EGYPTIAN
DENTAL JOURNAL

Vol. 62, 1081:1087, January, 2016

I.S.S.N 0070-9484

EDJ
EGYPTIAN DENTAL JOURNAL

WWW.EDA-EGYPT.ORG

A THREE – DIMENSIONAL EVALUATION OF THE ACCURACY OF "EXPRESS XT" VINYL POLYSILOXANE IMPRESSION MATERIAL USING SPRAY DISINFECTION TECHNIQUE WITH IMMEDIATE AND DELAYED POURING TIME (IN VITRO STUDY)

Norhan Naief Abd El Haliem*, Maha Ahmed Taymour **,
Tamer Moneir Mousa Nassef *** *and* Amina Abd El Latif Zaki ****

ABSTRACT

Objectives: The aim of this study was to evaluate the dimensional accuracy of the recently introduced vinyl polysiloxane impression material "Express XT" when subjected to sprayed disinfection with Cavicide1 disinfectant solution at two different pouring times. Using three dimensional DicoMesher software version3.

Methods: A total of twenty impressions of a standardized stainless steel mold were made using Express XT impression material in specially fabricated trays. The impressions were subjected to spray disinfection protocol using cavicide 1 disinfectant solution and then divided according to times of pouring into two groups immediate pour according to manufactures instructions and One-week delay pouring. Impressions were poured with a type IV extra hard dental stone. All measurements were performed on the photos of the produced cast by DicoMesher software a computer software program allowing three dimension recording. Results were statistically analyzed

Results: Immediate pouring time showed the lowest mean overall dimensional changes while delayed pouring time showed higher mean shrinkage. However, there was no statistically significant difference between the overall dimensional changes of the two groups.

Conclusion: Within the limitation of this study we concluded that different pouring times did not harm the dimensional stability of the die material.

* Msc Fixed Prosthodontics, Faculty of Oral and Dental Medicine, Cairo University
** Lecturer of Fixed Prosthodontics Faculty of Dentistry, Cairo University
*** Lecturer of Computer and Software Faculty of Engineering, Misr University for Science and Technology
**** Professor of Fixed Prosthodontics Faculty of Oral and Dental Medicine, Cairo University

INTRODUCTION

There is a variety of excellent impression materials available commercially for making impressions in restorative dentistry. However, proper material selection and observation of manipulative variables is mandatory for optimal results. Several factors play a role in stability of impressions, including: polymerization shrinkage, loss of by-products (water and alcohol) during setting, thermal contraction from oral temperatures to room temperature, imbibition when exposed to water, disinfectant or high humidity and incomplete recovery of deformation because of viscoelastic behavior. [1, 2]

The objective of disinfection process is to eliminate microorganisms from the surface of the impression. However, an undesirable side-effect of the disinfection process is the potential for a change in the dimensions of the impression that may be associated with a chemical or physic-chemical interaction between the set material and the disinfecting solution.[2]

The American Dental Association (ADA) and Center for Disease Control (CDC) have recommended disinfection of impressions immediately after removal from the mouth. This prevent the transmission infectious diseases such as staphylococcal infections, hepatitis A, B, C, tuberculosis (TB), herpes and acquired immune deficiency syndrome from the patient to the dentist and lab technician . Therefore, all dentists should be encouraged to disinfect impression materials as a routine procedure for infection control procedure.

Several studies have evaluated the dimensional accuracy of some of the elastomeric impression materials based on various factors including effects of repeat pour, temperature, humidity, disinfectants, impression techniques, and filler loading amongst others [3, 4] with some studies having considered the dimensional accuracy of the elastomeric impression materials with storage time.[5]

However, due to the various conditions impressions are subjected to during factors including long storage times and extreme changes in temperatures, there is a need to assess the stability of materials under these different conditions.

The null hypothesis of this study was that there is no difference in spray disinfection techniques with immediate or delayed pouring time on the dimensional accuracy of “Express XT” vinyl polysiloxane impression material.

MATERIAL AND METHODS

A standardized stainless steel mold was machine crafted following the American Dental Association specification no.19 and the international standard ISO 4823. The mold consists of a solid stainless steel cylinder of 38 mm diameter and 35 mm height. At 3 mm away from the upper surface of the cylinder a 4 mm width step is milled all around to create a smaller cylinder-shape evaluation of 30 mm diameter and 3 mm height. This step will act as a tray stopper during impression making. The upper surface of the smaller cylinder will receive indentations of 3 horizontal lines passing through the center with 2.5 mm distance between them. The horizontal lines will be intersected with 2 vertical lines each situated at 2.5 mm from the edge of the cylinder and 25 mm apart from each other. (Figure 1)

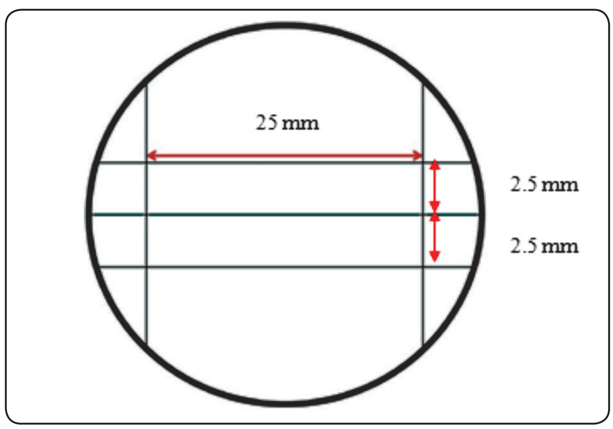

Fig. (1) Schematic diagram of the master model measurements

Sample size calculation done by PS (power and sample size) resulted a total of 20 samples at the actual power of 0.8511398.

Twenty special trays were made using Acrostone acrylic resin .In order to provide a uniform thickness of the impression material a 2mm spacer was constructed. Tray was finished, polished and left for 24 hours before usage. Tray adhesive was applied to the special tray and allowed to dry for three minutes.

Before making the impressions, the stainless steel model was cleaned with alcohol to remove any remnants or debris and allowed to air dry. The impression material Express XT (regular body, 3M)) was used to make a total of twenty impressions of the mold. The setting time was adjusted according to the manufacturer's instructions increased by 3 minutes to ensure complete set.

Impressions were divided into two groups (n=10) according to the pouring times: group (T1): immediate pour according to manufactures instructions and group (T2): One week delay pour

Spraying the impressions with the Cavicide1 (Metrex protecting People Company) disinfectant solution. Ensuring the complete coverage of the impression surface with the disinfectant; the impression was kept for 3 minute in plastic sealed bags, then rinsed under running water for 10 seconds, shaken to remove excess water and dried in room air before being poured.

Type IV extra hard dental stone (Zhermack) was used for pouring the impressions. The manipulation of dental stone was done following the manufacturer's instructions. Impressions submitted to delay pour were stored in a special container for the nominated storage time under the same conditions at room temperature 22±2ºC on the laboratory bench.

A digital camera with macro lens and 12.1 mega pixels was used to take photographs of the master model and the produced stone casts

All measurements were performed on the photos by DicoMesher software a computer software program allowing three dimension recording. It is a special version from DicoMesher software. [6, 7] This version used the JPG images as set of inputs, where a series of photos that cover the whole model to reconstruct the 3-D model.

This was done in two steps. First the photos were matched the program looks at each image, important points in it were determined, and these points were tracked on other photos.

The photos were then calibrated, which means that the positions of the camera (and its other parameters) when taking each picture were calculated from these tracked points.

The photos are segmented to square grids to measure the distance between nominated points as shown in the axial plane to the 3D images with the micro scalar X-Y plan.

The total number of squares vertically was calculated and divided by the diameter of master die to determined specific size of each square, then the measurement were made for the different locations (vertically and horizontally) by calculating the number of boxes and multiplying it by the actual size of box previously calculated.

The following seven measurements were obtained from the master and the samples in micrometer to determine the dimensional stability of the impression materials:

Four vertical measurements (1–4), and

Three horizontal measurements (5-6). (Figure 2)

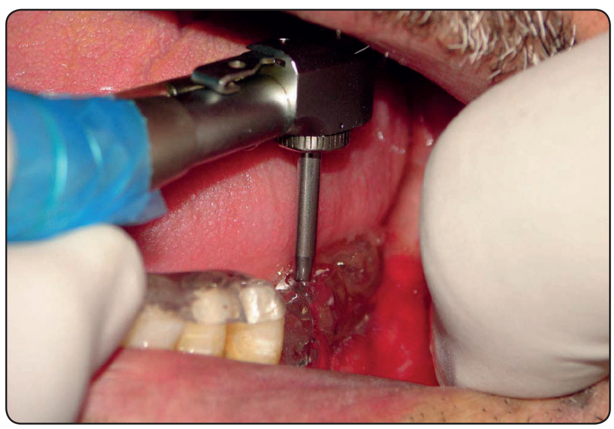

Fig. (2) The seven measured locations.

All data were collected, tabulated, and statistically analyzed.

Statistical analysis

Differences between master model measurements and stone model measurements represented the dimensional changes. Dimensional change data were explored for normality by checking the data distribution, calculating the mean and median values and using Kolmogorov-Smirnov and Shapiro-Wilk tests. All data showed non-parametric distribution. Data were presented as mean, standard deviation (SD), median and range values. Mann-Whitney U test was used to compare between the two pouring times. The significance level was set at $P \le 0.05$. Statistical analysis was performed with IBM SPSS Statistics Version 20 for Windows.

RESULTS

ST1 group (Sprayed disinfection technique with immediate pouring time) showed the lowest mean overall dimensional changes. The ST2 group (Sprayed disinfection technique with delayed pouring time) showed higher mean shrinkage. However, there was no statistically significant difference between the overall dimensional changes of the two groups.

The mean values, standard deviation (±SD) and the Kruskal-Wallis test results of the overall dimensional changes measurements in microns (µm) for the two tested groups are shown in table (1) and figure (3)

TABLE (1) Mean values (±SD) and the Kruskal-Wallis test results of the overall dimensional changes for the four tested groups.

Groups	Mean	± SD	P-value
T1	-0.14	0.29	0.776
T2	-0.21	0.36	

: Significant at P ≤ 0.05

Where:

T1 is the sprayed disinfected with immediate pour group

T2 is the sprayed disinfected with one week delayed pour group

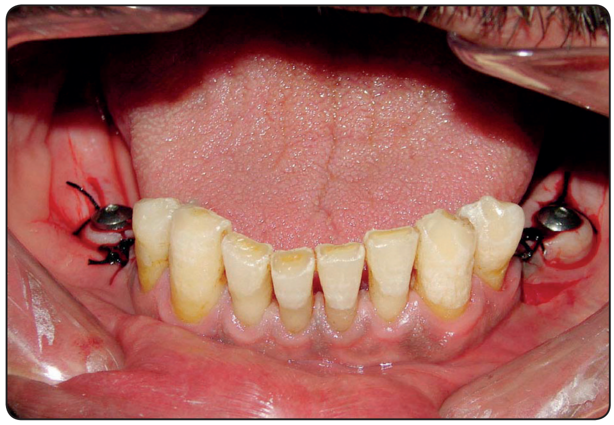

Fig. (3) Bar chart representing the means of the overall dimensional changes for the two pouring times

DISCUSSION

In recent years, the implementation of disinfection procedures for impressions made a considerable difference in dental school and laboratories. Surveys range from 37.5% [8,9] up to 90% of impressions disinfected in routine cases. Until 1991, rinsing of impressions under running water was the recommended practice. This has been shown to reduce by approximately 90% the counts of bacteria present on an impression surface.[10] However a significant number of bacteria still remain. More recent recommendations advocated the use of a disinfecting solution, but there is still no universally recognized impression disinfection protocol.

The role of disinfectant is dual purpose, in that it must be an effective antimicrobial agent, yet cause no adverse response to the dimensional accuracy and surface texture features of the impression materials and resultant gypsum cast. Controversy exists in the literatures as to whether the disinfection process causes degradation or distortion of impressions. [11] The response of individual brands of impression materials and gypsum products to disinfection procedure varied, suggesting a lack of compatibility between a protocol and a given material. Therefore individual analysis of impression materials was required to determine the efficacy of a specific disinfection procedure.

Cavicide1 as disinfectant was demonstrated to have biocidal effectiveness against the following microorganisms: Mycobacterium bovis BCG, Staphylococcus aureus, Pseudomonas,aeruginosa, Salmonella enteric, Trichophyton, mentagrophytes, Methicillin Resistant Staphylococcus aureus (MRSA) Vancomycin Resistant Enterococcus faecalis (VRE), Staphylococcus aureus with Reduced Susceptibility to Vancomycin (VRSA), Hepatitis B Virus (HBV), Hepatitis C Virus (HCV), Herpes Simplex Virus Type 1, Herpes Simplex Virus Type 2, Human Immunodeficiency Virus (HIV-1), Human Coronavirus, Influenza A2 Virus.[12]

The results of this study support the null hypothesis that there was no statistically significant difference in the dimensional stability of “Express XT” vinyl polysiloxane impression material even with spray disinfection techniques or between immediate and delayed pouring times.

The results of sprayed disinfection with immediate pour showed higher dimensional changes for the vertical measurement. These findings were in agreement with other studies [13-16].While disagreement with other ones [17-19]. This may be attributed to that the discrepancies which occur may be predominantly by the reaction of the components.

The result of sprayed disinfection with immediate pour showed lower dimensional changes for the horizontal measurement. These findings were in agreement with Melilli et al [20] and Stober et al [21].While disagreement with other studies [22-24]. This may be attributed to that all of the impression surfaces may not be adequately covered with disinfectant solution.

In general impression shrinkage results in oversized dies, which is advantageous in compensating for wax pattern and casting alloy shrinkage.[25] Thus, the oversized die could be helpful in full seating of a casting crown. It is critical to maintain the balance between impression shrinkage and expansion and to know how much the dimensional accuracy of the impression material might be affected by the disinfection process. Optimum crown seating has been determined to occur when a uniform 0.040 mm (40 mm) of axial space exists between the casting and the tooth. [26] This implies that if no other dimensional changes occur, an additional 0.025 mm (25 mm), or 2 layers of die spacer [27], would be nearly optimal for working dies.

Al-Omari et al [28] reported that changes of impressions produced by certain disinfectants were compensated by the setting expansion of the stone used to make the casts. This means that, provided they occur in the right direction, the changes of impressions and casts can compensate for each other, producing stone casts that are dimensionally closer to the original object than the impressions.[29]

Custom trays are more intimately adapted to the master model, requiring less impression material when compared to stock impression trays. [30, 31] Stock trays differ in design and physical properties, thus affecting accuracy. [32, 33] An improvement in accuracy is expected when a rigid tray is used, since it is able to resist the distortion forces that can cause plastic deformation when the impression tray is seated and removed. [34]

Also the progressive increase or decrease in dimensions of stone casts as time interval increased was due to contraction of the impression material. This decrease in interabutment distance might be explained on the basis of pattern of polymerization shrinkage of the addition silicone impression material. During polymerization reaction, the impression material shrank towards the center of the bulk of the material. However, the use of tray adhesive redirected the polymerization shrinkage towards the walls of the impression tray. So the impression material contracted towards the walls of the impression tray around each abutment. As there was bulk of impression material in between two abutments and also tray adhesive redirected the polymerization shrinkage towards the tray wall around each abutment, the position of midpoint of both abutments came closer i.e. interabutment distance decreased. [35]

CONCLUSIONS

Within the limitation of this study we concluded the different pouring times did not harm the dimensional stability of the die material.

RECOMMENDATIONS

Based on both D1 & D2 measurements in case of spray disinfection, immediate pouring protocol is recommended.

REFERENCES

1- Chong YH, Soh G, Setchell DJ. Relationship between contact angles of die stone on elastomeric impression materials and voids in stone casts. Dental Materials; 6:162–6. Christensen GJ. 1996. Marginal fit of gold inlay castings. Journal of Prosthetic Dentistry 1990; 16:297–305.

2- Cynthia SP, Mary PW, Aisling M, and Paulette S. Dimensional accuracy and surface detail reproduction of two hydrophilic vinyl polysiloxane impression materials tested under dry, moist, and wet conditions. Journal of Prosthetic Dentistry 2003; 90:365-72

3- Pant, R., Juszczyk, A. S., Clark, R. K. F., & Radford, D. R. Long-term dimensional stability and reproduction of surface detail of four polyvinyl siloxane duplicating materials. Journal of dentistry 2008; 36(6), 456–61.

4- Purk JH, Willes MG, Tira DE, Eick JD, Hung SH. The effects of different storage conditions on polyether and polyvinylsiloxane impressions. Journal of American Dental Association 1998; 129:1014-21.

5- Tjan AH, Nemetz H, Nguyen LT, Contino R. Effect of tray space on the accuracy of monophase polyvinyl siloxanes. Journal of Prosthetic Dentistry 1992; 68:19-21.

6- Nassef T M. New segmentation approach to extract human mandible bones based on actual computed tomography data. American Journal of Biomedical Engineering 2012; 2, 197-201.

7- Nassef T M. Computer-Assisted Tissue Engineering for Dental Applications: Multi-Object Reconstruction Technique. LAP Lambert Academic Publishing; 2012.

8- Jagger DC, Hugget R and Harison A. Cross-infection control in dental practice. British Dental Journal 1995; 6, 179-93.

9- Watkinson AC. Disinfection of impressions in UK dental schools. Br Dent journal 1988; 164, 22-3.

10- Leung RL and Schonfeld SE. Gypsum casts as spotential source of microbial cross-contamination. Journal of Prosthetic Dentistry 1983; 49, 210-1.

11- Rueggebery FA, Beall FE, Kelly MT and Schuster GS. Sodium hypochlorite disinfection of irreversible hydrocolloid impression material. Journal of Prosthetic Dentistry 1992;67(5), 628-31.

12- Metrex protecting people company, Metrex researcher. 1717 W. Collins Ave.Orange, CA 92867.U.S.A. Overview, E. 2012. MATERIAL SAFETY DATA SHEET, 1–6.

13- Pal, P. K., Kamble, S. S., Chaurasia, R. R., Chaurasia, V. R., & Tiwari, S. Evaluation of Different Disinfactants on Dimensional Accuracy and Surface Quality of Type IV Gypsum Casts Retrieved from Elastomeric Impression Materials Journal of international oral health 2014; 6(3); 77–81.

14- Saber, Kohsoltani, Abolfazli O. The Effect of Disinfection by Spray atomization on dimensional accuracy of condensation silicone impressions: Journal of Dental Research 2010; 4(4):124-129 .

15- Thouati A, Deveaux E, Iost A, Behin P. Dimensional stability of seven elastomeric impression materials immersed in disinfectants Journal of Prosthetic Dentistry 1996;76(1), 8–14.

16- Walker, M. P., Rondeau, M., & Petrie, C. Surface Quality and Long-term Dimensional Stability of Current Elastomeric Impression Materials after Disinfection Journal of Prosthodontics 2007; 16(5), 343–351.

17- Ahila, S. C., & Subramaniam, E. Comparative evaluation of dimensional stability and surface quality of gypsum casts retrieved from disinfected addition silicone impressions at various time intervals : An in vitro study. Journal of Dentistry and Oral Hygiene 2012; 4 ,34–43.

18- Ahmad, S., Tredwin, C. J., Nesbit, M., & Moles, D. R.Effect of immersion disinfection with Perform-ID on alginate, an alginate alternative, an addition-cured silicone and resultant type III gypsum casts. British dental journal 2007; 202(1); 36–7.

19- Silva MS, SALVADOR GM. Efect of the disinfection technique on the linear dimensional stability Journal of Applied Oral Science 2004;12(3), 244–249.

20- Melilli, D., Rallo, A., Cassaro, A., & Pizzo, G. The effect of immersion disinfection procedures on dimensional stability of two elastomeric impression materials Journal of Oral Science, 2008; 50(4), 441–446.

21- Stober, T., & Johnson, G. H. Accuracy of the newly formulated vinyl siloxanether elastomeric impression material. The Journal of Prosthetic Dentistry 2010; 103(4), 228–239.

22- Jagger, D. C., Vowles, R. W., Mcnally, L., Davis, F., & Sullivan, D. J. O. The Effect of a Range of Disinfectants on the Dimensional Accuracy and Stability of Some Impression Materials. european journal of prosthodontics and restorative dentistry 2007; 15(1), 23–28.

23- Iara, C., Carvalhal, O., Antônio, J., Mello, N. De, Sobrinho, L. C., & Correr, A. B. Dimensional Change of Elastomeric Materials after Immersion in Disinfectant Solutions for Different Times The journal of contemporary dental practice 2011; 12(4); 252–258.

24- Mehta, R., Dahiya, A., Mahesh, G., Kumar, A., Wadhwa, S., Duggal, N., & Pande, S. Influence of Delayed Pours of Addition Silicone Impressions on The Dimensional Accuracy of Casts Journal of Oral Health Community Dentistry2014; 8(September), 148–153.

25- 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,-53.

26- Taylor RL, Wright PS, Maryan C. Disinfection Procedures: Their Effect on the Dimensional Accuracy and Surface Quality of Irreversible Hydrocolloid Impression Materials and Gypsum Casts. Dental Materials 2002; 18(2):103- 110.

27- Lepe, X., & Johnson, G. H. Accuracy of polyether and addition silicone after long-term immersion disin- fection. journal of prosthetic dentistry 1997; 78, 245–249.

28- Al-Omari WM, Jones JC, Wood DJ. The effect of disinfect-ing alginate and addition cured silicone rubber impression materials on the physical properties of impressions and re-sultant casts. European Journal of Prosthodontics and Restorative Dentistry 1998; 6:103-10.

29- Kotsiomiti E, Tzialla A, Hatjivasiliou K. Accuracy and sta-bility of impression materials subjected to chemical disin-fection a literature review. Journal of Oral Rehabilitation 2008; 35:291-9.

30- De Araujo PA, Jorgensen KD. Effect of material bulk and undercuts on the accuracy of impression materials. Journal of prosthetic dentistry 1985;54:791-4.

31- Eames WB, Sieweke JC, Wallace SW, Rogers LB. Elastomeric impression materials: effect of bulk on accuracy. Journal of prosthetic dentistry 1979;41:304-7

32- Ceyhan JA, Johnson GH, Lepe X, Phillips KM. A clinical study comparing the three-dimensional accuracy of a working die generated from two dual-arch trays and a complete-arch custom tray. Journal of prosthetic dentistry 2003; 90:228-34.

33- Davis GB, Moser JB, Brinsden GI. The bonding properties of elastomer tray adhesives. Journal of prosthetic dentistry 1976; 36:278-85.

34- Sotiriou M, Hobkirk JA. An in vivo investigation of seating and removal forces associated with recording impressions in dentate patients. Journal of Prosthetic Dentistry 1995;74:455-62.

35- Revised American Dental Association Specification No. 19 for Non-Aqueous, Elastomeric Dental Impression Materials. The Journal of American Dental Association 1977; 94:733 41.