J Indian Prosthodont Soc (July-Sept 2013) 13(3):254–259
DOI 10.1007/s13191-012-0182-1

ORIGINAL ARTICLE

An Evaluation of Dimensional Accuracy of One-Step and Two-Step Impression Technique Using Addition Silicone Impression Material: An In Vitro Study

Neelam A. Pande · R. D. Parkhedkar

Received: 6 January 2011 / Accepted: 27 September 2012 / Published online: 10 October 2012

Abstract The study is aimed to evaluate the dimensional accuracy, the effect of undercut of two different configurations and the elastic recovery of addition silicone impression material assessed indirectly, by measuring the dimensions on stone models recorded from the impression of the master model, using one-step and two-step impression technique, for addition silicone impression materials. Measurements are taken to evaluate horizontal or linear and vertical dimensional changes, of the abutment V and abutment C from the stainless steel model. Heavy body/light body material is used for making one-step impression technique in a custom tray. Putty/light body is used for taking two-step technique in a stock metal tray. Improved die stone is used for pouring the impression. The different 11 locations on the dies produced by two different techniques are measured microscopically on image analyzer and compared with those of stainless steel model. Anova test was applied to test the differences of mean values of inter and intra abutment measurements, to calculate *p* value. Unpaired *t* test was applied to calculate *t* value. Results showed less deviation of stone models produced by one-step technique from stainless steel model, whereas the deviation of stone models produced by two-step is comparatively more. ($p < 0.01$). This difference of deviation is significantly less in one-step as compared to two-step technique. One-step is sufficiently dimensionally accurate than two-step technique in conjunction with addition silicone impression material. They have the best elastic recovery from the two undercut configurations.

Keywords Elastomeric impression materials · One-step impression technique · Two-step impression technique · Dimensional accuracy

This study was presented at scientific session of 57th Indian Dental Conference, Kochi, between 23rd and 26th Jan 2003.

N. A. Pande
Department of Prosthodontics, VSPM's Dental College & Hospital, Nagpur, Maharashtra, India

N. A. Pande (✉)
123, Rujuta Apartments, Pande Lay Out, Khamla, Nagpur 440025, India
e-mail: abhay.angp@gmail.com

R. D. Parkhedkar
Department of Prosthodontics, Dental College & Hospital, Parbhani, Maharashtra, India

Introduction

The goal of dental science is to conserve health, function and integrity of the dental arch of an individual as long as possible. With the trend towards conservation of the remaining teeth and patient's awareness about fixed prosthodontic work, dentists have resorted more to fixed restorations to satisfy their patients. Making an impression is an integral part of fixed prosthodontic treatment. Dental manufacturers have developed elastic impression materials capable of acceptable accuracy in clinical use. Rubber base impression materials have established popularity among other impression materials because of easier and more efficient technique and their capability of registering accurate impression with excellent surface reproduction.

Addition silicone impression has become the impression material of choice in many clinical situations [1–3]. They possess excellent physical properties and handling characteristics. Although they are the most expensive materials, they are used in wide variety of clinical situations, in fixed prosthodontics, conservative dentistry; removable prosthodontics complete denture prosthodontics and implant dentistry. The factors affecting dimensional change in of the impression are thermal contraction, polymerization shrinkage and contraction due to volatile byproducts. Addition silicone impression materials have superior dimensional stability and lower polymerization shrinkage. No byproducts result from the curing therefore shrinkage does not occur with these materials.

Tests for accuracy and characteristics of impression materials generally fall into one or more categories [4] these are:

(1) Linear tests which measure the material itself.
(2) Tests which depend upon the formation and measurement of gypsum die from the impression material, where the dies are dimensionally measured.
(3) Methods which employ the use of master dies and castings, where the accuracy of the impression material in question is judged by trial of the master casting on the stone die replica.

In this study two variations of addition silicone impression material are used.

Heavy body/light body one-step technique in which the materials polymerize in one stage and putty/light body two-step technique in which putty is first used alone as the initial step and then the final impression is made within the tray of putty material by use of a silicone of lower consistency. The measurements of the standard metallic die and gypsum product dies, prepared from two different techniques are evaluated by the standard microscopic measurements at 11 different locations.

Aims and Objectives

(1) To evaluate the accuracy of one-step impression technique with the two-step impression technique, for addition silicone impression materials.
(2) To evaluate the effect of undercut of two different configurations on the accuracy of impression materials and
(3) To evaluate the elastic recovery of an addition silicone by the use of these techniques.

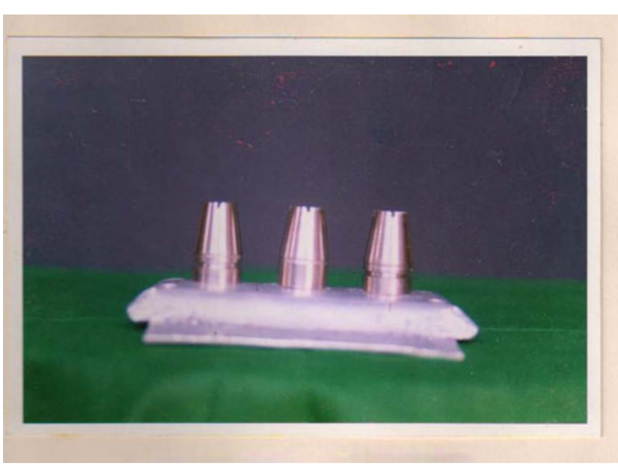

Fig. 1 Stainless steel model front view

Measurements at M1, M2, M3, M5, M6, M7, M9, M10 and M11 are taken to evaluate horizontal or linear dimensional changes and measurements M4 and M8 are taken to evaluate vertical dimensional changes, of the abutment V and abutment C respectively from the stainless steel model (Figs. 1, 2; Table 1). In the master model (Figs. 3, 4) at the periphery of the aluminium base four holes are made of about 3 mm diameter to receive the acrylic extension of the custom tray. These extensions ensured correct tray centering and uniform material thickness. Similar extensions are made on the stock metal tray also.

(1) Heavy body/light body addition silicone impression material is used for making one-step impression technique.

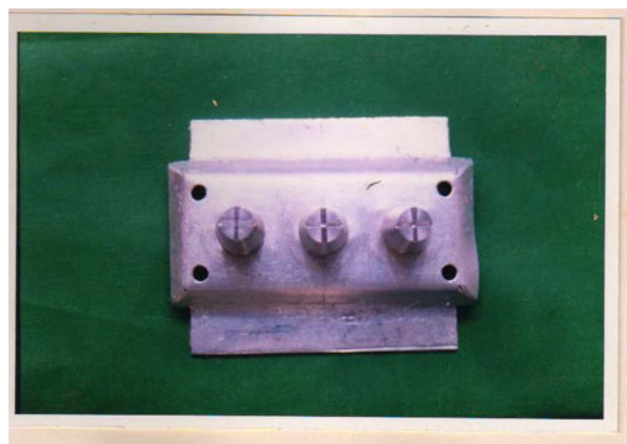

Fig. 2 Stainless steel model top view

Table 1 Description & measurements of 11 locations for stainless steel master model by image analyzer

M1	Occlusal diameter of abutment A	9.368 mm
M2	Cervical diameter of abutment A	14.815 mm
M3	Diameter of V-under cut of abutment A	13.233 mm
M4	Occlusal-gingival height of abutment A	17.738 mm
M5	Occlusal diameter of abutment B	9.368 mm
M6	Cervical diameter of abutment B	14.773 mm
M7	Diameter of C-undercut of abutment B	13.535 mm
M8	Occlusal-gingival height of abutment B	17.717 mm
M9	Distance between A and C	23.133 mm
M10	Distance between C and B	24.492 mm
M11	Distance between A and B	46.625 mm

(2) Putty/light body addition silicone impression material is used for taking two-step impression technique (Fig. 5).

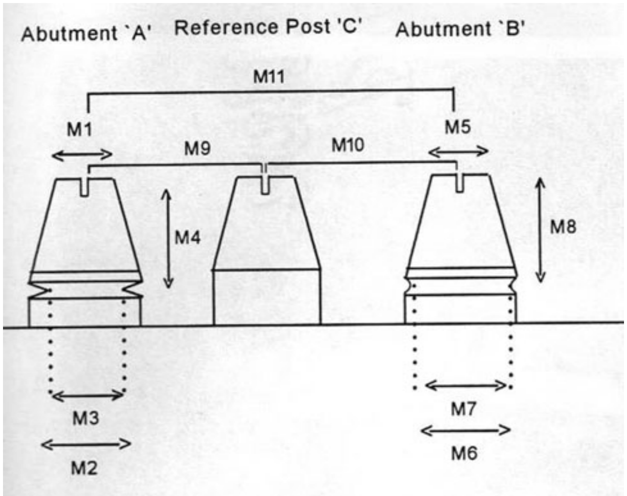

Fig. 3 Front view of stainless steel model

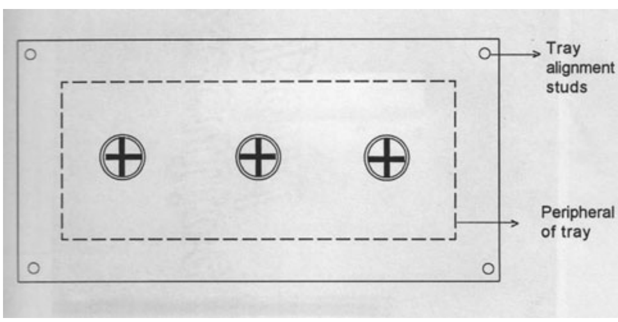

Fig. 4 Top view of stainless steel model

(3) *Custom acrylic perforated tray* required for taking heavy body/light body one-step impression technique. 3 mm wax spacer is given over each abutment to accommodate the subsequent impression material. Over this, 0.5 mm tin foil is adapted. Thickness of tray is 4 mm. It is well finished and polished 24 h before taking the impression (Fig. 6).

(4) *Stock metal perforated tray* is made for taking putty/light body two step impression technique (Fig. 7).

(5) *Improved die stone* is used for pouring the impression.

(6) *An image analyzer* attached to microscope capable of measuring 0.001 mm is used to measure the test samples at each measurement locations.

All impression materials are dispensed and mixed in standardized preparation according to manufacturers' recommendations.

Materials and Method

(1) *One-step impression technique using heavy body/light body impression material* For this technique, tray adhesive is applied evenly and thinly over the inner surface of the custom tray, extended 2 mm beyond the periphery and allowed to dry for 15 min. Within 2 min, from the start of mixing, heavy body material is mixed and tray is loaded. At the same time, the light body material is mixed by the assistant. It is immediately placed onto the abutment preparation and the loaded tray is placed onto the model. After 12 min, the impression is removed from the model (Fig. 8).

(2) *Two-step impression technique using putty/light body addition silicone impression material* For this

Fig. 5 Materials required for study

Fig. 6 Custom tray placed over stainless steel model

Fig. 7 Stock tray placed over stainless steel model

technique also, tray adhesive is applied to stock metal tray as mentioned before. Wax spacer 1.5 mm thick is placed over the abutments (A and B) as well as over the reference post (C), to provide uniform space to accommodate the subsequent light body material. The putty impression is made 1 min from the start of mixing and is removed along with the wax spacer 5 min later. The wax spacer is then removed and putty is stored undisturbed for 8 min to simulate the time required for gingival retraction and isolation of preparation. The light body impression material is then mixed and placed within 1 min from the start of mixing (Fig. 9). For both the techniques manufacturer's setting time is doubled to compensate delayed polymerization reaction compared with mouth temperature. In this way for each technique 15 impressions are poured in improved die stone. The different 11 locations on the dies produced by two different techniques are measured microscopically on image analyzer and compared with those of stainless steel model (Fig. 10).

Results and Observations

Means of all measurements of 11 locations and their corresponding standard deviations (SD) for each distance on the stone models are produced from 15 samples of both the techniques (Tables 2, 3). Statistical analysis shows less deviations of stone models produced by one-step impression technique from stainless steel model, whereas the deviations of stone models produced by two-step impression technique is comparatively more from stainless steel model. Also the inter-abutment dimensions (M9, M10 and M11) are increased compared with those of stainless steel model for the techniques. The intra-abutment dimension is (M1, M2, M3, M5, M6 and M7) decreased compared with those of the stainless steel model for both the techniques. The height or vertical dimension of each abutment A and B i.e. M4, M8 is also increased compared with stainless steel model in both the techniques. Statistically significant differences are seen in between the two techniques with stainless steel model at 11 locations ($p < 0.01$) (Table 4). This difference of deviation from stainless model is significantly less in one-step technique as compared to two-step technique. This shows that dimensions of stone models of one-step technique are nearer to standard stainless steel model than those produced by two-step technique.

Discussion [5–9]

The retention of a fixed partial denture depends on the tenso-frictional resistance which is developed between

Fig. 8 One step impression

Fig. 9 Two step impression

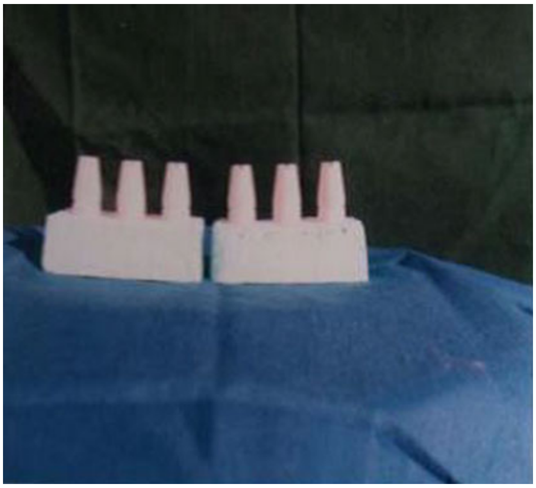

Fig. 10 Two dies with two different impression techniques

Table 2 Means of 3 measurements & corresponding SD for each location on the stainless steel model

Location	Mean (mm)	SD
M1	9.368	0.0028
M2	14.815	0.010
M3	13.233	0.0028
M4	17.738	0.015
M5	9.368	0.0028
M6	14.773	0.0051
M7	13.535	0.026
M8	17.717	0.020
M9	23.133	0.014
M10	24.492	0.20
M11	46.625	0.010

Table 3 Means of all measurements of 11 locations & their corresponding SD for each distance on the stone models produced for 15 samples by one-step & two-step technique

Location	One-step technique		Two-step technique	
	Mean D	SD	Mean D	SD
M1	9.365	0.0015	9.359	0.0023
M2	14.808	0.0029	14.808	0.0030
M3	13.222	0.0045	13.214	0.0040
M4	17.745	0.0035	17.750	0.0015
M5	9.363	0.0011	9.358	0.0017
M6	14.763	0.0018	14.759	0.0025
M7	13.525	0.0029	13.518	0.0020
M8	17.726	0.0016	17.729	0.0012
M9	23.144	0.0050	23.152	0.0028
M10	24.498	0.0026	24.505	0.0036
M11	47.643	0.0073	47.656	0.0068

Table 4 Deviation of all stone models of one-step with those of two-step impression technique at each location

Location	Mean difference	Standard deviation of diff. (SD)	Standard error of deviation (SED)	*t* values	*P* values
M1	0.0057	0.0023	0.00061	9.34	<0.001
M2	0.0097	0.0086	0.00223	4.35	<0.001
M3	0.0075	0.0040	0.00105	7.17	<0.001
M4	−0.0046	0.0029	0.00076	−6.08	<0.001
M5	0.0047	0.0015	0.00039	11.94	<0.001
M6	0.0042	0.0027	0.00072	5.92	<0.001
M7	0.0077	0.0030	0.00078	9.81	<0.001
M8	−0.0032	0.0018	0.00047	−6.80	<0.001
M9	−0.0075	0.0061	0.00157	−4.77	<0.001
M10	−0.0056	0.0037	0.00098	−5.71	<0.001
M11	−0.0130	0.0088	0.0022	−5.68	<0.001

surface to surface contact of inner surface of casted crowns and the outer surface of the prepared teeth in extra-coronal type of retainer. In this study inter-abutment distance of the dies is increased (M9, M10 and M11) than the master model in the area where the thickness of the material is more. Johnson and Craig (1986) also reported differences in inter-abutment measurements. Hung et al. (1992) found similar findings in his study. Although significant differences are seen between the two techniques compared with stainless steel model, the differences may not be of clinical importance. The increased in inter-abutment distance may be attributed to the adhesion of the impression material towards the adhesive coated tray. Because of the constraint imposed by an effective adhesive on uniform shrinkage upon setting, abutments in resultant cast may tend to be a greater distance apart than they were actually in the model in one-step technique. The light body material may have hydraulically displaced the preliminary putty impression during impression seating and the putty may have then exhibited some elastic recovery upon removal of the impression and resulted in formation of smaller dies, therefore large inter-abutment distance in two-step technique. Further, to throw light upon fact is that, the die material used for the purpose is same. The doubts of die material shrinkage on setting may be practically possible. But change will be same in both the techniques. This change in fact is more in two-step compared to one-step.

The investigations have some shortcomings as that of any in vitro study:

i. The environment of oral cavity cannot be optimally duplicated in vitro.
ii. Conditions not examined include the effect of oral fluids, gravity, soft tissues and different arch forms i.e. maxilla and mandible. This prevents direct

applications of these results when applied to the patient's mouth.

Conclusion

(1) The dimensional accuracy of addition silicone impression material is unsurpassed. They can record fine details because there is virtually no byproduct in the polymerization reaction.
(2) Although statistically significant differences in accuracy are found between the two techniques, they are not of significant magnitude to warrant the strong recommendation of one technique over the other.
(3) Comparing the two techniques, one-step technique is sufficiently dimensionally accurate than two-step technique in conjunction with addition silicone impression material.
(4) They have the best elastic recovery from the two undercut configurations.

Conflict of interest None.

References

1. de Araujo PA et al (1985) Effect of material bulk on the accuracy of impression materials. J Prosthet Dent 54(6):791–794
2. Breedling LC et al (1994) Custom impression trays: part 1-mechanical properties. J Prosthet Dent 71(1):31–34
3. Chai JY et al (1991) Adhesive properties of several impression material systems: part 2. J Prosthet Dent 66(3):287–292
4. Ciesco JN et al (1981) Comparison of elastomeric impression materials used in fixed prosthodontics. J Prosthet Dent 45(1):89–94
5. Eames WB et al (1979) Accuracy and dimensional stability of elastomeric impression materials. J Prosthet Dent 42(2):159–162
6. Gunther G, Welsh SL (1978) Evaluation of of rubber base impression materials. J Prosthet Dent 39(1):95–99
7. Hung SH et al (1992) Accuracy of one step verses two step putty wash addition silicone impression technique. J Prosthet Dent 67(5):583–589
8. Johnson GH, Craig RG (1985) Accuracy of four types of rubber impression materials compared with time of pour and repeat of models. J Prosthet Dent 53(4):484–490
9. Johnson GH, Craig RG (1986) Accuracy of addition silicones as a function of techniques. J Prosthet Dent 55(2):197–203