Dimensional Accuracy of Irreversible Hydrocolloid When Mixed with Disinfectant Solutions

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ABSTRACT

Introduction: Dental impressions, contaminated with blood and saliva are sources of cross-contamination and route for disease transmission. Dental impressions may be decontaminated when disinfectants are incorporated within the impression material, either in the alginate powder or in the mixing liquid. The objective of this study was to investigate the dimensional accuracy of alginate impression material when 1% povidone iodine and 0.1% chlorhexidine were used as mixing liquid.

Methods: A total of 69 impressions were obtained from a master model of a stainless-steel ruled block; 23 impressions for each group of water, 1% povidone iodine and 0.1% chlorhexidine, according to the liquid used for mixing alginate powder. After removal and careful inspection, impressions were immediately poured with type IV die stone. Distance between reference points was measured in casts by a travelling microscope. Collected data were entered in Microsoft Excel 2016 and converted into Statistical Package for Social Science (SPSS) version 20.0 for statistical analysis. The data were analyzed using one way ANOVA and post-hoc test.

Results: One way ANOVA analysis showed statistically no significant difference (P> 0.05) between different groups with respect to the dimensional change of the casts.

Conclusion: The dimensional accuracy of irreversible hydrocolloid impression material was not influenced when 1% povidone iodine and 0.1% chlorhexidine solution were used as mixing liquid instead of water.

Key words: Alginate impression; Dimensional accuracy; Disinfectant solutions; Irreversible hydrocolloid.

INTRODUCTION

A dental impression is a negative imprint to produce positive replica of oral structures which are used for fabrication of dental prosthesis, restoration or as a record.[1] An impression material should record the surface detail accurately and also transfer this detail to model, cast or die.[2] Obtaining an accurate cast from impression of oral structures, thus, is an important step in the success of many prosthodontic treatments.[2,3] Among various impression materials introduced in dentistry, alginate is still the most commonly used and have become an indispensable part of dental practice for some of its advantages like easy handling, low cost, capability of reproducing details and high comfort for the patient.[4,5]

While making impression, oral fluids like saliva, blood and other exudates which may contain pathogenic micro-organisms come in contact with impression materials.[6] With the possibility of cross infection, each patient should be considered potentially infected and so, all

Conflict of Interest: None

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impressions should be thoroughly disinfected.[7] Spray and immersion are the two most widely used disinfection technique for alginate impression material.[8] Disinfection by spraying may restrict the effectiveness of disinfection, particularly for the porous hydrophilic hydrocolloids, where microorganisms can penetrate through the body and survive in the impression.[9] Disinfection by immersion may lead to dimensional changes in alginate impression material owing to hydrophilic nature and imbibition property and might have a direct effect on the resulting prosthesis.[10]

Although routinely used spraying and immersion technique for disinfection could be effective in reducing cross-infection, compliance could be uneven as these procedures could be seen as additional time-consuming process. The difficulties associated with disinfecting alginate have resulted in self-disinfecting alginate.[11] It was determined that the incorporation of disinfectants into the alginate powder or mixing water provided an effective means of additional decontamination, without leading to adverse effects considering dimensional stability and surface accuracy.[12-14] Materials such as didecyldimethyl ammonium chloride[15], chlorhexidine, iodophores, phenolic and inorganic ions, such as copper and fluoride, quaternary ammonium compounds, have been used as disinfectant additives.[16]

However, only a few attempts have been made to add oral mouth rinses with alginate powder. This study investigated whether chlorhexidine gluconate 0.12% and povidone iodine 1% mixed with alginate affected the dimensional accuracy of the resulting gypsum casts.

METHODS

This in-vitro study was conducted at the Department of Prosthodontics, College of Dental Surgery, BPKIHS after obtaining ethical clearance from Institutional Review Committee of BPKIHS Dharan (IRC/2230/022). The sample size for the study was calculated based on a previous literature.[11] The total sample size was 69 which was divided into three groups: water, 1% povidone iodine (Aryadine, 0.1%w/v iodine) and 0.1% chlorhexidine (Aryahex) based on the liquid used for mixing alginate (Zelgan 2002, Dentsply). The entire procedure was done at room temperature between 18-21°C.

Fabrication of the master model

A master model (Fig. 1) was prepared according to revised American Dental Association specification no 19 for non-aqueous elastic dental impression materials.[17] It consisted of a ruled block (AA) made of stainless steel with three horizontal lines and two vertical lines CD and C'D'. The lines CD and C'D' were separated from each other by 25 mm (Fig. 2).

Making alginate impression

Stock perforated metal tray (U0) was modified to fit into the ruled block with at least 3 mm clearance for impression material. Impressions of ruled block were made in three groups based on the type of mixing liquid used. Following the manufacturer's recommended powder-liquid ratio (20 gram of powder in 45 ml of liquid), alginate was hand-mixed in a rubber bowl for 45 seconds, loaded into the modified tray and hand pressed against the test block until the setting of the impression occurred. Defective impressions were discarded and only the impressions with required landmarks without distortion were included in the study.

Pouring the gypsum casts

Type IV dental stone powder (Kalabhai) was mixed according to the manufacturer's recommendation and poured into the alginate impression. The poured impressions were left in air at room temperature for 1 hour to ensure complete setting of gypsum casts before taking them out of the impressions. Defective casts were excluded from the study.

Assessing the accuracy of test specimens

The dimensional accuracy was assessed by measuring the distance between the parallel lines CD and C' D' impressed on the test specimens (Fig 3). Measurements were taken by single investigator using a travelling microscope (Ycoo.TM) with 10X magnification (Fig 4). Three readings were obtained from each sample and the average of these values were calculated. For the validity of data, the travelling microscope was checked and rechecked for proper functioning after every 15 measurements using the ruled block which was of known measurement (25mm).

The dimensional accuracy, expressed as a percentage (L) was calculated using the equation: L= [(L2 – L1) / L1] x 100, in which L1 was the distance between the lines on the ruled block and L2 was the distance between the lines on the test specimens.

The obtained data were entered in Microsoft Excel 2016 and converted into Statistical Package for Social Science (SPSS) version 20.0 for statistical analysis. Test for normality of data was performed using Kolmogorov-Smirnov test which revealed normal distribution of data. So, data were analyzed in terms of descriptive statistics (mean and standard deviation) and the difference of means of distance and percentage change in between the groups were analyzed by using one way ANOVA. The probability of significance was set at 5% with confidence interval of 95%.

RESULT

The mean distance and mean percentage change for different groups are shown in Table 1. The mean distance was longer in the water group. The mean percentage change for povidone iodine group was equal to chlorhexidine group. The mean percentage change was least for water group.

Comparison of mean distance and mean percentage change in three different groups by one-way ANOVA (Table 2 and Table 3 respectively) showed statistically no significant difference in dimensional accuracy between water group, 1% povidone iodine group and 0.1% chlorhexidine group ($P > 0.05$).

Table 1: Mean distance(mm) and percentage change (%) for different groups of water, 1%povidone iodine and 0.1% chlorhexidine.

Group	Average distance (in mm)	Percentage Change (in %)
Water (N=23)	24.961 ± 0.027	0.154 ± 0.108
1% Povidone Iodine (N=23)	24.942 ± 0.038	0.231 ± 0.150
0.1% Chlorhexidine (N=23)	24.942 ± 0.032	0.231 ± 0.131

Table 2: One-way ANOVA for mean distance between three groups.

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	0.006	2	0.003	2.642	0.079
Within Groups	0.071	66	0.001		
Total	0.076	68			

Table 3: One-way ANOVA for mean percentage change between three groups.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0.090	2	0.045	2.642	0.079
Within Groups	1.130	66	0.017		
Total	1.221	68			

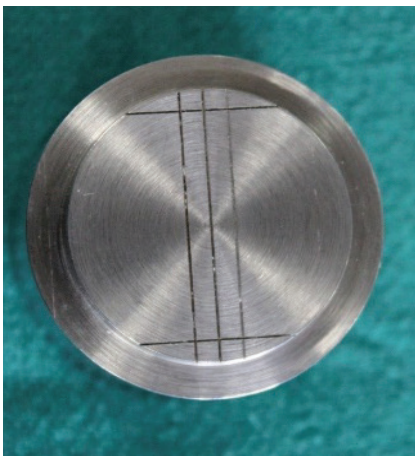

Figure 1: A stainless steel ruled block

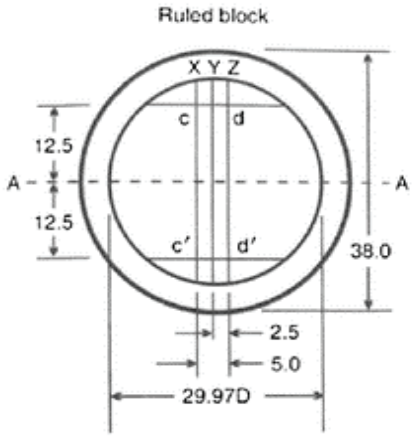

Figure 2: Measurements of stainless-steel ruled block

Figure 3: Test Specimen

Figure 4: Measurement of test specimen by travelling microscope

DISCUSSION

Disinfection of alginate impressions by conventional strategies of immersion and spraying provide only surface disinfection[11] despite the fact that oral microorganisms could easily get incorporated in impression materials during setting.[16] Self-disinfecting alginate impression materials have evolved where disinfection can be carried out by incorporating disinfectant within the alginate powder on manufacturer level or by directly mixing alginate powder with disinfectant solutions.[16] Studies have shown that self-disinfecting impression technique demonstrated better dimensional stability than spray and immersion techniques, and saved disinfection time.[18,19] The incorporation of disinfecting agents into impression materials could serve an important role in dental laboratory infection control as reported by some studies.[13,16,20-24]

The accuracy, in terms of dimensional differentiation of an impression in comparison with the original, can be experimentally tested by calculating the difference between marked points in the recorded object (master model) and its replica, either on the impressions directly or on the casts produced by them shortly after impression making. Measurements made in the impressions permits a thorough and scientifically correct view of the phenomena under study by restricting the materials involved and illuminating the interactions. On the other hand, measurements on casts are more correlated to the actual clinical and laboratory practice and are often practically advantageous although they slightly complicate the experimental procedure.[9,25] In our study, the measurements were made on the casts produced by alginate-water impressions and alginate-disinfectant impressions shortly after impression making.

Different master models have been used in literature which varies from use of a stainless-steel ruled block, metal edentulous model to the use of acrylic edentulous model. The measuring technique used in determining dimensional changes also varies from the use of analog vernier caliper, digital vernier caliper, image analyzing software to the use of measuring microscope. In our study, stainless steel ruled block of known dimension was used as master model and the required measurements were made using a travelling microscope. Travelling microscope is an instrument for measuring length with a resolution typically in the order of 0.01mm and is used for accurate measurement of the diameters of different objects. The purpose of this instrument is to aim at reference points with higher accuracy than is possible with bare eye.[26]

In our study, no significant dimensional changes were observed ($p>0.05$) when 1% povidone iodine (0.1% w/v of iodine) or 0.1% chlorhexidine solution was used to mix alginate instead of water. This result is in agreement with the studies conducted by Wang et al[11], Ramer et al[12], Benakatti et al[13], Nema[14], Rosen and Toutz[18], Cubas et al[21] and Matthew et al[27].

Touyz and Rosen reported that mix and soak technique was more effective at disinfecting the alginate than water-mixed alginate alone, or water-mixed alginate which was subsequently soaked in disinfectant solution.[19] Casemiro et al reported that the use of chlorhexidine solution for manipulation of alginate was better than the incorporation of chlorhexidine in the powder in terms of reducing the contamination presented by the impressions.[28]

However, the study by Gupta et al concluded that internal disinfection of alginate with chlorhexidine caused the highest dimensional change when compared to disinfection of alginate impression by spraying and immersion technique.[29] Similarly, Ismail et al concluded that more than 15 % of povidone-iodine caused dimensional changes in the alginate.[9]

In previous studies, the concentrations of chlorhexidine used to mix alginate powder were 0.05%. 0.12%. 0.2% and 0.5%.[11,13,14,18,20,21] With all of these concentrations of chlorhexidine, no significant dimensional changes were noted when mixed with alginate impression material except reported by Gupta et al[29] where they used 0.2% chlorhexidine gluconate. Similarly, in our study, 0.1% of chlorhexidine did not cause significant dimensional change of casts poured from alginate-chlorhexidine admix impression. The mean percentage change in the dimension of the casts in our study was 0.15% for povidone iodine and 0.13% for chlorhexidine, which was within the allowable range (0.15%) as reported in the previous literature.[30]

Both 0.1% and 0.2% concentrations of chlorhexidine have been proved to be effective against most of the microbes.[21,22,24] A study recommended 1g/L chlorhexidine solution

to produce the self-disinfecting impression material.[11] In addition to antimicrobial activity, 0.1% and 0.2% chlorhexidine when mixed with alginate powder had no adverse effect on compressive strength[22] and did not significantly alter dimensional stability, flow and surface detail reproduction.[13,21,23] Pradhan et al in their study concluded that irreversible hydrocolloid impression material mixed with 0.05%, 0.1% and 0.2% chlorhexidine exhibited self-disinfecting activity without influencing the dimensional stability of set material.[20]

Povidone iodine was used in the concentration of 1%, 5%, 10% and 20% to mix alginate in previous studies.[9,27] Other studies used 0.01% and 0.05% iodine solutions.[12,13,14] Among these concentrations, one study concluded that more than 15% povidone iodine could cause dimensional changes in alginate.[9] Other studies[12,13,14,27] showed no significant dimensional changes. Mathew showed excellent flow characteristics, surface quality and dimensional stability with 10% povidone iodone.[27]

Thus, based on previous studies and our findings, 0.1% chlorhexidine solution and 1% povidone iodine solution could be considered safe for mixing alginate in terms of both dimensional accuracy and antimicrobial efficacy. However, Khadeer et al concluded that soaking of irreversible hydrocolloid in 2% glutaraldehyde had more antimicrobial effect than mixing alginate with 0.02% chlorhexidine acetate solution or 15% povidone iodine solution.[8]

LIMITATIONS OF THE STUDY

- The present study is an in-vitro study where natural oral environment, soft tissues, saliva and sulcular fluids were not present.
- Dimensional changes were determined only in one plane in this study.
- Factors like flowability, elastic recovery, compressive strength, tear strength and surface details were not considered in this study

CONCLUSION

The dimensional change between master model and test specimen (casts) was insignificant when 1% povidone iodine and 0.1%chlorhexidine were used to mix alginate impression material. So, 1% povidone iodine and 0.1% chlorhexidine does not influence the dimensional accuracy of the cast obtained after pouring the irreversible hydrocolloid alginate impressions made from these disinfectant solutions. Hence, our study suggests the use of 1% povidone iodine and 0.1% chlorhexidine as a water substitute for mixing alginate. However, other properties of impression and cast should also be evaluated.

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