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Cross-contamination in the Dental Laboratory Through the Polishing Procedure of Complete Dentures

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Polishing of dental prostheses can cause a dangerous cycle of cross-contamination involving dentists, laboratory technicians, patients and auxiliary personnel. The aim of this study was to show the microbial contamination in the dental laboratory during the polishing procedure of complete dentures. For this purpose, 4 experiments were conducted. Experiment I - Determination of the total colony-forming units (CFU) counts contaminating complete maxillary dentures. During the polishing procedure, determination of the CFU counts transferred to the operator (Experiment II) and of the total CFU counts transferred to previously sterilized complete dentures (Experiment III). Experiment IV - The total counts of remaining CFU in the lathe spindle after Experiments II and III. Complete dentures were highly contaminated (mean = 1.4×10^7 CFU/mL). There was a elevated level of contamination by splatter and aerosols. There was high microbial transfer from the contaminated lathe spindle to the sterile prostheses (mean = 1.7×10^7 CFU/mL). The spindles were highly contaminated after polishing procedures (mean = 3.5×10^8 CFU/mL). The polishing of dental prostheses is a possible source of transmission of communicable diseases in the laboratory and requires improved techniques for infection control.

Key Words: cross infection, dental laboratory, dental prostheses.

INTRODUCTION

Cross contamination is a severe problem that involves health professionals, especially in dentistry. The transmission of diseases during treatment between patients and dentists, auxiliary personnel and dental laboratory technicians can occur if preventive measures are not taken. The risk of cross-contamination in dental clinics as well as transmission of microorganisms in prosthetic laboratories has been reported in various studies (1-3). More than 60% of the prostheses delivered to clinics from laboratories are contaminated with pathogenic microorganisms, i.e., streptococci, lactobacilli, diphtheroids originating in the oral cavity of other patients (1-3). In prosthetic laboratories, lathes and pumice, usually used for polishing procedures and finishing of prostheses have been described as the greatest sources of contamination with levels of contamination reported of 1.4-8.0 x 10^5 colony forming units (CFU) in pumice pans (4).

Kahn et al. (1) reported cross-contamination during polishing in an experiment which simulated routine polishing of complete dentures without using any disinfection measures before the procedure or with the addition of disinfectant to the pumice. Contaminated invisible aerosol particles remain in the air for

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long periods of time when using lathes for the polishing of prostheses (4,5). In spite of the fact that it is not possible to eliminate all sources of contamination in the laboratory, a series of prevention measures to decrease these levels should be adopted. The use of sterile pumice and rag wheels or the association of disinfectants with pumice for polishing is a viable alternative to significantly reduce cross-contamination in the laboratory (6-8).

Potentially pathogenic microorganisms, such as Gram-negative bacilli of the genus *Acinetobacter,* as well as *Micrococcus, Pseudomonas, Moraxella* and *Alcaligenes,* have been detected contaminating pumice in commercial laboratories (6,9). These bacteria, which are not part of normal oral flora, can cause serious diseases if passed to patients whose dentures are polished with contaminated material and to the technician by exposure to contaminated aerosol. Williams et al. (10) reported, in 1985, the increase of cases of pneumonia in individuals exposed to lathe aerosol. Sande et al.(11) reported 10 cases of infection by *Mycoplasma pneumoniae* involving persons working in dental prosthetic laboratories, suspecting that these infections derived from manipulation of prostheses contaminated by these microorganisms. Therefore, the use of aprons, gloves and protective glasses by the professionals should be a routine (12).

Dental prostheses should be disinfected before they are sent to the laboratory and upon return to the dental clinic (13) but, despite rigorous control of sterilization and disinfection of instruments in dental clinics, prosthetic appliances do not receive adequate infection control.

Jagger et al. (8), in 1995, published a study about attitudes to cross-infection control of dental laboratories in the U.K. They found that only 49% of the respondents had a cross-infection policy and of these, 61% used no disinfectant in the pumice and 93% did not disinfect the polishing instruments. The need of changing this panorama has led to publications on the possibility of transmission of microorganisms between patients and professionals who, directly or indirectly, handle dental material in both the clinic and the laboratory.

The objective of this research is to show, by reproducing the routine conditions of polishing complete dentures, the transmission of potentially pathogenic microorganisms to the operator, polishing cones and new prostheses.

MATERIAL AND METHODS

Selection of Patients

A total of 40 edentulous patients from the Complete Dentures Clinic of the School of Dentistry at Ribeirão Preto of the University of São Paulo participated of this study. They were of both sexes, ranging in age from 35 to 79 years and had complete maxillary dentures made of thermopolymerized resin and acrylic resin teeth. Patients who fulfilled 3 requirements were selected: had not taken antibiotics during the previous 6 months, had used a maxillary denture for at least 2 months which had not been polished during this time and used only toothbrushes and tooth paste or soaps for cleaning.

Microbial Processing

To verify the transfer of microorganisms from the polishing of complete dentures, four experiments were conducted (Figure 1).

Experiment I: Determination of CFU/mL of complete maxillary dentures demonstrating the contamination level of prostheses

Ten maxillary dentures were placed on sterile Petri plates and transferred to the Microbiology Laboratory. Under laminar flow, the dentures were washed with 10 mL PBS (phosphate buffered saline) using sterile toothbrushes for removal of microorganisms. The resulting suspensions were serial diluted (10^0-10^6) in PBS, pH = 7.2, seeded on Petri plates containing BHI agar, supplemented with 5% defibrinated sheep blood (S-BHIA), and incubated at 37°C for 48 h under anaerobic conditions (GasPack® Anaerobic System, BBL, Cockeysville, MD, USA).

The counts of anaerobe colony-forming units per milliliter of sterile PBS used to wash the dentures were determined.

Experiment II: Determination of CFU transferred to the professional during the polishing process of used complete dentures

The complete maxillary dentures of 30 patients were placed on sterile Petri plates and transferred to the

Prosthesis Laboratory for routine polishing with a lathe (style 15.2014, SS White, Dayton, OH, USA), disinfected with 2% iodophor and a frontal protection stand (VH Equipments, Araraquara, São Paulo, Brazil).

The polishing cones and pumice were submitted to sterilization in an ethylene oxide gas chamber. Following sterilization, random samples were tested to determine sterility. All tested materials were negative for culture growth.

The technician used sterile gloves, mask, protective glasses and apron. Four open Petri plates with the following culture media were attached to the technician: BHI agar, supplemented with 5% S-BHIA, Mitis Salivarius agar (MS) selective for *Streptococci*, MacConkey agar (MC) selective for Gram-negative microorganisms, Sabouraud dextrose agar (SDA) selective for yeast (all media were from Difco, Detroit, MI, USA) and Sucrose-Bacitracine agar (SB_{20}) selective for *mutans streptococci* (14). Each denture was polished for 4 min at 2,600 rpm, with the culture plates exposed on the thorax and abdomen of the technician for 2 min, respectively. The plates were then closed and incubated at 37°C for 48 h. MC and SDA cultures were maintained under aerobic conditions; SB_{20}, MS and S-BHIA used the anaerobic GasPack® system.

Experiment III: Determination of CFU transferred from contaminated polishing lathe to sterile dentures

Complete maxillary prostheses were made from a standard model to obtain samples with similar anatomy, size and rugosity to standardize conditions of microorganism transmission. Each denture received individual "blister" packaging and was submitted to sterilization in an ethylene oxide gas chamber, considered inert for prosthetic materials (7). A random sample of the dentures was tested for sterility. There was no culture growth.

After each polishing procedure of patient's denture in Experiment II, the technician, wearing new sterile gloves, began polishing of the sterile denture using the same cone and pumice used in Experiment II. After polishing, each denture was placed immediately on a sterile Petri plate and taken to the Microbiology Laboratory for processing with washing with PBS and brushing similar to the method of Experiment I.

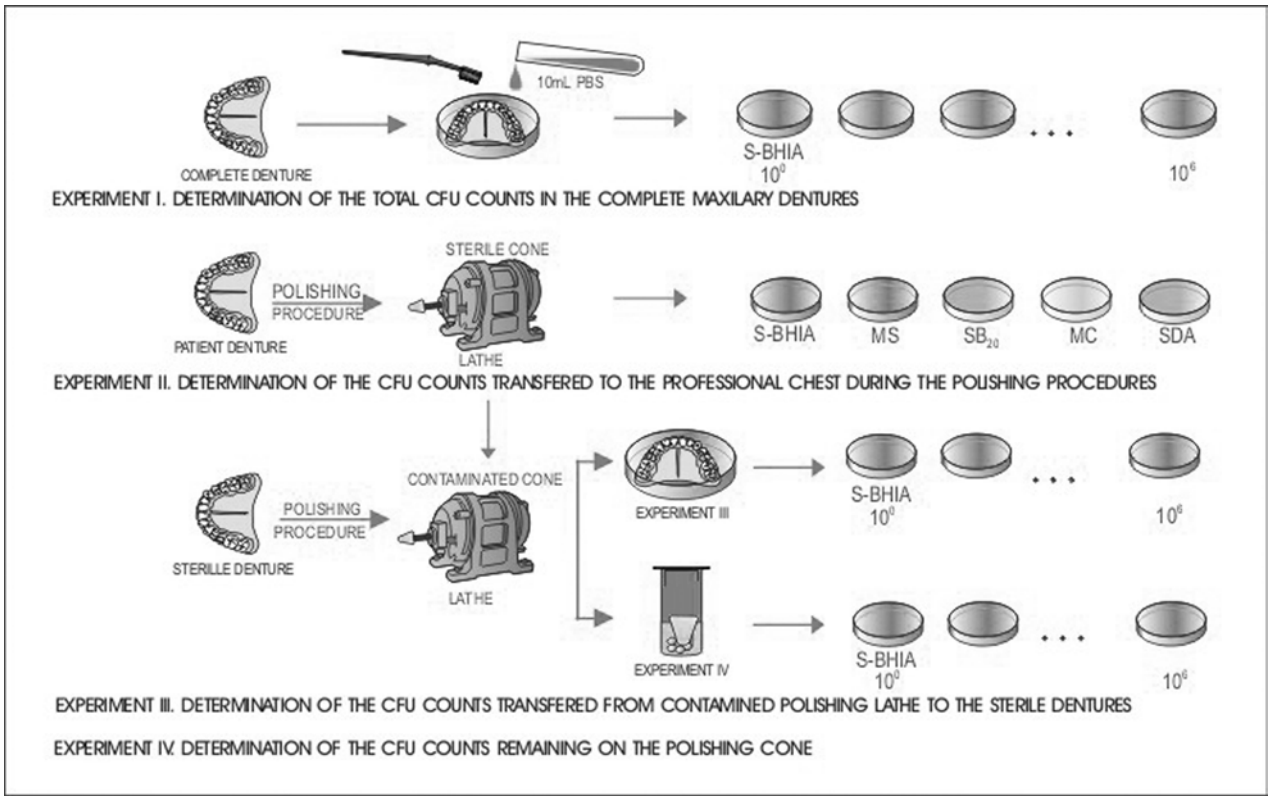

Figure 1. Study design.

Experiment IV: Determination of CFU remaining on the polishing cone after experiments II and III

After polishing the sterile denture in Experiment III, the 30 cones were removed aseptically, placed in a sterile container and taken to the Microbiology Laboratory for processing. Glass beads and 20 ml PBS were added to the container under laminar flow and were closed and spun for 1 min. Ten milliliters of the resulting suspension were diluted and seeded in S-BHIA.

RESULTS

The results are reported in Tables 1 and 2. Experiment I, determining the CFU in used complete dentures, showed that these dentures were highly colonized (mean 1.4 x 10^7 CFU per milliliter of fluid used to wash the dentures). In Experiment II, there was a high level of contamination by splatter and aerosols in the different selective culture media used to show the transmission of potentially pathogenic microorganisms to the operator (Table 2). Experiment III showed a mean transfer of 1.7 x 10^7 CFU/mL from patient´s prostheses to sterile prostheses. The mean number of remaining microorganisms on the cone after experiments II and III was 3.5 x 10^8 CFU/mL (Experiment IV).

DISCUSSION

Dental laboratory technicians are particularly vulnerable to microbial cross-contamination from the elastomeric impressions and from the dental prostheses they receive from dental offices (15,16). Casts poured from impressions can also harbor infectious microorganisms that can be distributed throughout the laboratory when the casts or dies are trimed (16).

The results of the four experiments conducted in this investigation revealed massive cross contamination in prosthesis laboratory routines and a strongly contaminating source in complete dentures of patients. The process of polishing using high-speed lathes can transmit disease between the dental clinic and the laboratory technician.

Polishing lathes are considered to be a source of contamination in prostheses laboratories. However, infection control measures are not being effectively applied. This research studied the transmission of microorganisms in the dental laboratory by means of lathes, using a method which reproduced laboratory polishing procedures.

Experiment I, determining the CFU in used complete dentures, showed that these dentures were densely colonized indicating a high level of contamination, especially considering that the patients in this study did not present any debilitating disease. Dentures of patients who are diseased, debilitated and/or immunocompromised have been reported to have even higher levels of contamination (12). In a similar study, Powell et al. (3) reported a high level of contamination of complete dentures, with the presence of α-hemolytic streptococci, β-hemolytic streptococci, *Klebsiella oxytoca* and *Pseudomonas* sp.

Bacterial contamination of scrub jackets during dental hygiene procedures was studied by Huntley and Campbell (17). They demonstrated that aerosols are produced during examination and scaling when hand instruments alone are used. The number of microorgan-

Table 1. Number of colony forming units per milliliter found in experiments I, III and IV.

Experiment	N	CFU/mL (mean)
I	10	1.4 x 10^7 ± 0.8 x 10^7
III	30	1.7 x 10^7 ± 1.5 x 10^7
IV	30	3.5 x 10^8 ± 9.0 x 10^8

CFU/mL = colony-forming units per milliliter of sterile PBS used to wash denture/cone.

Table 2. Mean and frequency of colony forming units (CFU) grown in different culture media transferred to the technician after polishing 30 dentures (Experiment II).

Culture media	CFU > 300		CFU (mean)
	N	%	
S-BHIA	29	96.7	298 ± 11
MS	12	40.0	187 ± 112
SB_{20}	8	26.7	160 ± 117
SDA	4	13.3	90 ± 112
MC	1	3.3	33 ± 65

S-BHIA: Brain heart infusion agar, supplemented with 5% defibrinated sheep blood
MS: Mitis Salivarius agar
SB_{20}: Sucrose-Bacitracine agar
SDA: Sabouraud dextrose agar
MC: MacConkey agar

isms is higher on sleeves than on the chest of scrub jackets, and is higher when ultrasonic or sonic scalers or air polishers are used.

Experiment II verified the transmission of microorganisms to the professional by aerosol contamination produced during the polishing process. Oral microorganisms such as *Streptococcus mutans* and non-oral potentially pathogenic microorganisms such as yeast and Gram-negative bacteria, which can cause eye and respiratory infections, were found in aerosol and splatter. Williams et al. (10) found Gram-negative *Acinetobacter* in cultures of pumice from laboratories. This non-oral bacteria has been associated with infections such as pneumonia, meningitis, septicemia and eye infections (9).

Experiment III showed a transfer of microorganisms from patient prostheses to sterile prostheses. These results can have serious implications because this experiment reproduced the conduct of most prosthesis laboratories where pumice and polishing cones are not changed or disinfected regularly between procedures on different prostheses. Because the typical users of dentures are the elderly who can have lowered immunological resistance, the transfer of microorganisms confirmed in Experiment III places these patients at risk for the development of infection caused by cross-contamination. In a similar study, Kahn et al. (1) reported a mean transfer of 5.0 x 10^5 CFU/mL of patient dentures to sterile dentures, noting the presence of pathogenic microorganisms such as *Staphylococcus aureus, Escherichia coli, Candida albicans* and α-hemolytic streptococci.

In Experiment IV, the remaining microorganisms on the cone after experiments II and III showed that the cone was highly contaminated even after the transfer of a large quantity of microorganisms to the sterile prosthesis, remaining as a source of infection ready to contaminate the environment, professional and future dentures continuing the cycle of cross infection. According to Molinari et al. (7), the cone should be changed after each polishing and then sterilized.

The 4 experiments showed that the handling of dentures between the dentist and the laboratory presents a dangerous source of cross-contamination that will continue placing the dentist, technician, patient and auxiliary personnel at risk until efficient measures of infection control are instituted.

The use of aprons, gloves and protective glasses (12) by professionals, the use of lathes with efficient shields (5), the association of disinfectants with pumice (7,8), the sterilization or disposal of the cone after each use (7), and the disinfection of dentures before sending them to the laboratory and upon return to the dental clinic (13) are means which can reduce the risk of cross-contamination.

Infection control measures such as the use of barriers during polishing, the disinfection of dentures before being sent to the laboratory and upon return to the dental clinic, the disposal or sterilization of the cone after each use, as well as the addition of disinfectants to pumice, and unit doses of pumice should be adopted with the objective of reducing the risk of cross infection.

In conclusion, complete dentures are massively contaminated with microorganisms and can serve as the primary source in the cycle of cross infection within dental laboratories. The polishing of dentures without previous disinfection leads to a high level of transfer of microorganisms to the professional, the polishing cone and the new dentures.

RESUMO

O polimento de próteses dentais pode causar um ciclo de contaminação cruzada envolvendo cirurgões-dentistas, técnicos de laboratório, pacientes e pessoal auxiliar. O objetivo deste estudo foi demonstrar a contaminação microbiana em laboratório dental durante os procedimentos de polimento de próteses totais. Com esse propósito, 4 experimentos foram idealizados: Experimento I - Determinação da contagem total de unidades formadoras de colônias (UFC) presentes em próteses totais superiores. Durante o procedimento de polimento, determinação da contagem de UFC transferidas para o operador (Experimento II) e contagem total transferida para próteses totais previamente esterilizadas (Experimento III). Experimento IV - Contagem total de UFC remanescentes no cone da politriz após a realização dos experimentos II e III. As próteses totais estavam altamente contaminadas (média = 1,4 x 10^7 UFC/mL). Observou-se um elevado nível de contaminação pelo aerosol. Houve transferência de microrganismos da politriz contaminada para as próteses esterilizadas (média = 1,7 x 10^7 UFC/mL). Os cones estavam altamente contaminados depois dos procedimentos de polimento (média = 3,5 x 10^8 UFC/mL). O polimento de próteses dentais é um possível veículo de transmissão de doenças no ambiente do laboratório e requer técnicas adequadas para o controle de infecção.

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