JACOBS PUBLISHERS

OPEN ACCESS

Jacobs Journal of Dentistry and Research

Research article

Evaluation of Ultraviolet light (UV) and Light emitter diode (LED) on Toothbrushes Decontamination : An Experimental *in vitro* Study

Bruna Rios Teófilo, graduate student, Larissa Mendonça de Oliveira, graduate student Luana Feitosa de Carvalho, graduate student, Rafaela Silva e Souza Lima, graduate student, Márcia Maria de Negreiros Pinto Rocha, PhD, Sérgio Luis da Silva Pereira*, PhD

University of Fortaleza(Unifor), Brazil

**Corresponding author: Dr. Sérgio Luis da Silva Pereira , Av. WashingtonSoares, 1321- Edson Queroz-Fortaleza/Ce-zip code: 60811-905, Tel: +558534773201; Email: luiss@unifor.br*

Received: 11-18-2015

Accepted: 12-23-2015

Published: 12-29-2015

Abstract

The aim of this study was to evaluate the effect of the ultraviolet light and light emitter diode on toothbrushes decontamination. Thirty adult patients with chronic gingivitis between the ages of 20 and 55 years old brushed their teeth three times a day for one week. After this period, the toothbrushes were collected for decontamination process and divided equally in three groups, as follow as: Control – no decontamination; LED – decontamination using light emitter diode; UV – decontamination using ultra violet light; Then, the toothbrushes were immersed for 30 seconds in test tubes containing Brain Heart Infusion (BHI) and placed in the stove at 37°C during 24 hours. The level of contamination by McFarland scale and morphological characteristics of the microorganisms were performed. UV and LED groups did not reduced the bacterial contamination ($p>0.05$), in spite of shifting the local microflora ($p<0.05$). Therefore, ultraviolet light and light emitter diode had a limited benefit on toothbrushes decontamination.

Keywords: Contamination; Toothbrush; Ultraviolet Light; Light Emitter Diode

Introduction

Regular plaque removal by effective tooth cleaning using a toothbrush is the most common and effective device that removes the bacterials from the oral cavity, reducing the risk for decay and periodontal diseases [1]. However, these devices may become heavily contaminated with microorganisms, implicating in the possibility of reinfection of a patient and resulting in simple or more complexes systemic diseases, namely in immunologically compromised and hospitalized patients [2-4].

Procedures for the decontamination of toothbrushes would prevent the risks of reinfection or infection by other pathogenic microrganisms from the envirommment [1]. Several chemical agents have been tested to reduce the toothbrush bacterial contamination, including chlorhexidine, essential oils and dentifrices [3-7]. However, because these methods are time consuming and may result in unwanted product residues [4], other household methods, such as microwave [8] and ulraviolet (UV) light [1,4,9-11] are been researched, showing conflicting results. It seems that low-intensity UV rays are not effective against certain microbes and molds[4]. Then machines using other light sources must be tested.

Few works analyzed the extent of bacterial decontamination using the UV light in a clinical trial and no studies evaluated the effect of light emitter diode (LED) on toothbrush decontamination. Then, the following experiment compared the efficacy of these physical methods as toothbrush sanitization machine.

Materials and Methods

Ethical aspects

The University's Ethics Committee approved the research protocol (Report Coética no. 783575/2014, University of Fortaleza).

Subjects

Thirty patients (15 male and 15 female aged 20-55 years) were enrolled in this study. All subjects had at least 20 natural teeth, presenting gingivitis but no signs of periodontitis, had no caries or extensive dental restorations and had not been exposed to systemic antibiotic treatment during past 6 months. Volunteers with medical disorders, using mouthwashes, smokers and pregnant women were excluded from the trial.

Clinical design

On day 0, each participant received a "kit" with a toothbrush (Leader®, Facilit Odontológica e Perfumaria Ltda., Rio de Janeiro, Brasil) and a fluoride dentifrice (Freedent®, Indústrias Raymond's São Paulo, Brasil). The participants were instructed to brush their teeth using their habitual technique, during one minute, three times a day, for one week. After tooth brushing the volunteers were instructed to rinse the brush heads under running tap water for ten seconds and hold the toothbrush at room temperature. Verbal and written instruction about the home procedures were given to all subjects. After seven days, the volunteers should return the toothbrushes to proceed for the laboratorial phase.

Laboratorial phase

The toothbrushes were designed to each group, by random allocation using a computer-generated random table made by a person not participant of the study: Control (n=10) – the toothbrushes were not decontaminated; LED (n=10): application of light emitter diode during 05 minutes (Foto Optilight LD Max, Gnatus®, 450 nm, 600mW); UV (n=10): application of ultraviolet light during 05 minutes ("Esterilizador de Escovas Portátil"®- Modelo RM-TS101, 270 nm, 3W).

After the decontamination process, the brush heads were covered with the plastic caps, identified according the group and sent to Microbiology's Laboratory for microbiological analysis. The brush heads were immersed in test tubes containing Brain Heart Infusion – BHI for 30 seconds and after this, they were putted in a stove at 37°C for 24h. The level of contamination by McFarland scale and morphological characteristics of the microorganisms was performed.

Statistical analysis

ANOVA and Student Newman-Keuls analysis were performed to evaluate statistical differences among groups (α=.05). For morphological analysis the chi-square test was used (α=.05). However, for illustrative purposes the results are showed as means, medians and standard deviations.

Results

All groups showed higher levels of bacterial contamination and not presented statistically significance difference among them (p>0.05) (Tables 1 and 2). In the control group gram + and gram- cocci were present in all toothbrushes and gram - cocci were absent in the other groups (p<0.05). In the LED and UV groups gram+ cocci and gram + bacilli were predominant, but no statistically significance difference was observed among them (p>0.05) (Table 3; Figure 1).

Table 1. Mean, Medians and standard deviation of the level of turbidity in the different groups.

Group	Control	LED	UV
Mean	4.8[a]	4.7[a]	4.9 [a]
Median	5[a]	5[a]	5[a]
Standard-deviation	0.5	0.5	0.3

*Values followed by same letters (a) in a same line did not differ statistically (p>0.05).

Table 2. Mean, Median and standard deviation of the level of sediment in the different groups.

Group	Control	LED	UV
Mean	2.6[a]	2.7[a]	2.7[a]
Median	3[a]	3[a]	3[a]
Standard-deviation	0.7	0.5	0.5

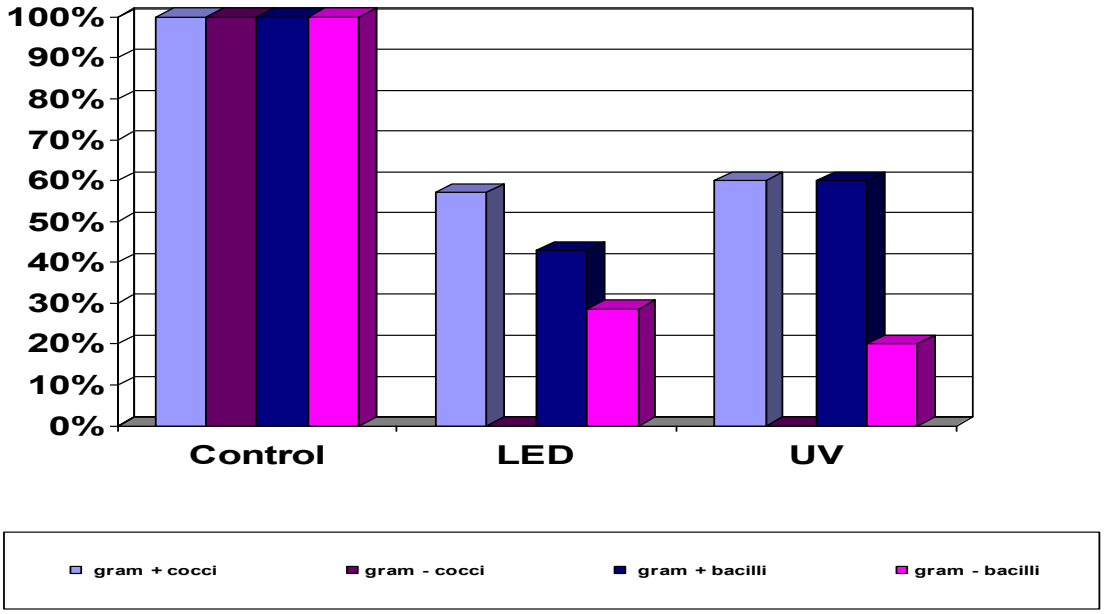
*Values followed by same letters (a) in a same line did not differ statistically (p>0.05).

Table 3. Percentage distribution among different morphotypes in the

	Control (a)	LED (b)	UV (b)
Gram+ cocci	100%	57.14%	60%
Gram- cocci	100%	0%	0%
Gram+ bacilli	100%	42.85%	60%
Gram- bacilli	100%	28.57%	20%

*Different letters showed significant statistically difference among groups (p<0.05).

Figure 1. Percentage distribution among different morphotypes in the groups



Discussion

Failure in maintaining adequate oral health status in the hospital environment can negatively affect the quality of life of patients and new condition can onset, such as pulmonary infection by microrganisms of the oral cavity [12]. Besides, contaminated toothbrushes contributed to the persistence of group A beta-hemolytic streptococci in the oropharynx and to the failure of penicillin therapy in some cases of pharyngotonsillitis [13].

To minimize this risk, toothbrushes are commonly used in hospital settings for oral care by nurses and may harbor potentially harmful microorganisms [14,15]. Even so, tooth brushing alone or in combination to chorhexidine showed no additional benefits for the prevention of nosocomial pneumonia [15]. So, is that the toothbrushes are not acting as agents of recontamination? Is that the problem is not the lack of decontamination of dental brushes before each use in these very contaminated environment?

In fact, a peer-reviewed literature review revealed that toothbrushes of oral diseased adults become contaminated with pathogenic bacteria from the dental plaque, environment, or a combination of factors. Surfaces in close contact with the patient such as bed frames, countertops, sinks and bedside tables may act as fomites. Some commonly observed nursing practices include storing the toothbrush in the bath basin with other bathing/personal supplies. These practices may impact the contamination of toothbrushes [16,17].

The higher levels of contamination of the control group showed that one-week contamination was sufficient for promotes the bacterial growth in the toothbrush head [4], including gram-negative bacilli, which are microorganisms very common in the oropharyngeal area of the hospitalized patients [15]. Microorganisms present on a contaminated toothbrush can remain viable for a period ranging from 24 h to 7 days; this fact shows the importance of the researches that evaluate decontamination methods to avoid in the spreading these microorganisms within the oral cavity [1]. Then, the present work was designed to evaluate the effect of the UV light on toothbrush decontamination in comparison to LED.

The toothbrushes of the UV group had the same level of turbidity and sediment than other groups, even though that showed lower percentage of bacterial morphotypes comparing to no decontaminated toothbrushes. In a similar study, toothbrushes decontamination using UV light for seven minutes was effective and showed a lower aerobic bacterial in relation to control group[1]. This may be due to the length UV light exposure the toothbrushes received during the sanitization process[11]. However, in the same way, LED showed similar results, even presented wavelength greater than UV light. Up to now, there are no studies evaluating the effect of LED on toothbrushes decontamination, so it is unable the data comparison with the current literature.

One of the possible reasons for the divergence of the results with UV light was the contamination time, which was just 48 hours in that study [1]. Other works showed positive results

using UV in the decontamination process [9,11]. The toothbrush sanitization machines for household was used diary, in which lower bacterial contamination is present, and it could explain the difference with our study.

Previous studies have revealed that the longer exposure to UV light is necessary to ensure a complete inactivation of all microorganisms[18,19], by damaging the DNA and disrupting the chemical bonds that hold the atom of DNA together in the microorganism [4]. Indeed, even using the double of the time recommended by the manufacturer, UV light did not significantly reduce the bacterial contamination on the brush heads when compared to microwave [4]. A previous literature review [20], has questioned the potential of low-intensity UV radiation in microbial inactivation. Furthermore, tightly packed bristles could not be in direct exposure to UV light and may explain these inexpressive results [4].

The American Dental Association (ADA) Council on Scientific Affairs' encourages patients to select a toothbrush sanitizer that is cleared by the Food and Drug Administration (FDA). Furthermore, the ADA invites consumers and professionals to critically review the claims made by manufactures of the toothbrush sanitizer which usually refer to sanitizing (not sterilizing) or reducing bacterial contamination on toothbrush [11]. In the present study, in spite of the manufacture indicates that the sanitizer machine was a "sterilizer device", it did not match this claim.

It seems that UV light and LED are not efficient in contaminated highly toothbrushes, such as that are used by patients with periodontal diseases and hospitalized patients, although they had affected the composition of the flora of the mouth, reducing the quantity of pathogenic gram-negative bacteria. Then, it is suggested that companies in the industry dental focus more frequent and comprehensive manner this issue by developing products more efficient to toothbrushes decontamination, specifically for hospitalized patients under intensive care, in which the level of contamination of the oral cavity is higher and more complex.

Conclusion

Ultraviolet light and light emitter diode had a limited benefit on toothbrushes decontamination.

References

1.Beneduce C, Baxter KA, Bowman J, Haines M, Andreana S. Germicidal activity of antimicrobials and violight personal travel toothbrush sanitizer: an in vitro study. J Dent. 2010, 38(8): 621-625.

2. Quirynen M, De Soete M, Pauwels M, Gizani S, Van Meerbeek B et al. Can toothpaste or a toothbrush with antibacterial tufts prevent toothbrush contamination? J Periodontol. 2003, 74(3): 312-22.

3. Sato S, Pedrazzi V, Guimarães Lara EH, Panzeri H et al. Antimicrobial spray for toothbrush disinfection: An in vivo evaluation. Quintessence Int. 2005, 36(10): 812-816.

4. Gujjari SK, Guijari AK, Patel PV, Shubhashini PV. Comparative evaluation of ultraviolet and microwave sanitization techniques for toothbrush decontamination. J Int Soc Prev Community Dent. 2011,1(1): 20-26.

5. Nelson-Filho P, Isper AR, Assed S, Faria G, Ito IY. Effect of triclosan dentifrice on toothbrush contamination. Pediatr Dent. 2004, 26(1):11-16.

6. Quirynen M, de Soete M, Pauwels M, Goossens K, Teughels W et al. Bacterial survival rate on tooth-and interdental brushes in relation to the use of toothpaste. J Clin Periodontol. 2001, 28(12):1106-1114.

7. Warren DP, Goldshcmidt MC, Thompson MB, Adler-Storthz K. The effects of toothpastes on the residual microbial contamination of toothbrushes. J Am Dent Assoc. 2001, 132(9): 1241–1245.

8. Chibebe J, Jr Pallos D. Evaluation of sterilization of toothbrushes in a microwave oven (in vitro study). Rev Biociênc. 2001, 7: 39-42.

9. Glass RT, Jensen HG. The effectiveness of a u-v toothbrush sanitizing device in reducing the number of bacteria, yeasts and viruses on toothbrushes. J Okla Dent Assoc. 1994, 84(4): 24–28.

10. Boylan R, Li Y, Simeonova L, Sherwin G, Kreismann J et al. Reduction in bacterial contamination of toothbrushes using the Violight ultraviolet light activated toothbrush sanitizer. Am J Dent. 2008, 21(5): 313–317.

11. Berger JR, Drukartz MJ, Tenenbaum MD. The efficacy of two UV toothbrush sanitization devices. A pilot study. NY State Dent J. 2008, 74(1): 50-52.

12. Sousa LL, e Silva Filho WL, Mendes RF, Moita Neto JM, Prado Junior RR. Oral health of patients under short hospitalization period: observational study. J Clin Periodontol. 2014, 41(6): 558-563.

13. Brook I, Gober AE. Persistence of group A betahemolytic streptococci in toothbrushes and removable orthodontic appliances following treatment of pharyngotonsillitis. Arc Otolaryngol Head Nec Surg. 1998, 124(9): 993-995.

14. Gibney J, Wright C, Sharma A, Naganathan V. Nurses' knowledge, attitudes, and current practice of daily oral hygiene care to patients on acute aged care wards in two Australian hospitals. Spec Care Dentist. 2015, 35(6): 289-293.

15. Vilela MC, Ferreira GZ, Santos PS, Rezende NP. Oral care and nosocomial pneumonia: a systematic review. Einstein. 2015, 13(2): 290-296.

16. Frazelle MR, Munro CL. Toothbrush contamination: a review of the literature. Nurs Res Pract. 2012, 2012:420630.

17. Mehta A, Sequeira PS, Bhat G. Bacterial contamination and decontamination of toothbrushes after use. NY State Dent J. 2007,73(3): 20-22.

18. Speert PT, Wannamaker LW. Susceptibility of group A streptococci to oleic acid and ultraviolet light. Comparison of strains from throat and skin. J Lab Clin Med. 1980, 96(2): 252-257.

19. Arrage AA, Phelps TJ, Benoit RE, White DC. Survival of subsurface microorganisms exposed to UV radiation and hydrogen peroxide. Appl Environ Microbiol. 1993, 59(11): 3545-3550.

20. Thomas B, Litopoulou-Tzanetaki E, Robinson RK. Existing and potential applications of ultraviolet light in the food industry: A critical review. J Sci Food Agric. 2000, 80(6): 637–645.