Journal of Nepal Dental Association (2009), Vol. 10, No. 2, Jul.-Dec., 88-96

Original Article

Comparative evaluation of dimensional accuracy of addition silicone and condensation silicone impression materials - An invitro study

Joshi PR[1], Bhat GS[2], Shenoy V[3]

[1]Prosthodontist, Nepal Police Hospital, Kathmandu, [2]Principal, Vyas Dental College, Jodhpur, India, [3]Professor and HOD, Department of Prosthodontics and Maxillofacial Prosthetics, Manipal College of Dental Sciences, Karnataka, India.

Abstract

Background: Amongst the silicone impression materials, the addition silicones are superior in accuracy and dimensional stability. These days a wide range of condensation silicones are marketed with claims of equally good results as addition silicones.

Aims and objectives: To evaluate and compare the time dependent dimensional accuracy and stability of addition silicone and condensation silicone impression materials.

Materials and methods: Two addition-cured silicones (Reprosil, Dentsply/ Caulk, USA and Express XT, 3M ESPE, Germany) and two condensation-cured silicones (Speedex, Coltene Whaledent, USA and Zetaplus, Zhermack, Italy) were evaluated. A stainless steel master die simulating a three unit fixed partial denture preparation was fabricated. For each brand of the impression material, 6 impressions were made and cast poured immediately. The impressions were repeatedly poured at 1 h, 24 h, 48 h and 16 8 h. Interpreparation dimension and occlusogingival dimension were measured in the recovered stone dies (Type IV, Kalrock) using a travelling microscope calibrated to an accuracy of 0.001 cm.

Results: i) the addition silicone impression materials were superior in accuracy and dimensional stability in comparison to condensation silicone; ii) at 1 hour of pour, all the materials tested seemed to have comparable accuracy and dimensional stability; iii) the gypsum dies produced from the successive pours of all the tested impression materials were generally larger in interpreparation distance and smaller in occlusogingival dimension than the stainless steel master die, with the addition silicone demonstrating the smallest change.

Conclusion: The addition silicones have better dimensional accuracy and stability than condensation silicones. An impression made from condensation silicone should be poured as soon as possible.

Key words: Accuracy, Addition silicone, Condensation silicone, Impression materials

Introduction

Accurate replication of tooth preparations and their arch positions require impression materials that exhibit good dimensional stability[1]. Nonaqueous elastomeric impression materials, or elastomers, were developed as an alternative to natural rubber during World War II. There are currently four basic types of elastomeric impression materials in use in the dental profession: (1) polysulfide, (2) condensation polymerizing silicone, (3) addition polymerizing silicone and (4) polyether.

The polysulfides are good in surface detail reproduction but they are dimensionally unstable when stored for a longer period of time. Other disadvantages of the polysulfides include the need to use custom-made rather than stock trays due to a greater chance of distortion, a bad odor, a tendency to run down the patient's throat due to lower viscosity and the lead dioxide materials that stain clothing. The polyether being hydrophilic absorbs water or fluids. It is a rigid material with high modulus of elasticity which makes it extremely difficult to remove from undercut areas. High cost, short working and setting time and high stiffness after setting limit their use[2].

Polyvinyl siloxanes are highly accurate, have little dimensional change after setting, moderately short

Correspondence
Dr. Pramod Raj Joshi, Nepal Police Hospital, Maharajgunj, Kathmandu, Nepal
E-mail: pramodrajjoshi@yahoo.com

working and setting time and excellent recovery from deformation on removal[3,4,4,5,6,7]. The addition silicones have overcome the disadvantage of polymerization shrinkage over the condensation silicone as there is no by-product release[3], condensation silicone has high polymerization shrinkage because of the release of alcohol by-product[2]. Loss of the by-product leads to measurable weight loss accompanied by shrinkage of the impression material on storage[8]. However, these days, a wide range of condensation silicones are marketed with claims of equally good results as addition silicones. In addition, various brands of condensation silicones available in the market are economically feasible in comparison to addition silicones.

Accuracy of impressions with repeated pours is of interest clinically, because duplicate models are sometimes desired. The dimensions of a model from a second pour can be affected by continuing polymerization of impression material and/by distortion of the impression with removal of the first model[9]. The contribution of the impression materials to a successful fixed partial denture can be increased by selecting a material which is stable enough to produce accurate casts from repetitive pours of a single impression. ADA Specification Number 19 recommends a maximum negative change in dimension of 0.5% after a minimum of 24 h[10].

The primary purpose of this study was to evaluate and compare the dimensional accuracy and stability of addition silicone and condensation silicone on repeated pours of single impression at various time intervals, viz, immediately, one hour, 24 hours, 48 hours and one week (168 h) after making the impression. The quantitative method was accomplished by microscopically measuring two critical dimensions of each stone die: (1) The interpreparation dimension (IP) and (2) the occlusogingival dimension (height) of the larger abutment (posterior).

Materials and methods

A machined standard stainless steel die preparation with specific dimensions (Figs. 1 & 2) was made so as to simulate a three-unit fixed partial denture situation replacing a mandibular first molar. Two dimensions, the interpreparation dimension and the occlusogingival dimension were measured on the master die and stone dies. In order to assess the linear change in the interpreparation distance, cross-grooves were prepared on the occlusal surfaces of the abutments as reference points. In the molar abutment, a vertical line which was used for assessing the vertical change in occlusogingival direction, was inscribed along the occlusogingival direction joining two circumferential lines which were 1 mm from the occlusal surface and 0.5 mm from the base. The measurements of the reference lines on the stainless steel master die were recorded as: i) interpreparation distance of 1.947 cm and ii) occlusogingival dimension (height) of 0.794 cm.

Standard 2 mm thick stainless steel copings were fabricated for each abutment with the purpose of producing uniform space for wash materials in putty impressions. For the purpose of impression making, perforated stainless steel custom trays were fabricated (Fig. 3). The tray was fabricated in such a way that the edges of the tray fitted into the 2 mm deep orientation ledges placed on the platform. In this way, the tray could be repeatedly and consistently seated in a self limiting way each time an impression was made so that there was approximately 7.0 mm clearance between its inner surface and the abutments.

In this study, a total of four elastomeric impression materials were evaluated: two brands of addition silicones (Reprosil, Dentsply/ Caulk, USA and Express XT, 3M ESPE, Germany) and two brands of condensation silicones (Speedex, Coltene Whaledent, USA and Zetaplus, Zhermack, Italy). All the materials, which were commercially available and recommended for use in making fixed partial denture impression, were stored at manufacturers' recommended temperatures before use and were mixed at room temperature and humidity so as to simulate their clinical use.

A two step putty-wash impression technique was used for making impression of the metal die using all the four types of impression materials (Table 1). The tray adhesive supplied by the manufacturer was evenly applied over the inner surface of the tray and extended approximately 2 mm on the outer surface along the periphery. To allow space for the wash thickness, 2 mm stainless steel spacer was placed on the abutments before making putty impression. Putty (base and catalyst) was mixed according to the manufacturers' recommended proportions, loaded into the tray and the tray seated over the stainless steel die as guided by the alignment ledges until firm contact was made, indicating that seating had occurred to the predetermined degree. All the materials were hand mixed, to get a homogenous mix, at room temperature and placed within the working time recommended by the manufacturer. After seating the tray, the impression was held with gentle finger pressure on the stainless steel master die for twice the indicated setting time to assure complete polymerization at room temperature. After the putty impression had completely set, impression was removed vertically. Metal spacers were carefully removed and the impressions were examined.

After removal and allowing for a short period of elastic recovery, light body material was introduced into the prespaced putty impression. Express XT Light Body impression material was available in automix syringe tips and was dispensed using an automixing device. For Reprosil Light Body, equal quantity of base and catalyst paste were dispensed directly from the tubes on clean glass slab according to the manufacturers' instruction and mixed with clean stainless steel spatula and the application was done with an impression syringe. For both the brands of condensation silicones, equal strand lengths of base material and activator were dispensed directly from the tubes on a clean glass slab according to the manufacturers' instruction and mixed with a clean stainless steel spatula and the application was done with an impression syringe. The impression was re-seated to the predetermined position and held with gentle finger pressure for an adequate amount of time to ensure that setting reaction was complete before removal. Since the reaction took place in room temperature, which was lower than the mouth temperature, the tray was held in place for a longer duration than the manufacturers' recommendation to ensure complete polymerization. After that, the impression was removed with straight pull directed along the path of withdrawal of the preparations. The impression was checked and impression with voids and other inaccuracies were discarded.

To prepare die stone casts, a ratio of 23 ml water to 100 gm die stone (Type IV, Kalrock) was used. It was first mixed by hand to incorporate the water and then mechanically mixed under vacuum for 15 sec. The mixture was placed into the impression from one end in small increments with a small instrument until it completely filled the tray. While pouring, the impression was kept on a vibrator to avoid any air bubble entrapment.

For each brand of addition silicone as well as condensation silicone, six impressions were made giving a total of 24 impressions. All the impressions were poured with high strength dental stone immediately after the impressions were obtained. After 45 minutes when the stone cast was completely set, a total of 24 casts were recovered. Likewise, the impressions were poured successively at 1 hour, 24 hours, 48 hours and 1 week (168 h) after the impressions were made and thus altogether 120 casts were made. Any cast which showed voids and other inaccuracies were discarded and replaced. All the casts were labeled with the first letter of the brand name coding the brand of the material. Roman numbers coded the sample number and Arabic numbers coded the pouring time (Fig. 4).

Before measurements were obtained, the casts were allowed to air dry for at least 48 hours and were carefully observed to verify the proper replication of the reference lines. The dental stone casts at the measurement locations were each measured with a travelling microscope (Parco) capable of measuring to 0.001 cm (Fig. 5). Each measurement of the stone dies was repeated three times to ensure its reproducibility and a mean was recorded for a particular dimension. To eliminate individual variability, all measurements were made by the same individual. A positioning device was made so that the measurement made for occlusogingival dimension on the stainless steel die and the stone dies could be reproduced. The accuracy of casts was expressed as percentage deviation from the standard die values. The difference between the mean of the stone cast (msc) and the mean of the stainless steel die (msd) divided by the mean of the stainless steel die multiplied by 100 was expressed as the percentage deviation from the stainless steel die for each impression material at each measurement location.

$$\text{Percentage deviation} = \frac{\text{msc - msd}}{\text{msd}} \times 100$$

Results

The mean (in cm) and standard deviation of interpreparation and occlusogingival measurements for silicone impression materials tested at various time are listed in Table 2. In this Table, the relative accuracies of first and second pours (0 h and 1 h) for the materials tested are depicted for interpreparation measurement. For all the tested materials, occlusogingival dimension is relatively stable at 0 h. The interpreparation distance, generally, increased for most stone dies compared with the stainless steel master die for all the tested materials. Occlusogingival dimension decreased for most of the materials compared with the stainless steel die. Graphic results of comparison of mean interpreparation and occlusogingival measurements for all materials tested with the master die are shown in Figs. 6 & 7.

Effects of time of pouring are shown in Table 3. There was no statistically significant difference in mean percentage change at each measurement (interpreparation and occlusogingival) for all the materials at 0 h, 1 h, 24 h and 48 h. Results of Kruskal Wallis Test indicated statistically significant change at 168 h ($p<0.05$) at both the dimensions for the materials tested. Graphic results are presented in Figs. 8 & 9 as percentage change of each measurement at various time intervals between the materials tested.

Table 4 shows mean and standard deviation of interpreparation and occlusogingival measurements between various time intervals for silicone impression materials tested. Regarding interpreparation distance, statistically significant differences were recorded between 0-1 hour for Express XT ($p<0.05$). Likewise, at interpreparation distance, statistically significant differences were recorded for Speedex and Zetaplus between 48 h to 168 h ($p<0.05$). Regarding occlusogingival dimension, statistically significant change was recorded for Zetaplus during 48 h to 168 h ($p<0.05$).

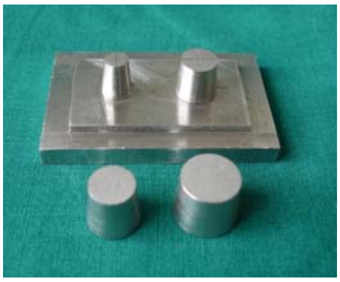

Fig 1: Stainless steel die with spacer

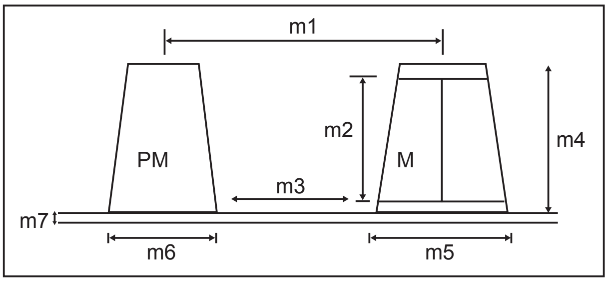

Fig 2: Diagram of stainless steel die with reference marks

Fig 3: Impression Trays and Final Impressions

m1 = interpreparation distance
m2 = occlusogingival distance (height)
m3 = distance between abutment preparation (10.5 mm)
m4 = occlusogingical dimesion of each died (9.5 mm)
m5 = gingival diameter of molar die (10.5 mm)
m6 = gingival diameter of premolar die (7.5 mm)
m7 = plateform thickness (5 mm)
M = molar abutment, PM = premolar abutment

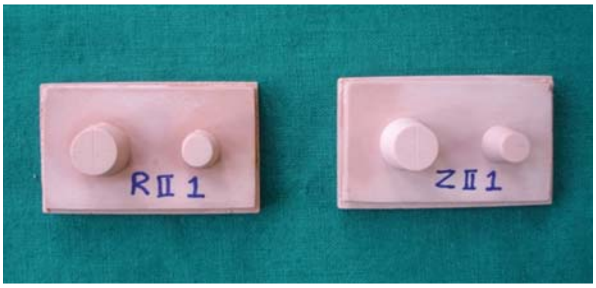

Fig 4: Stone dies

Fig. 5: Travelling Microscope

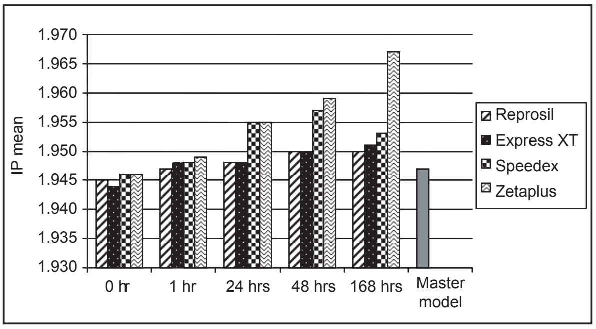

Fig 6: Comparison of mean interpreparation (IP) distance of addition silicone and condensation impression materials with master die

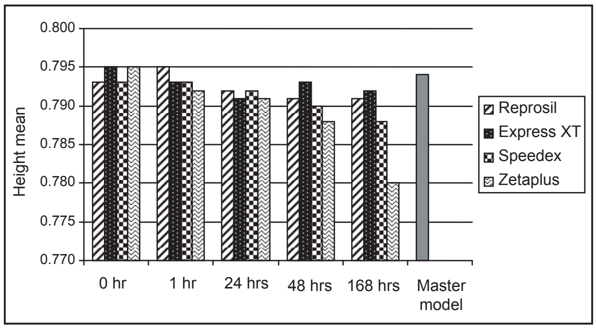

Fig 7: Comparison of mean occlusogingival dimension (height) of addition silicone and condensation impression materials with master die

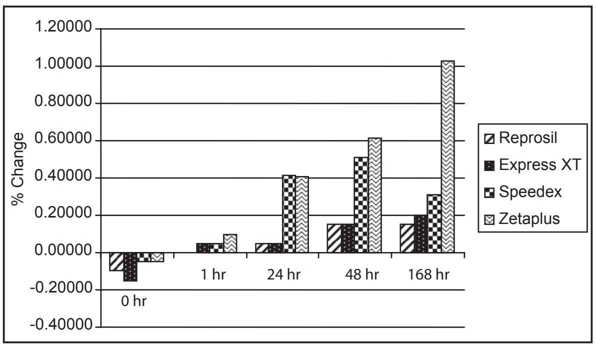

Fig 8: Comparison of mean percentage deviation of interpreparation distance at different time intervals between materials tested

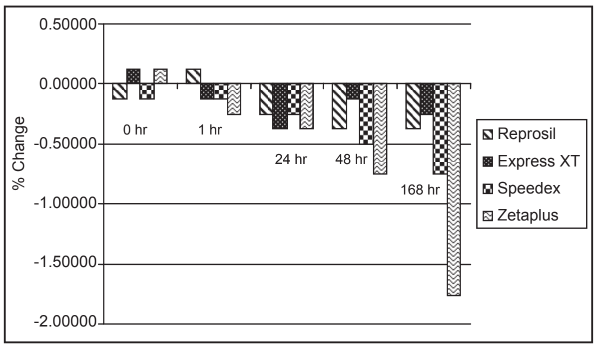

Fig 9: Comparison of mean percentage deviation of occlusogingival distance (height) at different time intervals between materials tested

Table 1: The details of the products involved in the study

Serial No.	Materials	Type	Manufacturer	Batch No.
1.	Express XT Putty Soft	Addition silicone	3M ESPE, Germany	P060626C, P060626B
	Express XT Light Body		3M ESPE, Germany	B263227, C264787
2.	Reprosil Putty	Addition silicone	Dentsply/ Caulk, USA	060818
	Reprosil Light Body		Dentsply/ Caulk, USA	060914
3.	Speedex Putty Base	Condensation silicone	Coltene Whaledent, USA	NI675
	Speedex Light Body		Coltene Whaledent, USA	0074657
4.	Zetaplus (Putty)	Condensation silicone	Zhermack, Italy	34522
	Oranwash L (Light body)		Zhermack, Italy	34467

Table 2: Mean and standard deviation of interpreparation distance and occlusogingival dimension (height) between silicone impression materials tested.

Time (h)	Product	N	Interpreparation distance		Occlusogingival dimension (Height)	
			Mean (cm)	Std. Deviation	Mean (cm)	Std. Deviation
0	Reprosil	6	1.945	.002	.793	.002
	Express XT	6	1.944	.005	.795	.004
	Speedex	6	1.946	.008	.793	.007
	Zetaplus	6	1.946	.008	.795	.007
1	Reprosil	6	1.947	.006	.795	.004
	Express XT	6	1.948	.005	.793	.002
	Speedex	6	1.948	.013	.793	.011
	Zetaplus	6	1.949	.013	.792	.006
24	Reprosil	6	1.948	.004	.792	.005
	Express XT	6	1.948	.002	.791	.011
	Speedex	6	1.955	.010	.792	.006
	Zetaplus	6	1.955	.006	.791	.013
48	Reprosil	6	1.950	.009	.791	.013
	Express XT	6	1.950	.011	.793	.007
	Speedex	6	1.957	.010	.790	.009
	Zetaplus	6	1.959	.018	.788	.016
168	Reprosil	6	1.950	.034	.791	.007
	Express XT	6	1.951	.005	.792	.015
	Speedex	6	1.953	.012	.788	.011
	Zetaplus	6	1.967	.031	.780	.020

Table 3: Mean percentage change of interpreparation distance and occlusogingival dimension (height) from master die for silicone impression materials tested

Deviation	Product	N	Interpreparation distance				Occlusogingival dimension			
			% Change	Std. Deviation	Kruskal Wallis Test X2(3)	p value	% Change	Std. Deviation	Kruskal Wallis Test X2(3)	p value
At 0 h	Reprosil	6	-.1000	.133	.344	.954 NS	-.1200	.325	.253	.969 NS
	Express XT	6	-.1500	.285			.1200	.611		
	Speedex	6	-.0500	.412			-.1200	.939		
	Zetaplus	6	-.0500	.428			.1200	.922		
At 1 h	Reprosil	6	.0000	.351	.473	.925 NS	.1200	.563	1.864	.601 NS
	Express XT	6	.0500	.305			-.1200	.365		
	Speedex	6	.0500	.697			-.1200	1.470		
	Zetaplus	6	.1000	.708			-.2500	.804		
At 24 h	Reprosil	6	.0500	.246	4.239	.237 NS	-.2500	.649	.302	.960 NS
	Express XT	6	.0500	.121			-.3700	1.471		
	Speedex	6	.4109	.524			-.2500	.765		
	Zetaplus	6	.4109	.380			-.3700	1.695		
At 48 h	Reprosil	6	.1500	.464	2.336	.990 NS	-.3700	.682	.501	.919 NS
	Express XT	6	.1500	.592			-.1200	.948		
	Speedex	6	.5130	.543			-.5000	1.239		
	Zetaplus	6	.6160	.935			-.7550	2.114		
At 168 h	Reprosil	6	.1500	1.788	8.050	.045 sig	-.3700	.999	8.150	.043 sig
	Express XT	6	.2000	.279			-.2500	1.934		
	Speedex	6	.3080	.643			-.7550	1.448		
	Zetaplus	6	1.0272	.590			-1.7630	2.553		

p = probability level (<0.05)

Table 4: Mean and standard deviation of interpreparation distance and occlusogingival dimension between various time intervals of silicone impression materials tested

Product	Duration	Interpreparation distance				Occlusogingival dimension			
		Paired differences		Wilcoxon Signed Ranks Test Z	p value	Paired differences		Wilcoxon Signed Ranks Test Z	p value
		Mean	Std. Deviation			Mean	Std. Deviation		
Reprosil	0 h – 1 h	-.0020	.004	-.841	.400 NS	-.0013	.003	-.841	.400 NS
	1 h – 24 h	-.0011	.007	-.105	.917 NS	.0021	.005	-.736	.462 NS
	24 h – 48 h	-.0020	.006	-.736	.462 NS	.0018	.010	-.736	.462 NS
	48 h – 168 h	-.0003	.037	-.135	.893 NS	-.0001	.017	-.105	.916 NS
Express XT	0 h – 1 h	-.0041	.002	-2.049	.040 sig.	.0020	.006	-.674	.500 NS
	1 h – 24 h	.0001	.005	-.211	.833 NS	.0011	.010	-.314	.753 NS
	24 h – 48 h	-.0021	.010	-.314	.753 NS	-.0018	.012	-.105	.916 NS
	48 h – 168 h	-.0008	.009	.000	1.000 NS	.0016	.015	-.105	.917 NS

table 4 cont ...

table 4 cont...

Product	Duration	Interpreparation distance				Occlusogingival dimension			
		Paired differences		Wilcoxon Signed Ranks Test Z	p value	Paired differences		Wilcoxon Signed Ranks Test Z	p value
		Mean	Std. Deviation			Mean	Std. Deviation		
Speedex	0 h – 1 h	-.0020	.009	-.946	.344 NS	-.0005	.013	-.210	.833 NS
	1 h – 24 h	-.0070	.010	-1.476	.140 NS	.0013	.008	-.526	.599 NS
	24 h – 48 h	-.0020	.015	-.314	.753 NS	.0021	.009	-.406	.684 NS
	48 h – 168 h	-.0030	.018	-1.976	.047 sig	.0016	.015	-.105	.917 NS
Zetaplus	0 h – 1 h	-.0025	.007	-.946	.344 NS	.0030	.006	-1.051	.293 NS
	1 h – 24 h	-.0036	.014	-.813	.416 NS	.0010	.015	-.315	.752 NS
	24 h – 48 h	-.0045	.020	-.933	.528 NS	.0028	.026	-.526	.599 NS
	48 h – 168 h	-.0048	.025	-1.999	.045 sig	-.0008	.016	2.120	.041 sig

p = probability level (<0.05)

Discussion

Interpreparation dimension (IP)

Interpreparation distance for all the dies produced immediately after making impression from Reprosil and Express XT decreased by -0.15% to -0.1%, whereas, for the same dimension, Speedex and Zetaplus revealed a decrease of -0.05%. All the four materials seemed to have comparable accuracy and dimensional stability at 1 hour of pour. At 1 hour of pour, Reprosil revealed the highest accuracy with no dimensional variation (Table 3).

The interpreparation distance increased for most stone dies compared with the stainless steel master die for all the tested materials. The effect of repouring on the interpreparation distance are shown in Figs. 6 & 8. Linke et al[11]. studied six types of impression materials and reported that the perimeter of the arch of the test cast was larger than the standard reference model. Gordon et al.[12] reported the interabutment distances were greater for all dies using polysulfide, polyether and addition silicone impression materials: a linear change of 45 µm to 100 µm greater than the standard was observed. Clinically, this change may result in fixed partial dentures that are too long mesiodistally. On the other hand, Craig[13], in a study, stated that no statistical or clinical differences existed in interpreparation distances in relation to master dies. Johnson and Craig[9] reported small differences that were insignificant in interabutment measurements when compared with the master model. Nissan et al[14]. reported an increase of 0.009% to 0.1% in the interabutment measurements.

Repour at 24 h showed the minimal percentage variation for addition silicone whereas condensation silicone revealed 0.41% increase in the interpreparation distance which represents a linear change of approximately 79.82 µm greater than the standard. At 48 hours of repour, interpreparation distance increased by 0.513% to 0.616% for Speedex and Zetaplus when compared with the master die. This represented an increase of 99.881 µm to 119.935 µm from the master die. Similarly, at 1 week of repour, for the same products, there was increase in the dimension by 0.308% to 1.027% when compared with master die. These values represented increase of 59.968 µm to 199.935 µm in comparison to the master die. The increased deviation in interpreparation distance for condensation silicone over the time period indicates a possible loss of volatile constituents (alcohol) yielding undesirable dimensional stability[1]. The study revealed statistically significant difference in interpreparation distance for both the products of condensation silicone during 48 h to 168 h of repour (p<0.05). The difference in the interpreparation distance between the master die and stone models repoured at 24 h, 48 h and 168 h for condensation silicone may be clinically important because this change may result in fixed partial dentures that are too long mesiodistally[12].

Regarding addition silicone impression materials tested, deviation in interpreparation distance ranged from -0.15% to 0.20% for all times of pour, when compared with the master die. These values represent a linear change of -29.205 µm to 38.94 µm which has questionable clinical significance. Consistent with previous studies on addition silicone, the materials used in this study were found to be dimensionally accurate even up to one week[12]. This is advantageous because casts can be poured up to 1 week without concern for dimensional accuracies as in the case when the impression needs to be sent to the laboratory for pouring.

The increase in the interpreparation distances seen may be explained by linear setting expansion of the die material. The increase in these distances may also be partially attributed to the impression material shrinkage upon setting towards the adhesive coated tray[9]. Because of the constrain imposed by an effective adhesive on uniform shrinkage upon setting, abutments in resultant casts may tend to be at a greater distance apart than actually were on the master die or in the mouth[7].

Occlusogingival dimension (height)

For pours immediately after making the impression and at 1 hour, vertical change for addition silicone impression materials and condensation silicone impression materials ranged from -0.12% to 0.12% and -0.25% to 0.12% respectively. At 24 hours of pour, the change in occlusogingival dimension for all the materials tested ranged from -0.37% to -0.25% (Table 3). These values are of less clinical significance, hence, all the four materials seemed to have comparable accuracy and dimensional stability during this period of time.

At 48 hours of repour, Speedex and Zetaplus showed the change in occlusogingival dimension of -0.50% and -0.755% respectively. These values represent a change of approximately - 39 µm and -59.947 µm respectively. For pours at 168 hours, Speedex and Zetaplus showed the change in occlusogingival dimensions of -0.75% to -1.763% (Table 3). These values represent a change of approximately -59.947 µm and -139.982 µm respectively. Table 4 reveals statistically significant difference in occlusogingival distance for Zetaplus between 48 h to 168 h of repour ($p<0.05$). These values may be clinically significant which may result in shorter castings made from the stone dies.

The effect of repouring on the occlusogingival distance are shown in Figs. 7 & 9. This study showed decrease in vertical height when compared to the standard for all impression materials tested which was in agreement with Stackhouse[15]. Craig[16], Linke et al.[11] and Johnson and Craig[9] also reported shorter vertical heights in their studies. Nissan J. et al.[14], in a study, reported a decrease of 0.8% to 3% in the occlusogingival measurements. This phenomenon occurred because of contraction of the impression material toward the tray walls, making the stone dies wider in the horizontal aspect and shorter vertically[9,17]. During polymerization reaction, impression materials shrink toward the center of mass; the use of tray adhesives, however, would redirect this shrinkage toward the impression tray wall. In contrast, in a study by Gordon et al.,[12] a slight increase of vertical heights for addition silicone impression was reported. Increase in vertical height was also reported by Hung et al[18].

The vertical change was found to be smaller for addition silicone for all times of pour than for condensation silicone materials; the addition silicone material demonstrated the smallest vertical change ranging from -0.37% to 0.12%. These values represent a linear change of -29.37 µm to 9.528 µm. Hence, the addition silicone impression materials tested were extremely stable over the 1-week period. It is desirable to minimize the decrease in height because a shorter model will produce a casting that is short at the margins[9]. A considerable gap or space may be detected when the die is undersized or short.

Conclusions

Within the limitations of this study, the following conclusions can be drawn.

1. The addition polymerization silicone demonstrated superior results in accuracy and dimensional stability in comparison to condensation silicone impression material. This material was extremely stable over the 1-week period. Amongst the addition silicone impression materials tested, Reprosil proved to be highly accurate.
2. Addition silicone and condensation silicone impression materials seemed to have comparable accuracy and dimensional stability at 1 hour of pour. For condensation silicones, the time interval between pours should not be greater than 1 hour. One can expect changes in dimensions of dies produced from successive pours of condensation silicone. Therefore, impressions made from condensation silicone should be poured as soon as possible.
3. The gypsum dies produced from the successive pours were generally larger in interpreparation distance and smaller in occlusogingival dimension than the stainless steel master die, with the addition silicone demonstrating the smallest change. Larger interpreparation distance may result in fixed partial denture that are too long mesiodistally, whereas, smaller occlusogingival dimension may result in shorter castings made from the stone dies.

References

1. Ciesco JN, Malone WF, Sandrik JL, Mazur B. Comparison of elastomeric impression materials used in fixed prosthodontics. J Prosthet Dent. 1981; 45: 89-94.
2. O'Brien WJ. Dental Materials and their selection. 3rd ed. IL: Quintessence Publishing Co, Inc; 2002. p 90-112.
3. Council on Dental materials, Instruments and Equipment: Vinyl Polysiloxane impression material: A status report. J Am Dent Assoc. 1990; 120: 595-6,598,600.
4. Craig RG, Urquiola NJ, Liu CC. Comparison of commercial elastomeric impression materials. Oper Dent. 1990; 15(3):94-104.
5. McCabe JF, Storer R. Elastomeric impression materials. The measurement of some properties relevant to clinical practice. Br Dent J. 1980; 149(3):73-9.

6. Wassell RW, Ibbetson RJ. The accuracy of polyvinyl siloxane impressions made with standard and reinforced stock trays. J Prosthet Dent. 1991 ;65(6):748-57.
7. Idris B, Houston F, Claffey N. Comparison of the dimensional accuracy of one- and two-step techniques with the use of putty/wash addition silicone impression materials. J Prosthet Dent. 1995; 74(5):535-41.
8. Wassell RW, Barker D, Walls AW. Crowns and other extra-coronal restorations: impression materials and technique. Br Dent J. 2002 29; 192(12):679-84, 687-90.
9. Johnson GH, Craig RG. Accuracy of four types of rubber impression materials compared with time of pour and a repeat pour of models. J Prosthet Dent. 1985; 53(4):484-90.
10. Council on Dental Materials and Devices: Revised American Dental Association Specification no. 19 for Non-aqueous, Elastomeric Dental Impression Materials. J Am Dent Assoc. 1977; 94:733-41.
11. Linke BA, Nicholls JI, Faucher RR. Distortion analysis of stone casts made from impression materials. J Prosthet Dent. 1985; 54(6):794-802.
12. Gordon GE, Johnson GH, Drennon DG. The effect of tray selection on the accuracy of elastomeric impression materials. J Prosthet Dent. 1990 ;63(1):12-5.
13. Craig RG. Review of dental impression materials. Adv Dent Res.1988; 2(1):51-64.
14. Nissan J, Laufer BZ, Brosh T, Assif D. Accuracy of three polyvinyl siloxane putty-wash impression techniques. J Prosthet Dent. 2000; 83(2):161-5.
15. Stackhouse JA Jr. The accuracy of stone dies made from rubber impression materials. J Prosthet Dent. 1970; 24(4):377-86.
16. Craig RG. Evaluation of an automatic mixing system for an addition silicone impression material. J Am Dent Assoc. 1985; 110(2):213-5.
17. Johnson GH, Craig RG. Accuracy of addition silicones as a function of technique. J Prosthet Dent. 1986; 55(2):197-203.
18. Hung SH, Purk JH, Tira DE, Eick JD. Accuracy of one-step versus two-step putty wash addition silicone impression technique. J Prosthet Dent. 1992; 67(5):583-9.