Marcio Jose Mendonça

Novas técnicas de desinfecção de moldes em Odontologia – Avaliação da eficácia microbicida e da precisão dimensional de modelos

Tese apresentada à Faculdade de Odontologia de Piracicaba, da Universidade Estadual de Campinas, para obtenção do título de Doutor em Materiais Dentários.

Orientador: Prof. Dr. Mário Alexandre Coelho Sinhoreti

PIRACICABA
2010

FICHA CATALOGRÁFICA ELABORADA PELA
BIBLIOTECA DA FACULDADE DE ODONTOLOGIA DE PIRACICABA
Bibliotecária: Marilene Girello – CRB-8ª. / 6159

M523n

Mendonça, Marcio José.
Novas técnicas de desinfecção de moldes em odontologia – avaliação da eficácia microbicida e da precisão dimensional de modelos / Marcio José Mendonça. -- Piracicaba, SP: [s.n.], 2010.

Orientador: Mario Alexandre Coelho Sinhoreti.
Tese (Doutorado) – Universidade Estadual de Campinas, Faculdade de Odontologia de Piracicaba.

1. Ácido peracético. 2. Análise microbiológica. I. Sinhoreti, Mario Alexandre Coelho. II. Universidade Estadual de Campinas. Faculdade de Odontologia de Piracicaba. III. Título.

(mg/fop)

Título em Inglês: New techniques for disinfection of dental impressions - microbiological and accuracy evaluation

Palavras-chave em Inglês (Keywords): 1. Peracetic acid. 2. Microbiological analysis

Área de Concentração: Materiais Dentários

Titulação: Doutor em Materiais Dentários

Banca Examinadora: Mario Alexandre Coelho Sinhoreti, Gelson Luis Adabo, Maximiliano Piero Neisser, Lourenço Correr Sobrinho, Rafael Leonardo Xediek Consani

Data da Defesa: 23-06-2010

Programa de Pós-Graduação em Materiais Dentários

UNIVERSIDADE ESTADUAL DE CAMPINAS
Faculdade de Odontologia de Piracicaba

A Comissão Julgadora dos trabalhos de Defesa de Tese de Doutorado, em sessão pública realizada em 23 de Junho de 2010, considerou o candidato MÁRCIO JOSÉ MENDONÇA aprovado.

Prof. Dr. MARIO ALEXANDRE COELHO SINHORETI

Prof. Dr. GELSON LUIS ADABO

Prof. Dr. MAXIMILIANO PIERO NEISSER

Prof. Dr. LOURENÇO CORRER SOBRINHO

Prof. Dr. RAFAEL LEONARDO XEDIEK CONSANI

DEDICATÓRIAS

A Deus, por sempre estar presente e atuante na minha vida pessoal e profissional!

Mas aquele que beber da água que eu lhe der nunca terá sede, porque a água que eu lhe der se fará nele uma fonte de água que salte para a vida eterna.
João, 4:13

A minha esposa Janaina, por ser meu porto seguro, meu alicerce e uma grande companheira para todas as horas, e ainda por acreditar no meu potencial.

She may be the song that summer sings, may be the chill that autumn brings, may be a hundred different things within the measure of a day.
The meaning of my life is she
She (Elvis Costello, Charles Aznavour, Herbert Kretzmer)

A Didi, Vô João (*in memorian*) e Vó Ana, exemplos de vida a serem seguidos, mestres da minha vida, que com grande amor conduziram meus passos. Sem vocês nunca teria chegado até aqui.

A Tia Maria (*in memorian*), exemplo de amor e bondade. Com muito prazer e alegria tive a oportunidade de conviver alguns anos contigo! Querida *sogra*, Obrigado!

Marcio José Mendonça

Novas técnicas de desinfecção de moldes em Odontologia – Avaliação da eficácia microbicida e da precisão dimensional de modelos

Tese apresentada à Faculdade de Odontologia de Piracicaba, da Universidade Estadual de Campinas, para obtenção do título de Doutor em Materiais Dentários.

Orientador: Prof. Dr. Mário Alexandre Coelho Sinhoreti

PIRACICABA
2010

AGRADECIMENTO ESPECIAL

Ao Prof. Dr. Mário Alexandre Coelho Sinhoreti,

Agradeço profundamente pela confiança depositada no potencial do nosso jovem colegiado de Odontologia da Unioeste.

Nesses anos de convivência muito agradáveis, tive a oportunidade aprender com o seu modo de agir: extremamente competente sem deixar que a humildade e a tranqüilidade sejam abaladas; um amigo sincero e pronto para ajudar sempre.

Exemplo de mestre, um poço de conhecimento e um mar de serenidade.

Muito Obrigado!

AGRADECIMENTOS

À Universidade Estadual de Campinas e à Faculdade de Odontologia de Piracicaba, em especial ao Programa de Pós-Graduação em Materiais Dentários, pelo desenvolvimento do Dinter Unioeste/UEL/Unicamp.

Aos Professores Lourenço Correr Sobrinho, Mario Fernando de Goes, Simonides Consani e em especial a coordenadora do Dinter Unioeste/UEL/Unicamp Prof[a]. Regina Maria Puppin Rontani, pelos momentos de aprendizado científico e pelas experiências trocadas sobre a função docente do magistério superior.

Aos funcionários do Programa de Pós-Graduação em Materiais Dentários da FOP/UNICAMP.

Aos funcionários da Biblioteca da Faculdade de Odontologia de Piracicaba-UNICAMP.

As funcionárias da secretaria de Pós-Graduação da Faculdade de Odontologia de Piracicaba, em especial a Sra. Érica A. Pinho Sinhoreti, pela presteza que sempre nos atendeu em todos os momentos.

À Coordenação de Aperfeiçoamento de Pessoal de Nível superior (CAPES) e a Fundação Araucária pela contribuição financeira ao desenvolvimento do DINTER.

Aos meus amigos do curso de Doutorado pelas trocas de conhecimentos e pelos vários momentos agradáveis compartilhados.

Aos meus amigos do colegiado de Odontologia da Unioeste, companheiros do dia-a-dia.

A todos aqueles que, embora não estejam aqui citados, direta ou indiretamente, contribuíram para que este trabalho fosse realizado.

meus sinceros agradecimentos.

Não existe um caminho para a felicidade.

A felicidade é o caminho.

Mahatma Gandhi

RESUMO

O objetivo desse trabalho foi avaliar no primeiro capítulo o efeito de agentes microbicida sobre moldes odontológicos contaminados e, no segundo capítulo a precisão dimensional de modelos obtidos a partir de moldes submetidos à desinfecção em glutaraldeído a 2% (Glutaron II®) e em ácido peracético a 0,2% (Sterilife®), utilizando os métodos de desinfecção por imersão e por nebulização ultrassônica. Para a avaliação do efeito microbicida, foram obtidos moldes separados em 5 grupos (n=6), para cada microrganismo testado: *Staphylococcus aureus* e *Bacillus atrophaeus:* A- – Imersão em Glutaron II® por 10 minutos; B - Imersão em Sterilife® por 10 minutos; C – Nebulização ultrassônica por 10 minutos em Glutaron II®; D - Nebulização ultrassônica por 10 minutos em Sterilife e E – Controle, ausência de desinfecção. Os resultados obtidos foram submetidos a análise estatítica ANOVA, seguido do Teste de Tukey, $p < 0,05$. Após a análise dos resultados verificou-se que a técnica de nebulização ultrassônica promoveu redução de 100% dos microrganismos para ambas soluções avaliadas. Da mesma forma, a técnica de imersão em Sterilife® proporcionou redução de 100% dos microrganismos testados, porém, a técnica de imersão em Glutaron II® apresentou resultados inferiores e estatisticamente significantes quando comparada aos demais grupos. No segundo capítulo desse estudo para a avaliação da precisão dimensional dos modelos, foram obtidos 40 amostras separadas aleatoriamente em 5 condições experimentais (n=8): I – Controle, ausência de desinfecção, II – Imersão em Glutaron II® por 10 minutos, III - Imersão em Sterilife® por 10 minutos, IV – nebulização ultrassônica por 10 minutos em Glutaron II® e V - nebulização ultrassônica por 10 minutos em Sterilife®. Os moldes foram vazados em gesso tipo IV, e a mensuração dos modelos foi realizada na altura e no diâmetro, utilizando-se um projetor de perfil acoplado a um sistema de medição digital. Os resultados obtidos foram submetidos a análise estatística ANOVA seguido do Teste de Tukey ($p < 0,05$). Após a análise dos resultados demonstrou que os grupos I, II e III não diferiram estatisticamente entre si, tanto em diâmetro como em altura. O grupo IV apresentou resultados menores e signficativamente diferentes dos demais para o diâmetro. Já para altura, os resultados demonstraram similaridade entre os grupos I, II, III e IV. Para o grupo V, os resultados obtidos diferiram estatisticamente dos demais grupos tanto para altura como para o diâmetro. De acordo com

os resultados obtidos nos dois capítulos do presente estudo foi possível observar que o Sterilife® quando utilizada em imersão, já apresenta efeito microbicida satisfatório, porém, quando utilizada através de nebulização ultrassônica, mostrou-se prejudicial na precisão dimensional dos modelos obtidos. Já para o Glutaron II®, a técnica de imersão demonstrou eficácia microbicida inferior quando comparada as outras combinações testadas, porém, quando utilizado através da nebulização ultrassônica a sua eficácia microbicida foi aumentada sem interferir na precisão dimensional dos modelos.

Palavras-chave: Desinfecção, precisão dimensional, moldes odontológicos

ABSTRACT

The objective of this study was to evaluate the microbicidal agents effect over contaminated dental impression, which is presented in the first chapter, and the precise dimension of casts obtained from impression submitted to disinfection in 2% glutaraldehyde (Glutaron II®) and in 0.2% peracetic acid (Sterilife®), using the disinfection methods of immersion and ultrasonic nebulization, in the second chapter. To evaluate the microbicidal effect, the casts were separated in 5 groups (n=6) to each microorganism tested: *Staphylococcus aureus* and *Bacillus atrophaeus*: A – Immersion in Glutaron II® for 10 minutes; B – Immersion in Sterilife® for 10 minutes; C – Ultrasonic nebulization for 10 minutes in Glutaron II® ; D – Ultrasonic nebulization for 10 minutes in Sterilife® and E – Control, disinfection absence.The results obtained were submitted to ANOVA statistic analysis following the Tukey test, $p < 0,05$. After the result analysis, it was noticed that the ultrasonic nebulization presented reduction of 100% in the microorganisms in both solutions evaluated. The same happened with the immersion technique in Sterilife® that also demonstrated reduction of 100% in the microorganisms tested, but the immersion technique in Glutaron II® presented inferior and statistically significant results when compared to other groups. For dimensional precision evaluation 40 samples were obtained and separated randomly in 5 experimental conditions (n=8): I – Control, absence of disinfection; II – Immersion in Glutaron II®; III – Immersion in Sterilife® for 10 minutes; IV – Ultrasonic nebulization for 10 minutes in Glutaron II® and V – Ultrasonic nebulization for 10 minutes in Sterilife®. The dental impressions were poured with type IV gypsum and their height and diameter were measured by a profile projector joined to a digital measurement system. The results obtained were submitted to ANOVA statistic analysis following the Tukey test, $p < 0,05$. The analysis' results showed that groups I, II and II didn't differ statistically among themselves in both diameter and height. Group IV presented better and significantly different results from the others regarding to diameter. In terms of height, the results are similar among the groups I, II, III and IV. However, group V obtained results statistically different from the others for both height and diameter. For Glutaron II® the immersion technique showed microbicidal effectiveness inferior when compared to other combinations tested, but when used through the ultrasonic nebulization it

demonstrated microbicidal effectiveness superior without interfering on the dimensional precision.

Key-words: Disinfection, dimensional precision, dental impressions

SUMÁRIO

INTRODUÇÃO

Os profissionais de Odontologia estão sujeitos ao contato com grande variedade de microrganismos presentes no sangue e na saliva dos pacientes, assim como nos aerossóis produzidos durante o atendimento. A conscientização do potencial de disseminação de microrganismos nos consultórios odontológicos tem aumentado significativamente e, como resultado, esforços têm sido realizados para eliminar possíveis rotas de transmissão e contaminação cruzada de diversas doenças (Johnson *et al.*, 1998). Os moldes odontológicos são freqüentemente contaminados com saliva, biofilme e sangue (Martin *et al.*, 2007). A manipulação desses moldes contaminados pode contribuir para a disseminação de microrganismos causadores de doenças infecto-contagiosas, como o vírus da imunodeficiência humana (HIV), da hepatite B, dentre outros (ADA, 1996).

Atualmente, uma variedade de produtos químicos é comercializada como agentes adequados para a desinfecção de moldes odontológicos, sendo que uma desinfecção bem sucedida, além de eficaz, deve manter as propriedades físico-químicas dos materiais de impressão (Al-Jabrah *et al.*, 2007; Kotsiomiti *et al.*, 2008) e ainda não interferir negativamente na obtenção dos modelos, considerando que esses modelos em gesso serão a base para a confecção de próteses odontológicas.

Dentre os desinfetantes químicos disponíveis, o glutaraldeído tem sido amplamente utilizado e tem demonstrado efeito bactericida, fungicida e virucida (Russel, 1994), além de apresentar compatibilidade com muitos materiais (Rutala & Weber, 2004). Apesar dessas afirmações, recentes relatos de surtos bacterianos envolvendo micobactérias e bacilos têm levado ao questionamento do potencial bactericida do glutaraldeído (Grande *et al.*, 2002; Vizcaino-Alcaide *et al.*, 2003; Pineau *et al.*, 2008). Além disso, o glutaraldeído libera vapores tóxicos (Giammanco *et al.*, 2009), irritantes e alérgenos, que provocam irritação dos olhos, nariz e garganta, alergia, dermatite de contato, asma e rinite. Além disso, deve ser utilizado em locais bem ventilados e requer o uso de máscaras, luvas e óculos (Cowan *et al.*, 1998; Rutala & Weber, 1999).

Diante disso, o ácido peracético tem sido considerado um instrumento eficaz e uma alternativa segura ao glutaraldeído por instituições como o Food and Drug Administration (FDA), Centers for Disease Control and Prevention (CDC) e da Associação de Profissionais de Infecção Controle e Epidemiologia (APIC) (Cowan *et al.*, 1998; Rutala & Weber, 1999). Reconhecido como um potente agente microbicida, o ácido peracético, na área hospitalar, é utilizado para esterilização de hemodialisadores e desinfecção de alto nível. Segundo a Proposta de Classificação dos Esterilizantes e Líquidos Químicos Desinfetantes, publicada no Federal Register, pelo FDA, o ácido peracético é declarado como um agente não tóxico, não alergênico e considerado irritante leve, indicado para esterilização e desinfecção (Food and Drug Administration, 1998).

Considerando os métodos de desinfecção citados na literatura científica odontológica, além do processo de desinfecção por imersão, que é o mais utilizado, mais recentemente foi apresentado o método de desinfecção por nebulização (Wu *et al.*, 2008). A nebulização é utilizada com propósitos terapêuticos e sanitários, especialmente para fins de tratamentos médicos (Waner & Rao, 1980). Este é caracterizado pela dispersão em ar de uma substância líquida (Waner & Rao, 1980), sendo no caso dos nebulizadores ultrassônicos, o aerossol produzido através da vibração do cristal piezoelétrico, que emite ondas ultra-sônicas. Nesse tipo de nebulização, o aerossol é produzido com partículas muitas pequenas, aproximadamente 1,13 µm após 10 minutos de nebulização ultrassônica (Steckel & Eskandar ., 2003). Isso, proporcionaria penetração mais efetiva da substância desinfetante com a superfície do material de moldagem, potencializando o efeito microbicida das soluções desinfetantes.

Dentre os diversos materiais de moldagem utilizados na clínica odontológica o polivinisiloxano destaca-se por ser o material com maior precisão dimensional (Petrie *et al.*, 2003) e, por se hidrófilo é capaz de copiar regiões úmidas de sulcos gengivais (Takahashi & Finger, 1991). Além desses fatores, o polivinisiloxano apresenta resistência à ruptura e tempo de trabalho moderados, rápida recuperação elástica, ausência cheiro ou sabor, podendo ser vazado até 72 horas após a obtenção do molde (Petrie *et al.*, 2003) e também pela facilidade de manuseio devido aos dispensadores automáticos (Lepe & Johnson, 1997; Chen *et al.*, 2004).

Considerando os problemas relacionados ao desinfetante glutaraldeído, a recente introdução do uso do ácido peracético e da técnica nebulização ultrassônica em Odontologia e, além disso, a importância de que métodos de desinfecção sejam eficientes contra microrganismos e também não interfiram na precisão dimensional dos modelos obtidos, o objetivo neste trabalho foi avaliar a utilização do ácido peracético a 0,2% na técnica de desinfecção por nebulização ultrassônica sobre moldes odontológicos em polivinilsioloxano, quando comparada a técnica de desinfecção por imersão e a solução de glutaraldeído a 2%. A presente Tese é composta por dois artigos, contemplados nos capítulos 1 e 2, cujos objetivos foram, respectivamente:

1) Determinar a eficácia microbicida do ácido peracético e do glutaraldeído utilizados nas técnicas de nebulização ultrassônica e de imersão, sobre moldes em polivinilsiloxano contaminados.

2) Avaliar a precisão dimensional de modelos obtidos a partir de moldes em polivinilsiloxano submetidos às técnicas de nebulização ultrassônica e de imersão, com soluções de ácido peracético e glutaraldeído.

CAPÍTULO I:

Microbiological evaluation of the ultrasonic nebulization effect with peracetic acid and glutaraldehyde on disinfection methods of dental impressions

ABSTRACT

The disinfection of dental impressions is a mandatory step in order to decrease the risk of cross contamination in dental offices. Recently, ultrasonic nebulization was indicated as an efficient microbicidal technique for disinfecting contaminated dental impressions, however, there is still a need to evaluate different chemical disinfectant applied in ultrasonic nebulization. Thus, the objective of this study was to make a comparative evaluation of the microbicidal effect of 2% glutaraldehyde and 0.2% peracetic acid, using the methods of disinfection by immersion and ultrasonic nebulization of dental impressions made with vinyl polysiloxane. Bactericial efficacy was examined using *Staphylococcus aureus* and *Bacillus atrophaeus* as indicators. For this purpose, impressions were obtained and distributed randomly in 5 groups, n=6 for each microorganism: A – 2% glutaraldehyde immersion for 10 minutes; B – 0.2% peracetic acid immersion for 10 minutes; C – ultrasonic nebulization for 10 minutes in 2% glutaraldehyde solution; D – ultrasonic nebulization for 10 minutes in 0.2% peracetic acid solution and E - control, without any disinfectant treatment. The results obtained demonstrated that the ultrasonic nebulization technique presented 100% reduction in the microorganisms for the two solutions tested. Similarly, the technique of immersion in peracetic acid demonstrated 100% reduction in the microorganisms tested, however, the technique of immersion in glutaraldehyde presented lower values, with statistically significant differences when compared with the other groups. The findings indicated that for the disinfection of dental impressions made with vinyl polysiloxane, the ultrasonic nebulization technique was superior to the immersion technique.

Keywords: Ultrasonic nebulization, disinfection, dental impression, peracetic acid.

INTRODUCTION

Dental professionals are subject to contact with a large variety of microorganisms that are present in patients' blood and saliva, as well as in the aerosols produced during treatment. Many of these microorganisms may cause infectious diseases, such as hepatitis B, tuberculosis, herpes, pneumonia and the Acquired Immunodeficiency Syndrome (AIDS).[1-3] As clinical procedures are performed using complex equipment and instruments, these infectious diseases may potentially be transmitted from the patient's oral cavity to the professional and environment, leading to the risk of cross infection.[4] Thus, the dental team must follow the universal infection control recommendations, as all patients must be treated as potential carriers of pathogenic microorganisms.[3]

The use of procedures and precautions in the dental office and in dental laboratories has prevented the risk of cross contamination. These procedures constitute personal protection and the elimination of pathogenic microorganisms present in dental materials, such as for example, impression materials and stone casts sent to prosthesis laboratories.[5] The impressions are considered contaminated, because during the impression technique, the material comes into contact with sources of contamination (saliva and blood), and on being removed, carry with them a large number of microorganisms from the oral flora.[6,7] Therefore, impressions and prosthodontics are the main potential transmission via between patients and the dental team.[8] Retention of these oral microorganisms on impression surfaces is expected, and could persist during the following periods, causing them to be transferred to the stone casts, and consequently, placing at risk all those who handle them.[5,9-11] Thus, decontamination of the impressions is an essential stage in cross infection control.[9] Therefore, effective infection control measures must be mandatory in dental offices and dental prosthesis laboratories, in order to reduce potential cross infection.[8]

Impressions must initially be rinsed to remove saliva, blood and debris, nevertheless, a significant number of pathogenic microorganisms still remain adhered to these impression surfaces.[1,6,11] For this reason, in addition to washing them under running water, the ADA recommends the use of a disinfectant solutions for impression.[1] Among the available chemical disinfectants, glutaraldehyde has been widely used, and has

demonstrated a bactericidal, fungicidal and virucidal effect, in addition to being compatible with many materials.[12,13]

Nevertheless, glutaraldehyde releases toxic vapors, irritants and allergens that cause irritation to the eyes, nose and throat, allergy, contact dermatitis, asthma and rhinitis.[14] Moreover, it must be used in well ventilated places and requires the use of masks, gloves and goggles.[15,16] Furthermore, recent reports of outbreaks of bacteria involving mycobacteria and bacillus have led to the bactericidal potential of glutaraldehyde being questioned.[17-19]

In view of this, peracetic acid has been considered an efficacious instrument and safe alternative to glutaraldehyde by institutions such as the Food and Drug Administration (FDA), Centers for Disease Control and Prevention (CDC) and the Association for Professionals in Infection Control and Epidemiology (APIC).[4] Recognized as a powerful microbicidal agent, peracetic acid is used in the hospital area for sterilization of hemodialyzers and high level disinfection. According to the Proposal for Classification of Sterilants and Disinfectant Chemical Liquids, published in the Federal Register, by the FDA, peracetic acid is declared to be a non toxic, non allergenic agent, considered a mild irritant, indicated for high level sterilization and disinfection. [20]

Among the disinfection methods mentioned in the dental scientific literature, in addition to the process of disinfection by immersion, the method of disinfection by nebulization has more recently been mentioned.[21] This method is used for therapeutic and sanitary purposes, especially for purposes of medical treatments.[22] It is characterized by dispersion of a liquid substance into the air[22], and in the case of ultrasonic nebulizers, the aerosol is produced by vibration of the piezoelectric crystal that emits ultrasonic waves. In this type of nebulization, the aerosol is produced with very small particles, measuring approximately 1.13 µm after 10 minutes of ultrasonic nebulization[23], which provides more effective penetration of the disinfectant substance into the surface of the impression material, potentiating the microbicidal effect of disinfectant solutions.

In view of the above explanation, the objective of this study was to make a comparative analysis of the microbicidal effect of 2% glutaraldehyde and 0.2% peracetic

acid, using the methods of disinfection by immersion and ultrasonic nebulization of dental impressions made of vinyl polysiloxane.

METHODOLOGY

Vinyl polysiloxane (Aquasil Easy Mix Putty and Aquasil Ultra LV, Dentsply, Milford, DE, USA), was used and manipulated in accordance with the manufacturers' instructions. *Staphylococcus* spp and *Bacillus* spp are normally used as test microorganisms for low and high level hospital disinfectants, respectively. In order to make a comparative evaluation of the bactericidal efficacy of the ultrasonic nebulization method with the immersion method of two disinfectants: 0.2% peracetic acid (Sterilife, Lifemed, Rio Grande do Sul, Brazil) and 2% glutaraldehyde (Glutaron II, Rioquímica, São Paulo, Brazil), the microorganisms *Staphylococcus aureus* (ATCC 6538, Cefar Diagnóstica, São Paulo, Brazil) and *Bacillus atrophaeus* (ATCC 9372, Cefar Diagnóstica, São Paulo, Brazil) were used. The disinfection process by means of ultrasonic nebulization was performed using an ultrasonic nebulizer (Pulmonosic Star II, Soniclear**,** São Paulo, Brazil*)*, set at an ultrasonic frequency of 2.4 MHz, nebulization rate of 1.25 cc/min, and the disinfectant solution mist was guided into an airtight and transparent plastic box sterilized by ethylene oxide (20 x 20 x 25 cm). The samples in the box were disinfected by means of ultrasonic nebulization and kept for 10 min until the fog in the box reached saturation. [21]

The dental impressions made of vinyl polysiloxane were obtained using a sterilized stainless steel pattern model, and its fabrication was based on other studies.[2,5,10,24,25] After obtaining the impressions by means of the 1 step impression technique, they were artificially contaminated for 60 minutes with 10 µL of *S. aureus* or 10 µL of *B. atrophaeus*, by means of a saline solution with turbidity corresponding to a bacterial concentration of 0.5 on the Mc Farland scale (1.5 x 10^8 cfu/mL). After contamination, the impression obtained were washed in a saline solution sterilized for 10 second with the object of simulating the clinical condition of rinsing the impressions.[9,14,25] After this, the impressions were randomly distributed into 5 groups (n=6), for each microorganism: A – immersion in 2% glutaraldehyde for 10 minutes; B – immersion in

0.2% peracetic acid for 10 minutes; C – ultrasonic nebulization for 10 minutes in 2% glutaraldehyde-solution; D – ultrasonic nebulization for 10 minutes in 0.2% peracetic acid solution and E - control, without any disinfectant treatment to evaluate the amount of microorganisms carried by the impressions. After the procedures of the respective experimental groups, the impressions were immersed in 90 mL of a sterilized saline solution. To recover the microorganisms, this solution containing the impressions was mechanically agitated (Q220, Quimis, São Paulo, Brazil) for 120 seconds, and then 20 µL of this solution was innoculated in Petri plates containing Mueller Hinton Agar (Oxoid, Basingstoke, Hampshire, England) with the aid of a disposable calibrated loop (Cral, São Paulo, Brazil). After the period of 48h of incubation at 37°C, the estimated number of colony-forming units per milliliter (cfu/mL) in the plates presenting bacterial growth was analyzed.

The percentage of removal rate for each species of microorganism tested was calculated by using the formula: removal rate (%) = 100 x (treated/control). The bactericidal efficacy was expressed by the logarithmic reduction factor (RF), calculated by means of the equation: $\log_{10}$ reduction = $\log_{10}$ (cfu/mL) of the control group - $\log_{10}$ (cfu/mL) of the disinfection group.

Analysis of variance (ANOVA) was used to compare the removal rates of each test specimen between the treatments by using the software Bioestat 5.0. A value of $p < .05$ was considered significant. Post-hoc comparison was made using the Tukey Test.

RESULTS

For the microorganism *S. aureus*, all the evaluated groups demonstrated removal rate of 100% and RF of 6.79, considering that the initial bacterial concentration was 6.11×10^6. The statistic analysis of the obtained results in the evaluation of this microorganism didn't present statistically different data for the experimental groups evaluated, as presented in Table I.

Table I – Effectiveness of disinfectants agents for removing *S. aureus*

Groups	*S. aureus*		
	Post treatment (ufc/mL) §	**Removal rate (%)**	**RF**
Immersion in Glutaraldehyde	0.00 (± 0.00)	100.00	6.79
Immersion in Peracetic Acid	0.00 (± 0.00)	100.00	6.79
Nebulization with Glutaraldehyde	0.00 (± 0.00)	100.00	6.79
Nebulization with Peracetic Acid	0.00 (± 0.00)	100.00	6.79
Control	6.11×10^6 ($\pm 2.92 \times 10^6$)	-	-

§ Mean final counts, after treatment with disinfectants agents

The analysis of the obtained results during the experimental group analysis for the *B. atrophaeus* demonstrated that the experimental groups of immersion in peracetic acid and ultrasonic nebulization with peracetic acid and glutaraldehyde presented removal rate of 100% and RF of 6.40. On the other hand the group in glutaraldehyde immersion presented removal rate of 89.13% and RF of 0.97 and was significantly different from the other experimental groups (Table II).

Table II – Effectiveness of disinfectants agents for removing *B. atrophaeus*

Groups	*B. atrophaeus*		
	Post treatment (ufc/mL) §	**Removal rate (%)**	**RF**
Immersion in Glutaraldehyde	2.75×10^5 ($\pm 7.78 \times 10^4$)	89.13*	0.97
Immersion in Peracetic Acid	0.00 (± 0.00)	100.00	6.40
Nebulization with Glutaraldehyde	0.00 (± 0.00)	100.00	6.40
Nebulization with Peracetic Acid	0.00 (± 0.00)	100.00	6.40
Control	2.53×10^6 ($\pm 4.49 \times 10^5$)	-	-

§ Mean final counts, after treatment with disinfectants agents
* $p < 0.05$ = statistically significant differences

DISCUSSION

A variety of chemical products are sold as agents suitable for disinfecting dental impressions.[8] In spite of being recommended previously, the efficacy of glutaraldehyde against some microorganisms has been questioned, as in the study of Grande *et al.*[18] in which, after procedures of bronchoscope disinfection with 2% glutaraldehyde for 20 minutes, the growth of some microorganisms were found, therefore, the disinfection process was considered insufficient. In the study of Pineau *et al.*[19] the

authors verified that the 2% glutaraldehyde solution promoted superior accumulation and fixation of proteins during the reprocessing of endoscopes, when compared with the 0.15% peracetic acid solution. Therefore, the use of glutaraldehyde for the disinfection of reusable medical devices has been abandoned in favor of a solution that does not promote this fixation.

Peracetic acid acts rapidly and efficaciously against bacteria, fungi and viruses. Contrary to the majority of chemical disinfectant products, including glutaraldehyde, it is not inactivated in the presence of organic matter.[16] Moreover, peracetic acid does not leave residues and produces no noxious byproducts, it is a material that is safe for the patient, operator and environment, and the end products are water, oxygen and carbon dioxide.[13,17] Peracetic acid acts by oxidation and is effective against all the microorganisms, even in low concentrations.[4,11]

According to Chassot *et al.*[4] peracetic acid should replace glutaraldehyde, and also be widely used for various items in dentistry, contributing to controlling and minimizing the risk of cross contaminations. Ceretta *et al.*[11] also demonstrated the efficacy of peracetic acid, which promoted complete sterilization of dental instruments at a concentration of 2 500ppm, requiring a time of 20 minutes.

In addition to the comparative evaluation of the disinfectant solutions of glutaraldehyde and peracetic acid by immersion, in this study a new disinfection method by means of ultrasonic nebulization was also evaluated, which was first mentioned for Dentistry clinical by Wu *et al.*[21] in a study that evaluated the action of electrolyzed oxidizing water on dental impressions made of alginate. Ultrasonic nebulization occurs due to a piezoelectric device that generates ultrasonic vibration of the disinfectant solution, breaking it up into very small particles[23], facilitating their penetration into the target to be disinfected. Since this nebulization occurs inside a closed receptacle, the dental impression remains in an environment saturated with 100% disinfectant solution vapor. This favors the impression material integrity, as the chance of direct contact with the solution is diminished when compared with the immersion method.[21]

The results of the comparative evaluation of the two disinfectant solutions demonstrated that for the microorganism *S. aureus* both solutions presented a reduction rate

of 100%, both in the immersion and nebulization methods. *S. aureus* is a Gram positive bacteria and is frequently included in infection control studies because of its important pathogenicity and its resistance to drying, heat and some groups of disinfectant agents.[26,27] Furthermore, this microorganism is a causative pathogen of respiratory infections, and is frequently isolated from complete dentures and the oral cavity.[28,29]

The results found for the *S. aureus* of 100% removal rate for glutaraldehyde and peracetic acid solutions were expected due to the microbicide effectiveness in these solutions. The peracetic acid is considered a strong disinfectant, with a large incidence of antimicrobial activity.[30] The glutaraldehyde is a powerful microbicide agent, although not all the microorganisms present the same susceptibility to this solution.[31]

For the *B. atrophaeus*, the nebulization method presented a reduction rate of 100% for the two tested solutions. Whereas, in the immersion method, the peracetic acid presented a reduction rate of 100% and the glutaraldehyde solution showed a reduction rate of 89.13 %. *B. atrophaeus* is commonly used as a biologic market to monitor sterilization processes, for evaluating disinfection procedures, and microbiologic barriers.[21,32-34] Furthermore, previous studies have presented that *B atrophaeus* has shown greater resistance to glutaraldehyde when compared with other species[35], besides the glutaraldehyde microbicide capacity is dependent of the complex relation among the concentration, temperature and pH of the disinfectant solution.[31]

That way, the differences found for the ultrasonic nebulization and immersion methods may be explained by the fact that disinfection involves a combination of physical and chemical processes.[36] In the studies developed by Steckel *et al.*[2] the authors verified that during the process of ultrasonic nebulization there were changes on the droplet size, surface tension, viscosity and saturated vapor pressure that can be result of temperature change and solution concentration in the nebulizer reservatory. If it is to be considered in this study, this could explain the superior bactericide effect of the glutaraldehyde solution in the ultrasonic nebulization method over *B. atrophaeus* when compared to the immersion. Possibly the ultrasonic nebulization of glutaraldehyde solution resulted on the concentration increase of this solution, besides that, due to the possible increase of saturated vapor pressure there was a more effective contact of the disinfectant solution over the impression,

contributing to the superiority of the microbicide effect presented on the glutaraldehyde solution nebulized ultrasonically.

Though the positive results obtained in this study for the ultrasonic nebulization method, it is suggested that other studies be developed in order to evaluate this method regarding to the fidelity of the casts, besides the evalutation of other disinfectant substances and other impression materials. In summary, the results of this study demonstrated that the ultrasonic nebulization is an effective microbicide method for impressions in polyvinylsiloxane, for both the 2% glutaraldehyde solution and 0.2% peracetic acid, and the immersion method is also effective when used in 2% glutaraldehyde solution.

ACKNOWLEDGEMENTS

The authors thank the Fundação Araucária – PR, CCBS/Unioeste and CAPES for financing the research.

REFERENCES

1. ADA Council on Scientific Affairs and ADA Council on Dental Practice. Infection control recommendations for the dental office and the dental laboratory. J Am Dent Assoc. 1996; **127**:672-680.
2. Johnson GH, Chellis KD, Gordon GE, Lepe X. Dimensional stability and detail reproduction of irreversible hydrocolloid and elastomeric impressions disinfected by immersion. J Prosthet Dent. 1998;**79**:446-453.
3. Gordon BL, Burke FJ, Bagg J, Marlborough HS, McHugh ES. Systematic review of adherence to infection control guidelines in dentistry. J Dent. 2001;**29**:509-516.
4. Chassot AL, Poisl MI, Samuel SM. In vivo and in vitro evaluation of the efficacy of a peracetic acid-based disinfectant for decontamination of acrylic resins. Braz Dent J. 2006;**17**:117-121. doi:10.1590/S0103-64402006000200006.
5. Chen SY, Liang WM, Chen FN. Factors affecting the accuracy of elastometric impression materials. J Dent. 2004;**32**:603-609. doi:10.1016/j.jdent.2004.04.002.

6. Turhan Bal B, Yilmaz H, Aydin C, Al FD, Sultan N. Efficacy of various disinfecting agents on the reduction of bacteria from the surface of silicone and polyether impression materials. Eur J Prosthodont Restor Dent. 2007;**15**:177-182.
7. Melilli D, Rallo A, Cassaro A, Pizzo G. The effect of immersion disinfection procedures on dimensional stability of two elastomeric impression materials. J Oral Sci. 2008;**50**:441-446.
8. Al-Jabrah O, Al-Shumailan Y, Al-Rashdan M. Antimicrobial effect of 4 disinfectants on alginate, polyether, and polyvinyl siloxane impression materials. Int J Prosthodont. 2007;**20**:299-307.
9. Taylor RL, Wright PS, Maryan C. Disinfection procedures: their effect on the dimensional accuracy and surface quality of irreversible hydrocolloid impression materials and gypsum casts. Dent Mater. 2002;**18**:103-110. doi:10.1016/S0109-5641(01)00027-6.
10. Lepe X, Johnson GH. Accuracy of polyether and addition silicone after long-term immersion disinfection. J Prosthet Dent. 1997;**78**:245-249.
11. Ceretta R, Paula MM, Angioletto E, *et al*. Evaluation of the effectiveness of peracetic acid in the sterilization of dental equipment. Indian J Med Microbiol. 2008;**26**:117-122. doi:10.4103/0255-0857.40523.
12. Russell AD. Glutaraldehyde: current status and uses. Infect Control Hosp Epidemiol. 1994;**15**:724-733.
13. Rutala WA, Weber DJ. Disinfection and sterilization in health care facilities: what clinicians need to know. Clin Infect Dis. 2004;**39**:702-709. doi:10.1086/423182.
14. Giammanco GM, Melilli D, Rallo A, Pecorella S, Mammina C, Pizzo G. Resistance to disinfection of a polymicrobial association contaminating the surface of elastomeric dental impressions. New Microbiol. 2009;**32**:167-172.
15. Cowan RD, Ayliffe GAJ, Badd JR, *et al.* Cleaning and disinfection of equipment for gastrointestinal endoscopy. Report of a Working Party of the British Society of Gastroenterology Endoscopy Committee. Gut. 1998;**42**:585-593.
16. Rutala WA, Weber DJ. Infection control: the role of disinfection and sterilization. J Hosp Infect. 1999;**43:**S43-S55. doi:10.1016/S0195-6701(99)90065-8.

17. Vizcaino-Alcaide MJ, Herruzo-Cabrera R, Fernandez-Aceñero MJ. Comparison of the disinfectant efficacy of Perasafe and 2% glutaraldehyde in in vitro tests. J Hosp Infect. 2003;**53**:124-128. doi:10.1053/jhin.2002.1296.
18. Grande NS, Nakayama RA, Machado AMO, et al. Evaluation of the risk of bacterial contamination in the patient submitted to bronchoscopy, after reprocessing the bronchoscope. J Pneumol. 2002;**28**:250-260. doi:10.1590/S0102-35862002000500003.
19. Pineau L, Desbuquois C, Marchetti B, Luu Duc D. Comparison of the fixative properties of five disinfectant solutions. J Hosp Infect. 2008;**68**:171-177. doi:10.1016/j.jhin.2007.10.021.
20. Food and Drug Administration. General hospital and personal use devices: proposed classification of liquid chemical sterilants and general purpose disinfectants-FDA. Proposed rule. Fed Regist. 1998;**63**:59917-59921.
21. Wu G, Yu X, Gu Z. Ultrasonically nebulised electrolysed oxidising water: a promising new infection control programme for impressions, metals and gypsum casts used in dental hospitals. J Hosp Infect. 2008;**68**:348-354. doi:10.1016/j.jhin.2008.01.024.
22. Wanner A, Rao A. Clinical indications for and effects of bland, mucolytic, and antimicrobial aerosols. Am Rev Respir Dis. 1980;**122**:79-87.
23. Steckel H, Eskandar F. Factors affecting aerosol performance during nebulization with jet and ultrasonic nebulizers. Eur J Pharm Sci. 2003;**19**:443-455. doi:10.1016/S0928-0987(03)00148-9.
24. Nissan J, Gross M, Shifman A, Assif D. Effect of wash bulk on the accuracy of polyvinyl siloxane putty-wash impressions. J Oral Rehabil. 2002;**29**:357-361.
25. Wadhwani CP, Johnson GH, Lepe X, Raigrodski AJ. Accuracy of newly formulated fast-setting elastomeric impression materials. J Prosthet Dent. 2005;**93**:530-539. doi: 10.1016/j.prosdent.2005.03.007.
26. Bell JA, Brockmann SL, Feil P, Sackuvich DA. The effectiveness of two disinfectants on denture base acrylic resin with an organic load. J Prosthet Dent. 1989;**61**:580-583.

27. Chau VB, Saunders TR, Pimsler M, Elfring DR. In-depth disinfection of acrylic resins. J Prosthet Dent. 1995;**74**:309-313.
28. Wilkieson C, Samaranayake LP, MacFarlane TW, Lamey PJ, MacKenzie D. Oral candidosis in the elderly in long term hospital care. J Oral Pathol Med. 1991;**20**:13-16.
29. Marsh PD, Percival RS, Challacombe SJ. The influence of denture-wearing and age on the oral microflora. J Dent Res. 1992;**71**:1374-1381. doi:10.1177/00220345920710070501.
30. Kitis M. Disinfection of wastewater with peracetic acid: a review. Environ Int. 2004;**30**:47-55.
31. Russell AD. Bacterial spores and chemical sporicidal agents. Clin Microbiol Rev. 1990;**3**:99-119.
32. Baird RM. Sterility assurance: concepts, methods and problems. In: Russell AD, Hugo WB, Ayliffe GA, editors. Principles and practice of disinfection, preservation, and sterilization. Oxford: Blackwell Science; **1999**. p. 787-799.
33. Weber DJ, Sickbert-Bennett E, Gergen MF, Rutala WA. Efficacy of selected hand hygiene agents used to remove *Bacillus atrophaeus* (a surrogate of *Bacillus anthracis*) from contaminated hands. JAMA. 2003;**289**:1274-127. doi:10.1001/jama.289.10.1274.
34. Moldenhauer JE, Bass SA, Kupinski MJ, Walters ML, Rubio SL. Microbial barrier assessment of Tyvek stopper packaging for rubber closures. PDA J Pharm Sci Technol. 1996;**50**:391-398.
35. Boucher RM. Potentiated acid 1,5 pentanedial solution--a new chemical sterilizing and disinfecting agent. Am J Hosp Pharm. 1974;**31**:546-557.
36. Abdelaziz AA, el-Nakeeb MA. Sporicidal activity of local anaesthetics and their binary combinations with preservatives. J Clin Pharm Ther. 1988;**13**:249-256.

CAPÍTULO II:

Effect of ultrasonic nebulization with peracetic acid and glutaraldehyde on accuracy of vinyl polysiloxane impressions

ABSTRACT

The aim of this study was to evaluate the effect of different disinfection techniques on the accuracy of dental impressions made of vinyl polysiloxane. For this purpose, 40 test specimens made of vinyl polysiloxane were obtained using a pattern cylinder and they were randomly divided into 5 experimental conditions: I – Control, impressions without any disinfection, II – Immersion in Glutaron II® for 10 minutes, III - Immersion in Sterilife® for 10 minutes, IV – ultrasonic nebulization for 10 minutes in Glutaron II® and V - ultrasonic nebulization for 10 minutes in Sterilife®. The impressions obtained were poured in type IV gypsum and both the height and diameter of the stone casts were measured. For this purpose a profile projector joined to a digital measurement system was used. Statistical analysis of the results obtained demonstrated that groups I, II and III did not differ statistically among themselves, both in diameter and height. Group IV presented statistically different results from the others for diameter. Whereas for height, the results were shown to be similar among groups I, II, III and IV. For Group V, the results obtained were statistically different for both height and diameter from those of the other groups. According to the results, it was possible to conclude that Sterilife® negatively affected the accuracy when used with ultrasonic nebulization. Whereas the other combinations of technique and disinfection agent had no influence on the accuracy of the stone casts.

Keywords: Dental impression, disinfection, accuracy.

INTRODUCTION

There has been increasing awareness of the potential dissemination of microorganisms in dental offices, and as a result, efforts have been made to eliminate the possible vias of transmission and cross contamination of several diseases.[1] Intraoral impressions are frequently contaminated with saliva, biofilm and blood.[2] Manipulation of these contaminated impressions may contribute to the dissemination of causative microorganisms of infectious and contagious diseases, such as the human immunodeficiency virus (HIV) Hepatitis B virus, among others.[3]

At present, there is a variety of chemical products sold as agents suitable for disinfecting dental impressions, and in addition to being efficacious, a successful disinfection must maintain the physico-chemical properties of the impression materials[4,5] and also not interfere negatively in the obtainment of stone casts, since these are made of gypsum and will be the basis for making the dental prostheses.

Among the chemical disinfectants available, glutaraldehyde has been widely used, and has demonstrated a bactericidal and fungicidal effect and virucidal action,[6] in addition to presenting compatibility with many impression materials.[7] Nevertheless, glutaraldehyde releases toxic vapors,[8] irritants and allergens that cause irritation to the eyes, nose and throat, allergy, contact dermatitis, asthma and rhinitis.[9,10]

Peracetic acid has been considered an efficacious instrument and a safe alternative to glutaraldehyde.[9,10] Recognized as a powerful microbicidal agent, peracetic acid is used in the hospital area for sterilizing hemodialyzers and high level disinfection. According to the Proposal for Classification of Sterilants and Disinfectant Chemical Liquids, published in the Federal Register, by the FDA, peracetic acid is declared to be a non toxic, non allergenic agent, considered a mild irritant, indicated for high level hospital sterilization and disinfection.[7,11] However, the use of peracetic acid on dental impressions is still hardly mentioned in the scientific literature.

During the impression disinfection process, in addition to the impression material and chemical agents, another factor to consider is the disinfection technique, as these three factors are interdependent for obtaining stone casts that are faithful and free of

contamination. In this context, immersion has been widely used; however, present studies have introduced the method of disinfection by ultrasonic nebulization in Dentistry.[12] The classical nebulization process has been used for medical treatment purposes.[13] Nebulization is characterized by dispersion into the air of a liquid substance[13], and in the case of ultrasonic nebulizers, the aerosol is produced by means of vibration of a piezoelectric crystal that emits ultrasonic waves. Furthermore, this method has the advantage of requiring a small quantity of solution, around 10 mL for each disinfection cycle. When used for disinfection, the interaction of the effect of ultrasonic nebulization and the chemical agent may potentiate its action, as was shown in the study of Mendonça et al.[18] in which the process of ultrasonic nebulization of 2% glutaraldehyde solution showed higher microbicidal efficacy than the method of immersion in the same chemical agent.

Considering the higher microbicidal efficacy of the ultrasonic nebulization method over the process of immersion of dental impressions using different chemical agents, and the scarcity of studies that evaluate the effect of this method on the dimensional precision of dental impressions, it was judged necessary to make a comparative evaluation of the effect of these methods with different chemical agents on the accuracy of impressions made with vinyl polysiloxane.

METHODOLOGY

The materials used are shown in Table 1.

Table 1 – Materials used, Manufacturer and Lot

Material	Commercial Brand – Manufacturer	Lot
Vinyl polysiloxane	Aquasil Easy Mix Putty, Dentsply Caulk, Milford, USA.	08080
	Aquasil Ultra LV, Dentsply Ind. e Com. Ltda, Petrópolis, RJ, Brazil.	070510
0.2% Peracetic Acid	Sterilife®, Lifemed Ind. Equip. Art. Med. Hosp. S.A., Pelotas, RS, Brazil.	0123008230
2% Glutaraldehyde	Glutaron II®, Ind. Farm. Rioquímica Ltda., São José do Rio Preto, SP, Brazil.	0811271
Type IV Gypsum	Durone IV, Dentsply Ind. e Com. Ltda, Petrópolis, RJ, Brazil.	970481

The accuracy of impressions submitted to different disinfection techniques was evaluated by means of stone casts obtained from a stainless steel pattern model, their fabrication being based on other studies.[1,14,15,19,20] This pattern model presented a cylindrical format prepared with a diameter of 9 mm, height of 10 mm and joined to it there was a mobile device that ran along a vertical bar, allowing the cylinder to meet with a tray containing the impression material in a standardized thickness. The trays were prepared with 20mm of height and 20 mm of internal diameter. This mobile device allowed standardization of pressure used during the act of taking the impression (Figure 1).

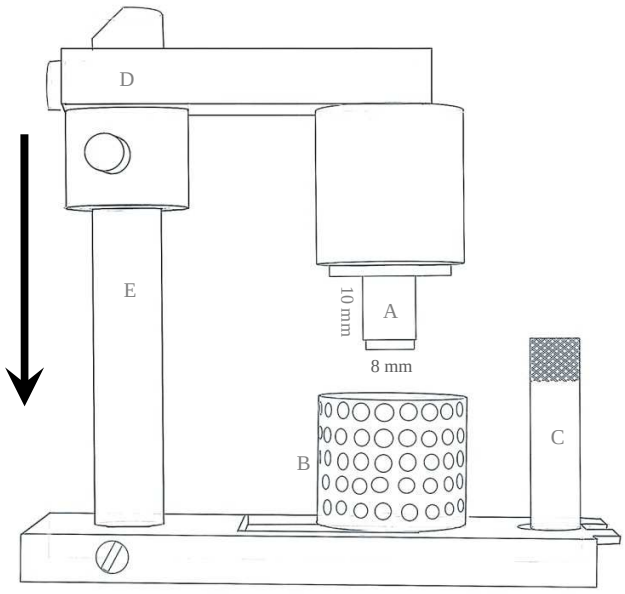


Figure 1: Diagram illustrating the stainless steel pattern apparatus used for the impression. A- Pattern model, B – Impression tray, C – pin for fixing tray, D – mobile device, E – Fixed vertical bar.

In addition to the technique for disinfection by immersion for 10 minutes, the technique for disinfection by ultrasonic nebulization was also evaluated. This technique was performed using an ultrasonic nebulizer (Pulmonosic Star II, Soniclear), set at an ultrasonic frequency of 2.4 MHz, nebulization rate of 1.25 cc/min, and the disinfectant solution mist was guided into a transparent plastic box (20 x 20 x 25 cm). The samples in the box were disinfected by means of ultrasonic nebulization and kept for 10 min until the fog in the box reached saturation.[16] The solutions used were Sterilife® (0.2% peracetic acid) and Glutaron II® (2% glutaraldehyde).

The impressions were obtained with Aquasil® vinyl polysiloxane by means of the 1 step impression technique, made with the putty and light-body materials simultaneously, and the impressions were allowed to polymerize on the stainless steel pattern model for 12 minutes[21] and remained in a controlled environmental condition at 23±1ºC. The putty consistency VPS material was proportioned and manipulated based on the manufacturer's instructions, and for the light-bodied material, the automatic dispenser

was used. The 40 impressions obtained were washed under running water for 10 seconds and then randomly submitted to one of the 5 experimental conditions (n=8), according to Table 2. When the disinfection period had elapsed, the impressions were again washed under filtered running water for 10 second and dried with air jets. After the period of 1 hour, in order to favor the release of hydrogen, the impression were filled with improved type IV gypsum to obtain the stone casts. The gypsum was manipulated in accordance with the manufacturer's instructions. To spatulate the gypsum, a mechanical vacuum spatulator (A 300, Polidental) was used for 60 seconds. The gypsum was poured into the impression under vibration, in small quantities, until it was completely filled. After the gypsum had set (1 hour), the stone cast was separated from the impression, identified, and remained in a controlled environmental condition at 23±1ºC, relative humidity between 40 and 60%, for the time interval of 24±1 hour. After this period, the measurements of the stone casts were taken.

Table 2 – Groups experimentals

	Experimentals Groups
I	Control
II	Immersion in Glutaraldehyde for 10 minutes
III	Immersion in Peracetic Acid for 10 minutes
IV	Nebulization with Glutaraldehyde for 10 minutes
V	Nebulization with Peracetic Acid for 10 minutes

The stone casts were measured in a profile projector (VB300/P, Starret) coupled to a digital measurement system (Quadra Check 200®, Metronics), with a readout capacity of 0.001 mm, taking the measurements of the height (h) and diameter (d) of each test specimen (Figure 2), with the measurements of all the samples being taken by the same, previously trained examiner. Each stone cast was measured six times and an arithmetic mean was obtained for each of the sample. The examiner had no knowledge of the treatment performed in each sample. That way, the evaluation of the test specimen dimensional precision in percentage was verified by the difference between the stone cast dimension and the stainless steel pattern divided by the dimension of the stainless steel pattern.

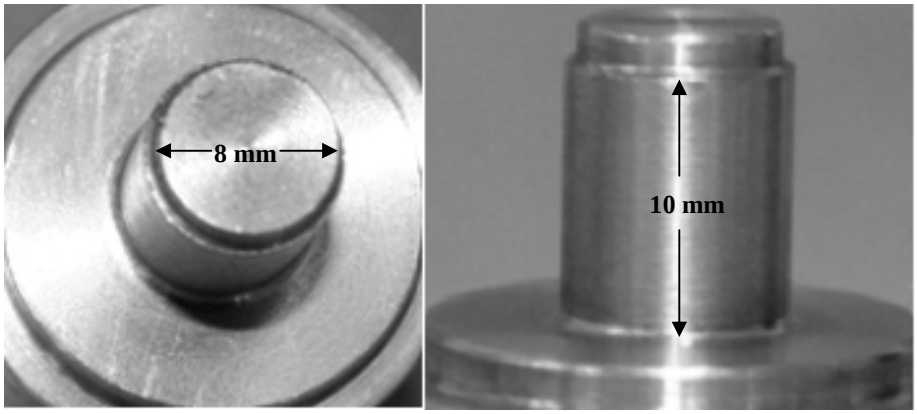


Figure 2: Stainless steel pattern model used for obtaining the test specimens

The mean results of dimensional alteration of each test specimen according to its experimental group were statistically analyzed using the Bioestat 5.0 *software,* by means of the analysis of variance ANOVA and the Tukey *pos hoc* Test, at a level of confidence of 95 % ($p < 0.05$).

RESULTS

The mean dimensional alteration values obtained from the readout of the test specimen diameters are show in Table 3. Statistical analysis showed that Groups I, II and III had the highest mean percentages of dimensional alteration and did not differ among them. Group IV showed intermediate mean and differed statistically from the others. The group V differed statistically from the other groups and presented the lowest mean dimensional alteration .

Table 3 - Mean values and standard deviation of dimensional alteration (%) for the test specimen diameters.

Group	***Mean***	***SD***
Control	-1.63	(±0.48)a
Immersion in Glutaraldehyde	-1.61	(±0.41)a
Immersion in Peracetic Acid	-1.59	(±0.58)a
Nebulization with Glutaraldehyde	-0.89	(±0.29)b
Nebulization with Peracetic Acid	-0.27	(±0.08)c

Different letters signify groups with statistically different values

Mean dimensional alteration values verified from readout of test specimen heights were are show in table 4. Statistical analysis of these results demonstrated that Groups I, II, III and IV did not differ among them, while Group V showed the highest mean dimensional alteration.

Table 4 - Mean values and standard deviation of dimensional alteration (%) for the test specimen heights.

Group	**Mean**	**SD**
Control	-1.39	(±0.33)a
Immersion in Glutaraldehyde	-1.47	(±0.24)a
Immersion in Peracetic Acid	-1.48	(±0.29)a
Nebulization with Glutaraldehyde	-1.58	(±0.26)a
Nebulization with Peracetic Acid	-2.09	(±0.54)b

Different letters signify groups with statistically different values

DISCUSSION

In dental clinics and prosthesis laboratories, the working team handles materials contaminated by direct contact with patients' oral tissues. When impressions and prosthetic parts are not duly disinfected they become the main transmission pathway of infectious and contagious diseases to the laboratory technician, dentist and patient, and that is why they must be submitted to the disinfection process to prevent cross contamination.[2,4,22]

In view of the above-mentioned facts, the disinfection of impressions is a mandatory procedure in daily clinical activity. Moreover, it is also very important to correctly select the method and disinfectant solution to be used. A variety of chemical products are currently sold as agents suitable for disinfecting dental impressions.[4] This has enabled new combinations of techniques and disinfectant solutions to be made, however, without reports in the literature.

One of the important aspects that must be taken into consideration when using chemical methods for sterilization is the degradation of equipment by corrosion. Cerreta et al.[23] verified that peracetic acid can be used as chemical sterilant of dental instruments at a concentration of 2500 ppm, without corrosive harm. Nevertheless, according to the manufacturer, Sterilife® can be used only on metal tray made of stainless steel series 304L and 316 L.

Evaluation of the dimensional precision of stone casts obtained from impressions submitted to greatly differing processes of disinfection have been amply reported in scientific literature, and the majority concluded the disinfection methods do not significantly alter the dimensional precision of stone casts.[2,5] However, no studies were found, which evaluated the dimensional precision of stone casts obtained from impressions disinfected by means of peracetic acid and the ultrasonic nebulization technique.

The results of the present study demonstrated that the impressions submitted to immersion, both in glutaraldehyde and in peracetic acid, as well as the control group, showed no statistically significant difference in their accuracy. Many studies have found similarity among the experimental groups that used a disinfectant solution with VPS.[2,24] However, there were no studies found evaluating the accuracy of VPS immersed in a peracetic acid solution. In Chen *et al.*[15] study they used a pattern model and metal tray

similar to the one used in the present study and the differences in the accuracy measured in stone casts obtained from impressions made by different impression materials were evaluated but without being submitted to disinfection processes. In the study mentioned above, the dimensional alteration values in contraction percentage found for vinyl polysiloxane varied between 1.00 $\pm$ 0.79 and 1.35 $\pm$ 0.77, confirming the results of this study for the control group.

In the present study all the stone casts presented smaller dimensions than the stainless steel pattern ones, which is a similar finding to others already known.[15,25] These results were probably reached due to the fact that during the polymerization reaction, the impression material shrinks toward the center of mass. In the absence of an adhesive tray, there would be unrestricted polymerization shrinkage of the impression material, resulting in a cast that is smaller in diameter and height.[25] The adhesive tray was not used in this study as the trays had mechanically retentive features (Figure 1), which probably were not enough to direct the mass contraction to the tray wall. In addition to this, the mechanical spatulation in cast vacuum can be contributed to a decrease of the setting time and consequently lower compensation of the impression contraction material.

No evaluation has yet been described in the literature with regard to the accuracy of dental VPS impressions submitted to the ultrasonic nebulization technique, with the use of glutaraldehyde or peracetic acid solutions. In the present study, analysis of the results of dimensional alteration in the diameter of the test specimens demonstrated that ultrasonic nebulization with the use of glutaraldehyde solution showed statistically different values in comparison with those of all the other experimental groups, presenting a smaller dimensional alteration than the control group (I) and the immersion groups (II and III). Whereas the ultrasonic nebulization group with the use of Sterilife® presented less dimensional alteration than all the groups. Nevertheless, as regards the dimensional alteration of the height of the samples, it presented greater dimensional alteration than all the groups. Thus, ultrasonic nebulization with peracetic acid showed the worst (2.09% for height) and the best (0.27% for diameter) results for dimensional alteration in comparison with the other groups. In view of this, it is possible to infer that the interaction of the

peracetic acid solution and the ultrasonic nebulization process interfered negatively in the accuracy of the stone casts, leaving them more shrinkage.

It is well-know that an increase in concentration of the drug solution during ultrasonic nebulization occurs during the operating period of a nebulizer.[26] This effect is one consequence of water evaporation that accompanies the aerosol output.[27] In agreement with these ideas Steckel *et al.*[28] verified that during the nebulization ultrasonic process there were changes on the droplet size, surface tension, viscosity and saturated vapor pressure that can be result of temperature and solution concentration in the nebulizer reservatory. These changes normally result in the solution concentration increase which can, consequently, raise the drug solutions' osmolarity and this situation could potentially enhance adverse reactions to the nebulized liquid. Thus, the fact that the Sterilife® solution was used by means of ultrasonic nebulization may have altered the droplet size and increased the saturated vapor pressure. In addition to that it may have potentiated the contact and the effect of absorption of this solution into the polymeric matrix of the VPS causing greater dimensional alteration of the stone cast. When this situation is transported to clinical practice it could act negatively on the stone cast obtainment used to make prosthetic crowns.

Selection of a disinfection technique must be based on various criteria in addition to the accuracy of the stone casts obtained, including the microbicidal capacity of the disinfectant agent. In a recent study by Mendonça et al.[18] the authors evaluated Glutaron II® and Sterilife® solutions from a microbiological point of view, in two disinfection methods: Ultrasonic nebulization and immersion. In this study peracetic acid demonstrated total microbicidal efficacy in both methods, and glutaraldehyde presented total microbicidal activity only for the impressions submitted to ultrasonic nebulization. In view of the results of the present study and the study of Mendonça et al.[18] it may be suggested that in dental offices the application of ultrasonic nebulization must preferably be used with solutions of glutaraldehyde, since the peracetic acid should be used only by means of the immersion technique.

CONCLUSION

Considering the methodology used and the results obtained, it was possible to conclude that:

- Ultrasonic nebulization with peracetic acid solution interfered negatively in the height of the stone casts, while the glutaraldehyde solution presented better accuracy when used by means of ultrasonic nebulization, when compared with the control group.

- The immersion technique both in the glutaraldehyde and peracetic acid solutions did not interfere in the accuracy of the stone casts obtained, when compared with the control group.

ACKNOWLEDGEMENTS

The authors thank Luiz Felipe Aroca for making the diagrammatic drawing and the Fundação Araucária – PR, CAPES and CCBS/Unioeste for financing the research.

REFERENCES

1. Johnson GH, Chellis KD, Gordon GE, Lepe X. Dimensional stability and detail reproduction of irreversible hydrocolloid and elastomeric impressions disinfected by immersion. J Prosthet Dent. 1998;79:446-453.
2. Martin N, Martin MV, Jedynakiewicz NM. The dimensional stability of dental impression materials following immersion in disinfecting solutions. Dent Mater. 2007;23:760-768.
3. ADA Council on Scientific Affairs and ADA Council on Dental Practice. Infection control recommendations for the dental office and the dental laboratory. J Am Dent Assoc. 1996; 127:672-680.
4. Al-Jabrah O, Al-Shumailan Y, Al-Rashdan M. Antimicrobial effect of 4 disinfectants on alginate, polyether, and polyvinyl siloxane impression materials. Int J Prosthodont. 2007;20:299-307.

5. Kotsiomiti E, Tzialla A, Hatjivasiliou K. Accuracy and stability of impression materials subjected to chemical disinfection - a literature review. J Oral Rehabil. 2008;35:291-299.
6. Russell AD. Glutaraldehyde: current status and uses. Infect Control Hosp Epidemiol. 1994;15:724-733.
7. Rutala WA, Weber DJ. Disinfection and sterilization in health care facilities: what clinicians need to know. Clin Infect Dis. 2004;39:702-709.
8. Giammanco GM, Melilli D, Rallo A, et al. Resistance to disinfection of a polymicrobial association contaminating the surface of elastomeric dental impressions. New Microbiol. 2009;32:167-172.
9. Cowan RD, Ayliffe GAJ, Badd JR, et al. Cleaning and disinfection of equipment for gastrointestinal endoscopy. Report of a Working Party of the British Society of Gastroenterology Endoscopy Committee. Gut. 1998; 42:585-593.
10. Rutala WA, Weber DJ. Infection control: the role of disinfection and sterilization. J Hosp Infect. 1999;43:S43-S55.
11. Food and Drug Administration. General hospital and personal use devices: proposed classification of liquid chemical sterilants and general purpose disinfectants-FDA. Proposed rule. Fed Regist. 1998; 63(215):59917-59921.
12. Petrie CS, Walker MP, O'mahony AM, Spencer P. Dimensional accuracy and surface detail reproduction of two hydrophilic vinyl polysiloxane impression materials tested under dry, moist, and wet conditions. J Prosthet Dent. 2003;90:365-372.
13. Takahashi H, Finger WJ. Dentin surface reproduction with hydrophilic and hydrophobic impression materials. Dent Mater. 1991;7:197-201.
14. Lepe X, Johnson GH. Accuracy of polyether and addition silicone after long-term immersion disinfection. J Prosthet Dent. 1997;78:245-249.
15. Chen SY, Liang WM, Chen FN. Factors affecting the accuracy of elastometric impression materials. J Dent. 2004;32:603-609.
16. Wu G, Yu X, Gu Z. Ultrasonically nebulised electrolysed oxidising water: a promising new infection control programme for impressions, metals and gypsum

casts used in dental hospitals. J Hosp Infect. 2008;68:348-354.

17. Wanner A, Rao A. Clinical indications for and effects of bland, mucolytic, and antimicrobial aerosols. Am Rev Respir Dis. 1980;122:79-87.
18. Mendonça MJ, Rafael RS, Menoli RA, et al. Microbiological evaluation of the ultrasonic nebulization effect with peracetic acid and glutaraldehyde on disinfection methods of dental impressions.2010.
19. Nissan J, Gross M, Shifman A, Assif D. Effect of wash bulk on the accuracy of polyvinyl siloxane putty-wash impressions. J Oral Rehabil. 2002;29:357-361.
20. Wadhwani CP, Johnson GH, Lepe X, Raigrodski AJ. Accuracy of newly formulated fast-setting elastomeric impression materials. J Prosthet Dent. 2005;93:530-539.
21. Caputi S, Varvara G. Dimensional accuracy of resultant casts made by a monophase, one-step and two-step, and a novel two-step putty/light-body impression technique: an in vitro study. J Prosthet Dent. 2008;99:274-281.
22. Chassot AL, Poisl MI, Samuel SM. In vivo and in vitro evaluation of the efficacy of a peracetic acid-based disinfectant for decontamination of acrylic resins. Braz Dent J. 2006;17:117-121.
23. Ceretta R, Paula MM, Angioletto E, et al. Evaluation of the effectiveness of peracetic acid in the sterilization of dental equipment. Indian J Med Microbiol. 2008;26:117-122.
24. Herrera SP, Merchant VA. Dimensional stability of dental impressions after immersion disinfection. J Am Dent Assoc. 1986;113:419-422.
25. Ceyhan JA, Johnson GH, Lepe X. The effect of tray selection, viscosity of impression material, and sequence of pour on the accuracy of dies made from dual-arch impressions. J Prosthet Dent. 2003;90:143-149.
26. O'Callaghan C, Barry PW. The science of nebulised drug delivery. Thorax. 1997;52:S31-S44.
27. Ip AY, Niven RW. Prediction and experimental determination of solute output from a Collison nebulizer. J Pharm Sci. 1994;83:1047-1051
28. Steckel H, Eskandar F. Factors affecting aerosol performance during nebulization with jet and ultrasonic nebulizers. Eur J Pharm Sci. 2003;19:443-455.

CONSIDERAÇÕES GERAIS

Devido ao aumento da conscientização do risco de contaminação cruzada presente nos procedimentos ligados à obtenção de moldes odontológicos, diversas técnicas e soluções desinfetantes têm sido relatadas na literatura odontológica. Na busca da combinação técnica e desinfetante ideal para os materiais de impressão odontológicos, recentemente, foi introduzida a técnica de nebulização ultrassônica como meio eficaz de desinfecção desses materiais. Somado a isso, nos últimos anos, a eficácia microbicida do glutaraldeído tem sido questionada. Por esses motivos, o presente trabalho objetivou avaliar o método de nebulização ultrassônica e a utilização do ácido peracético, comparados a técnica de imersão e a solução de glutaraldeído, ambos utilizados rotineiramente em Odontologia, do ponto de vista de eficácia microbicida e de manutenção da precisão dimensional dos modelos obtidos.

No primeiro capítulo, a partir de moldes odontológicos de silicona por adição, previamente contaminados com microrganismos padrão para desinfetantes hospitalares de baixo e alto nível, a eficácia microbicida de duas soluções desinfetantes (ácido peracético a 0,2% e glutaraldeído a 2%) utilizadas por meio de duas técnicas de desinfecção (nebulização ultrassônica e imersão) foi avaliada de forma comparativa. Os resultados indicaram que o ácido peracético apresentou 100% de eficácia microbicida contra os microrganismos testados quando foi aplicado através das duas técnicas avaliadas. A solução de glutaraldeído quando utilizada através de imersão teve efeito microbicida menor quando comparado às outras combinações de solução e técnica. Tal resultado pode ter ocorrido devido ao possível efeito potencializador da nebulização ultrassônica sobre a solução de glutaraldeído, alterando a concentração da solução contida no reservatório do nebulizador, diminuindo o tamanho das partículas nebulizadas, aumentando a pressão de vapor saturada, possibilitando contato mais efetivo da névoa sobre o material de moldagem e tornando-a mais eficaz contra os microrganismos, quando comparado à solução de glutaraldeído utilizada por meio da imersão.

No segundo artigo, foi avaliada a precisão dimensional de modelos obtidos a partir de moldes odontológicos de silicona por adição desinfetados por meio de soluções de glutaraldeído e ácido peracético, aplicados em técnicas de nebulização ultrassônica e

imersão. Os resultados desse estudo demonstraram que a técnica de imersão, utilizada com ambas soluções, não influenciou na precisão dimensional dos modelos obtidos quando comparados ao grupo controle. De outro lado, a técnica de nebulização ultrassônica quando utilizada para aplicação da solução de ácido peracético demonstrou influenciar negativamente na precisão dimensional dos modelos obtidos. Tal resultado pode ser explicado pelo efeito da nebulização ultrassônica sobre a solução de ácido peracético. Durante o processo de nebulização ultrassônica as soluções utilizadas sofrem alterações em sua concentração, temperatura, tamanho das partículas da névoa, viscosidade e pressão saturada de vapor. Tais alterações podem refletir negativamente sobre o material nebulizado, fato que ocorreu sobre os moldes de silicona por adição que apresentaram precisão dimensional inferior quando comparada aos demais grupos experimentais.

O processo de desinfecção de moldes odontológicos envolve combinação de processos físicos e químicos. Na busca de uma combinação de método e solução desinfetante ideal, deve-se considerar a interação das propriedades microbicidas juntamente com o efeito sobre os moldes e modelos de gesso obtidos, já que esses servirão de base para a construção da prótese dental. No presente estudo, verificou-se que a técnica de nebulização ultrassônica proporcionou eficácia microbicida contra 100% dos microrganismos testados para as duas soluções testadas. Esse resultado é especialmente importante para a solução de glutaraldeído pois, quando utilizada através de imersão, mostrou menor eficácia microbicida que as outras combinações testadas. Já o ácido peracético, mostrou-se eficaz nas duas técnicas imersão e nebulização ultrassônica, resultado provavelmente devido à capacidade comprovada dessa solução como desinfetante de alto nível hospitalar.

Porém, a precisão dimensional dos modelos obtidos quando submetidos às combinações de técnicas e soluções testadas mostrou resultados diferentes dos obtidos na análise microbiológica. A precisão dimensional dos modelos não sofreu alteração quando utilizou-se a técnica de imersão, porém, quando a técnica de nebulização ultrassônica foi utilizada, a solução de ácido peracético influenciou negativamente na precisão dimensional dos modelos, em tese, devido ao efeito potencializador da nebulização ultrassônica sobre a solução de ácido peracético. A solução de ácido peracético é considerada um desinfetante

de alto nível hospitalar e já na técnica de imersão mostrou-se eficaz do ponto de vista microbiológico. Tal fato deve ser considerado, pois as alterações que ocorrem nas soluções nebulizadas ultrassonicamente, como aumento da concentração, do tamanho das partículas da névoa e da pressão de vapor saturada (Steckel *et al.*, 2003) para o ácido peracético, demonstraram resultados negativos para a precisão dimensional dos modelos obtidos,

Cabe ao profissional da Odontologia, portanto, o discernimento das características específicas da solução desinfetante e da técnica utilizada, bem como da interação de ambas, a fim de se obter o resultado desejado. Como demonstrado no presente estudo, a solução de ácido peracético quando utilizada de forma tradicional, imersão, já apresenta efeito microbicida satisfatório, porém, quando utilizada através de nebulização ultrassônica, mostrou-se prejudicial na precisão dimensional dos modelos obtidos. Já para a solução de glutaraldeído, a técnica de imersão demonstrou eficácia microbicida inferior quando comparada as outras combinações testadas, porém, quando utilizada através da nebulização ultrassônica a sua eficácia microbicida foi aumentada sem interferir na precisão dimensional dos modelos de gesso. Diante dos resultados do presente estudo pode-se sugerir o uso da nebulização ultrassônica com solução de glutaraldeído para moldes odontológicos em silicona por adição, já o ácido peracético deveria ser utilizado somente através da técnica de imersão.

CONCLUSÃO

Dentro das limitações desse estudo, e diante dos resultados obtidos foi possível concluir que:

As técnicas de desinfecção de moldes em silicona por adição por nebulização ultrassônica com solução de glutaraldeído a 2% por 10 minutos e por imersão em solução de ácido peracético a 0,2% por 10 minutos demonstraram os melhores resultados quanto a avaliação da eficácia microbicida e da precisão dimensional dos modelos de gesso.

REFERENCIAS[*]

1. ADA Council on Scientific Affairs and ADA Council on Dental Practice. Infection control recommendations for the dental office and the dental laboratory. J Am Dent Assoc. 1996; 127(5): 672-80.
2. Al-Jabrah O, Al-Shumailan Y, Al-Rashdan M. Antimicrobial effect of 4 disinfectants on alginate, polyether, and polyvinyl siloxane impression materials. Int J Prosthodont. 2007; 20(3): 299-307.
3. Chen SY, Liang WM, Chen FN. Factors affecting the accuracy of elastomeric impression materials. J Dent. 2004; 32(8): 603-9.
4. Cowan RD, Ayliffe GAJ, Badd JR, Bradley CR, Chivers SM, Holton J *et al.* Cleaning and disinfection of equipment for gastrointestinal endoscopy. Report of a Working Party of the British Society of Gastroenterology Endoscopy Committee. Gut. 1998; 42(4): 585-93.
5. Food and Drug Administration. General hospital and personal use devices: proposed classification of liquid chemical sterilants and general purpose disinfectants-FDA. Proposed rule. Fed Regist. 1998; 63(215): 59917-21.
6. Giammanco GM, Melilli D, Rallo A, Pecorella S, Mammina C, Pizzo G. Resistance to disinfection of a polymicrobial association contaminating the surface of elastomeric dental impressions. New Microbiol. 2009; 32(2): 167-72.
7. Grande NS, Nakayama RA, Machado AMO, Yamaguti FA, Uehara C. Evaluation of the risk of bacterial contamination in the patient submitted to bronchoscopy, after reprocessing the bronchoscope. J Pneumol. 2002; 28(5): 250-60.
8. Johnson GH, Chellis KD, Gordon GE, Lepe X. Dimensional stability and detail reproduction of irreversible hydrocolloid and elastomeric impressions disinfected by immersion. J Prosthet Dent. 1998; 79(4): 446-53.

[*] De acordo com a norma da UNICAMP/FOP, baseada na norma do International Committee of Medical Journal Editors – Grupo de Vancouver. Abreviatura dos periódicos em conformidade com o Medline.

9. Kotsiomiti E, Tzialla A, Hatjivasiliou K. Accuracy and stability of impression materials subjected to chemical disinfection - a literature review. J Oral Rehabil. 2008;35(4): 291-9.
10. Lepe X, Johnson GH. Accuracy of polyether and addition silicone after long-term immersion disinfection. J Prosthet Dent. 1997; 78(3): 245-9.
11. Martin N, Martin MV, Jedynakiewicz NM. The dimensional stability of dental impression materials following immersion in disinfecting solutions. Dent Mater. 2007;23(6): 760-768.
12. Petrie CS, Walker MP, O'mahony AM, Spencer P. Dimensional accuracy and surface detail reproduction of two hydrophilic vinyl polysiloxane impression materials tested under dry, moist, and wet conditions. J Prosthet Dent. 2003; 90(4): 365-72.
13. Pineau L, Desbuquois C, Marchetti B, Luu Duc D. Comparison of the fixative properties of five disinfectant solutions. J Hosp Infect. 2008; 68(2): 171-7.
14. Russell AD. Glutaraldehyde: current status and uses. Infect Control Hosp Epidemiol. 1994; 15(11): 724-33.
15. Rutala WA, Weber DJ. Disinfection and sterilization in health care facilities: what clinicians need to know. Clin Infect Dis. 2004; 39(5): 702-9.
16. Rutala WA, Weber DJ. Infection control: the role of disinfection and sterilization. J Hosp Infect. 1999; 43 Suppl: S43-S55.
17. Steckel H, Eskandar F. Factors affecting aerosol performance during nebulization with jet and ultrasonic nebulizers. Eur J Pharm Sci. 2003; 19(5): 443-55.
18. Takahashi H, Finger WJ. Dentin surface reproduction with hydrophilic and hydrophobic impression materials. Dent Mater. 1991; 7(3): 197-201.
19. Vizcaíno-Alcaide MJ, Herruzo-Cabrera R, Fernandez-Aceñero MJ. Comparison of the disiectant efficacy of Perasafe® and 2% glutaraldehyde in in vitro tests J Hosp Infect. 2003; 53(2): 124-8.
20. Wanner A, Rao A. Clinical indications for and effects of bland, mucolytic, and antimicrobial aerosols. Am Rev Respir Dis. 1980; 122(5 Pt 2): 79-87.

21. Wu G, Yu X, Gu Z. Ultrasonically nebulised electrolysed oxidising water: a promising new infection control program for impressions, metals and gypsum casts used in dental hospitals. J Hosp Infect. 2008; 68(4): 348-54.

APÊNDICE

Ilustração da metodologia

I – Padrão de aço inoxidável utilizada para a obtenção dos moldes

I I – Ato de moldagem

III – Molde imerso no meio contaminante

IV – Enxágüe do molde com solução salina esterilizada

V – Solução de glutaraldeído a 2%

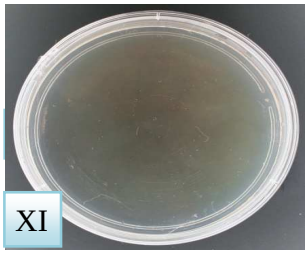
VI – Solução de ácido peracético a

VII – Nebulizador ultrassônico

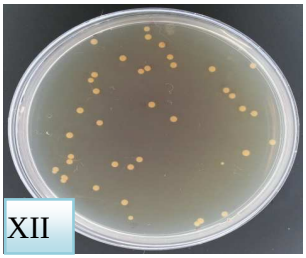
VIII – Caixa plástica transparente acoplada ao nebulizador ultrassônico

IX – Névoa sendo aplicada sobre o molde

X



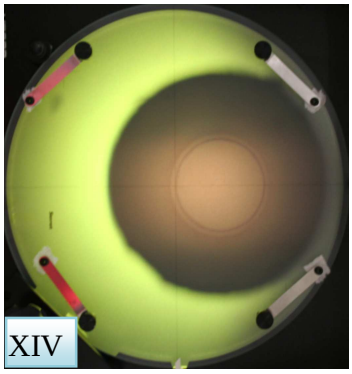
XI

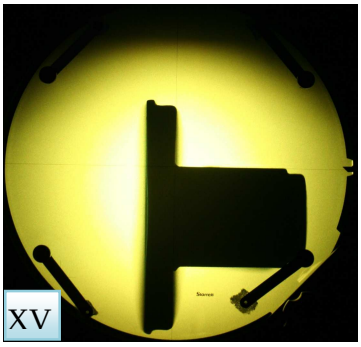


XII

X – Contador de colônias automático
XI – Placa de Petri com ausência de crescimento bacteriano
XII – Placa de Petri com crescimento de *Staphylococcus aureus*

XIII


XIV


XV

XIII – Projetor de perfil

XIV – Superfície do modelo de gesso

XV – Perfil do modelo de gesso

ANEXO

Declaração do direito autoral transferido a editora quando a tese for defendida em formato alternativo

UNICAMP

UNIVERSIDADE ESTADUAL DE CAMPINAS

FACULDADE DE ODONTOLOGIA DE PIRACICABA

Declaração

As cópias de artigo de minha autoria ou de minha co-autoria, já publicados ou submetidos para publicação em revista científicas ou anais de congresso sujeitos a arbitragem, que constam da minha Dissertação/Tese de Mestrado/Doutorado, intitulada "Novas técnicas de desinfecção de moldes em Odontologia – Avaliação da eficácia microbicida e da precisão dimensional de modelos", não infringem os dispositivos da Lei n.º9.610/98, nem o direito autoral de qualquer editora.

Piracicaba, 23 de junho de 2010

Marcio José Mendonça
Autor
RG 25.657.483-2

Mário Alexandre Coelho Sinhoreti
Orientador
RG 18.897.368