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CLINICAL ARTICLE

Chloroform in the Endodontic Operatory

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This article reviews the role chloroform has played in dentistry and describes an occupational health clinical investigation into the possible hazards of chloroform use in the operatory. Due to a Food and Drug Administration ban on drugs and cosmetics containing chloroform, there has been some confusion as to whether the use of chloroform in the practice of dentistry is considered unsafe or has been prohibited. Utilizing common endodontic treatment methods employing chloroform, this study reports no negative health effects to the dentist or assistant and air vapor levels well below Occupational Health and Safety Administration mandated maximum levels. The report concludes that, with careful and controlled use, chloroform can be a useful adjunct in the practice of dentistry. The Food and Drug Administration has no jurisdiction over a dentist's use of chloroform in clinical practice and has not proven that chloroform is a human carcinogen.

Over the last 15 yr, the use of chloroform has come to be viewed negatively due to a Food and Drug Administration (FDA) prohibition on its use in all drug and cosmetic product formulations. As our society as a whole has attempted to strive for a "zero risk" environment, the use of chloroform in the practice of dentistry has come under scrutiny and attack (1–4).

This investigation was started with the purpose of reviewing the historical and current role chloroform has played in dentistry, conducting an occupational health clinical investigation to assess the possible hazards of chloroform use in the operatory and to determine whether a rational justification exists for the careful and controlled use of chloroform.

In 1893 Austin C. Hewitt (5) read papers on chloroform analgesia before the Iowa State Dental Society advocating its use as a surgical analgesic. While not gaining a widespread popularity as an anesthetic, chloroform did continue to receive notice by dentists, and dental applications were discovered. Endodontists found that it was useful in bleaching procedures; to remove organic debris, to act as a desiccant and as an agent in the bleaching of fluorosis. It was also effective in obturation techniques such as the dip technique for custom fitting of the gutta-percha point, as a solvent in the chloropercha technique or as a solvent in retreating gutta-percha fillings. An obvious conflict exists in that the endodontic literature still discusses the use of chloroform even though many practitioners are uncertain if it is safe to use in dental practice. Indeed, an extensive study was recently conducted to try to find a "safe" gutta-percha solvent (6). This article will attempt to answer the question—"Is chloroform safe and legal to use in dental practice"?

Chloroform vapor is a central nervous system depressant and is toxic to the liver and kidneys. Experimental human exposures show that 14,000 to 16,000 ppm cause rapid loss of consciousness in man, whereas single exposures of 1000 ppm cause dizziness, nausea, and after effects of fatigue and headache. Prolonged exposure to 80 to 240 ppm cause lassitude, digestive disturbances, and mental dullness, whereas 20 to 70 ppm produce milder symptoms (7). The primary routes of potential human exposure to chloroform are ingestion, inhalation, and dermal contact. Potential human exposure may occur by breathing air contaminated with chloroform, eating food or drinking water that contains chloroform, or by absorption of chloroform through the skin. Drinking water supplies may contain chloroform as a by-product of chlorination for disinfection purposes. Occupational exposure may occur during the manufacture of chloroform or during one of its uses. Chloroform is used in a number of industries other than dentistry including: building and paperboard industries, iron and steel manufacturing, internal combustion engine industries, pesticide manufacturing, paint stores, breweries, dry cleaning and food processing (8). This usage has caused the Occupational Health and Safety Administration (OSHA) to mandate guidelines concerning exposure to chloroform. These guidelines state that "occupational exposure shall be controlled so that no worker will be exposed to chloroform in excess of 10 ppm determined as a time-weighted average exposure for up to a 10-h workday, 40-h work wk, or for any 10-min period to more than 50 ppm" (9, 10).

MATERIALS AND METHODS

A clinical investigation was performed to determine whether the use of chloroform in the dental operatory during patient treatment would meet the OSHA standards for occu-

pational exposure, and whether or not the use of chloroform in the operatory would pose any health threat or concern for the dentist or assistant. In the course of a standard 8-h workday, two patients who were deemed to benefit from chloroform-assisted dental therapy were appointed for treatment. One patient required endodontic retreatment, so removal of gutta-percha by using chloroform as a solvent was performed. The second patient required conventional endodontic therapy accomplished by the use of a chloroform dip gutta-percha master cone and lateral condensation. Evaluation of exposure using the chloropercha technique was not attempted.

An industrial hygiene air sampling survey was performed to determine whether chloroform levels exceeded the permissible exposure limit 8-h time-weighted average of 2 ppm during endodontic procedures utilizing chloroform. Two air sampling devices were strategically placed in the treatment operatory of an open bay multioperatory clinical setting. Dupont P-4000 (Fig. 1) air samplers using coconut shell charcoal solid sorbent tubes functioned throughout an 8-h time period. Additional air sampling devices were attached to both the dentist and the assistant to conduct employee breathing zone air samples (Fig. 2). The charcoal capillary tube is used to trap and transfer the air sample to a gas chromatography spectrometer which provides a specific quantitative analytic method. This is the recommended OSHA compliance method (9). A ceiling evaluation sample of 15 min was taken during the maximum expected airborne concentration of chloroform and other samples of longer duration were taken to obtain average exposure values. The samples were then analyzed.

In addition, an initial health screening evaluation was performed on both the dentist and the assistant before the patient treatment appointment. Tests performed included CBC, SMA 7, EKG, urine analysis, pulmonary functions test, and both PA and lateral chest X-rays. A CBC and SMA 7 were obtained within 5 h following the chloroform treatment appointments. A follow-up health screening evaluation was performed 1 yr after the clinical study.

The endodontic treatments were completed using the methods common to these situations. Dentist and assistant wore gloves, masks, and eye protection. Chloroform had been previously transferred from a quart bottle to a 50-ml holding bottle with a medicine dropper screw cap. All endodontic treatment was performed with rubber dam isolation.

For endodontic retreatment, chloroform was removed from the small bottle and six drops were placed in a dappen dish. A 1-ml syringe with 22-gauge needle was used to draw up the entire amount of chloroform from the dappen dish and carry it to the tooth. Using small diameter files, the chloroform was worked into the gutta-percha, eventually completing negotiation to the apex and the canal was reshaped and cleansed. Chloroform had the potential for vaporization over approximately a 15-min period.

For the chloroform dip procedure, the chloroform was removed from the small bottle and six drops were again placed into the dappen dish. Grasping a prefitted master cone with locking pliers, 2 to 3 mm of the tip was placed into chloroform for 1 to 2 s. The master cone was seated into the canal and withdrawn. This was repeated several times until the desired fit was accomplished. In this procedure the chloroform was exposed to air for approximately 5 min.

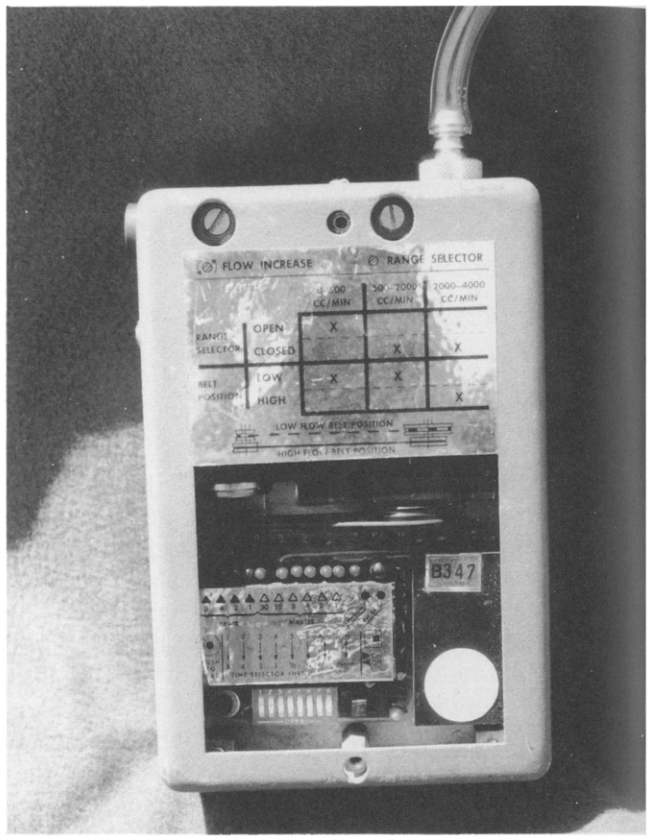

FIG 1. Dupont P-4000 Air Sampler used to survey chloroform levels.

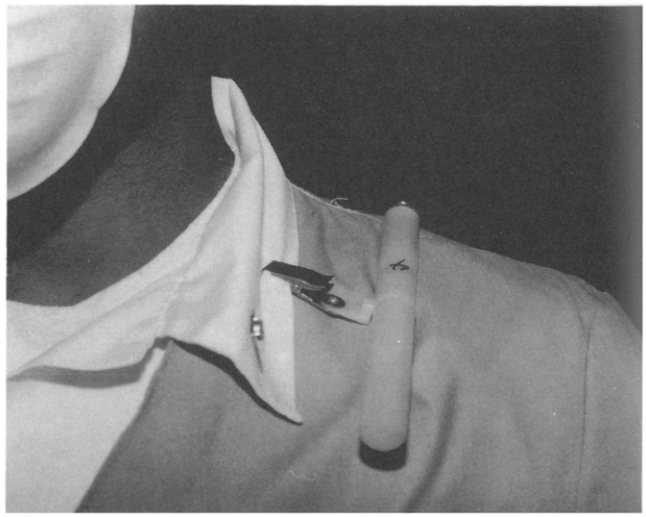

FIG 2. Tube positioned on employee to collect breathing zone sample.

RESULTS

The area air samples measured <0.57 ppm for a 5.5-h sample. The individual breathing air samples measured <0.88 ppm over 150 min, which equates to an 8-h time-weighted average of <0.275 ppm (11). All health screening tests before and after the clinical study were within normal limits. No liver, lung, or kidney damage or impairment was detected. Air samples were found to be well below the permissible

exposure limit-time-weighted average for chloroform, therefore practically eliminating any health hazard.

DISCUSSION

The prudent individual might question whether or not the above clinical study alone is sufficient to warrant use of chloroform. Air sampling techniques, while in common usage, are not always as accurate or reproducible as might be desired. The best question might be: is there any reason to not use chloroform as an adjunct to dental practice? The Centers for Disease Control, the National Institute of Dental Research, and the Library of the American Dental Association were all contacted and a request was made for any "statistics, case reports, or scientific studies ... on the morbidity or mortality of dental practitioners ... associated with the use of chloroform in the practice of dentistry." All responded that they had no studies, data, or reports which showed that dentists suffered morbidity or mortality from exposure to chloroform. From all evidence available, it can be concluded that the dentist and his staff are at no or minimal health risk by using chloroform in the dental practice.

The next question might be whether it is legal or ethical to use chloroform in the dental practice. In an effort to determine whether organized dentistry has an official policy on the use of chloroform in dental practice, both the American Dental Association Council on Dental Therapeutics and the Legal Affairs Office of the American Dental Association were contacted. Their correspondence states that the American Dental Association has no policy statement on the use of chloroform in dentistry. "If practitioners choose to soften gutta percha with chloroform, the FDA has no authority to force dentists to discontinue that practice." Also, the "FDA has no jurisdiction over a dentist's practice. It can control products, not procedures."

Since the FDA ban in 1976, the dental literature continues to contain investigations using chloroform-softened master gutta-percha cones as either a primary method of endodontic obturation or as a means of comparison to other obturation methods. Some articles mention this ban with accurate statements, while others cloud the issue with incorrect information. Mattison et al. (3) stated that, "In view of the FDA's ban on the use of chloroform from Accepted Dental Therapeutics, the continued use of this solvent cannot be justified." With statements such as this in the literature, it is no wonder that confusion abounds about the safety of chloroform use in dental practice. It is important to remember that the only ban on chloroform is for use in drugs or cosmetics where close repeated contact exposure to the skin may pose a potential for it becoming a carcinogen. The latest information from the International Agency for Research on Cancer (IARC) states that it "considered the evidence for the carcinogenicity of chloroform in humans to be inadequate" (8). The statement of Paracelcus several centuries ago should be kept in mind, "all substances can be remedies or poisons depending on the dosage and mode of application" (12). This is certainly true of chloroform. Through professional, careful usage there does not seem to be any clinical, legal, or ethical reason why chloroform should not be used in the dental operatory. Dentists currently using chloroform in the methods described should feel comfortable they are in compliance with all known standards.

The opinions expressed in this article reflect the personal views of the authors and are not necessarily the views of the United States Army.

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References

1. Morse DR, Wilcko JM, Pullon PA, Furst LM, Passo SA. A comparative tissue toxicity evaluation of the liquid components of gutta percha root canal sealers. J Endodon 1981;7:545–50.
2. Yancich PP, Hartwell GR, Portell FR. A comparison of apical seal: chloroform versus eucalyptol-dipped gutta-percha obturation. J Endodon 1989;15:257–60.
3. Mattison GD, Delivanis PD, Thacker RW, Hassel KJ. Effect of post preparation on the apical seal. J Prosthet Dent 1984;51:785–9.
4. Kaplowitz GJ. Evaluation of gutta-percha solvents. J Endodon 1990;16:539–40.
5. Jorgensen NB, Hayden J. Sedation, local and general anesthesia in dentistry. Philadelphia: Lea & Febiger, 1980.
6. Wourms DJ, Campbell AD, Hicks ML, Pelleu GB. Alternative solvents to chloroform for gutta-percha removal. J Endodon 1990;16:224–6.
7. U.S. Department of Health and Human Services, Occupational Health Guidelines for Chemical Hazards, DHHS (NIOSH) Publication No. 81–123, January 1981.
8. The Fifth Annual Report on Carcinogens: summary 1989. U.S. Department of Health and Human Services, Public Health Service.
9. Criteria document: Recommendations for an occupational exposure standard to chloroform. U.S. Department of HEW. Washington, DC: GPO, 1974.
10. Material Safety data sheet, chloroform. Schenectady, NY: Genium Publishing Corp., 1988.
11. Hillman DR, Morris SE. Memorandum: Air sample result for chloroform. Industrial Hygiene Section, PMS, U.S. Army Medical Activity, Fort Bragg, NC, September 10, 1990.
12. Stanley HR. Pulpal responses to ionomer cements-biological characteristics. Am Dent Assoc 1990;120:25–9.