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Original Article

A self-disinfecting irreversible hydrocolloid impression material mixed with povidone iodine powder

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ABSTRACT

Objectives: The aim was to evaluate the effect of adding povidone (PVP) iodine powder with different concentrations to irreversible hydrocolloid on both microbiological and dimensional stability. **Materials and Methods:** Regular set of (alginate) irreversible hydrocolloid was selected as control group. PVP-iodine powder was mixed with the alginate powder at concentrations of 1, 5, 10, 15, and 20% by weight (test groups). All specimens were tested for their antimicrobial effect against *Streptococcus mutans* and *Staphylococcus aureus* as well as dimensional stability. **Results:** The results of test groups showed that concentrations 1, 5, and 10, weight % had little effect against *S. mutans* and *S. aureus* microorganisms. While concentrations 15 and 20 weight % had demonstrated greater effect on microbial growth. The mean of dimensional stability in mm of modified alginate with PVP-iodine at 15 and 20 weight % was –0.119 ± 0.255 and –0.035 ± 0.074, respectively. While the mean dimensional stability in mm of unmodified alginate was –0.112 ± 0.176 . The results of dimensional stability showed that 15 and 20 concentrations of test groups adversely affect the dimensional stability. The adverse effect was noticed to be significant in concentration 20%, where as it was nonsignificant in 15% concentration. **Conclusion:** Modified alginate impression material with 15 weight % PVP-iodine powered give the material, a self-disinfected properties with less deteriorating effect on dimensional stability.

Key words: Alginate, disinfection, povidone iodine

INTRODUCTION

Undoubtedly, alginate is one of the most popular materials for making an impression of the mouth. Accurate impressions are necessary for construction of any dental prosthesis.[1] Dental impressions can easily become contaminated with patient's blood and saliva, and hence these are considered as a potential source of cross-infection not only to the dentist and patient but also to the dental technician.[2]

Guidelines have been established by American Dental Association (ADA) to limit cross-contamination during dental clinical and laboratory procedures such as impression disinfection. On the basis of these guidelines, researchers have proposed many methods of disinfection for irreversible hydrocolloid impression material. There have been many proposed methods of disinfection for irreversible hydrocolloid

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impression materials such as spray and immersion techniques which provide only surface disinfection effect.[3-5] The time period and mode of application of disinfectant depend on the ability of the impression material to withstand the process of disinfection without any adverse effect on dimensional stability of the material.[6]

However, spraying that is performed with reduced contact time may restrict the effectiveness of disinfection, particularly for the porous hydrophilic hydrocolloids, where microorganisms can penetrate through the body and survive in the impression.[7] It was determined that the incorporation of disinfectants into the hydrocolloid powder[8,9] or mixing water[2] provides an effective means of additional decontamination, without leading to adverse effects considering dimensional stability[10] and surface accuracy.[11]

Follow-up studies of irreversible hydrocolloid impression materials that were pre-impregnated with disinfectants have shown that this technique reduced the overall quantity of bacteria on the impression material, demonstrated greater dimensional stability than spray and immersion techniques, and saved disinfection time.[2]

However, the self-disinfecting impression would be disinfected throughout the material and not just on the surface as would normally occur. This resulted in the development of self-disinfecting irreversible hydrocolloid impression materials that are pre-impregnated with disinfectants.[12] Powder form of povidone PVP-iodine had been previously demonstrated as potent disinfectants was selected.[13,14]

Searching for effective antimicrobial disinfectants without deterioration of dimensional stability of impression material is an optimal requirement of this study. Hence, this study had two phases; the first phase was dealing with identifying a disinfectant PVP-iodine with different concentrations (1, 5, 10, 15, and 20 weight %), and which one is powerful enough to produce antimicrobial effect against the most common oral microorganisms *Streptococcus mutans* and *Staphylococcus aureus*. The second phase of this study was concerned with the effective disinfectants concentration that not deteriorates the dimensional stability of alginate impression.

MATERIALS AND METHODS

Alginate powder (Cavex CA37 regular set, dust-free alginate impression material Cavex Holland) was modified by adding 1, 5, 10, 15, and 20 weight % of PVP-iodine powder (PVP-iodine, Powdered Polyvinyl-PVP-iodine complex Acros organics, USA). The modified material was mixed according to the manufacturer instructions.

Microbiological effect of the modified alginate with disinfectants was done according to the procedure described by Fuss *et al*.[15] (agar diffusion method) as follow; sterile needle caps were used to form standard punctures (5 mm in diameter) in the agar media. Both the modified and the unmodified alginate powders were mixed and condensed into the prepared punctures using a sterile stainless steel condenser. Fresh subcultures of the tested bacteria (*S. mutans* and *S. aureus*) were prepared on brain–heart infusion broth where the bacterial count of each organism was adjusted to be 5 × 106 bacteria/ml. Sterile swabs were used for implanting the tested organisms on the agar media. Bacterial stuff was then incubated for 24 h before evaluating the growth behavior of each organism. The microbiological effect of the disinfectant was determined by microbial growth inhibition as noted by growth inhibition zone around the implanted alginate sample in the agar media [Figures 1 and 2].

Dimensional stability was investigated on laboratory study on 120 casts (die-stone, Type IV; Heraeus Kulzer Dental Ltd.) were taken from 120 alginate impressions for stainless steel master complete edentulous model which is positioning prisms four with 2 mm height, the impressions were taken by custom made of light-cured acrylic special trays with a wax spacer was positioned over the entire master die, to provide uniform spacing (2 mm) and consistent seating against the die base for the acrylic resin trays then impressions were divided into groups according to study.

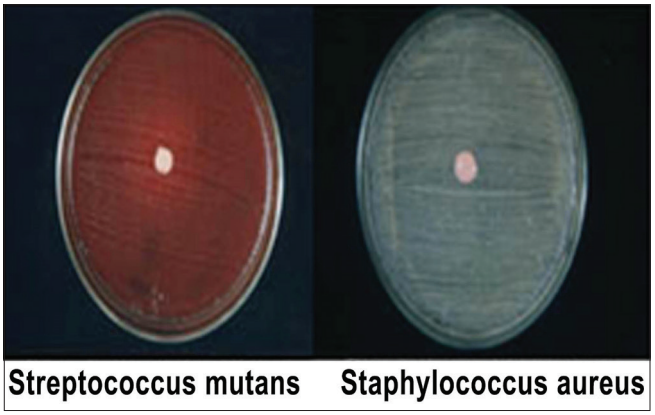


Figure 1: Growth of bacteria around unmodified alginate

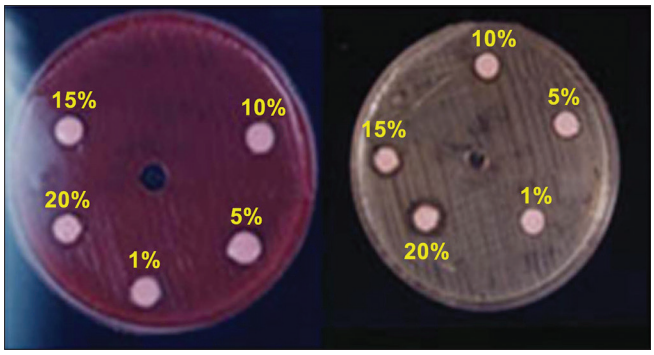


Figure 2: Effect of povidone-iodine on bacterial growth

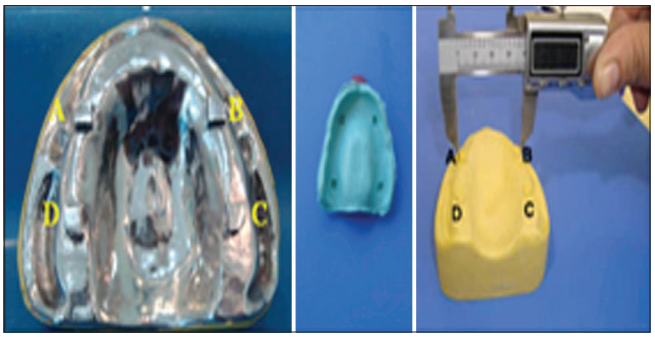


Figure 3: Stainless steel master model (left) impression to the master model (middle) measuring the cast by electronic digital caliper (right)

Group A: Control group consists of 20 casts taken from alginate impression with no modifications.

Group B: Test group which is subdivided into five subgroups consists of 20 casts for each subgroup:

- Subgroup B1: Alginate impression with modification 1% by weight
- Subgroup B2: Alginate impression with modification 5% by weight
- Subgroup B3: Alginate impression with modification 10% by weight
- Subgroup B4: Alginate impression with modification 15% by weight
- Subgroup B5: Alginate impression with modification 20% by weight.

The impressions were allowed to set for 6 min at room temperature before they were poured in die stone. The stone casts were allowed to set for 2 h before separation and were dried at room temperature for at least 24 h before being measured. Finally, measurements were recorded for the stone casts to indirectly assess the dimensional stability. The dimensions measured included the points (A–B), (C–D), (A–C), and (B–D). Five test groups and one control group were tested. Measurements of the metal master die and stone casts were recorded using an electronic digital caliper (electronic digital calipers HY-097, 0.01 mm; Huayi Co, Hangzhou, China) [Figure 3]. Differences between the mean dimensions of the stone casts and the steel master die were expressed as percentage of deviation. Chi-square test was used to analyze the results.

RESULTS

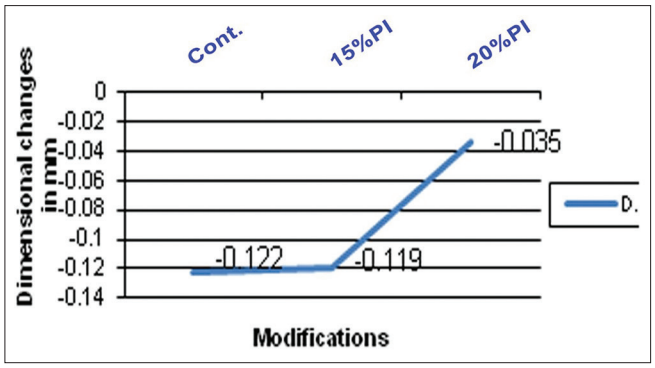
No antibacterial effect was noticed for the unmodified alginate (control group) on the microorganisms under investigation. This finding was manifested by the absence of growth inhibition zone around the implanted alginate plug. The results of modified irreversible hydrocolloid with PVP-iodine showed that 1, 5, and 10, weight % had little effect against *S. mutans* and *S. aureus* microorganisms, so they were excluded from the study. While concentrations 15 and 20 weight % had demonstrated greater antibacterial effects on microbial growth [Figures 1 and 2].

The mean dimensional stability in mm of modified alginate with PVP-iodine at 15 and 20 weight % was −0.119 ± 0.255 and −0.035 ± 0.074, respectively. Furthermore, the mean dimensional stability in mm of unmodified alginate was −0.112 ± 0.176. Chi-square test indicated a significant difference between the nonparametrical data of dimensional stability recorded for the tested subgroup B5 and the control Group A, where as it showed nonsignificant difference between subgroup B4 of 15 weight % concentration and the control Group A (Chi-square, $P < 0.001$) [Graph 1].

DISCUSSION

Undoubtedly, the effective antimicrobial disinfectants without deterioration of physicomechanical properties of impression material are an optimal requirement of disinfectant. PVP-iodine disinfectant has been tested and proven to fulfill these criteria as reviewed in literatures.[16]

The ADA and the American Heart Association have suggested using PVP-iodine for subgingival irrigation. Diluted PVP-iodine may be able to kill *Actinobacillus actinomycetemcomitans*, *Porphyromonas gingivalis*, herpesviruses, and other periodontal pathogens *in vitro* in as little as 15 s of contact and bacteria and yeasts *in vivo* within 5 min of contact. Allergic sensitization to PVP-iodine is rare. With respect to toxicity, there are no reports of impaired wound healing of skin or mucosa and no untoward systemic or tissue reactions after intraoral use of PVP-iodine. Considering its



Graph 1: Dimensional changes

potent and broad-spectrum antimicrobial activity, good safety profile, and low financial cost, it seems reasonable to propose the use of PVP-iodine in the disinfection of periodontal lesions.[15-17]

Some authors have advised the use of agar diffusion method for evaluating the microbial growth.[18] Results of pouring unmodified alginate mix into the agar punctures showed no antibacterial effect against the implanted microorganisms as revealed by the absence of any inhibitory microbe growth zone around the poured alginate. This finding could be explained by the fact that regular alginate set had no antibacterial activity.[9]

Results of *in vitro* microbiological evaluation revealed that modified alginate with concentrations 1%, 5%, and 10% has little and nonsignificant effects which are matching with other study of the effect of PVP-iodine with low concentrations.[16] While 15 and 20 weight % PVP-iodine have significant antibacterial activity. These findings could be explained as follows: The presence of higher modification ratios of chemical disinfectant water provides greater surface area of the disinfectant powder exposed to the mixing water. Accordingly, the possibility of dissolving higher amount of the disinfectant is increased and this lead to higher concentration of the disinfectant agent and consequently higher antibacterial effect.[19]

There are many factors that affect the dimensional stability of the impression materials such as continuing polymerization, release of stresses, and interactions with the storage environment may, if allowed to act long enough, alter the impression dimensions and produce a distorted reproduction.[8,20,21]

The dimensional differentiation of an impression in comparison with the original can be experimentally tested by calculating the difference between marked points of the recorded object (master model) and its replica, shortly after impression making.[22]

The result of these study showing that there was difference in dimensions between the control Group A and the test subgroups which was significant in subgroup B5 and was nonsignificant in subgroup B4. This observation could be explained by that PVP-iodine consumes part from the mixing water ratio which is important in dissolving calcium sulfate dihydrate reactor. Moreover, dissolution of this reactor is responsible for the release of calcium ions that replace either the sodium or potassium ions of the alginate compound transferring its soluble form into insoluble calcium alginate.[23,24] Accordingly, the consumption of this water decreases the rate of reactor ionization and so retards the setting time.[18]

This result appeared accepted and follow the normal phenomenon as a part of mixing liquid has been spent at the time of setting reaction and this consumption in most materials is accompanied with materials shrinkage.[25]

CONCLUSION

Based on the findings of this study, modified alginate impression material with 15 weight % PVP-iodine is the recommended concentration to produce the self-disinfecting impression material with less deteriorating effect.

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Conflicts of interest
There are no conflicts of interest.

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