

Effect of ultraviolet radiation combined with immersion disinfection of silicone impressions infected with hepatitis B virus and HIV.

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Abstract

Purpose: The objective of the present study was to evaluate the effect of ultraviolet ray combined with immersion method on the disinfection of silicone impression materials.

Methods: Forty eight silicone impressions were rinsed by flushing water and then completely dried. Impressions were randomly divided into A and B groups (n=24). In group A, serum sample with positive hepatitis B virus was smeared evenly on the surface of dental impressions. In group B, serum samples positive for Human Immunodeficiency Virus (HIV) were evenly smeared on the surface of dental impressions according to the procedures described in group A. The dental impressions were sub-grouped into 1, 2, 3 and 4 groups (n=6). A1 and B1 were established as control groups. In A2 and B2 groups, dental impressions were subjected to ultraviolet radiation at intensity of 7000 $\mu\text{W}/\text{cm}^2$ for 30 s. In A3 and B3 groups, dental impressions were immersed in 2% glutaraldehyde solution for 5 min.

Results: In A4 and B4 groups, the impressions were subjected to ultraviolet radiation for 30 s, and subsequently immersed in 2% glutaraldehyde solution for 5 min. 2% glutaraldehyde immersion or ultraviolet radiation disinfection alone failed to achieve high disinfection effect. Combined use of ultraviolet radiation and 2% glutaraldehyde immersion can eliminate both HBV and HIV.

Conclusion: Ultraviolet radiation combined with 2% glutaraldehyde immersion exerts high effect upon the disinfection of dental impressions infected with HBV and HIV.

Keywords: Ultraviolet ray, Immersion disinfection, Silicone rubber impression disinfection, Hepatitis B virus, Human immunodeficiency virus (HIV).

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Introduction

Dental impressions consist of taking into the mouth a material able to register the anatomical details of the desired area that is dimensionally stable. The impression can be used to represent the anatomy of the impressed area [1]. During this procedure, the impression materials contact with the saliva and blood, which are sources of contamination, and carries a high quantity of microorganisms of the oral flora upon the removal from the mouth. Common materials used for dental impressions are sodium alginate, polyether and silicones-both condensation-cured silicones and addition-cured silicones, such as polyvinyl siloxane etc. Several types of dental impressions currently employed in dentistry have a great potential to retain microorganisms on their surfaces [2,3].

American dental association guidelines states that impression should be rinsed to remove saliva, blood and debris and then disinfect before being sent to the laboratory, otherwise it may cause severe contaminated during dental procedures. Contamination of the working atmosphere by several microorganisms from the oral flora during the clinical practice

of dentistry offers constant risks to the health professionals [4]. Strong evidences have been shown in the literature regarding the pathogenesis and intensity of the viruses of Hepatitis B (HBV), herpes, tuberculosis and Acquired Immunodeficiency Syndrome (AIDS) in dentistry [3,4]. According to the guidelines recommended by American Dentist Association, the impression materials should be immediately disinfected after tooth extraction. Besides the first round of running water irrigation, the dental impressions should be repeatedly disinfected using the disinfectants [5]. In accordance with the operation guidelines proposed by the Ministry of Health in China in 2005, appropriate disinfection or sterilization methods should be implemented based upon the dental instruments and materials [6]. However, this type of irrigation alone fails to completely eliminate the contaminants. The priority of dental professionals is mainly how to enhance the efficiency of different disinfections methods. The disinfection of impressions is a fundamental procedure in the routine dental practice.

In this investigation, the optimal disinfection technique was urgently explored by establishment of dental impressions

infected with HBV and HIV. Subsequently, the disinfection effects of glutaraldehyde immersion, ultraviolet radiation disinfection or combined use of two techniques were closely observed and statistically compared.

Materials and Methods

Materials

ABI7500 fluorescent quantitative PCR analyser (Applied Biosystems, USA); Hepatitis B virus nucleic acid assay kit (DaAn Gene Co., Ltd. of Sun Yat-sen University, registration number: 20163400142); HIV-1 nucleic acid assay kit (DaAn Gene Co., Ltd. of Sun Yat-sen University, registration number: 20163400154); elastomer impression material (Shanghai Huge Medical Instrument Co., Ltd. China); Nippo SGL-500 ultraviolet lamp (Shunde, China); 2% glutaraldehyde solution (Lircon, Shandong, China); HBV and HIV-positive serum solution (Daqing Longnan Hospital, Heilongjiang, China).

Model establishment

In total, 48 patients admitted to our hospital between Jan-Jun 2015 were randomly recruited in this study. The study procedures were approved by the ethics committee of our hospital. Forty eight pairs of silicone impressions (maxilla and mandible) were constructed strictly according to the manufacturer's instructions. All the procedures were accomplished by the same nurse. The dental impressions were washed using flushing water and dried immediately after removal of dental impressions. Forty eight pairs of dental impressions were established and infected with HBV and HIV. In the A group, HBV-positive serum solution was evenly smeared on the anterior, bilateral posterior dental and palate regions of the maxilla and the anterior, bilateral posterior dental and mouth base regions of the mandible of the dental impressions. An equivalent quantity of HIV solution was smeared on the surface of dental impressions according to the procedures described in the A group.

Grouping

After HBV and HIV smearing for 3 min, all dental impressions in both A and B groups were subsequently divided into four subgroups (n=6 for each subgroup). The dental impressions in A1 and B1 groups were established as control groups. In A2 and B2 groups, dental impressions were subjected to ultraviolet radiation at intensity of 7000 $\mu\text{W}/\text{cm}^2$ for 30 s. In A3 and B3 groups, dental impressions were immersed in 2% glutaraldehyde solution for 5 min. In A4 and B4 groups, the impressions were subjected to ultraviolet radiation for 30 s, and subsequently immersed in 2% glutaraldehyde solution for 5 min.

Subgrouping

In each subgroup of A group, HBV sample was collected using a cotton swab containing 100 μl of physiological saline from

the anterior, bilateral posterior dental and palate regions of the maxilla and the anterior, bilateral posterior dental and mouth base regions of the mandible. The virus sample was mingled with 200 μl of physiological saline, repeatedly shocked and prepared for subsequent fluorescent quantitative PCR detection of HBV-DNA. Negative result was defined when the HBV-DNA level was less than 1×10^3 and positive findings was obtained when the HBV-DNA level exceeded 1×10^3 . In each subgroup of group B, HIV-1 nucleic acid level was detected using the same procedures described in group A. The detection result was expressed as the logarithm value of HIV elimination. Disinfection effect was obtained when the logarithm value exceeded 5.

Statistical evaluation

SPSS 19.0 statistical software was used for data analysis (SPSS Inc., Chicago, IL, USA). Relevant parameters among different groups were statistically compared by using t-test. A p value of less than 0.05 was considered as a level of statistical significance.

Results

Disinfection effect on HBV

As illustrated in Table 1, the effect of three disinfection methods upon eliminating HBV was statistically compared. Statistical analysis revealed that negative results were obtained in 2 dental impressions after ultraviolet radiation disinfection for 30 s and the remaining 10 impressions were still positive for HBV (P=0.511). In the 2% glutaraldehyde immersion group, only 1 dental impression was negative for HBV after 5 min immersion, and the other 11 impressions yielded positive HBV (P=0.612). All 12 dental impressions were negative for HBV after combined use of ultraviolet radiation for 30 s and 2% glutaraldehyde immersion for 5 min (P=0.024).

Disinfection effect on HIV

As revealed in Table 2, the effect of three disinfection methods upon eliminating HIV was statistically compared. Prior to impression disinfection, the mean logarithm value of HIV was measured as 0.196. Statistical analysis revealed that the mean logarithm value of HIV was statistically increased to 2.947 after ultraviolet radiation disinfection for 30 s (P=0.042). In the 2% glutaraldehyde immersion group, the mean logarithm value of HIV was elevated up to 3.132 after 5 min 2% glutaraldehyde immersion (P=0.037). The mean logarithm value of HIV was the highest among three disinfection methods of 5.334 after combined use of ultraviolet radiation for 30 s and 2% glutaraldehyde immersion for 5 min (P=0.025).

Table 1. Comparison of effect of three disinfection different methods on eliminating HBV-DNA (expressed as positive result).

	Control group (n)	Experimental group (n)	P value
Ultraviolet radiation	12+	10+	0.511

Effect of ultraviolet radiation combined with immersion disinfection of silicone impressions infected with hepatitis B virus and HIV

Glutaraldehyde immersion	12+	11+	0.612
Ultraviolet radiation			
+Glutaraldehyde immersion	12+	0	0.024

Table 2. Comparison of effect of three disinfection different methods on eliminating HIV-1 nucleic acid (expressed as logarithm value).

	Control group (n)	Experimental group (n)	P value
Ultraviolet radiation	0.196	2.947	0.042
Glutaraldehyde immersion	0.196	3.132	0.037
Ultraviolet radiation+			
Glutaraldehyde immersion	0.196	5.334	0.025

Discussion

Transmission of pathogens to healthcare workers is constantly originated from their exposure to blood, tissue or other body fluids. Blood or saliva is considered as a direct carrier of infection, whereas contaminated equipment’s, surfaces and airway carry infection indirectly. AIDS, hepatitis, herpes and tuberculosis are very frequently passed to the physicians and nurses through patients and this issue is commonly encountered in dentistry. Dentistry may play a role in the transmission of infection through dental impressions [7,8]. Instructing dentists about infection control may decrease the odds of infection transmission. Dental impression, a prerequisite for all dental procedures has direct contact with saliva and blood and thus is a potential source of cross-infection. According to the British Dental Association, infection control is a core element of dental practice. An impression, if not disinfected, can cross-contaminate the entire laboratory area, allowing microorganisms to spread from the laboratory to the clinical practice. Although almost all of the respondents realized the importance of hand washing before and after the impression making, only half of them used the appropriate method of hand washing [9]. Dental impressions contaminated with patient’s blood and saliva cause contamination of the stone cast models. Moreover, microbiological examination of these casts in many studies has shown pathogenic microorganisms. A survey done on 400 Dental laboratories in USA found that that besides lack of knowledge about disinfecting procedures for impressions, dentists and labs disinfect impressions for longer than recommended durations because of the lack of awareness [10]. In this study, HBV and HIV-infected dental impressions were successfully established and three disinfection methods were employed for sterilizing the dental impressions.

Glutaraldehyde is recommended as the primary disinfection agent for infectious hepatitis proposed by the World Health Organization (WHO) worldwide. Various methods have been employed including the use of disinfectant sprays, solutions and ethylene oxide gas sterilization. These solutions may

produce irritating vapours, depending on the disinfectant used. Previous investigations [10,11] have demonstrated that the size and stability of the silicone impressions present with no significant changes after immersion in 2% glutaraldehyde solution for 30 min. Therefore, 2% glutaraldehyde immersion was adopted in this study for the disinfection of silicone dental impressions.

The use of ultraviolet rays can be a good alternative choice for disinfection because ultraviolet chambers are available in most of the dental clinics and are used to store sterilized dental instruments to avoid recontamination from dental operatory [12]. Ultraviolet rays have long been recognized as an effective method for eliminating microorganisms without requiring chemicals or heat. When microorganisms are exposed to ultraviolet rays at a particular wavelength (200-280 nm), their reproduction capability is destroyed and inactivation occurs at a faster rate, so that they no longer pose threat to humans. Therefore, this study was conducted to evaluate the efficacy of ultraviolet rays to disinfect dental impression materials at different time intervals was determined and was compared with 2% glutaraldehyde.

Multiple factors that affect the effectiveness of Ultraviolet light include time, intensity, humidity and direct access to the organism [13]. Since dental impressions do not get exposed from all areas, it is necessary that ultraviolet light must be reflected from different directions. Ultraviolet light of 200-280 nm wavelengths is lethal to bacteria, bacterial spores, viruses, mold, mold spores, yeast and algae. Since the penetrating power of ultraviolet light is low, it is not readily absorbed by organic materials. Before ultraviolet light disinfection, cleaning of visibly soiled surfaces is necessary. While using dental UV chamber the wavelength used is 254 nm which is quite effective for disinfecting impression. Also the changes in the surface details as well as the dimensional accuracy of the impression are affected to a varying degree by these disinfectants. In current study, the disinfection effects of 2% glutaraldehyde immersion, ultraviolet radiation disinfection or combined use were statistically compared to explore the optimal disinfection method for dental impressions. Ultraviolet radiation combined with 2% glutaraldehyde immersion exerts higher effect upon the disinfection of dental impressions infected with HBV and HIV compared with the single use of 2% glutaraldehyde immersion or ultraviolet radiation. However, due to the limited viral types and dental materials used in this study, the disinfection effect of different techniques remains to be further explored and validated.

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