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The Effect of a Range of Disinfectants on the Dimensional Accuracy and Stability of Some Impression Materials

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Abstract - *Disinfection of dental impressions should be considered as a routine procedure in dental surgeries and dental laboratories. Disinfectants can have deleterious effects on some properties of impression materials. The aim of this study was to evaluate the dimensional accuracy and dimensional stability of a model dental stone, reproduced from five commonly used impression materials (Aquasil soft putty/Aquasil Ultra LV; Aquasil Monophase; Aquasil Ultra Heavy; Impregum F and Provil putty/ Provil Light CD wash) retained by their adhesives in acrylic resin trays and exposed to three disinfectant solutions (Perform ID; Haz-Tabs and MD 520). Two hundred models were used to investigate the effect of the three disinfectants on the dimensional accuracy of the five impression materials. Five impressions were taken for each impression material for each disinfection treatment group. Measurements were carried out using a High Precision Reflex Microscope. All materials demonstrated a percentage change in dimensions when subjected to no disinfection when compared to the brass master die and all materials demonstrated a percentage change in dimension when subjected to the different disinfection procedures. The results of this study have demonstrated that for all of the materials investigated, the changes in dimensional stability were small in the order of microns. These changes may however be of clinical significance for procedures requiring a high degree of accuracy, for example fixed prosthodontics. The materials respond differently depending on the disinfectant used and it may therefore be appropriate that manufacturers recommend the use of particular disinfectants for their products in order to ensure optimum dimensional accuracy and stability.*

KEY WORDS: Disinfection; Dimensional Accuracy and Stability; Impressions

INTRODUCTION

The principal potential route of transmission of infection from a patient to a dental technician is by contaminated impressions and other prosthetic materials[1]. It has been suggested that dental impressions may transmit a variety of microorganisms from the oral cavity and in addition models poured from impressions might also harbour infectious microorganisms that can be distributed throughout the laboratories when models or dies are handled[2,3]. To avoid cross contamination of the dental surgery and laboratory staff, it has been recommended therefore that impressions must be disinfected immediately after their removal from the mouth. Therefore, the disinfection of dental impressions should now be considered as a routine procedure in dental surgeries and dental laboratories.

There are several ways in which an impression material can be disinfected including the popular methods of spray and immersion disinfection. Spray disinfection is a simple and convenient method, however there are some concerns that this procedure may not ensure thorough disinfection of all the impression material[4,5]. Immersion disinfection is perhaps considered to be a more reliable method which should ensure a more even contact between the disinfectant and the impression material[6-9].

A large number of chemicals are marketed as agents suitable for disinfection but are not all compatible with all types of impression material. There are two important factors to consider when choosing a disinfectant, namely, its ability to eliminate microbial contamination and its effect on the resultant gypsum cast. It is recognised that immersion disinfection can have deleterious effects on some properties of the impression materials, for example dimensional accuracy, stability and wettability[10-12]. The literature varies markedly in the concentration, type and immersion times of disinfection protocols, making it difficult to assess the most appropriate method[9]. There is also very little guidance provided by manufacturers as to the most suitable disinfectants to use with their products. Many of the previous studies have only considered the effect of the disinfectant on the dimensional accuracy of the impression material and do not consider the dimensional stability. These studies do not take in to account that for many dentists the impressions are sent to external laboratories with a subsequent delay in them being poured. The dimensional stability is therefore of key importance in these situations. The aim of this study was to evaluate the dimensional accuracy and dimensional stability of a model, reproduced from five commonly used impression materials (1 polyether and 4 silicone), retained by their adhesives in acrylic resin trays and exposed to three disinfectant solutions.

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MATERIALS AND METHOD

The five types of dental impression materials used for the study were Aquasil soft putty/Aquasil Ultra LV; Aquasil Monophase; Aquasil Ultra Heavy (Dentsply, Weybridge, UK); Impregum F (3M Seefeld, Germany) and Provil putty/ Provil Light CD wash (Heraeus Kulzer). Three different disinfectant solutions were used for the study and are presented in Table 1. No disinfection protocol was used as a control. The model material used was dental stone (Kaffir-D South Western Industrial Plaster / water:powder ratio of 0.30). The use of a single die material is a limitation of this study and it is appreciated that there are range of materials which are available for use as model materials. Dental stone however has been widely used for decades and was therefore selected for use in this study.

Preparation of the brass master die

A brass master die was machined to simulate the shape of the edentulous maxillary residual ridge. Three small holes 2.5 mm in diameter were drilled into the top surface of the ridge, one at the anterior midline and two in the molar areas, to serve as landmarks. Cross-shaped lines representing index marks were scribed alongside and adjacent to the three small holes onto the top surface of the die. The index marks were "A" in the right molar region, "B" at the anterior midline just to the right of the anterior hole and "C" in the left molar region (Figure 1). All horizontal surfaces had been precisely machined to be parallel to each other. The opposing vertical surfaces had a slight convergence to facilitate separation of the impression from the die. The sharp line angles and point angles were slightly rounded during the final finishing to avoid tearing of the impression material. Custom trays were made from the die in light cured acrylic resin (Magilight, Schottlander, UK).

Dimensional accuracy

One hundred models were used to investigate the effect of the three disinfectants on the dimensional accuracy of the five impression materials. Five impressions were taken for each impression material for each disinfection treatment group. For the non-disinfection control group, all of the impressions were rinsed with water but not subjected to any disinfectant treatment and representative of those impressions which would not normally be subjected to a disinfection procedure. For Perform ID one packet of

Table 1. *Immersion Disinfectant Solutions used in the study together with their manufacturer*

Product	*Chemistry*	*Concentration*	*Method of disinfection*	*Time mins*	*Manufacturer*
Perform-ID	Potassium–peroxomonosulphate Sodium benzoate Tartaric acid	2 %	Immersion	10	Schülke and Mayr GmbH Norderstedt, Germany
Haz-tabs	Sodium-Dichloroisocyanurate	10,000ppm available chlorine	Immersion	10	Guest Medical Limited, EdenBridge Kent UK
MD 520	Glutaraldehyde Alkylbenzyldimethyl Ammonium chloride Antifoaming agent Complexing agent	Full-strength	Immersion	5	Durr Dental Kornwestheim Germany.

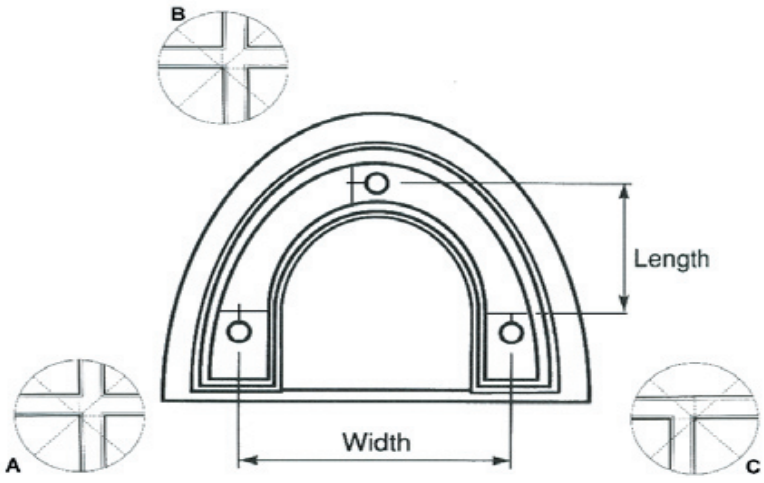

Figure 1. *Schematic drawing of the brass die indicating the lines measured and index marks (A, B and C). (Actual length of brass die is 40.75±0.005 mm and width is 50.16± 0.006 mm).*

Perform ID was added to 2 litres of tepid water and allowed to dissolve and impressions were immersed for 10 mins. For MD 520 all of the impressions were submerged in neat MD-520 for 5 mins and for the Haz Tabs, half a tablet was added to 1 litre of cold water and all the impressions were treated for 10 mins.

Five impressions were taken for each impression material and for each disinfection treatment group. Prior to taking the impression, adhesives approved by the manufacturer for use with each of the impression materials, were applied to special trays and allowed to dry for 4 minutes. The impression materials were mixed according to manufacturer's instructions and once set, the impression was snap-removed from the brass die and rinsed under tap water for 10 s. The impression was left to further polymerise on the bench for 30 minutes before being subjected to the disinfection treatment. The impression was rinsed again under tap water for 10 s and excess water shaken off. The impressions were poured in dental stone and the model was labelled and left for 24 hours before measuring for dimensional accuracy.

Dimensional Stability

For the dimensional stability study, the materials and method were followed as outlined above for each of the impression materials subjected to each of the disinfectants. One hundred models were used in total. As with the dimensional accuracy study for the non-disinfection group all of the impressions were rinsed with water but not subjected to any disinfectant treatment. Following the disinfection procedure the impression was rinsed with water for 10 seconds and excess water shaken off. The impression was stored with a damp cotton wool roll and sealed in a labelled bag for 3 days. This would be representative of those impressions that are sent to external laboratories with a resultant delay in pouring up. After 3 days the impression was poured in dental stone, the model was labelled and left for 24 hrs before measurements were recorded for the dimensional stability.

Measurement technique

The measurements were carried out using a High Precision Reflex Microscope (Reflex Measurement Ltd, Somerset, UK) by a trained operator using a technique previously described [12]. Measurements were taken of the relative positions of index marks A, B and C with the highest power magnification (x 67) using a 10 µm diameter light spot. The manufacturer claims that the instrument has a resolution of 1 µm (0.001mm) and has estimated the repeatability of recording well-defined points as being 2 µm (0.002) mm in the horizontal direction and 15 µm (0.015 mm) in the vertical direction. For each dimension, on the stone models, five readings were taken and the mean value and the standard deviation were calculated. To serve as a standard, ten readings were taken for each dimension on the brass master die and recorded digitally.

To study the effect of the disinfectants on the impressions, the linear distances between the index marks were measured on the brass master die that was used as a standard against which the measurements on the stone casts were compared.

The results were subjected to statistical analysis in the form of an analysis of variance. For those groups which demonstrated a significant difference, the results were subjected to multiple range tests. This test applies a multiple comparison procedure to determine which means are significantly different from others. A statistically significant difference was estimated at a 95% confidence level.

RESULTS

The results of the study are presented in Tables 2-5. Table 2 illustrates the percentage changes in length and width for all groups of impression materials treated with non disinfection for both studies of Dimensional Accuracy and Dimensional Stability. These materials were simply rinsed with water. Tables 3, 4 and 5 illustrate the percentage changes in length and width for all groups of impression materials treated with Haz-Tabs, MD- 520 and Perform ID respectively for both studies of dimensional accuracy and dimensional stability.

For dimensional accuracy, of those materials not subjected to disinfection, all materials demonstrated a very small percentage change in width with no significant difference between materials. The greatest change was for Provil (P) (0.28%). In terms of length, there were significant differences between groups (p=0.014). All materials demonstrated a percentage shrinkage with the exception of Aquasil Monophase (AM) with a 0.06% expansion. Provil again demonstrated the greatest change (0.26%) and Aquasil Soft Putty/LV (LV) the smallest change (0.04%). For dimensional stability, the greatest change in width was for Impregum F (I) (0.4%) and the smallest for Aquasil Ultra LV wash (0.14%). There were significant differences between groups for change in length (p=0.0028). Impregum F was the most stable with 0.012% shrinkage and Aquasil Ultra Monophase and Aquasil Ultra LV wash had the greatest change (0.19%).

For impression materials disinfected with Haz-Tabs all materials demonstrated shrinkage. In terms of width for dimensional accuracy, the greatest shrinkage was seen for Aquasil Ultra LV (0.27%) and the smallest for Aquasil Ultra Heavy (AH) (0.14%). The differences between materials, however, were not significant. There were significant differences between materials (p=0.04) for change in length. The smallest change was recorded for Provil (0.03%) and the greatest for Impregum F (0.16%). For dimensional stability, all materials demonstrated a percentage shrinkage, with the smallest change for Aquasil Ultra Monophase and Provil (both 0.15%). The least dimensionally stable material was Impregum F (0.31%). There were significant differences noted (p=0.0026) for change in length with Provil (0.30%) being the most affected material and Aquasil Ultra LV wash (0.07%) being the least.

For impression materials disinfected with MD-520 all materials demonstrated shrinkage. For dimensional accuracy there were no significant differences between the materials. The smallest change was recorded for Aquasil Ultra Heavy (0.19%) and the greatest for Aquasil Ultra LV wash (0.25%). For change in length dimension, the least affected materials were Aquasil Ultra Monophase and Aquasil Ultra LV wash (both 0.12%) and the most affected Provil (0.21%). For dimensional stability there were significant differences

Table 2. *Change in width and length of impression materials not subjected to disinfection. The materials were rinsed with water. (Dimensional Accuracy and Dimensional Stability).*

		Dimensional Accuracy				*Dimensional Stability*			
Impression Material		*Average*	*Variance*	*Standard Deviation*	*% change*	*Average*	*Variance*	*Standard Deviation*	*% change*
Impregum F (I)	Width	0.090	0.004	0.066	0.18	0.20	0.111	0.108	0.40
	Length	0.069	0.003	0.058	0.16	0.005	0.001	0.04	0.012
Aquasil Monophase (AM)	Width	0.100	0.002	0.046	0.20	0.11	0.001	0.03	0.23
	Length	0.028	0.006	0.082	0.06	0.07	0.000	0.02	0.19
Aquasil Putty /LV wash (LV)	Width	0.102	0.002	0.044	0.2	0.07	0.008	0.09	0.14
	Length	0.02	0.002	0.048	0.04	0.05	0.000	0.01	0.13
Awuasil Ultra Heavy (AH)	Width	0.115	0.002	0.048	0.23	0.15	0.000	0.02	0.3
	Length	0.068	0.001	0.032	0.19	0.08	0.000	0.02	0.30
Provil (P)	Width	0.144	0.001	0.044	0.28	0.14	0.004	0.06	0.28
	Length	0.106	0.002	0.046	0.26	0.03	0.001	0.03	0.08

Dimensional Accuracy
For change in width there was no significant differences between groups (p=0.52).
For change in length there were significant differences between AH-AM; LV-P; AM-P (p=0.014).

Dimensional Stability
For change in width there was no significant differences between groups (p=0.10).
For change in length there were significant differences between AH-I; AH-P; LV-I; I-AM; AM-P; (p=0.003).

Table 3. *Change in width and length of impression materials subjected to disinfection with Haz Tabs. (Dimensional Accuracy and Dimensional Stability).*

		Dimensional Accuracy				*Dimensional Stability*			
Impression Material		*Average*	*Variance*	*Standard Deviation*	*% change*	*Average*	*Variance*	*Standard Deviation*	*% change*
Aquasil Ultra Heavy (AH)	Width	0.07	0.001	0.27	0.14	0.10	0.002	0.053	0.20
	Length	0.03	0.001	0.009	0.08	0.06	0.007	0.08	0.08
Impregum F (I)	Width	0.097	0.002	0.04	0.19	0.15	0.001	0.03	0.31
	Length	0.065	0.000	0.014	0.16	0.06	0.001	0.08	0.15
Aquasil Monophase (AM)	Width	0.097	0.13	0.116	0.19	0.08	0.012	0.11	0.15
	Length	0.37	0.002	0.041	0.080	0.09	0.001	0.03	0.23
Provil (P)	Width	0.09	0.002	0.05	0.189	0.07	0.001	0.02	0.15
	Length	0.12	0.008	0.09	0.19	0.12	0.012	0.10	0.30
Aquasil Putty /LV	Width	0.14	0.001	0.04	0.27	0.10	0.001	0.04	0.20
	Length	0.03	0.001	0.038	0.08	0.03	0.000	0.02	0.07

Dimensional Accuracy
For change in width there was no significant differences between groups (p=0.60).
For change in length there were significant differences between AH-P; LV-P; AM-P; (p=0.04).

Dimensional Stability
For change in width there was no significant differences between groups (p=0.29).
For change in length there were significant differences between AH-I; LV-I; LV-P; I-P; (p=0.003).

Table 4. *Change in width and length of impression materials subjected to disinfection with MD 520. (Dimensional Accuracy and Dimensional Stability).*

Impression Material		*Dimensional Accuracy*				*Dimensional Stability*			
		Average	*Variance*	*Standard Deviation*	*% change*	*Average*	*Variance*	*Standard Deviation*	*% change*
Aquasil Ultra Heavy (AH)	Width	0.09	0.001	0.037	0.19	0.08	0.001	0.02	0.16
	Length	0.057	0.000	0.017	0.13	0.04	0.001	0.03	0.10
Impregum F (I)	Width	0.108	0.002	0.04	0.21	0.07	0.002	0.05	0.14
	Length	0.06	0.006	0.08	0.15	0.03	0.000	0.03	0.08
Provil (P)	Width	0.119	0.001	0.031	0.24	0.18	0.001	0.03	0.36
	Length	0.08	0.004	0.06	0.21	0.06	0.004	0.02	0.16
Aquasil Monophase (AM)	Width	0.124	0.0025	0.05	0.24	0.114	0.001	0.04	0.22
	Length	0.04	0.0007	0.026	0.12	0.07	0.0001	0.0003	0.18
Aquasil Putty /LV	Width	0.12	0.002	0.049	0.25	0.14	0.009	0.09	0.29
	Length	0.04	0.0007	0.028	0.12	0.0004	0.004	0.06	0.001

Dimensional Accuracy
For change in width there was no significant differences between groups (p=0.84).
For change in length there was no significant differences between groups (p=0.71).

Dimensional Stability
For change in width there were significant differences between AH-P; LV-I; I-P (p=0.03).
For change in length there was no significant difference between groups (p=0.05).

Table 5. *Change in width and length of impression materials subjected to disinfection with Perform ID. (Dimensional Accuracy and Dimensional Stability).*

Impression Material		*Dimensional Accuracy*				*Dimensional Stability*			
		Average	*Variance*	*Standard Deviation*	*% change*	*Average*	*Variance*	*Standard Deviation*	*% change*
Provil (P)	Width	0.027	0.001	0.035	0.05	0.08	0.002	0.045	0.16
	Length	0.057	0.001	0.04	0.14	0.04	0.001	0.035	0.11
Aquasil Ultra Heavy (AH)	Width	0.058	0.005	0.07	0.11	0.13	0.002	0.05	0.26
	Length	0.04	0.001	0.031	0.11	0.02	0.005	0.07	0.05
Impregum F (I)	Width	0.05	0.006	0.079	0.11	0.10	0.005	0.07	0.21
	Length	0.09	0.003	0.059	0.24	0.035	0.001	0.035	0.08
Aquasil Monophase (AM)	Width	0.07	0.003	0.057	0.15	0.116	0.000	0.019	0.23
	Length	0.04	0.001	0.03	0.11	0.08	0.000	0.02	0.19
Aquasil Putty /LV	Width	0.119	0.004	0.064	0.23	0.10	0.001	0.02	0.21
	Length	0.03	0.001	0.028	0.008	0.06	0.000	0.017	0.15

Dimensional Accuracy
For change in width there was no significant differences between groups (p=0.26).
For change in length there was no significant differences between groups (p=0.13).

Dimensional Stability
For change in width there was no significant difference between groups (p=0.58).
For change in length there was no significant difference between groups (p=0.25).

between materials for change in width (p=0.029). Provil was the least dimensionally stable of the materials tested (0.36%) and Impregum F (0.14%) the most stable. For change in length the most stable material was Aquasil Ultra LV wash (0.001%) and the least stable was Aquasil Monophase (0.18%). There were no significant differences between the materials.

For impression materials disinfected with Perform-ID all materials demonstrated shrinkage. There were no significant differences recorded between groups for dimensional accuracy or stability. For dimensional accuracy, the smallest change in width was recorded for Provil (0.05%) and the greatest for Aquasil Ultra LV wash (0.23%). Aquasil Ultra LV wash, however had the smallest change in length (0.08%) whereas Impregum F demonstrated the greatest change (0.24%). For dimensional stability, the least change in width dimension was for Provil (0.16%) and the most change for Aquasil Ultra Heavy (0.26%). For length, the most stable material was Aquasil Ultra Heavy (0.05%) and the greatest change was recorded for Aquasil Ultra Monophase (0.19%).

DISCUSSION

The disinfection of dental impression materials is an essential stage in cross infection control. There is however a considerable variation in the dental literature in the disinfection protocols which are used together with much controversy on their relative effects on the accuracy and stability of the impression materials. The aims of this study were to evaluate the dimensional accuracy and stability of five impression materials which had been exposed to three disinfectants. It is appreciated that in this study had some limitations in that there were several variables which were not considered independently, for example the effect of the tray material, adhesives and the thickness of the light and heavy body impression materials. The measurements were carried out using a High Precision Reflex Microscope and the manufacturer claims that this instrument has a resolution of 1 µm (0.001mm) and has estimated the repeatability of recording well-defined points as being 2 µm (0.002 mm) in the horizontal direction and 15 µm (0.015 mm) in the vertical direction. It was therefore possible to record changes in dimensions for the impression materials in fine detail. Within the limitations of the study the results showed that, in general all materials demonstrated a high degree of dimensional accuracy and stability. There were however some changes recorded in the dimensional accuracy and stability depending on which disinfectant was used. These changes, although small, may be of clinical significance in fixed prosthodontics.

This study reinforced the fact that a universal protocol is not suitable given the wide range of impression materials which are currently available. Since it is often difficult to make direct comparisons with the results of other studies due to differences in the disinfection protocols used, this study used protocols according to the manufacturers' guidelines and should therefore provide a baseline for further studies of this type.

CONCLUSIONS

The results of this study have demonstrated that for all of the materials, the changes in dimensions were small in the order of microns. These changes may however be of clinical significance for procedures requiring a high degree of accuracy, for example fixed prosthodontics. The materials responded differently depending on the disinfectant used. It may therefore be appropriate that manufacturers recommend the use of particular disinfectants for their products in order to ensure optimum dimensional accuracy and stability.

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REFERENCES

1. Watkinson AC. Disinfection of impressions in UK dental schools. *British Dental Journal* 1988; **164** :22-23.
2. Rowe AHR, Forrest JO. Dental impressions: the probability of contamination and a method of disinfection. *British Dental Journal* 1978; **145**: 184-186.
3. Leung RL, Schonfeld SE. Gypsum casts as a potential source of microbial cross-contamination. *Journal of Prosthetic Dentistry* 1983; **49**: 210-211.
4. Stern MA, Johnson GH, Toolson LB. An evaluation of dental stones after repeated exposure to spray disinfectants. Part I: Abrasion and compressive strength. *Journal of Prosthetic Dentistry* 1991; **65**: 713-718.
5. Drennon DG, Johnson, GH, Powell GL. The accuracy and efficacy of disinfection by spray atomisation on elastomeric impressions. *Journal of Prosthetic Dentistry* 1998; **62**: 468-475.
6. Lepe X, Johnson GH. Accuracy of polyether and addition silicone after long-term immersion disinfection. *Journal of Prosthetic Dentistry* 1997;**78**: 245-249.
7. Milward PJ, Waters MG. The effect of disinfection and a wetting agent on the wettability of addition polymerised silicone impression materials. *Journal of Prosthetic Dentistry* 2001; **86**: 165-167.
8. Lepe X, Johnson GH, Berg JC, Aw TC, Stroh GS. Wettability, imbibition and mass change of disinfected low viscosity impression materials. *Journal of Prosthetic Dentistry* 2002; **88**: 268-276.
9. Taylor RL, Wright PS, Maryan C. Disinfection procedures: their effect on dimensional accuracy and surface quality of irreversible hydrocolloid impression materials and gypsum casts. *Dental Materials* 2002; **18**: 103-110.
10. Johnson GH, Chellis KD, Gordon GE, Lepe X. Dimensional stability and detail reproduction of irreversible hydrocolloid and elastomeric impressions disinfected by immersion. *Journal of Prosthetic Dentistry* 1998; **79**: 446-453.
11. Kess RS, Combe EC, Sparks BS. Effect of surface treatments on the wettability of vinyl polysiloxane impression materials. *Journal of Prosthetic Dentistry* 2000; **84:** 98-102.
12. Jagger DC, Al Jabra O, Harrison A, Vowles RW, McNally L. The effect of a range of disinfectants on the dimensional accuracy of some impression materials. *European Journal of Prosthodontics and Restorative Dentistry* 2004; **12:** 154-160.