Disinfection of gutta-percha cones with chlorhexidine and sodium hypochlorite

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Objectives. To evaluate the effectiveness of chlorhexidine (CHX) or sodium hypochlorite (NaOCl) in disinfecting gutta-percha cones, to verify contamination of gutta-percha cones in their boxes, and to identify microorganisms after intentional contamination by handling cones.

Study design. Gutta-percha cones contaminated in vitro with several microorganisms were left in contact with tested disinfecting solutions for different times, sterility of storage boxes was evaluated by immersing cones in broth medium, and the microorganisms most frequently found in handling cones were identified using biochemical tests.

Results. CHX was not effective in eliminating *Bacillus subtilis* spores on gutta-percha cones after 72 h of contact with the disinfecting substance. 5.25% NaOCl eliminated spores from gutta-percha after 1 min of disinfection. The cones evaluated from their boxes did not show contamination in 94.5% of the cases. The microbial genus most frequently found after intentional contamination with gloves was *Staphylococcus*.

Conclusion. 5.25% NaOCl is an effective agent for a rapid disinfection of gutta-percha cones. (Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2005;100:512-7)

Gutta-percha cones are, at present, the most commonly used material for the obturation of the root canal system. They are biocompatible, dimensionally stable, radiopaque, and thermoplastic. Moreover, they are easily removed from the root canal when necessary.1

Even though gutta-percha cones are produced under aseptic conditions and present potential antimicrobial properties, especially owing to their zinc oxide component,2 they can be contaminated by handling, even if carefully removed from their packages. They can also be contaminated by aerosols and physical sources during the storage process.3

It would be worthwhile if cones used to fill the root canal system were free from pathogenic microorganisms because endodontic therapy is mainly a procedure of decontamination in order to prevent the dissemination of microorganisms throughout the root canal system and periapical tissues.4 Moreover, penetration of bacteria into the blood stream of systemically compromised patients should be avoided because of the risk of infective endocarditis.5 Owing to the thermoplastic characteristic of gutta-percha cones, they can not be sterilized by the conventional process in which moist or dry heat is used because this may cause alteration to the gutta-percha structure. Therefore, a rapid chairside chemical disinfection is needed.4,6

Several chemical solutions for cold disinfection have been evaluated, such as polyvinylpyrrolidone-iodine, ethyl alcohol, sodium hypochlorite, hydrogen peroxide, quaternary of ammonium, glutaraldehyde, and chlorhexidine liquid. The time for these substances to kill microorganisms ranges from a few seconds to substantial periods of time.3-7

Nowadays, an increasing interest has arisen regarding the antimicrobial activity of chlorhexidine (CHX), either in gel or in liquid form.7,8 Sodium hypochlorite (NaOCl) is one of the most widely used endodontic solutions, either as an irrigant or for rubber dam and cone decontamination. Its concentration ranges from 0.5% (Dakin solution) to 5.25%.3

Certain species of *Bacillus* and *Clostridium* can form “cells of repose” called spores (endospores). They are more resistant to physical and chemical agents than vegetative forms and represent a form of survival and not a form for bacterial reproduction.9

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The objective of this study was to evaluate the effectiveness of chlorhexidine (CHX) or sodium hypochlorite (NaOCl) in disinfecting gutta-percha cones, to verify contamination within their box, and to identify microorganisms after intentional contamination by handling cones.

MATERIAL AND METHODS

Two different presentation forms of CHX gluconate (gel and liquid) and NaOCl were tested to disinfect the gutta-percha cones. The concentrations of CHX gluconate tested were 0.2%, 1.0%, and 2.0%. For NaOCl the concentrations were 0.5%, 1%, 2.5%, 4%, and 5.25%. All substances were prepared by the same manufacturer (Proderma Farmácia de Manipulação, Piracicaba, Brazil). The manufacturer diluted NaOCl and CHX liquid at different concentrations in sterile water without preservatives. The solutions were prepared in small amounts 24 hours before the commencement of the experiment. CHX gel consisted of a gel base (1% natrosol, a hydroxyethylcellulose) and CHX gluconate. A solution containing 0.89% sterile saline and 1% natrosol gel were used as controls.

The species of microorganisms used in this experiment were the facultatively anaerobic microorganisms Enterococcus faecalis (ATCC 29212) and Streptococcus sanguis (ATCC 25923), and aerobes Staphylococcus aureus (ATCC 25923), Candida albicans (NTCC 3736), and Bacillus subtilis (ATCC 19659) in vegetative and spore forms.

Tanari R8 gutta-percha accessory cones (Tanariman Industrial, Manacapuru, Brazil) were used in this experiment.

The testing times for NaOCl and CHX to disinfect the cones were: immediate, 45 seconds, and 1, 3, 5, 10, 15, 20, and 30 minutes in contact with the substances. For CHX, other times were added: 45 minutes and 1, 2, 3, 5, 10, 12, 24, 48, and 72 hours.

The methodology used for contamination of the cones with the Bacillus subtilis spore was a modification of the one described by Siqueira et al. 7

Number of gutta-percha cones used

In order to test the antimicrobial activity of NaOCl and CHX for each tested microorganism, gutta-percha cones were placed in test tubes, each tube having 11 cones and 5 mL of each microbial suspension. These were left in the suspension for up to 30 minutes. The gutta-percha cones were then used to test the substances (n = 10) and 1 tube was used as a control group. There were a total of 297 tubes. For the CHX solutions additional testing times (from 45 min to 72 h) were included, with each tube containing 7 gutta-percha cones (6 for the test substances and 1 for the control), for a total of 210 tubes. Three replicates were made for each microorganism tested. One cone was transferred straight to a tube containing only 5 mL thioglycolate in order to allow microbial growth (positive control group).

The experiment involved 5 different microbial species; however, 1 species was in either vegetative or spore form. Therefore 3,042 gutta-percha cones were used, comprising 26 boxes.

Bacillus subtilis spore suspension and contamination of the cones

Microbe strain B subtilis was grown in a soil extract nutrient broth for 72 h at 37°C. This culture was poured into a tissue grinder and macerated to break up the pellicle which had formed. It was then filtered through a sterile funnel containing moist cotton into sterile tubes.

In order to test the antimicrobial activity of NaOCl and CHX, gutta-percha cones were placed in tubes each containing 5 mL of a filtrate from a 72-h culture of B subtilis.

The tubes were vortexed and allowed to stand for 15 min. After this, the contaminated cones were transferred to petri dishes overlain with 2 layers of filter paper.

The contaminated specimens were then placed in a vacuum dryer containing silica and dried under vacuum for 24 h. Spores dried and maintained under these conditions usually survived for 7 or more days.

Contamination of the gutta-percha cones with the other tested microorganisms

Isolated 24 h colonies of pure cultures of each microorganism were grown on 5% sheep blood—brain heart infusion agar plates (BHI agar; Lab M, Bury, UK). These were incubated either aerobically at 37°C (aerobic microorganisms) or in an atmosphere of 10% CO₂ (facultative microorganisms) for 18 to 24 hours. Afterwards, tubes containing a 4.5-mL thioglycolate sterile culture medium suspension were individually inoculated with these microorganisms (Lab M). These were adjusted spectrophotometrically at 800 nm (OD₈₀₀) to match the turbidity of 1.5 × 10⁸ cfu/mL (equivalent to 0.5 McFarland standard) according to Koo et al. 10 The cones remained in contact with the microbial suspension for 2 hours in order to promote surface contamination.

Testing the antimicrobial activity of the substances

The contaminated gutta-percha cones were transferred to test tubes containing 3 mL of each solution being tested and left to stand over the different experimental times. After their removal from the test solutions, the gutta-percha cones were transferred to tubes with 5.0 mL thioglycolate broth containing neutralizers, such as 0.6% sodium thiosulphate for NaOCl and Tween 80 plus...
0.07 lecithin for CHX. Having completed the transfer, the test tubes were vortexed and incubated either aerobically at 37°C (aerobic microorganisms) or in an atmosphere of 10% CO₂ (facultative microorganisms) for 7 to 21 days (especially for growth of the *B. subtilis* spores). The tubes were checked daily for turbidity as an indication of microbial growth. After 7 days (for all vegetative forms) or 21 days (for spore form), agar plates were inoculated with 10 μL from each test tube, these plates being left at 37°C for 24-48 hours in appropriate gaseous conditions (as described above) to investigate all possible microbial growth. The purity of the positive cultures was confirmed by Gram staining, by colony morphology on blood agar plates, and by the use of biochemical identification kits (API 20 Strep, API C AUX, API 20 Staph, and Rapid ID32A; BioMérieux, Marcy-l’Etoile, France). The time spent for each substance to produce total microbial inhibition growth was recorded. All times were converted to seconds and analysed statistically using the Kruskal-Wallis test, with the significance level set at *P* < .05.

**Evaluation of the contamination of gutta-percha cones in their boxes**

This part of the work was undertaken during endodontic treatment performed by final year students at the Dental School of Piracicaba, State University of Campinas, Brazil.

A total of 85 gutta-percha cones (30 freshly opened boxes: 15 boxes from Tanariman, and 15 from Dentsply [Dentsply Indústria e Comércio, Petrópolis, Brazil]) previously sterilised with ethylene oxide were used, and the time between the opening of the storage boxes and their use was recorded. Tables I and II show the characteristics of the cones according to their manufacturer and size.

After removal from the box, each cone was transferred to test tubes containing 1 mL of thioglycolate broth. One cone was used for each tube. The test tubes were then vortexed, incubated at 37°C for 24-48 hours in appropriate gaseous conditions for up to 21 days and checked daily for the appearance of turbidity in the BHI broth. After this period, blood agar plates were inoculated with 10 μL from each tube and left at 37°C for 24-48 days in appropriate gaseous conditions to investigate all possible bacterial growth. The purity of the positive cultures was confirmed by Gram staining, by colony morphology on blood agar plates, and by the use of biochemical identification kits as mentioned above.

**Intentional contamination of the gutta-percha cones during manipulation with gloves**

Fifteen students performing endodontic treatment were asked to handle a medium size secondary gutta-percha cone (Tanari; Tanariman Industrial), freshly removed from an unopened box, for 30 seconds. It was to be handled with their own gloves and without using sterile gauze.

Each cone was then immediately transferred to tubes containing 1 mL of thioglycolate culture medium (Lab M) and transported within 15 minutes to a CO₂ incubator in the microbiology laboratory. The maximum time between sample collection and laboratory processing was 4 hours.

The test tubes were left at 37°C for 7 to 21 days in a CO₂ atmosphere for microbial growth. Moreover, 10-fold serial dilutions, up to 10⁻⁴, were made in test tubes containing thioglycolate culture medium. Fifty μL of the serial dilutions 10⁻², 10⁻³, and 10⁻⁴ were plated, using sterile plastic spreaders, onto 2 plates of 5% defibrinated sheep blood BHI agar (Oxoid, Basingstoke, UK). One series of plates was incubated at 37°C for 7 to 21 days in CO₂ atmosphere for detection of facultative microorganisms and the other series at room atmosphere. The same dilutions were also plated on Agar Dextrose Sabouraud (Oxoid) supplemented with 100 μg/mL of chloramphenicol (Medley, Campinas, Brazil) for yeasts and incubated aerobically at 30°C for 2 days.

**Microbial identification**

Preliminary characterization of microbial species was based on colony features (i.e., size, color, shape, height, surface, texture, consistency, brightness, and hemolysis) visualized under a stereoscopic lens (Lambda Let 2; Atto Instruments, Hong Kong). Isolates were then purified by subculture, Gram stained, and tested for catalase production, and their gaseous requirements were established by incubating for 2 days aerobically and anaerobically. Based on this information it was possible to select appropriate procedures to identify the species as follows:

- Rapid ID 32A (BioMérieux) for strict anaerobic, gram-negative rods.
- RapID ANA II System (Innovative Diagnostic Systems, Atlanta) for anaerobic gram-positive cocci.
- API Staph (BioMérieux) for staphylococci and micrococci (gram-positive cocci, catalase-positive)
- Rapid ID 32 Strep (BioMérieux) for streptococci (gram-positive cocci, catalase-negative)
- RapID NH System (Innovative Diagnostic Systems) for *Eikenella, Haemophilus, Neisseria* and Actinobacillus.
- API C Aux (BioMérieux) for yeast.

Miniapi software (BioMérieux) was used to automatically read ID 32 tests and visually read API range tests from BioMérieux.
Table I. Time needed to disinfect gutta-percha cones immersed in chlorhexidine and sodium hypochlorite

<table>
<thead>
<tr>
<th>Chemical solutions</th>
<th>B. subtilis (vegetative form) ATCC 19659</th>
<th>B. subtilis (spore cells) ATCC 19659</th>
<th>C. albicans ATCC 3736</th>
<th>E. faecalis ATCC 29212</th>
<th>S. aureus ATCC 25923</th>
<th>S. sanguis ATCC 25923</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5% NaOCl</td>
<td>30 min ab A</td>
<td>30 min ab A</td>
<td>30 min a A</td>
<td>30 min a A</td>
<td>30 min a B</td>
<td>30 min a A</td>
</tr>
<tr>
<td>1.0% NaOCl</td>
<td>20 min ab A</td>
<td>20 min ab A</td>
<td>20 min a A</td>
<td>20 min a A</td>
<td>20 min a B</td>
<td>20 min a A</td>
</tr>
<tr>
<td>2.5% NaOCl</td>
<td>10 min ab A</td>
<td>10 min a b</td>
<td>10 min ab A</td>
<td>10 min a B</td>
<td>10 min a B</td>
<td>10 min a B</td>
</tr>
<tr>
<td>0.2% chlorhexidine gel</td>
<td>45 s b A</td>
<td>1 min b A</td>
<td>45 s ab A</td>
<td>45 s b A</td>
<td>45 s ab A</td>
<td>45 s ab A</td>
</tr>
<tr>
<td>1.0% chlorhexidine gel</td>
<td>2 h a AB</td>
<td>&gt; 72 h a A</td>
<td>15 s b B</td>
<td>15 min ab B</td>
<td>30 s b B</td>
<td>15 s b B</td>
</tr>
<tr>
<td>2.0% chlorhexidine gel</td>
<td>1 min b AB</td>
<td>&gt; 72 h a A</td>
<td>15 s b B</td>
<td>1 min b AB</td>
<td>15 s b B</td>
<td>15 s b B</td>
</tr>
<tr>
<td>0.2% chlorhexidine liquid</td>
<td>30 s b B</td>
<td>&gt; 72 h a A</td>
<td>15 s b B</td>
<td>30 s b AB</td>
<td>15 s b B</td>
<td>15 s b B</td>
</tr>
<tr>
<td>1.0% chlorhexidine liquid</td>
<td>15 s b B</td>
<td>&gt; 72 h a A</td>
<td>15 s b B</td>
<td>15 s b B</td>
<td>15 s b B</td>
<td>15 s b B</td>
</tr>
<tr>
<td>2.0% chlorhexidine liquid</td>
<td>15 s b B</td>
<td>&gt; 72 h a A</td>
<td>15 s b B</td>
<td>15 s b B</td>
<td>15 s b B</td>
<td>15 s b B</td>
</tr>
</tbody>
</table>

Different letters (from a to d and A to B) mean different values. Capital letters show statistical analysis horizontally (Kruskal-Wallis P < .05). Lower case letters show statistical analysis vertically (Kruskal-Wallis P < .05).

RESULTS
Effectiveness of the antimicrobial agents in disinfecting gutta-percha cones

The samples’ normalities were tested using the GMC program (USP, Ribeirão Preto, Brazil), demonstrating that the data were nonparametric. Then the samples were compared using the Kruskal-Wallis test (BioEstat program; CNpq 2000, Brasília, Brazil), with significance level at P < .05. The data were converted to seconds, minutes, and hours in order to make the comparison of the results easier.

Table I shows the time spent by all tested substances to disinfect gutta-percha cones.

The results show that CHX, at all concentrations and presentation forms tested, was not effective in eliminating B subtilis spores on gutta-percha cones, even after 72 hours of contact.

5.25% NaOCl eliminated spores from gutta-percha after 1 minute of contact.

Both substances were able to eliminate all vegetative microorganisms in 30 minutes or less. The exceptions were E faecalis and the vegetative form of B subtilis, which took 2 hours to be killed by 0.2% CHX gel.

Evaluation of the contamination of gutta-percha cones in their boxes

Our results showed that 94.5% of the cones did not show contamination, especially the Tanari cones (15/15). These cones came from boxes that were opened not only at the time of the experiment but also up to 2.5 years before. Only 3 Dentsply cones (3/15) were contaminated with Staphyloccocus epidermidis and S aureus. Similar results were found for the cones taken from previously opened boxes (Table II).

Intentional contamination of the gutta-percha cones during manipulation with gloves

Table III shows the microorganisms found after handling contaminated gutta-percha cones. Staphylococcus was the bacterial genus most frequently recovered (100%), followed by Micrococcus (33.3%), Propionibacterium (33.3%), Streptococcus (26.7%), Bacillus (20%), and Lactobacillus (13.3%).

DISCUSSION

Gutta-percha cones cannot be sterilized by heat. Therefore a chairside decontamination using a chemical agent should be adopted in routine endodontic practice to render them, both the master and the accessory gutta-percha cones, free of microorganisms. Furthermore, it is difficult to know beforehand how many accessory cones will be used during lateral condensation. Therefore, an effective chemical agent that acts quickly against surface contaminant microorganisms should be used for their decontamination.

In endodontic therapy the decontamination of gutta-percha cones can be accomplished with effective chemical agents because natural contamination of the cones consists mainly of vegetative bacterial cells rather than resistant bacterial spores. However, gutta-percha cones that have been in contact with patients should be discarded.

A decontamination program begins with a cleaning method that assures a reduction of the natural bioburden, which is the initial population of viable microorganisms present on the material, and the guarantee of a proper and successful application of a disinfectant, a sanitizer, or a sterilant for use in health care. Therefore, the correct term for the cleaning of gutta-percha cones with a chemical agent is disinfection.

Chlorhexidine kills vegetative bacteria by disrupting the membrane integrity and inducing the precipitation of the cytoplasm.
used in endodontics either as an irrigant solution or as an intracanal medication, giving good performance. The natrosol gel (hydroxyethyl cellulose, pH 5.5) used as a base for CHX gluconate is soluble in water and widely used to thicken shampoos, gels, and soaps.

The present study showed that 0.2%, 1%, and 2% CHX, in both liquid and gel forms, were not effective at the high disinfection level of gutta-percha cones contaminated with spores of B subtilis, even after 72 hours of contact, agreeing with Siqueira et al, who found that 2% CHX solution did not disinfect gutta-percha cones contaminated with B subtilis spores after 10 minutes of exposure. Other authors have reported that CHX can be effective against spores.

CHX, especially CHX liquid, can disinfect cones infected with B subtilis in a vegetative form, which in our study only took from 15 to 30 seconds. Stabholz et al also showed that 2% CHX liquid killed B subtilis in vegetative form after 10 minutes of exposure. It was also effective against the other tested microorganisms, taking from 15 s to 2 h to eliminate them from the gutta-percha cone surfaces.

CHX in liquid formulation took less time to kill microorganisms than CHX gel; 0.2% CHX gel took 2 h to eliminate E faecalis and the vegetative form of B subtilis.

Sodium hypochlorite has antibacterial and sporidical activities related to the liberation of active chlorine. Chlorine may inhibit the germination and the outgrowth of bacterial spores. NaOCl, a widely used endodontic irrigant, is efficient in dissolving organic tissues as well as eliminating microorganisms.

Senia et al observed that the vegetative form of B subtilis was killed after 45 s of immersion in 5.25% NaOCl, whereas the spore forms were eliminated in 1 min. Our findings are similar. Stabholz et al showed that 5.25% NaOCl was effective after 10 min of contact with the vegetative form of B subtilis. Cardoso et al, testing the “decontamination” of cones with different concentrations of NaOCl, observed that the sporidical activity changes according to concentration. Other reasons for the rapid bactericidal and sporidical action of NaOCl still have not been found, but may be related to the presence of zinc oxide in the composition of gutta-percha cones.

Our results agree with Senia et al, Frank and Pelleu, and Siqueira et al, who observed that 5.25% NaOCl disinfects gutta-percha cones contaminated with B subtilis spores after 1 min exposure as it stops the germination and outgrowth of bacterial endospores. This was the reason for the negative microbial growth after using 5.25% NaOCl. However, this does not mean that the cone became sterile, because sterilization means fully killing or removing all life forms from inanimate objects and surfaces, including the inactivation or removal of spores and viruses.

The antimicrobial activity of NaOCl was related to its concentration, i.e., higher concentrations took less time to inhibit bacterial growth than lower concentrations: 5.25% NaOCl took from 15 s to 1 min to kill all microorganisms, whereas 0.5% NaOCl took 30 min. Our results do not agree with the findings of Cardoso et al and da Motta et al regarding the time taken by 0.5%, 1%, and 2.5% NaOCl to exert antimicrobial activity. According to these authors, 0.5 and 1% NaOCl took only 1 and 5 min, respectively, to kill Staphylococcus aureus and Escherichia coli strains and B subtilis spores. According to da Motta et al, 2.5% NaOCl was able to sterilize cones contaminated with Bacillus stearothermophilus. In the present study, 5 different strains were used as well as the B subtilis spore. Therefore, the range of microorganisms tested, as well as the range of the antimicrobial agents, was greater than in previous studies.

Therefore, under the experimental conditions of this study, the use of lower concentrations of NaOCl is not recommended for gutta-percha cone disinfection owing to the longer time they take to kill microbial cells. Time is even more critical when it is necessary to disinfect extra accessory cones during lateral condensation, because it is not practical to wait 10 to 30 min for cone disinfection. Moreover, even those clinicians who do not use NaOCl in high concentration because it is aggressive to periapical tissues, should have in their practice small amounts of freshly prepared 5.25% NaOCl solution for

<table>
<thead>
<tr>
<th>Table II. Contamination of gutta-percha cones according to the opening time of the boxes</th>
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<tbody>
<tr>
<td>Opening time</td>
</tr>
<tr>
<td>Freshly opened</td>
</tr>
<tr>
<td>Up to 6 months</td>
</tr>
<tr>
<td>7 months to 1 year</td>
</tr>
<tr>
<td>1.1 year to 2 years</td>
</tr>
<tr>
<td>More than 2 years</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Table III. Microorganisms isolated from the handling of manipulated cones (n = 15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Species</td>
</tr>
<tr>
<td>Staphylococcus aureus</td>
</tr>
<tr>
<td>Staphylococcus epidermidis</td>
</tr>
<tr>
<td>Micrococcus spp.</td>
</tr>
<tr>
<td>Propionibacterium acnes</td>
</tr>
<tr>
<td>Streptococcus salivarius</td>
</tr>
<tr>
<td>Bacillus spp.</td>
</tr>
<tr>
<td>Lactobacillus spp.</td>
</tr>
</tbody>
</table>
rapid use. Such a solution should be kept in dark flasks, protected against light and high temperatures, because these agents can degrade its stability.11

Evaluation of the contamination of gutta-percha cones in their boxes

Our results showed that 94.5% of the cones did not show contamination, agreeing with the findings of Bartels,20 Montgomery21 and da Motta et al.3 The cones came from boxes that were opened at the beginning of the experiment to 2.5 years before. When microbial growth was present, the genus most frequently found was Staphylococcus, confirming the work of Montgomery.21 However, there is still the possibility of cross-contamination when collecting microbial samples.

Intentional contamination of the gutta-percha cones during manipulation with procedure gloves

Gutta-percha cones should be manipulated with sterilized tweezers and gauzes. Unfortunately it is common to see clinicians manipulating them with their gloves. In this study, 100% of the cones manipulated with gloves showed microbial growth. The microorganisms mostly frequently isolated, such as Staphylococcus epidermidis, Staphylococcus aureus, Propionibacterium acnes, Lactobacillus spp., and Micrococcus spp., are normal inhabitants of the human skin. Streptococcus salivarius belongs to the mouth microbiota, being especially found on the tongue and in saliva. Bacillus spp. are gram-positive rod spore-producers that grow better in aerobic conditions and are considered surface contaminants.22

In conclusion, even though gutta-percha cones are usually sterile during storage, they can be easily contaminated if incorrectly manipulated. NaOCl at 5.25% concentration is an effective agent for a rapid high disinfection level of gutta-percha cones. Even though 2% CHX is able to kill all vegetative forms in a short period of time, this agent did not eliminate B subtilis spores within the times tested.

We would like to thank Dr Glauícia Maria Bovi Ambrosano for invaluable work with statistical analysis, Mr Adailton dos Santos Lima for technical support, and Biolab Métrieux for lending the MiniApi equipment.

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