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ORIGINAL ARTICLE

Evaluation of Effect of Tray Space on the Accuracy of Condensation Silicone, Addition Silicone and Polyether Impression Materials: An In Vitro Study

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Abstract Optimal thickness of impression materials in the custom tray in order to get the most accurate impression. To investigate the effect of different tray spacer thickness on the accuracy and the dimensional stability of impressions made from monophasic condensation silicone, addition silicone and polyether impression materials. Three different types of elastomeric monophasic impression materials were used for making the impression of a master die with tray having tray spacer thickness of 2, 4 and 6 mm. Each type of impression was poured in die stone after 1 h. Each cast was analyzed by a travelling microscope and compared with the master die. The data was tabulated and subjected to statistical evaluation. The results of the study indicated that the impressions made from 2 to 4 mm spaced trays produced more accurate stone casts when compared to 6 mm spaced tray. No statistical significant differences were observed between the accuracy and dimensional stability of the three materials tested. Minimum changes were observed when the cast was poured after 1 h and the tray space was 2 mm for all the materials tested. It is therefore advisable not to exceed tray space of 2 mm.

Keywords Condensation silicone · Addition silicone · Polyether

Introduction

The accurate fit of the fabricated prostheses in relation to dental and oral tissues is one of the primary criteria to achieve the objective of maintaining the health of tissues for the longevity of the service which depends upon accurate recording of tissue surface with setting of impression materials in contact during impression making procedure.

In terms of accuracy and dimensional stability, the elastomeric impression materials have been found better than hydrocolloids [1–3]. The use of tray spacer in customized impression trays has been advised to get the optimal thickness of impression materials in terms of accuracy and flow whereas the use of stock trays does not give accurate results [1–6]. There are four basic types of elastomeric impression materials currently used in the dental profession i.e. polysulphide rubber, condensation silicone, addition silicone and polyether.

The literature reveals some controversies regarding use of tray spacer and use of various elastomeric impression materials to achieve the accuracy of resultant die for fabrication of prostheses which will fit accurately [1, 7, 8]. Certain authors have an opinion that a space ranging between 1 and 5 mm has no differences in effect on the accuracy of the impressions [1, 7–9] and according to another author 2–9 mm will not produce significant differences [10].

Therefore, the present study was designed to investigate the effect of different tray spacer thickness of 2, 4 and 6 mm on the accuracy and the dimensional stability of

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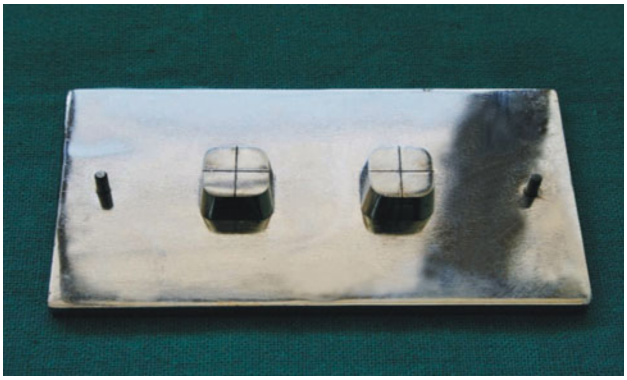


Fig. 1 Martinistic steel master die with 2 full crown abutments and alignment pins

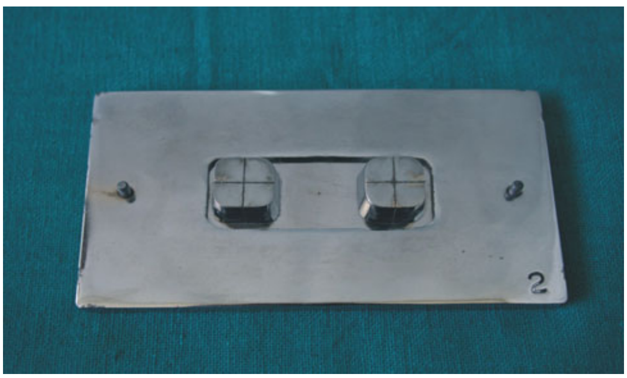


Fig. 2 Master die with guide plate for 2 mm spaced tray

impressions made from monophasic condensation silicone, addition silicone and polyether impression materials.

Materials and Methods

The various elastomeric monophasic impression materials used in the study are condensation silicone (Speedex, 0145259, Coltene/Whaledent Inc.,Ohio), addition silicone (Reprosil, 100901, Dentsply Caulk) and polyether (Impregnum soft, 431745, 3M ESPE Seefeld, Germany).

A standard martensitic steel die simulating abutments for fixed partial denture with a height of 9.01 mm, mesiodistal dimension 13.73 mm, buccolingual dimension 14.01 mm and interabutment distance 35.04 mm, was fabricated. The abutments had a 5° axial taper in relation to the vertical axis. Reference lines were inscribed on the top and side of the abutments to represent the occlusal and buccal surface for the purpose of measurements (Fig. 1). Pin A and B on the master die will guide the correct seating of the impression tray. The measurements of various dimensions of the master model were made. Three Customized martensitic steel trays and guide plates with 2, 4,

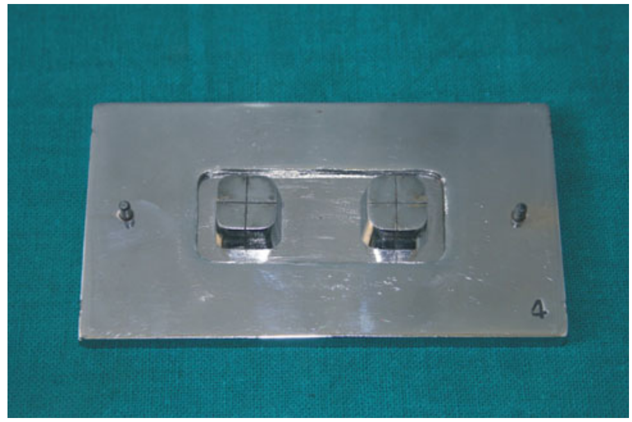


Fig. 3 Master die with guide plate for 4 mm spaced tray

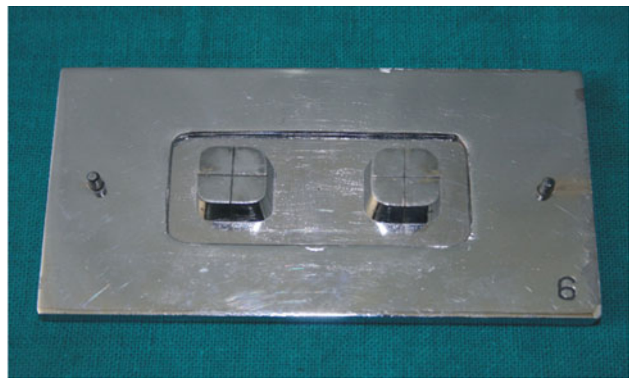


Fig. 4 Master die with guide plate for 6 mm spaced tray

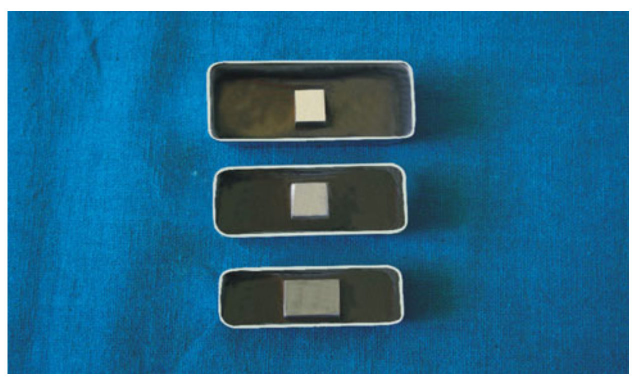


Fig. 5 Impression surface of customized martensitic steel impression trays with 2, 4 and 6 mm tray space

6 mm space between interface of tray and all surfaces of abutment and interabutment area were fabricated (Figs. 2, 3, 4, 5). Five sets of each type of tray and a guide plate for each type were fabricated.

Each impression material was dispensed and mixed according to manufacturer's instructions. The impression material was applied around the metal abutments and the

Fig. 6 Impression with monophasic condensation silicone impression material with 6 mm tray space

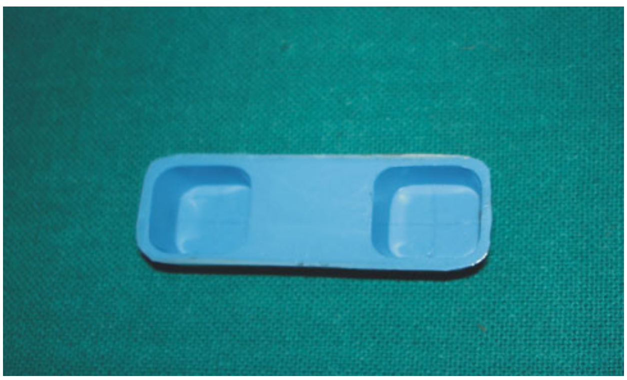


Fig. 7 Impression with monophasic addition silicone impression material with 2 mm tray space

Fig. 8 Impression with monophasic polyether impression material with 4 mm tray space

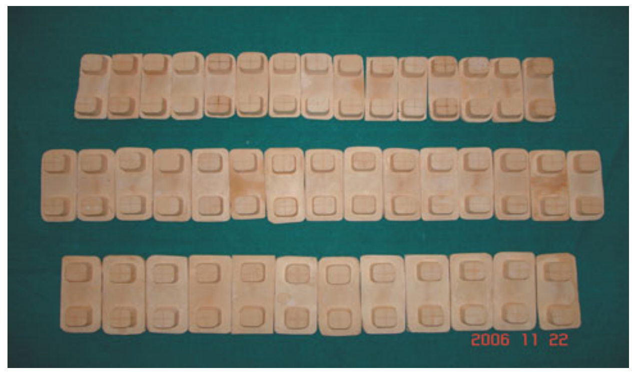


Fig. 9 Die stone casts

remaining material was placed in the tray. The tray was seated with light pressure until it was guided in place by the alignment pins and the guiding plates, and the excess flowed out through the holes provided in the tray. Five impressions, each were made with trays with spacer of 2, 4 and 6 mm for each material (Figs. 6, 7, 8). Thus a total of 45 impressions were made for all the three materials. One hour after each impression had set; it was poured with high strength die stone (Ultra Rock, die stone class IV, Kalabhai Karson Pvt. Ltd. India) (Fig. 9). The impressions were poured with the help of model vibrator (Confident, C-71, Confident Dental Equipments Ltd.) The travelling microscope capable of measuring up to 0.001 mm was used to measure the interabutment distance, mesiodistal dimension as well as buccolingual dimension and height of the abutments of master die and resultant stone dies obtained after making the impression with each of the impression material used for the study (Fig. 10).

The procedure was used for measuring 45 die stone casts pertaining to each of the three impression material and made from impressions with different tray spacer thickness. Measurement of each dimension of the die stone cast was repeated three times and the mean was used as the final measurement. These were recorded and the results were compared with those obtained with the master die, analyzed and subjected to statistical analysis.

Result

The measurements were tabulated in Tables 1, 2, 3, 4, 5 and Graph 1

Discussion

The tabulated values in various tables were analyzed and the following inferences were drawn.

Interabutment Distance

The resultant measurement values of the dies recovered using 2 mm spaced tray when poured at 1 h interval and compared with values of master die showed decrease in

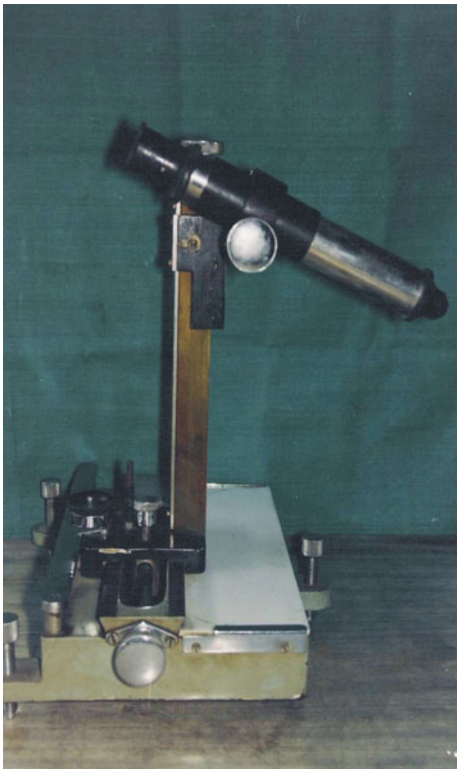


Fig. 10 Travelling microscope

Table 1 Shows the dimensions of the master die

Height	9.01 mm
Mesiodistal dimension	13.73 mm
Buccolingual dimension	14.01 mm
Interabutment distance	35.04 mm

Table 2 Shows comparison of interabutment distance obtained from die stone casts with the master die showing mean, standard deviation, percentage deviation and actual deviation from master die

Tray space	Materials	Mean (mm)	Standard deviation	Percentage deviation	Actual deviation
2 mm	C.S	35.00	0.00	0.114	0.04
	A.S	35.0	0.011	0.1141	0.04
	P.E	35.0	0.00	0.1141	0.04
4 mm	C.S	34.96	0.013	0.228	0.08
	A.S	34.99	0.01	0.1426	0.05
	P.E	34.99	0.180	0.1426	0.05
6 mm	C.S	34.93	0.175	0.003	0.11
	A.S	34.91	0.1831	0.371	0.13
	P.E	34.75	0.685	0.8276	0.29

interabutment distance, which may be accounted for by the polymerization shrinkage of the impression material towards the largest bulk lying in the area between the two

Table 3 Shows comparison of mesiodistal dimension obtained from die stone casts with the master die showing mean, standard deviation, percentage deviation and actual deviation from master die

Tray space	Materials	Mean (mm)	Standard deviation	Percentage deviation	Actual deviation
2 mm	C.S	13.55	0.028	1.3109	0.18
	A.S	13.51	0.019	1.6023	0.22
	P.E	13.57	0.315	1.1653	0.16
4 mm	C.S	13.52	0.017	1.5294	0.21
	A.S	13.44	0.072	2.112	0.29
	P.E	13.50	0.253	1.6751	0.23
6 mm	C.S	13.49	0.124	1.7479	0.24
	A.S	13.57	0.109	1.1653	0.16
	P.E	13.47	0.353	1.8936	0.26

Table 4 Shows comparison of buccolingual dimension obtained from die stone casts with the master die showing mean, standard deviation,percentage deviation and actual deviation from master die

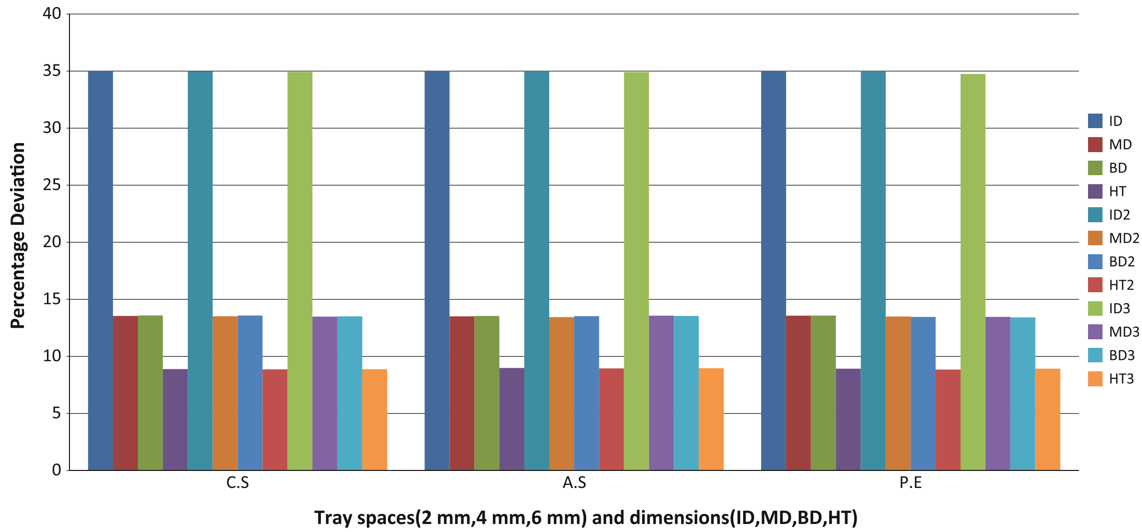
Tray space	Materials	Mean (mm)	Standard deviation	Percentage deviation	Actual deviation
2 mm	C.S	13.59	0.083	2.9978	0.42
	A.S	13.55	0.135	3.2834	0.46
	P.E	13.58	0.230	3.0692	0.43
4 mm	C.S	13.58	0.125	3.0692	0.43
	A.S	13.53	0.034	3.211	0.45
	P.E	13.46	0.8879	3.9257	0.55
6 mm	C.S	13.51	0.162	3.5688	0.50
	A.S	13.55	0.045	3.283	0.46
	P.E	13.42	0.2148	4.2112	0.59

Table 5 Shows comparison of height obtained from die stone casts with the master die showing mean, standard deviation,percentage deviation and actual deviation from master die

Tray space	Materials	Mean (mm)	Standard deviation	Percentage deviation	Actual deviation
2 mm	C.S	8.89	0.2010	0.3319	0.12
	A.S	8.99	0.083	0.2219	0.02
	P.E	8.93	0.181	0.8879	0.08
4 mm	C.S	8.88	0.2021	1.4428	0.13
	A.S	8.95	0.204	0.6659	0.06
	P.E	8.85	0.419	3.1076	0.28
6 mm	C.S	8.90	0.172	1.2209	0.11
	A.S	8.97	0.035	0.4439	0.04
	P.E	8.93	0.176	0.8879	0.08

abutments. These results are in agreement with the findings of Brosky et a1. [11] and Tjan et a1. [12].

The values of measurements obtained from the dies prepared with 4 mm spaced tray when poured at 1 h



Graph 1 Mean percentage deviation of ID, MD, BD and HT measured on the recovered die stone casts from that of master die for C.S, A.S and P.E Impression materials

interval and compared with values of master die, showed a slight decrease in interabutment distance which may be accounted for by the above mentioned reason, but there is increase in the percentage deviation which can be attributed to the larger bulk of the impression material when compared to values obtained where 2 mm spaced tray were used.

The dies fabricated for the impression obtained using 6 mm spaced tray and poured in die stone at 1 h and compared with values of master die showed greater magnitude of percentage deviation which can be attributed to still larger quantity of impression material in 6 mm spaced tray in comparison where trays having 2 and 4 mm space. The differences in the interabutment distance of the die stone casts obtained from 2 to 4 mm spaced trays when compared to master die were not significant whereas, it was very highly significant where 6 mm spaced tray was used.

Mesiodistal Dimension

The resultant measurement values of the dies recovered using 2 mm spaced tray when poured at 1 h interval and compared with values of master die showed slight increase in the mesiodistal dimension, which can be attributed to the polymerization shrinkage of the impression material towards the largest bulk in the center and also to the polymerization shrinkage towards the impression tray walls.

The values of measurements obtained from the dies prepared with 4 mm spaced tray when poured at 1 h interval and when compared with values of master die, showed an increase in the percentage deviation when compared to casts poured using 2 mm spaced tray. This can be accounted for the greater bulk of material in 4 mm spaced tray.

The dies fabricated for the impression obtained using 6 mm spaced tray and poured in die stone at 1 h and compared with values of master die show a slight higher magnitude of percentage deviation which can be attributed to greater bulk of impression material when compared to 2 and 4 mm tray space. Statistical analysis showed no significant differences among the three tray spaces. These results are in concurrence with the findings of Tjan et al [12].

Buccolingual Dimension

The resultant measurement value of the dies recovered using 2 mm spaced tray when poured at 1 h interval and compared with values of master die showed that there is increase in the buccolingual dimension, which can be attributed to the polymerization shrinkage of the impression material towards the largest bulk in the center and also the polymerization shrinkage towards the impression tray walls.

The values of measurements obtained from the dies prepared with 4 mm spaced tray when poured at 1 h interval and when compared with values of master die, showed a slight increase in the percentage deviation when compared using 2 mm spaced tray which may be accounted to the greater bulk of material in tray having 4 mm space.

The dies fabricated for the impression obtained using 6 mm spaced tray and poured in die stone at 1 h and compared with values of master die showed slight higher magnitude of percentage deviation which can be attributed to greater bulk of impression material when compared to dies obtained from trays having 2 and 4 mm space. Statistical analysis for buccolingual dimension showed no significant differences among the three tray spaces.

Height

The resultant measurement value of the dies recovered using 2 mm spaced tray when poured at 1 h interval and compared with values of master die indicate that there is slight decrease in the height of the abutment. This can be attributed to the polymerization shrinkage of the impression material towards the impression tray walls because of the constraint induced on the impression material by an effective adhesive during setting of the impression material.

The values of measurements obtained from the dies prepared with 4 mm spaced tray when poured at 1 h interval and when compared with values of master die, showed an increase in the percentage deviation when compared using 2 mm spaced tray which may be accounted to the greater bulk of material and in turn greater polymerization shrinkage in 4 mm tray space.

The dies fabricated for the impression obtained using 6 mm spaced tray and poured in die stone at 1 h and compared with values of master die showed a higher magnitude of percentage deviation which can be attributed to greater bulk of impression material when compared to 2 and 4 mm tray space. Statistical analysis showed that there were no significant differences among 2 and 4 mm tray spaces, where as statistically significant differences existed for 6 mm tray space when compared to master model. These results are in concurrence with the findings of Tjan et a1. [12].

Multiple group comparisons using Tukey's HSD test and unpaired student '*t*' test for interabutment (ID), mesiodistal (MD), buccolingual (BL) and height (HT) at 1 h showed no significant differences with each other. These findings are in agreement with the findings of Lacy et al. [3], and Tjan et al. [12].

It can be seen that the mesiodistal and buccolingual dimensions of the stone models obtained from the impression trays with 2, 4 and 6 mm tray space, did not show significant differences when compared to the master die. However, there was a significant decrease in the interabutment distance and height when impressions were made using impression trays with 6 mm tray space.

From this study, the most important observation was that there were no significant differences in the dimensions of the die stone casts poured from all the three elastomeric materials at one hour time interval as shown in Graph 1.

As the dimensional changes are minimal using a tray spacer of 2 mm for all the materials tested, it is recommended that no purpose will be served by providing a spacer of more than 2 mm.

Limitations/Further Improvement of the Study

1. Impressions were pressed by hand and hence cannot be considered as standardized. But, since impressions in mouth are made by hand pressure, the results can be correlated to clinical conditions.
2. No undercuts were present in the master die to simulate the cervical constriction present on natural teeth.
3. The experiment could not be performed identically to pouring a cast from an intra-oral impression. Condition not examined included the effect of oral fluids, soft tissue and differing arch forms. There is scope for further research taking these factors into consideration.

Conclusion

From the results of foregoing study, the following conclusions have been drawn:

The impressions made from 2 to 4 mm spaced trays produced more accurate die stone casts but statistically insignificant when compared to 6 mm spaced tray.

Minimum changes were observed when tray space was 2 mm for all the materials tested. It is therefore advisable not to exceed tray space of 2 mm for any of the elastomeric impression materials tested.

It was also observed that there were no statistically significant differences in the dimensions of the die stone casts poured, using any of the three elastomeric impression materials. Thus no statistical significant differences were observed between the accuracy and dimensional stability of the three materials tested.

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