive mercury vapors.

The continued use of an ultrasonic condensing instrument for placement of amalgam restorations would certainly result in the deposition of a great many small mercury droplets throughout a dental operatory. It would appear, therefore, that the use of ultrasonic amalgam condensers would be contra-indicated until such time as the safety of the instruments has been well established especially after long periods of use in areas with poor air ventilation.

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Fig. 1. A cloud of material, arrows, is being emitted from the amalgam at the tip of an ultrasonic amalgam condensing instrument. The particles, also shown in Fig. 3, settle on the instrument handle, A, and may be responsible for some of the haze surrounding the handle.

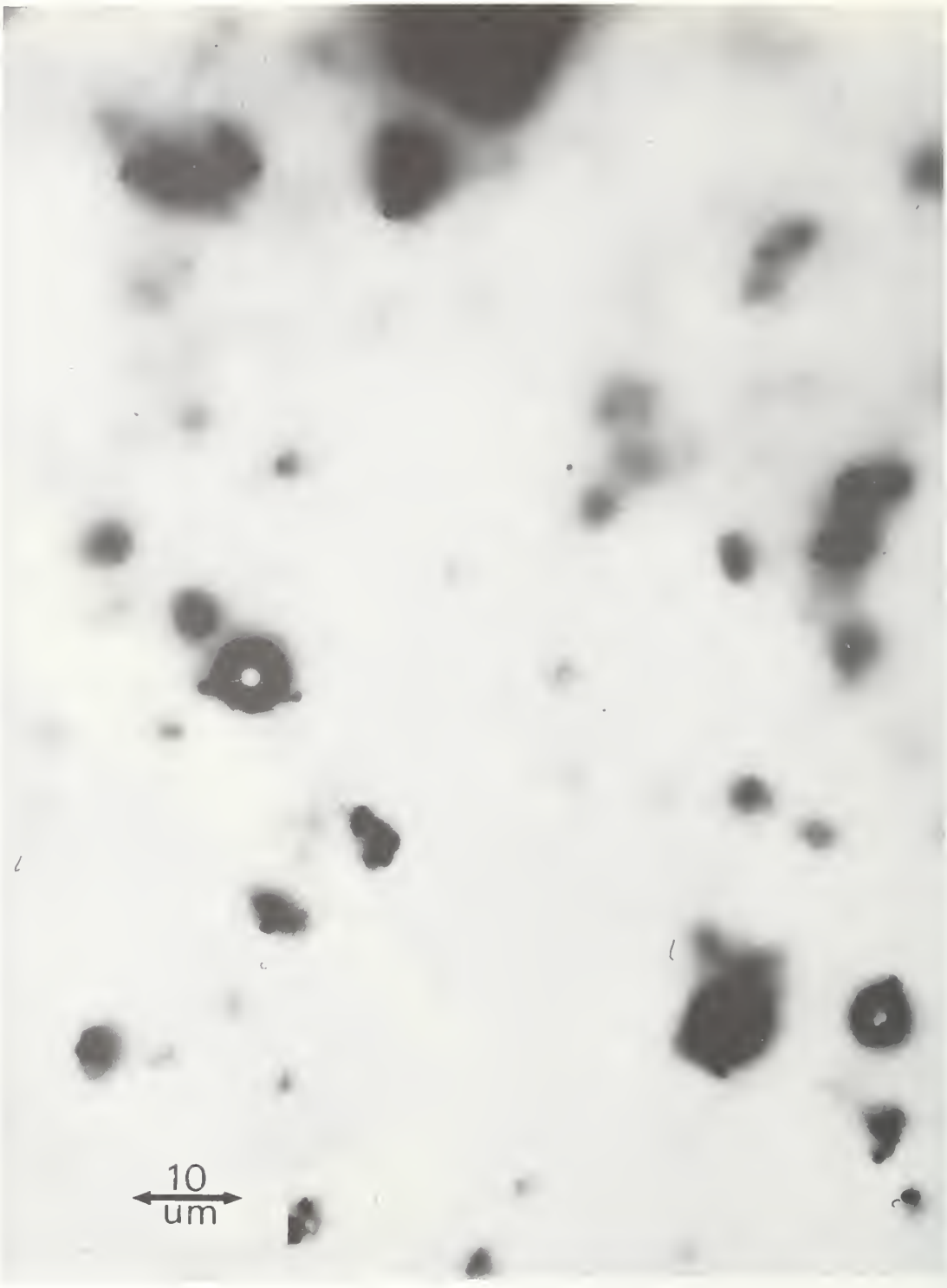

Fig. 2. Material collected by a suction and filter device held 7 cm above the ultrasonic condensing instrument during amalgam condensation. Mercury droplets and alloy particles can be observed throughout.

Fig. 3. A porcelain tooth and the surrounding operating field after condensation of 3 amalgam mixes into the tooth. The background is plain black paper. Note the great number of mercury and alloy particles that have been deposited around the operating site. The dark area behind the tooth is a shadow caused by the oblique lighting used in making the photograph.


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