

A Study on the Effect on Surface Detail Reproduction of Alginate Impressions Disinfected with Sodium Hypochlorite and Ultraviolet Light – An *In Vitro* Study

H. S. Shambhu, Anil Kumar Gujjari

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Objectives of the study: To evaluate the surface detail reproduction of dental casts with impressions made using commercially available alginate impression materials after disinfecting with chemical disinfectant sodium hypochlorite and physical means of disinfection using ultraviolet radiation. **Materials and methods:** A stainless steel die was used to make impression according to ADA/ANSI specification No. 18 having 25, 50 and 75 μm lines. Totally 70 impressions were made and divided in to 7 groups. The impressions in the first group were only rinsed with 250 ml of water. The 2nd, 3rd and 4th groups were disinfected by immersing in sodium hypochlorite for 1, 5 and 10 minutes, respectively. Fifth, 6th and 7th group samples were disinfected by placing them in ultraviolet chamber for 6, 12 and 18 minutes, respectively. All the impressions were poured immediately using type III gypsum. The casts were recovered and subjected for evaluation of the 75 μm lines using stereomicroscope. **Results:** There was no statistically significant change in the surface detail reproduction when disinfected with sodium hypochlorite or ultraviolet radiation. **Conclusion:** Alginate impressions subjected to immersion disinfection using sodium hypochlorite for 1, 5 and 10 minutes and subjected to ultraviolet disinfection for 6, 12 and 18 minutes exhibited no statistically significant differences for surface detail reproduction compared to control groups.

Keywords: Disinfection, Irreversible hydrocolloid, Surface detail

Introduction

Impression making is an important aspect of prosthodontics. Impression materials are believed to carry various microorganisms from the oral cavity due to direct contact with saliva and possibly blood. Because of greater awareness and concern about infection control, disinfection procedures have been suggested to reduce the transmission of infections to dentists and laboratory technicians [1, 8].

The disinfection of dental impression materials has become a critical topic of universal concern, because it may be the first link in microbial contamination during dental care [11].

As alginate impression materials do not tolerate heat, the recommendations have been concentrated on chemical solutions. Some disinfectant solutions used to treat impressions in the dental operatory may cause significant dimensional changes, particularly with overexposure. So physical means of disinfections are used, such as ultraviolet (UV) radiation.

Leung and Schonfeld found that contaminated impressions can transfer bacteria to stone casts [2].

Sodium hypochlorite has been shown to be an effective bacterial, viral and fungal disinfectant for irreversible hydrocolloid impressions [10, 14]. Sodium hypochlorite has

H. S. Shambhu ✉ • A. K. Gujjari
Department of Prosthodontics,
Crown and Bridge, J.S.S. Dental College and Hospital,
Mysore, Karnataka, India

e-mail: drshambhu@yahoo.com

been shown to be a fast acting broad-spectrum disinfectant [3, 6].

UV rays are used to disinfect water supplies, laboratory equipments, contact lens, dental hand piece [4, 8], and impression materials and implants [7, 17].

Materials and Methods

A stainless steel test die was constructed according to American National Standards Institute/American Dental Association (ANSI/ADA) specification No. 18 for alginate impression materials. The die consisted of two parts fabricated following a barrel and piston design (Fig. 1).

A circular stainless steel block which acted as a piston.

A hollow stainless steel ring was used, which acted as a barrel, to retain and confine the impression material.

Three vertical lines of 25 mm length and of 25 μm , 50 μm and 75 μm width were engraved on the metal surface of the stainless steel block (Fig. 4). Two additional horizontal lines 25 mm apart from each other were engraved perpendicular to the previously marked lines.

The stainless steel ring was lubricated with soft white petroleum jelly. The stainless steel block was cleaned with alcohol and allowed to air dry prior to recording each impression. The stainless steel ring was placed on the stainless steel block and impressions were made.

Preweighed alginate powder was mixed with deionized water at room temperature. The alginate powder was wetted manually for 15 seconds, followed by mechanical mixing for 30 seconds, in an auto mixer to get homogeneous mix. The mixed material was placed on the center of the stainless steel block surface after the placement of the ring within 1 minute from the start of mixing. A glass plate was placed on ring surface with sufficient force to seat the plate firmly against the stainless steel ring. The glass plate was then loaded with 1 kg weight on top of it. About 3 minutes after the minimum setting time recommended by the manufacturer, the stainless steel ring was separated along with the impression from the stainless steel block surface. Therefore, the separation time was approximately 5 minutes from the start of mixing.

Totally 70 alginate impressions were made of the metal die. The impressions were divided into 7 groups with 10 samples in each group for control group with water rinse, immersion for 1 minute, immersion for 5 minutes, immersion for 10 minutes, UV radiation for 6, 12 and 18 minutes.

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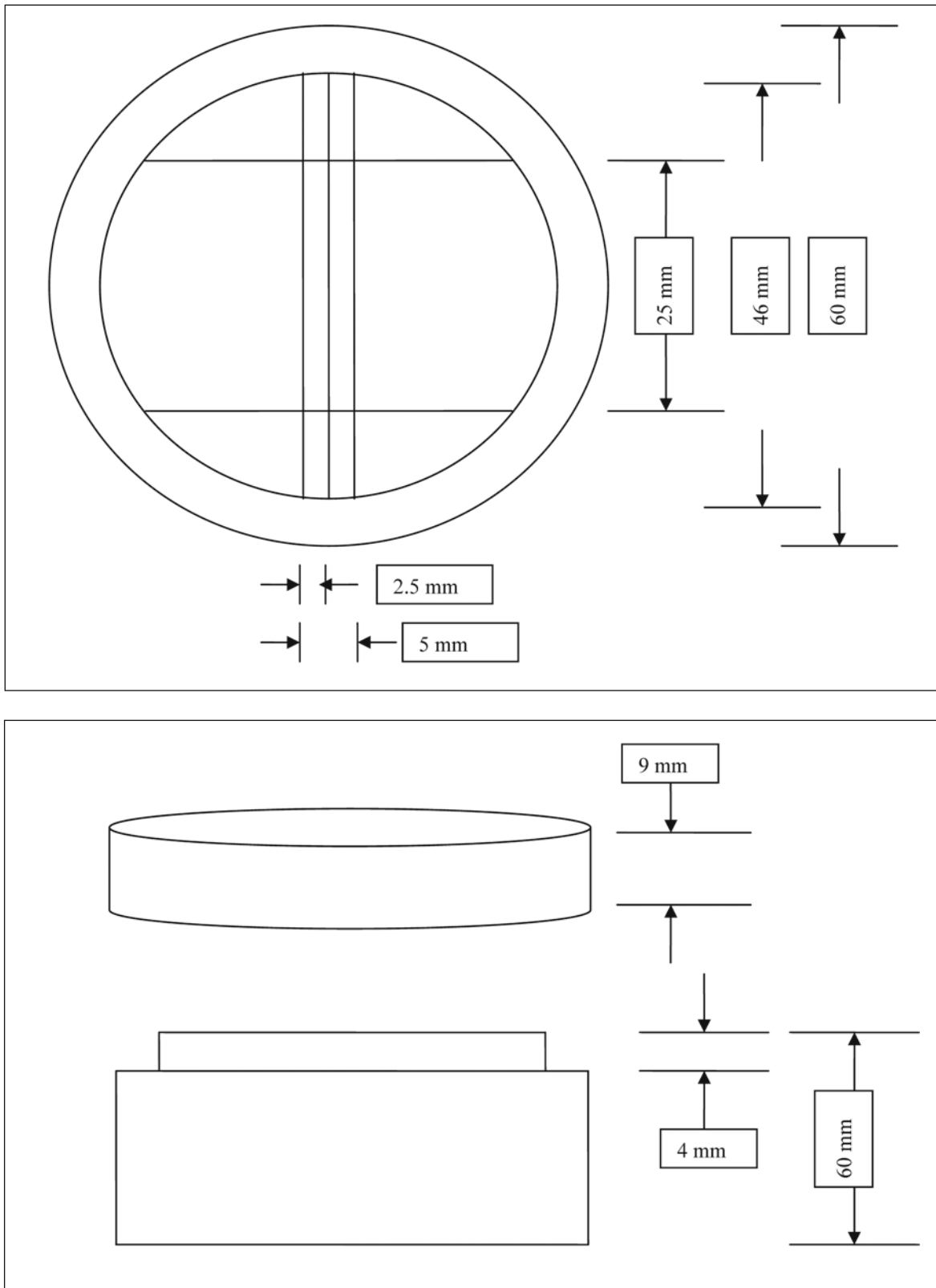


Fig. 1 Diagrammatic representation of the stainless steel die

Disinfection Procedures

For control group after the impressions were separated from the test block, the impression surface was immediately assessed visually for reproduction of the lines from the test block surface. To pass the ANSI/ADA specification for detail reproduction, the alginate has to reproduce visually the full 25 mm length of the 50 μm wide line. The impressions were washed using 250 ml of distilled water for 10 seconds to mimic the water rinsing clinically after the impression was made.

For disinfection using sodium hypochlorite the impressions were washed with 250 ml of sterile water for 10 seconds. Each impression was then immersed in 250 ml of freshly prepared sodium hypochlorite 0.525% solution for 1, 5 and 10 minutes. Fresh disinfectant was used for each impression. Immediately following disinfection for the prescribed immersion time, the impressions were rinsed again with 250 ml of sterile water and gently shaken to remove excess disinfectant and water.

For disinfection using UV radiation the impressions were washed with 250 ml of sterile water for 10 seconds. Each impression was then kept in UV chamber for 6, 12 and 18 minutes. The samples were placed in the UV chamber in such a way that the impressions were exposed to UV rays directly. Immediately following disinfection for the prescribed radiation time, the impressions were rinsed again with 250 ml of sterile water and gently shaken to remove excess water.

Pouring of Gypsum Casts

If the impressions passed ANSI/ADA specification, they were cast in type III dental stone. Dental stone was mixed as recommended by the manufacturer under vacuum. The vacuum mixed dental stone was poured against the treated impression surface by vibrating a small quantity down the entire length of the reproduced vertical lines. Additional stone was allowed to flow over the surface. The poured impression was air stored at room temperature for 1 hour, after which it was separated. After retrieval of the casts, the specimens were numbered for identification. The specimens were allowed to dry for a minimum of 24 hours before evaluation of detail reproduction.

Detail Reproduction of Stone Casts

According to ANSI/ADA specification No. 18, dental stone casts made from alginate specimens have to reproduce the 75 μm wide line. For grading purposes both the 75 μm and

50 μm wide lines were assessed for alginate impressions. All stone specimens were examined under low angle (20-degree angle of incidence to the surface) illumination at $\times 30$ magnification with a stereomicroscope to which a camera is connected. For better discrimination between specimens, a scoring system with rating values from 1 to 4 was followed:

- Rating 1 - Well defined, sharp detail, continuous line
- Rating 2 - Continuous line but with some loss of sharpness
- Rating 3 - Loss of continuity of the line or significant loss of detail
- Rating 4 - Failure to reproduce lines.

Results

All the statistical calculations were done through SPSS (Statistical Presentation System Software) for Windows Version 14.0 Evaluation version (SPSS, 2005. SPSS Inc, New York). Statistical methods applied study were, Frequencies/Descriptives, Correlations and Kruskal-Wallis H.

Interpretation of Results

Table 1a and 1b Kruskal values or non-parametric values reveal non-significant Chi-square value. Different groups in their Kruskal value the mean ranks obtained for different groups were found to be statistically same (Chi-square = 0.568; $p < 0.904$).

Table 1a Kruskal-Wallis ranks

Groups	n	Mean rank
Control	10	19.45
1 minute sodium hypochlorite	10	19.35
5 minutes sodium hypochlorite	10	20.60
10 minutes sodium hypochlorite	10	22.60

Table 1b Kruskal-Wallis test statistics

	Kruskal value
Chi-square	0.568
Degree of freedom	3
Asymptomatic significance	0.904

Table 2a and 2b Kruskal values or non-parametric values reveal non-significant Chi-square value. Different groups in their SH value the mean ranks obtained for different groups were found to be statistically same (Chi-square = 0.094; $p < 0.993$).

Table 2a Kruskal-Wallis ranks

Groups	n	Mean rank
Control	10	20.30
6 minutes UV	10	20.15
12 minutes UV	10	20.15
18 minutes UV	10	21.40

Table 2b Kruskal-Wallis test statistics

	Kruskal value
Chi-square	0.094
Degree of freedom	3
Asymptomatic significance	0.993

Interpretation of Graphs

Figure 2 shows the percentage deterioration of the surface detail after disinfecting with sodium hypochlorite. The disinfectant used under the regimen employed does affect the surface detail of the impression after immersion for 5 and 10 minutes.

Figure 3 shows the percentage deterioration of the surface detail after disinfecting with UV light. The disinfectant used

under the regimen employed does affect the surface detail of the impression after exposing for 18 minutes.

Discussion

Several previous investigations [12, 13, 16] have shown sodium hypochlorite to exhibit no clinically significant effect on the surface detail reproduction of alginate impressions.

The effectiveness of sodium hypochlorite as a disinfectant is influenced by a number of factors including concentration and age of the solution, disinfection contact time and accessibility of the organisms, presence of organic material, and presence of metal catalysts, pH [14], temperature and chemical additives to the sodium hypochlorite [13]. The presence of organic material is another factor influencing the efficacy of sodium hypochlorite disinfection [14]. Metal impressions trays can diminish the activity of the sodium hypochlorite solution. Copper, nickel, cobalt and other metals have been shown to be catalysts of chlorine solution decomposition. Decomposition of active chlorine in the sodium hypochlorite solution may occur with repeated contact with the trays. Fresh sodium hypochlorite solution was used for each impression in this study to limit this effect. The effectiveness of sodium hypochlorite was also reduced by alginate impression material and dilution of the solution. Time and conditions of storage were of secondary importance [9].

Disinfection by UV radiation has been applied to dental materials a number of times. Viable bacteria were effectively

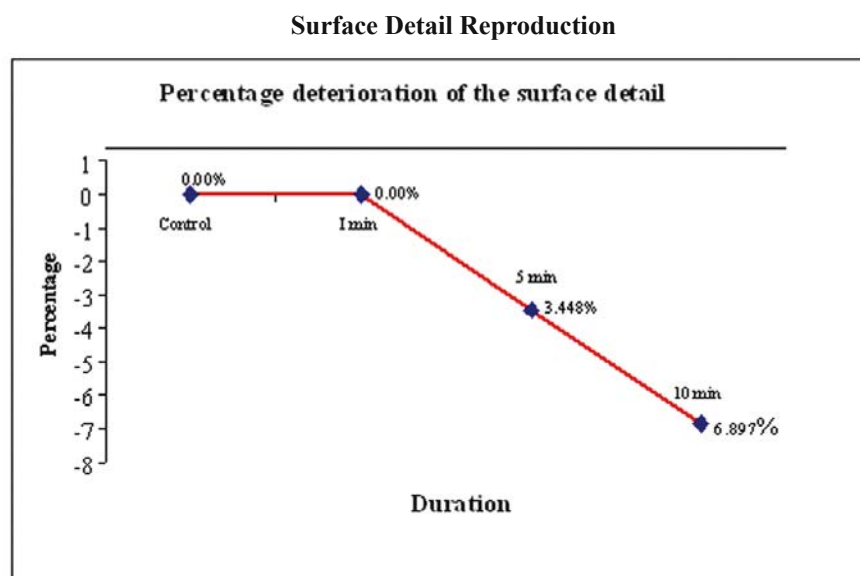


Fig. 2 Sodium hypochlorite disinfection

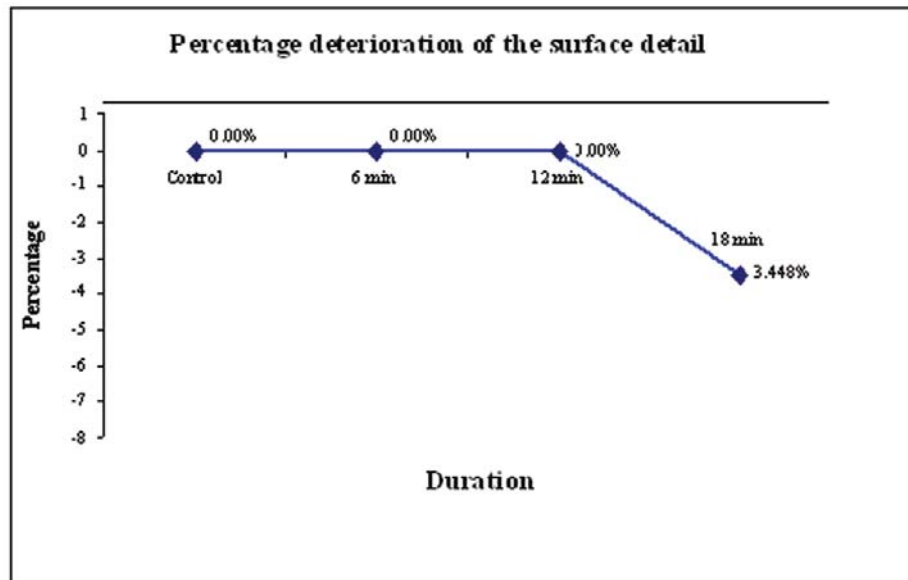


Fig. 3 UV disinfection



Fig. 4 Stainless steel block

removed from smooth exterior surfaces but remained in the deep crevices of both dental burs and impressions [15]. UV radiation has been used to disinfect water supplies, laboratory equipment, such as in laminar flow hoods, and rooms and halls in hospitals [5]. UV light causes the formation of thymine containing photoproducts in the DNA of affected cells. The UV chamber consisted of an UV tube (Phillips TUV 15W/G1598) which emits UV radiation at a wavelength of approximately 250 nm within the enclosed unit. The chamber was designed to reflect the UV light emitted so that the items within the unit will be exposed to UV radiation from many directions. Effectiveness of UV rays as a method of disinfection depends on a number of factors, among these are time, intensity, humidity and direct access to the organism.

To represent the initial removal of the oral organic material, the impressions were rinsed with 250 ml of sterile water for 10 seconds before disinfection, to simulate the rinsing of impression in clinical conditions. Water rinsing assists in removal of saliva, blood, mucosal debris and microorganisms from impressions. After immersion disinfection, rinsing aids in the removal of remaining disinfectant solution that may be detrimental to the surface of the gypsum casts.

In this study using Tropicalgin and Kaldent dental stone, the 75 μ line was evaluated for surface detail reproduction. 50 μ and 25 μ lines were also evaluated as well, whenever possible. The samples were rated on a visual scale of 1–4 according to the quality of the reproduction of the line. To provide greater differentiation, two evaluators were asked to grade the specimens based on graded scoring system as described earlier. The raters were unaware of the test specimen being evaluated. The established grading system was found to be reproducible and satisfactory. The findings of this study appear to agree with those of previous workers [14, 17], with regard to the surface detail of casts from those impressions treated with chlorine-based disinfectants and disinfection with UV radiation. From a clinical standpoint, casts with scores of 1 and 2 are considered satisfactory for diagnostic purposes or for use in fabrication of removable prosthesis including cast partial dentures. Casts that were rated greater than a score of 3 might have very little clinical use. The results of all the experiments show that impression material can act as a vehicle for transfer of microorganisms from clinic to the laboratory. The only effect on the alginate impressions

noted at the macroscopic level was a pink color produced by sodium hypochlorite immediately after immersion of the impressions. This effect is in line with the study conducted by Westerholm et al. in 1992 [11].

The drawbacks of this study were that only one type of alginate was used. The exposure time of sodium hypochlorite and UV radiation were different as they were specified by ADA and by the manufacturer of UV chamber and could not be compared with each other. Many studies show that the combination of alginate and the disinfectant used can affect the surface detail reproduction to some extent. This study showed the combination of Tropicalgin chromatic alginate was compatible with the disinfectants used in the study as there was no significant effect on the surface detail reproduction.

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