Testing of several methods of sterilization in dental practice

Falak Jamani,[1] Taha Rababah,[2] Rasha Qsous,[3] Hani Ababneh[4] and Daameh Daameh[5]

اختبار عدد من طرق التعقيم في أعمال طب الأسنان

فلك جمعاني، وطه ربابعة، ورشا قسوس، ودعمة دعمة، وهاني عبابنة.

تم اختبار أداء الموصّدات، وأفران الحرارة الجافة، والمحاليل الكيماوية المستعملة في تعقيم أدوات طب الأسنان، وقد جرى فحص موصّدتين (أوتوكلافين) وجهازين لغلي الماء و٢٧ فرناً بالحرارة الجافة، وكلها تخدم ٧٣ عيادة لطب الأسنان. وكانت الاختبارات التي أجريت هي الاختبارات البيولوجية والأشرطة التي تختبر كفاءة الوقت والبخار والحرارة TST . وقد ثبت فشل فرن واحد للحرارة الجافة وجهازي غَلْي الماء في تعقيم الأدوات. وتم تجميع مئة قطعة من أدوات ومعدّات طب الاسنان عشوائياً بعد تعقيمها بالوسائل الكيماوية، ثم فحصها جرثومياً. واستُخدمت لهذا الغرضَ اختبارات بيولوجية. وظهر نمو جرثومي في ستين عينة من بينها. الأمر الذي يبيّن أن التعقيم الكيماوي ليس كافياً في أعمال طب الأسنان.

The performance of autoclaves, dry-heat ovens and chemical solutions used for sterilization of dental instruments has been tested. Two autoclaves, 2 boiling-water devices and 27 dry-heat ovens serving 73 dental clinics were examined. Biological tests and TST (time, steam, temperature) strip tests were conducted. One dry-heat oven and the two boiling-water devices failed to produce adequate sterilization. An assortment of 100 dental instruments and equipment that had been sterilized by chemical means were randomly selected and examined for the presence of bacteria. Biological tests were used. Sixty samples were found to be growth-positive. Chemical sterilization was shown to be inadequate for dental practice.

Test de plusieurs méthodes de stérilisation utilisées en pratique dentaire
Les performances des autoclaves, des fours à chaleur sèche et des solutions chimiques utilisés pour la stérilisation des instruments dentaires ont été contrôlées. Deux autoclaves, deux bouilleurs et 27 fours à chaleur sèche en service dans 73 cabinets dentaires ont fait l'objet d'un examen. Des tests biologiques ainsi que des tests à l'aide d'indicateurs basés sur le temps, la vapeur et la température (TST) ont été effectués. Un four à chaleur sèche et les deux bouilleurs n'ont pas produit un degré de stérilisation approprié. Un assortiment de 100 instruments et articles dentaires qui avaient été stérilisés par des moyens chimiques a été choisi au hasard et examiné à la recherche de bactéries, en utilisant des tests biologiques. Sur soixante de ces instruments, on a observé une croissance de bactéries, ce qui montre que la stérilisation chimique n'est pas appropriée pour les instruments destinés aux soins dentaires

[1]Consultant in Prosthetics; [2]Specialist in Dental Public Health; [3]Specialist in Microbiology; [4]Resident Dentist; Royal Medical Services, Queen Alia Military Hospital, Amman, Jordan.

Introduction

Dental professionals are exposed to infection during their work because of the many potential sources of infection in dental practice, such as the wide variety of microorganisms in the blood and saliva of patients. The infection could be direct infection, contact infection, smear infection, droplet infection or cross infection. The incidence of hepatitis B and the prevalence of the carrier state are increasing. It is believed that in the United Kingdom general dental practitioners treat as many as 250 carriers each day, and in many cases these carriers are not identified [*1*].

In the Middle East and Africa, the percentage of hepatitis B virus (HBV) carriers ranges from 20% to 30%, and hepatitis C virus (HCV) carriers form 20% of new cases [*2*].

There is a large and growing amount of literature on the hazards of cross infection from contaminated and inadequately sterilized instruments in dental practice. It is the duty of all the members of a dental team to ensure that all the necessary procedures (thorough sterilization) are taken to protect themselves and their patients from cross infection [*3*].

Aims and objectives

- To test the performance of autoclaves, dry-heat ovens, boiling-water devices and chemical disinfectants used for sterilization of instruments and equipment in dental practice.
- To implement a preventive strategy against cross infection.
- To encourage a policy of quality control.

Materials and methods

The study consisted of two major parts. The first was to examine the efficiency of sterilization carried out by autoclaves, dry-heat ovens and boiling-water devices. The second was to examine the efficiency of sterilization carried out by chemical solutions. Two autoclaves, 2 dry-heat ovens and 2 boiling-water devices serving 73 dental clinics (representing 84% of the dental clinics in the Royal Jordanian Medical Services) were examined. Sterilized samples including mouth mirrors, probes, excavators and tweezers were collected from the clinics, put in sterile envelopes prepared previously for this purpose and sent immediately to the microbiology laboratory in Queen Alia Military Hospital, Amman, for culturing. Biological tests for all samples were carried out, and the TST strip indicator test was also considered (not all clinics used this strip). In the Microbiology Laboratory, external surfaces were cultured using the swab-rinse technique. Sample tubes were incubated at 35 °C for 24 hours and then subcultured on tryptic-digest casein–soy (TS) blood agar aerobically and anaerobically. Colonies were examined by Gram stain and identified by biochemical tests; results were registered.

In the second part of the study, 100 samples from different hospitals were collected randomly; transport media were used for this purpose. The samples included burs, matrix retainers, matrix blades, saliva ejectors (plastic), cement spatulas, etc. The samples were sent immediately to the microbiology laboratory in Marka Medical Centre, in Amman, for culturing.

The culturing technique was swab-rinse technique using brain-heart infusion broth supplemented with 5% beef extract broth. The cultures were incubated at 35 °C for 24 hours on tryptic-digest casein–soy blood agar plates. Gram stain tests were performed for identification of microorganisms, and the results noted [*4,5*].

Results

After incubation at 35 °C for 24 hours the microorganisms noted in Tables 1 and 2 were detected.

Discussion

The dental profession should be alert to the problem of cross infection and must emphasize the significant role of sterilization as an effective mean to minimize the risk of cross infection. Once an autoclave, dry-heat oven or any sterilizer is installed in a dental practice, it must be monitored on a regular basis to check that adequate conditions for sterilization have been attained and maintained [*6,7*]. The literature describes several methods and products to ensure effective sterilization, and these include biological and chemical indicator devices [*8*].

In this study, the authors used the above products and methods in the microbiology laboratory to evaluate the performance of 2 autoclaves, 27 dry-heat ovens and 2 boiling-water devices used for sterilization of dental instruments. In addition we have used the culture method for testing the efficiency of chemical sterilization. In testing dry-heat ovens, which were all Aesculap models, 1 out of 27 failed to produce adequate sterilization. *Staphylococcus epidermidis* and *Micrococcus* sp. were isolated.

A study done by E.A. Field in 1988 to evaluate the performance of 157 autoclaves found that 6 out of 157 failed to produce adequate sterilization [*9*].

We may conclude that the performance of dry-heat ovens is acceptable as a method of sterilization but it takes a long time—one hour after reaching 160 °C; another disadvantage is that most dry-heat ovens do not have an uninterrupted cycle, which renders them liable to interruption of sterilization.

Staphylococcus aureus bacterial growth was isolated from instruments sterilized by boiling-water device. This suggests that boiling water is not an effective method of sterilization: M.V. Martin and his colleagues in their study in 1985 [*10*] to evaluate the efficiency of boiling-water devices showed that boiling water does not even disinfect and should be rejected as a method of sterilization.

In the second part of the study, 100 dental items were sterilized by chemical means (Savlon hospital concentrate solution; chlorohexidine gluconate 1.5% w/v and cetrimide 15% w/v) with dilution rate 35 ml made up to 1 litre with water (which was not checked for sterility). Bacteria and fungi were isolated from 60 samples.

Table 1 **Results of Part One of the study**

Type of sterilizer	No. of samples	Result of growth	Type of microorganism
Dry-heat oven	1	+ve	*Staphylococcus epidermidis* *Micrococcus* sp.
Boiling water device	2	+ve	*Staph. aureus*
Dry-heat oven	26	–ve	
Autoclave	2	–ve	

Samples taken from mouth mirror, probe, excavator and tweezers

The identified microorganisms were:

Gram +ve: *Staphylococcus aureus*, *Staph. epidermidis*. *Bacillus* sp.. *Strept. enterococci*.

Gram –ve: *Pseudomonas aeruginosa*, *Enterobacter* sp.

Fungi: *Aspergillus* sp.. *Candida albicans*.

In Martin's study [*10*] to evaluate the efficiency of boiling-water devices used under the supervision of a microbiologist, 81% of the microorganisms identified before treatment remained viable, showing that boiling water does not even disinfect. Practitioners

Table 2 **Results of Part Two of the study**

Samples taken	Number +ve	Type of microorganism
16 burs	15	*Streptococcus enterococci* *Staphylococcus epidermidis* (coagulase –ve) *Bacillus* sp. *Enterobacter* sp. *Staph. aureus* (coagulase +ve) *Candida albicans* *Pseudomonas aeruginosa* *Strept. viridans*
6 condensers	4	*Bacillus* sp. *Staph. epidermidis* (coagulase –ve)
6 handpieces	2	*Aspergillus* sp. *Bacillus* sp. *Strept. enterococci*
10 saliva ejectors	6	*Bacillus* sp.
10 matrix bands	2	*Bacillus* sp. *Strept. viridans*
4 spatulas	2	*Bacillus* sp.
6 abrasive stones	6	*Bacillus* sp. *Staph. aureus* (coagulase +ve) *Strept. pyogenes* *Staph. epidermidis* (coagulase –ve)
8 three-in-one syringes	5	*Bacillus* sp. *Strept. enterococci* *Pseudomonas aeruginosa* *Strept. viridans*
4 US scaling tips	3	*Bacillus* sp. *Streptococcus viridans*
10 plastic instruments	7	*Bacillus* sp. *Strept. viridans* *Staph. epidermidis* (coagulase –ve)
4 burnishers	2	*Bacillus* sp.
6 polish brushes	5	*Strept. enterococci* *Staph. epidermidis* (coagulase –ve) *Bacillus* sp. *Aspergillus* sp.
8 matrix retainers	1	*Bacillus* sp.

who still use boiling water for sterilization are therefore continually exposing their patients to the risk of cross infection.

The second part of the study showed that disinfectant materials give totally inadequate sterilization. So chemical sterilization is not recommended in dental practice for the following reasons:

- in general, it is less lethal to pathogenic organisms than sterilization by other means
- it cannot be monitored biologically
- instruments must be handled aseptically, rinsed in sterile water and dried within sterile towels after chemical sterilization
- instruments sterilized by chemical solutions are not wrapped and therefore must be used immediately or stored in a sterile container
- too much time is needed, not less than three hours and usually from six to ten hours
- it may cause rust and corrosion of the instruments
- chemical agents may easily be misused by dental assistants [*11*].

In general, a chemical agent for disinfection (other than sodium hypochlorite) in the dental setting must be registered in the United Kingdom as a hospital disinfectant, must be tuberculocidal and must neutralize, as a minimum, both lipophilic and hydrophilic viruses [*11*].

Conclusions

- It is concluded that autoclaving is the method of choice for sterilization of dental instruments. It is effective, fast, safe and uses an uninterrupted cycle.
- The dry-heat oven is effective, but using an uninterrupted cycle is recommended.
- Cold sterilization—chemical disinfectant—is not suitable for sterilization in dental practice.
- Boiling-water devices are not effective for sterilization of dental instruments; they should be discarded and condemned.

Recommendations for infection control and the dental team

The following recommendations were made in the light of current knowledge and are subject to alteration and updating.

- The concept of "universal precautions" should be implemented and well-known by all dental professionals; it refers to a method of infection control in which all human blood and certain human body fluids (saliva in dentistry) are treated as if known to be infectious for HIV, HBV and other blood-borne pathogens. The same infection control procedures are to be used for all patients [*11*].
- A thorough and updated medical history should be obtained from a patient, either by direct discussion or through charts.
- Cleaning of instruments: visible deposits must be removed; ultrasonic cleaners are recommended. Heavy-duty gloves should be worn, and great care should be taken when handling sharp instruments [*12,13,14*].
- *Sterilization of instruments*

  The method of choice for all instruments is the autoclave, using one of the following time–temperature combinations:

Temperature °C	Minimum hold time minutes
134–138	3
126–129	10
121–124	15
115–118	30

The first option is frequently recommended for dental instruments.

A dry-heat oven, with an uninterrupted cycle, including a holding time of 60 minutes at 160 °C, is an effective mean of sterilization.

Disinfectants (cold sterilization solutions) are not suitable for routine use.

Boiling water is not an effective method for sterilization in dentistry.

• *Disposables*: the general use of disposable items is recommended whenever possible, including but not limited to towels, cartridges, needles, impression trays, suction tips, beakers, air syringes, polishing brushes, burs, gloves [*15,16,17*].

• *Personal protection*: should include protective gloves, protective glasses for patients, face mask and protective apron [*18*].

• *Aspiration and ventilation*: the risk of cross infection is reduced by good ventilation and by efficient high-speed aspirators.

• *Disposal of waste*: sharp items should be placed in a rigid and safe container, which should not be filled more than two thirds of its capacity. Arrangements for the collection and incineration of surgical waste should be made locally. Needles, cartridges and other surgical waste must never be dumped on a normal refuse tip or other unauthorized site.

• *Laboratory items*: impressions and appliances should be rinsed thoroughly before sending to the laboratory. Technicians should wear gloves, glasses and masks when handling impressions and pouring models. A receiving area should be established separate from the production area. Containers should be sterilized or disinfected after each use; solid waste that is soaked or saturated with body fluids should be placed in sealed, sturdy, impervious bags.

• *Training*: all dental staff should be trained thoroughly and understand the policies adopted for prevention of cross infection. All procedures should be reviewed from time to time to ensure that they are being implemented correctly.

• Regular and random checks on the effectiveness of sterilization should be done.

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