CROSS INFECTION AND MERCURY VAPOUR HAZARD WITH DENTAL AMALGAM CARRIERS*

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ABSTRACT

This study determined the effectiveness of disinfection and sterilising procedures on dental amalgam carriers and evaluated their release of mercury vapour during autoclaving.

Plastic internal spring mechanism and metal spring carriers were studied. Plastic carriers were disinfected by 1 per cent glutaraldehyde soak for 10 minutes, water wash, rinse in 70 per cent isopropyl alcohol followed by absolute alcohol and towel drying. The amalgam reservoirs of 75 disinfected plastic carriers and 20 autoclaved metal carriers were swabbed and cultured aerobically on blood agar plates. Metal carriers were also either paper bagged or open stacked in autoclave after which mercury in the exhaust vapour was measured photoacoustically.

Twenty-three per cent of disinfected plastic carriers produced some bacterial growth, mainly Streptococcus salivarius, with some Streptococcus mutans. None of the autoclaved metal carriers produced bacterial growth. The paper bagged metal carriers emitted 6.15 ± 1.03 ng Hg/m³ while the open stacked metal carriers emitted 4.37 ± 1.28 ng Hg/m³. These values were not statistically different (P>0.05).

The rigorous disinfection regime utilised in this study did not prevent bacterial growth in the plastic amalgam carriers. Bagging was ineffective in containing mercury vapour during autoclaving. A sterilisation regime in which amalgam carriers are autoclaved after every use, coupled with effective venting of autoclave exhaust gases, is recommended.

INTRODUCTION

Both dental surgery personnel and patients are increasingly aware of potential cross infection hazards. There is no room for inadequate cross infection control, but recent studies of dental practices have identified wide variations in the management of the sterilisation and disinfection processes1-3. Despite the development of comprehensive protocols by national dental associations and other health promoting agencies there remains a variation in standards between individual practices. Whilst there has been much publicity on the potential for dental handpieces, unsterilised between patients, to harbour bacteria and viruses,4,5 humbler dental instruments with similar characteristics may be equally able to act as vehicles for cross infection in the dental surgery. The dental amalgam carrier is one such routinely used device which is commonly in contact with oral fluids but which often escapes the sterilisation process in favour of the less desirable disinfection procedure. A recent study6 revealed that while all dentists in a New Zealand city routinely sterilised their hand instruments after every patient only eight per cent sterilised their amalgam carriers (all by means of autoclaving). The remainder used a variety of disinfecting procedure, mainly by means of external wiping.

Autoclaving of contaminated dental instruments is universally preferred method of sterilising dental instruments. It is a low-cost and generally hazard free process, provided operating and maintenance protocols are adhered to. One basic requirement for an autoclaving installation is that exhaust gasses be properly vented to the external environment. This is both to maintain comfort in the operatory and to minimise the possibility of contamination from components of the autoclave exhaust gasses. One such potential contaminant is mercury from hand instruments and amalgam carriers. Many studies have determined mercury vapour levels in dental operatories but little is known of contribution of the contribution of amalgam carriers via the autoclaving process.

The aims of this study were therefore to 1) evaluate by microbiological means, sterilisation and disinfection regimes employed for dental amalgam carriers; and 2) measure the mercury vapour emitted during the autoclaving of dental amalgam carriers.

*Adapted from the Free Communication of the same title which was awarded First Prize in the Unilever Award Competition at the 15th Asian Pacific Dental Congress at Kuala Lumpur, 22-27, April 1993.
MATERIAL AND METHOD

Two types of amalgam carrier were in common use. One type utilised an internal spring mechanism and had either a metal or plastic casing. The other type employed an external spring mechanism. All metal and some plastic types could be satisfactorily autoclaved (Fig. 1).

![Figure 1. - Metal external mechanism amalgam carrier (A) and plastic internal mechanism amalgam carrier (B)](image)

Disinfection and sterilisation regimes: Seventy-five plastic, internal mechanism amalgam carriers were disinfected after intraoral use. The disinfection procedure involved soaking the fully assembled carriers in a 1 per cent glutaraldehyde solution for 10 minutes, followed by a water rinse, a 70 per cent isopropyl alcohol rinse, and absolute alcohol rinse and towel drying. Twenty metal, external mechanism carriers were autoclaved after intraoral use.

The amalgam reservoir of each carrier was then swabbed and these were smeared on Columbia blood agar plates. The plates were incubated aerobically at 30°C for 1 day, followed 2 days at 23°C. Typical colonies were isolated and inoculated on further blood agar plates, leading to a series of pure cultures. Swabs from these cultures were smeared onto Rigosa medium, which is actinobacillus-specific and onto mitis-salivarius agar, which is used to characterise streptococci. No attempt was made to identify anaerobic organisms or viruses.

Mercury vapour determination: A photoacoustic method was used to determine mercury vapour levels. This involved pumping a known volume of air across gold-coated sand in a closed glass vessel. This was heated to 400°C, releasing the mercury which passed to a silica cell illuminated by a mercury lamp. The mercury resonance radiation from the lamp was absorbed in proportion to the amount of mercury in the cell. Upon quenching, the energy was released as heat which caused a corresponding rise in cell pressure. As the light source modulated at a fixed frequency pressure fluctuation occurred at the same frequency and could be detected as sound. This was amplified and was digitally displayed as ng Hg. By allowing for sample volume and ambient temperature this could be expressed as ng Hg/m³ at a reference temperature of 21°C.

Baseline readings were determined by taking six measurements outdoors, and a large operative dental clinic in the morning before commencement of treatment. Six measurements were also determined for each of autoclave (empty); autoclave containing six open-stacked, used metal amalgam carriers; and autoclave containing six paper bagged, used metal amalgam carriers.

RESULTS

Bacteriological studies: Twenty-three per cent of the disinfected plastic amalgam carriers produced bacterial growth. Two morphologically different colony types were seen. Most were small (0.5-1.5 mm diameter), white, wet mucoid colonies with poorly defined margins showing no zone of haemolysis. A few were smaller (about 0.5 mm diameter), raised, yellowish-white and sticky on blood agar, but spherically-shaped and blue-tinged on mitis-salivarius agar. Cocci, both singly and in chains, stained Gram positive for both types. The former bacteria were probably Streptococcus salivarius and the latter Streptococcus mutans. None of the autoclaved metal amalgam carriers produced bacterial growth.

Mercury vapour: The mean mercury vapour levels determined outdoors, in a student operative clinic and in the exhaust gases of an autoclave (empty, with open stacked amalgam carriers and with paper bagged amalgam carriers) are shown in Fig. 2. Analysis of variance showed the F statistic = 32.32. Scheffe’s test identified statistically differences at the p < 0.05 level confidence.
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DISCUSSION

Bacteriological studies: This study underlines the difficulty dentists have in meeting current cross infection control standards. Many plastic amalgam carriers cannot withstand the autoclaving process. Metal alternatives are more costly and procedures for handling the external spring type evaluated demand changes in clinical routine. Nevertheless the rigorous disinfection procedure evaluated was only 75 per cent effective against common oral bacteria.

The United States Centers for Disease Control distinguishes between instruments which normally penetrates soft tissue or bone and others used in the oral cavity. Sterilisation of the former group is mandatory, preferably by autoclaving. Dry heat or chemical vapour sterilisation of the latter group is recommended where possible. Disinfection, which is a less certain process than sterilisation is admitted as an alternative but it is implicit that this lesser procedure carries a definite level of risk. Only the most rigorous disinfection procedures have the potential to prevent bacterial cross infection and chemical germicides must be at "tuberculosis at use" concentrations to eliminate the risk of viral contamination.

It would be foolish for a dentist to use intraoral devices which cannot be effectively sterilised if inexpensive and satisfactory sterilisable devices are readily available. This study confirmed that metal amalgam carriers could be effectively sterilised by autoclaving but that disinfection of plastic amalgam carriers was not a reliable procedure.

Mercury vapour: FDI Technical Report No. 7, 1988 recommends that "The heating of mercury or any equipment used with amalgam be avoided. Instruments contaminated with amalgam should be cleaned before sterilisation." It contains no advice with respect to the evacuation of autoclave exhaust gases, though the desirability of working in well ventilated spaces is emphasised.

Rothwell et al demonstrated elevated mercury vapour levels with hot air sterilisation. They recommended a filter system in preference to a simple air extractor. Cooley et al determined mercury vapour levels generated by a chemical vapour steriliser. They found that the steriliser was already contaminated with mercury. Recently used amalgam carriers contributed to an atmospheric mercury vapour level higher than the threshold limit value (TLV) of 0.05mg Hg/m³ considered safe for a working week. They also found that paper bagging used amalgam carriers reduced the mercury vapour level below the TLV.

In this study all mercury vapour levels were below the TLV. Nevertheless open air readings and those for a well ventilated clinic were significantly lower that those readings made beside an autoclave containing used amalgam carriers. The autoclave itself contained an elevated level of mercury vapour. This was confirmed by carrying out a series of measurements on a brand new autoclave of the same specifications. Mercury vapour levels were similar to those obtained in the open air. The contamination may have been due to a single gross episode or an
accumulation of small volumes of mercury over a long period. Paper bagging the apparently clean amalgam carriers did not significantly reduce the atmospheric mercury vapour levels. This is contrary to the finding of previous authors. There seems no good reason for gas permeable paper bags to restrict the passage of mercury vapour and it may be that the less sensitive measurement device used by these workers, or the close stacking of the bags produced equivocal data. Bagging instruments for sterilisation in non-vacuum autoclaves is not recommended practice.

This study is in accord with others in identifying mercury contamination of heat sterilisation systems as a source of potentially hazardous mercury vapour.

CONCLUSIONS

Dental amalgam carriers are potential sources of cross infection if not properly sterilised. Autoclaving is preferred. Disinfection is unsatisfactory.

Dental amalgam carriers release mercury vapour during autoclaving. This is not restricted by paper bagging.

Adequate ventilation should minimise the surgery mercury vapour burden from this source.

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