



A study to compare the accuracy of various impression techniques of elastomeric impression materials used in fixed prosthodontics

Dental Science

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ABSTRACT

The aim of the study was to compare the dimensional accuracy of impressions obtained from six techniques. Six impressions were made with each of six different techniques and divided in to group 1 to 6. Casts were poured and inter-abutment/ intra abutment distances were measured. Full arch wax spacer was most accurate followed by dual arch 1-step, quadrant arch wax spacer, full arch polyethylene, quadrant arch polyethylene, in that order, dual arch twostep was least accurate. Dies were larger in all the techniques except buccolingual dimension of dual arch technique. This deviation ranged from 7μ to -18μ in mesio-distal direction while it was -29μ to 28μ in bucco-lingual direction. Results show that clinically acceptable impressions can be made with all the techniques except dual arch 2 step technique.

KEYWORDS:

Impression, elastomers, triple-tray, spacer

Introduction:

Precision has a critical role in determining the success of fixed prosthesis. There is anecdotal evidence supporting internal and marginal fit as criteria of success for fixed prosthodontics¹⁻⁴ so it is important to have an accurate and dimensionally stable impression for manufacturing well-fitting indirect restorations.⁵ The most common conventional impression materials used for definitive impressions in fixed prosthodontics are elastomers. These materials exhibit excellent dimensional stability and precision and have been successfully used in fixed prosthodontics for many decades.^{6,10} But these materials are technique sensitive and hence the method of making impression can greatly influence the accuracy. Custom trays were once popular but clinician had to spend more time on the fabrication process and different studies suggest that although the custom tray technique is most accurate other techniques apparently produce clinically acceptable results¹¹ Customizing the stock tray with silicon putty and later refining it with light body has become the order of the day. Even this method clinician would like to modify to incorporate user friendliness and to economize the process. Hence they resort to quadrant impression with stock tray and dual arch impressions. Dual arch impressions also known as closed arch impressions was first used with putty and light body impression material in 1971. This technique was first described by Wilson and Werrin in 1983.¹² This technique reduces chair side time, expense, patients discomfort and gagging and the dimensions of working dies from a custom tray impression did not differ significantly from those created with dual arch trays.¹³

Materials and methods

Maxillary and mandibular dentulous typodont models were mounted on fixed path articulator at inter-cuspal position. Right mandibular first molar was removed and socket was filled with wax to simulate residual ridge. Adjacent second premolar and second molar were prepared to receive full coverage ceramo-metal restoration. Index markings were made on the occlusal surfaces of the molar and premolars using tapered fissure bur. These markings enabled inter abutment and intra abutment distances (Figure 1). Then impressions were made using techniques as mentioned in Table 1. Six impressions were made for each techniques and each technique was assigned a group no from 1 to 6 (Table 1). For group 1 and 3 1mm of wax spacer was used. Tray adhesive was applied to all the trays and dried in air for 5 minutes. Impressions were poured in vacuum mixed type IV die stone. The impressions were separated 24 hours later the measurement from the master models and stone dies were made using a toolmakers microscope (Figure 2) capable of measuring up to 0.001mm the microscope with graduated eye piece (30X) was used to measure inter-abutment and intra abutment distances. The inter-abutment distance was measured between

premolar and molar whereas intra abutment distance was measured facio-lingually and mesio-distally (Figure 3). The measurements of each cast were measured three times, the mean and S.D. were calculated. The dimensions of the master model were used as control and were compared to the dimensions of the stone dies. The data analysis was done using statistical package for social studies (SPSS). The values were subjected to students unpaired t test to find association between two means. The comparisons were made through the values of p derived from the t test. The t value and exact p value were calculated separately for each of the parameters. A p value of less than 0.05 was indicative of significance.

Figure 1



Figure 2



Figure 3

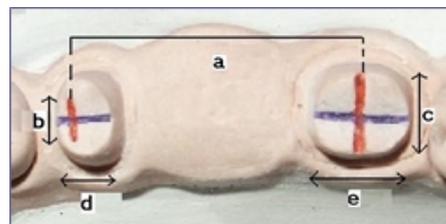


Table 1

Group	Technique
I	Full arch impressions (wax spacer) using stock tray.
II	Full arch impressions (polyethylene spacer) using stock tray.
III	Quadrant impressions (wax spacer) using stock tray.
IV	Quadrant impressions (polyethylene spacer) using stock tray.
V	Dual arch impressions (one-step technique) using triple tray.
VI	Dual arch impressions (two-step technique) using triple tray.

Results:

When mesio-distal dimension (molar) of six impression techniques

were compared with master model, dual arch 1 step technique was closest to master model but the difference was not statistically significant(p=0.09) (Table 1 and Table 2). Full arch wax spacer showed same results with p=0.068. Statistically significant differences were observed in case of quadrant arch wax spacer (p=0.027), dual arch 2 step (p=0.018), full arch polyethylene spacer (p=0.015), and quadrant arch polyethylene spacer (p=0.009). When the comparisons were made in bucco-lingual direction for molar statistically no significant differences were observed in full arch wax spacer (p=0.842) and dual arch 1 step (p=0.146). However significant differences were seen in quadrant arch wax spacer (p=0.013), full arch polyethylene and quadrant arch polyethylene spacer showed identical values (p=0.004), it appeared that a highly significant difference was observed with dual arch 2 step technique (p=0.000).

For premolar dies the differences in mesio-distal dimension, similar trend was seen with no statistical differences in case of full arch wax spacer (p=0.057), and dual arch one step (p=0.050) while the differences in case of quadrant arch wax spacer (p=0.027), dual arch 2 step (p=0.012), full arch polyethylene spacer(p=0.037), and quadrant arch polyethylene spacer(p=0.014) were significant. In bucco-lingual direction, only in case of full arch wax spacer differences were non-significant, while rest showed statistically significant differences.

When comparisons were made for inter-abutment distance the differences were non-significant for full arch wax spacer (p=0.076) and dual arch 1 step (p=0.074). Significant differences were observed with quadrant arch wax spacer (p=0.038), dual arch 2 step (p=0.003), full arch polyethylene spacer (p=0.033), and quadrant arch polyethylene spacer(p=0.006)

Table 2

		Model	Mean±S.D.	Difference from master model	Level of significance			
					t-value	p-value		
Molar	Mesiodistal Distance	Master model	6.842	-	-	-		
		Full arch wax spacer	6.854 ±0.0049	0.012	2.138	0.068		
		Full arch polyethylene spacer	6.859 ±0.0045	0.017	3.462	0.015		
		Quadrant wax spacer	6.857 ±0.0046	0.015	3.093	0.027		
		Quadrant polyethylene spacer	6.860 ±0.004	0.018	4.158	0.009		
		Dual arch 1 step technique	6.852 ±0.0044	0.010	1.958	0.099		
		Dual arch 2-step technique	6.858 ±0.0041	0.016	3.660	0.018		
		Molar	Buccolingual Distance	Master model	5.981	-	-	-
				Full arch wax spacer	5.991 ±0.0457	0.010	0.210	0.842
Full arch polyethylene spacer	6.009 ±0.0005			0.028	5.022	0.004		
Quadrant wax spacer	5.998 ±0.0089			0.017	1.817	0.013		
Quadrant polyethylene spacer	6.009 ±0.0051			0.028	5.116	0.004		
Dual arch 1 step technique	5.975 ±0.0032			-0.006	-1.723	0.146		
Dual arch 2-step technique	5.967 ±0.0026			-0.014	-5.186	0.000		
Premolar	Mesiodistal Distance	Master model	4.181	-	-	-		
		Full arch wax spacer	4.188 ±0.0026	0.007	2.469	0.057		

		Full arch polyethylene spacer	4.193 ±0.004	0.012	2.831	0.037
		Quadrant wax spacer	4.194 ±0.0037	0.013	3.104	0.027
		Quadrant polyethylene spacer	4.195 ±0.0035	0.014	3.700	0.014
		Dual arch 1 step technique	4.189 ±0.0040	0.008	2.672	0.050
		Dual arch 2-step technique	4.196 ±0.0037	0.015	3.812	0.012
Premolar	Buccolingual Distance	Master model	2.777	-	-	-
		Full arch wax spacer	2.787 ±0.0091	0.010	0.982	0.371
		Full arch polyethylene spacer	2.794 ±0.0037	0.017	4.144	0.009
		Quadrant wax spacer	2.792 ±0.0035	0.015	3.944	0.011
		Quadrant polyethylene spacer	2.798 ±0.0028	0.021	7.052	0.000
		Dual arch 1 step technique	2.766 ±0.0029	-0.011	-3.355	0.020
		Dual arch 2-step technique	2.748 ±0.0026	-0.029	-10.296	0.000
		Inter abutment distance		Master model	20.326	-
Full arch wax spacer	20.333 ±0.0029			0.007	2.236	0.076
Full arch polyethylene spacer	20.341 ±0.0048			0.015	2.930	0.033
Quadrant wax spacer	20.339 ±0.0044			0.013	2.798	0.038
Quadrant polyethylene spacer	20.342 ±0.0032			0.016	4.561	0.006
Dual arch 1 step technique	20.335 ±0.0036			0.009	2.254	0.074
Dual arch 2-step technique	20.343 ±0.0028			0.017	5.592	0.003

Discussion:

Fabrication of fixed prosthesis is done on accurate casts obtained from precise impressions. The polyvinyl siloxane impression materials have been shown to be superior in accuracy and dimensionally stable, but they are technique sensitive and hence the method of impression can greatly influence the accuracy of impressions used in making crowns and fixed partial dentures. Putty materials are heavily filled so the polymerization shrinkage is minimal. Customizing the stock tray with silicone putty to control the bulk of less heavily filled material and later refining it with light body is more economic and fast way. Dual arch impressions became popular lately, as three records were made simultaneously. This technique reduces chair side time, expense, material, patients discomfort and gagging.^{14,15,16}

In this study the molar and premolar dies seemed to become larger than the prepared teeth in both mesio-distal and bucco-lingual dimension in full arch impression techniques (wax and polyethylene spacer). A similar behavior was seen in quadrant arch impression techniques (wax and polyethylene spacer). A dual arch impression technique (1 step and 2 steps) also produces the dies that were larger than the prepared teeth in mesio-distal dimension, but were smaller than the prepared teeth in bucco-lingual direction. In bucco-lingual direction the larger dies can be attributed to use of tray adhesive. The

use of tray adhesive redirects the shrinkage towards the walls of impression trays.²¹ These results were in agreement with the study conducted by Johnson and Craig.¹⁷ For full arch stock tray Gordon G. E et al and Hung S.H et al reported the same in mesiodistal dimension, although they didn't measure bucco-lingual dimension (Table 4).¹⁸ Clinically a die slightly larger than the prepared tooth is desirable because the space is necessary for the cement¹⁸, which in addition to the space provided by the spacer, contributes to 25- 40 microns.^{20,21,22}

In this study smaller dies were reported for dual arch technique, the findings were similar to those of Larson et al.²³ The reason for smaller dies in the bucco-lingual direction in dual arch technique could be attributed to the recoil of the impression material on removal from master model. The shorter sides of the plastic dual arch trays could be another reason.²¹ In absence of tray adhesive there is unrestricted polymerization shrinkage, resulting in smaller dies²¹

Considering mesio-distal dimension of the molar tooth (Table 2) full arch wax spacer and dual arch one step showed the least deviation (0.010mm and 0.012mm respectively). This was followed by quad arch wax impression (0.015mm), dual arch two step (0.016), full arch polyethylene (0.017mm) in that order. Bucco-lingually (Table 2) full arch wax spacer and dual arch one step were most accurate with least deviation of (0.010) and (-0.006) respectively, followed by quadrant arch wax space (0.017mm), full and quadrant arch polyethylene wax spacer (0.028mm). The least accurate was dual arch 2 step technique (-0.014mm). Statistically significant differences were seen in quadrant arch wax spacer, full and quadrant arch polyethylene spacer and dual arch 2 step technique (p<0.05). However the magnitude of this difference would be clinically insignificant. The thickness of die spacer varies from 8-40 microns.²¹ To compensate for the narrower dimension in the bucco-lingual direction in dual arch 2 step impression technique (-14 microns), it is advisable to include an extra coat of die spacer. Premolar dies also seem to behave in a similar manner as molar dies (Table 2) mesiodistally the deviation most accurate was full arch wax spacer with deviation of 0.007mm followed by dual arch I step(0.008), full arch polyethylene spacer (0.012mm) quadrant arch wax (0.013mm) quadrant arch polyethylene(0.014), dual arch two step (0.015mm). Bucco-lingually (table 2) full arch wax spacer and dual arch one step were most accurate with least deviation of (0.010mm) and (-0.011mm)

respectively, followed by quadrant arch wax space (0.015mm), full polyethylene wax spacer (0.017mm) and quadrant arch poly (0.021mm). The least accurate was dual arch 2 step technique (-0.029mm). The inference can be derived from this data that full arch wax spacer is most accurate followed by dual arch 1 step technique.

When the comparisons were made between range of deviation for buccolingual and mesiodistal direction, the deviation in mesiodistal direction (0.007mm-0.018mm) was less when compared to buccolingual (-0.029-0.028mm). In dual arch impressions the deviation in the buccolingual direction was more than mesio distal. This could be attributed to the recoil of the impression material on removal from master model. The inaccuracies in mesio-distal direction were reduced as the measurements were done on the occlusal surfaces where the mesh connected the tray sides have provided some resistance to the distortion. Inaccuracies could be more near unsupported border than near occlusal surface.

On comparing the inter abutment distances for all six impression techniques were compared, it was found that full arch wax spacer (20.333mm) and dual arch 1 step technique (20.335mm) were closer to master model, with deviation of (0.007mm and 0.009mm) respectively, followed by quadrant arch wax spacer(0.013), full arch polyethylene spacer((0.015mm) and quadrant arch polyethylene spacer (0.016mm) The maximum deviation was shown by dual arch 2 step(0.017mm). Thus an inference can be drawn that full arch wax spacer and dual arch 1 step technique produces accurate casts for fixed dental prosthesis. These findings were in confirmation with Nissan J et al.²⁴ This tendency of increased inter-abutment dimension was also noted by Johnson and Craig, Gordon G.E et al and Hung S.H et al.^{17,18,19} In a study conducted by Cox J. R et al²⁵ (Table 4)

Although the full arch wax spacer and dual arch 1 step techniques resulted in more accurate dies, clinically acceptable impressions can be made with other techniques used in present study. Clinically a die slightly larger than the preparation is desirable because space is necessary for luting agent. The increased size of stone die in this investigation in mesiodistal and buccolingual direction may be desirable whereas the narrower dimension of dies in dual arch impression could be masked by coats of die spacer.

Table 3

Model	Mesio-distal Distance (Molar)		Bucco-lingual Distance (Molar)		Mesio-distal Distance (Premolar)		Bucco-lingual Distance (Premolar)		Inter- abutment distance	
	Mean±S.D. (mm)	p-value	Mean±S.D.	p-value	Mean±S.D.	p-value	Mean±S.D.	p-value	Mean±S.D.	p-value
Master model	6.842	-	5.981	-	4.181	-	2.777	-	20.326	-
Full arch wax spacer	6.854 ±0.0049	0.068	5.991 ±0.0457	0.842	4.188 ±0.0026	0.057	2.787 ±0.0091	0.371	20.333 ±0.0029	0.076
Dual arch 1 step technique	6.852 ±0.0044	0.099	5.975 ±0.0032	0.146	4.189 ±0.0040	0.050	2.766 ±0.0029	0.020	20.335 ±0.0036	0.074
Quadrant wax spacer	6.857 ±0.0046	0.027	5.998 ±0.0089	0.013	4.194 ±0.0037	0.027	2.792 ±0.0035	0.011	20.339 ±0.0044	0.038
Full arch polyethylene spacer	6.859 ±0.0045	0.015	6.009 ±0.0005	0.004	4.193 ±0.004	0.037	2.794 ±0.0037	0.009	20.341 ±0.0048	0.033
Quadrant polyethylene spacer	6.860 ±0.004	0.009	6.009 ±0.0051	0.004	4.195 ±0.0035	0.014	2.798 ±0.0028	0.000	20.342 ±0.0032	0.006
Dual arch 2- step technique	6.858 ±0.0041	0.018	5.967 ±0.0026	0.000	4.196 ±0.0037	0.012	2.748 ±0.0026	0.000	20.343 ±0.0028	0.003

Table 4 Comparison of salient features of different impression techniques in the present study with that of others in published studies

Salient features	Mesio-distal distance (using full stock tray)	Bucco-lingual distance (using full stock tray)	Bucco-lingual distance (using triple tray)	Inter-abutment distance (using full stock tray)	Inter-abutment distance (using triple tray)
Present Study	Increase	Increase	Decrease	Increase	Increase
Johnson and Craig ¹⁷	Increase	Not studied	Not studied	Increase	Not studied
Gordon G.E et al ¹⁸	Increase	Not studied	Not studied	Increase	Not studied

<i>Hung S.H et al</i> ¹⁹	Increase	Not studied	Not studied	Increase	Not studied
<i>Nissan J et al</i> ²⁰	Not studied	Not studied	Not studied	Increase	Not studied
<i>Cox J. R et al</i> ²⁵	Not studied	Not studied	Increase	Not studied	Increase
<i>Larson T.D et al</i> ²³	Not studied	Not studied	Decrease	Not studied	Not studied
<i>Ceyhan J.A et al</i> ²¹	Not studied	Not studied	Decrease	Not studied	Not studied

Summary and conclusion:

Within the limitations of the study and after analysis of the results obtained from the study, following conclusion can be drawn:

Full arch wax spacer technique produced most accurate casts. Almost similar accuracy was obtained with dual arch one step technique, while dual arch two step technique was the least accurate technique. Quadrant arch wax spacer technique, full arch polyethylene and quadrant arch polyethylene were next in same order. Clinically acceptable impressions can be made with all the techniques except dual arch two step technique.

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