Original Article

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Dentistry Section

Influence of Custom Trays, Dual-Arch Passive, Flexed Trays and Viscosities of Elastomeric Impression Materials on Working Dies

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ABSTRACT

Introduction: Dual arch impression technique signifies an essential improvement in fixed prosthodontics and has numerous benefits over conventional impression techniques. The accuracy of working dies fabricated from dual arch impression technique remains in question because there is little information available in the literature.

Aim: This study was conducted to compare the accuracy of working dies fabricated from impressions made from two different viscosities of impression materials using metal, plastic dual arch trays and custom made acrylic trays.

Materials and Methods: The study samples were grouped into two groups based on the viscosity of impression material used i.e. Group I (monophase), whereas Group II consisted of Dual Mix technique using a combination of light and heavy body material. These were further divided into three subgroups A, B and C depending on the type of impression tray used (metal dual arch tray, plastic dual arch tray and custom made tray). Measurements of the master cast were made using profile projector. Descriptive statistics like mean, Standard Deviation (SD) were calculated for all the groups. One way analysis of variance (ANOVA) was used for multiple group comparisons. A p-value of 0.05 or less was considered statistically significant.

Results: The gypsum dies obtained with the three types of impression trays using two groups of impression materials were smaller than the master models in dimensions.

Conclusion: The plastic dual arch trays produced dies which were the least accurate of the three groups. There was no significant difference in the die dimensions obtained using the two viscosities of impression materials.

Keywords: Crown and bridge, Impression, Profile projector, Quadrant, Technique

INTRODUCTION

Accurate impressions are of utmost importance in dentistry, particularly in the field of crown and bridge work [1]. Indirect technique for fabricating crowns and fixed partial dentures has been a blessing to dentistry. It permits most of the laboratory procedures involved in the fabrication of a restoration to be done in absence of the patient. For the restoration to fit precisely, the cast on which it is prepared must be an exact replica of the prepared tooth in the mouth. Hence a perfect and precise impression of the prepared tooth is obligatory [2].

Dual arch quadrant impression trays are often used to make simultaneous impressions of the prepared tooth and opposing arch. This impression technique produces articulated casts with superior occlusal accuracy compared to whole-arch casts mounted in centric relation either with an interocclusal record or hand articulated. This single impression allows the operator to record the prepared tooth, adjacent teeth, and opposing teeth in elastomeric impression material in the Maximum Intercuspal Position (MIP) and reduces the effects of clinical variables as mandibular flexure and tooth intrusion, technical variables as dimensional alterations in materials, and practical errors during articulation. It is mainly indicated for single posterior indirect restorations where mutually protected occlusion and a stable MIP exist [3]. This technique reduces chair time, expense, effort and error because it requires fewer steps. It also reduces patient discomfort and gagging [4].

The dual arch quadrant impression tray technique has been cited often in the literature as an alternative method for making impressions for fixed prosthodontics, and it has been recommended for use with a variety of impression materials and methods [5].

Area of concern is that the accuracy of the casts generated by this technique can get altered by the type of tray and viscosity of the impression material used [6]. The ideal impression material should possess acceptable mechanical properties to endure stresses under different conditions. An impression material that is excessively rigid hinders its removal over tissue undercuts and also increases the likelihood of die breakage upon its removal from the stone die. Conversely, using an impression material that possesses low rigidity could facilitate its removal over tissue undercuts and prevents breakage of the stone die [7]. The higher viscosity materials are used to compensate for the poor support provided by the dual arch; however they may increase the distortion in a flexible tray [8]. Hence, the objective of the study was to evaluate and compare the accuracy of working dies produced under the influence of different viscosities of elastomeric impression materials made using custom trays, passive and flexed dual arch trays.

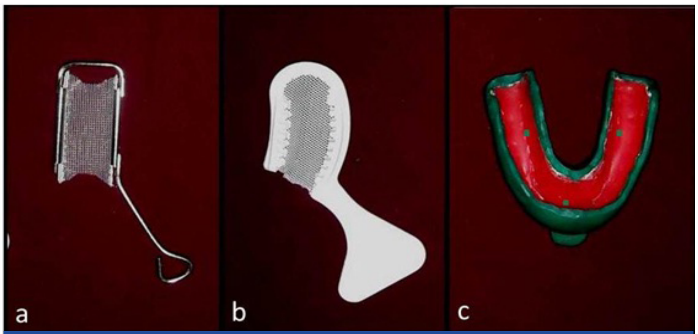
MATERIALS AND METHODS

The present in vitro study was conducted at College of Dental Sciences, Davangere from December 2008 to December 2009. Three different types of trays were used [Table/Fig-1] and for the purpose of the study the samples were grouped as mentioned in [Table/Fig-2]. A total of 60 impressions were made, comprising of 10 in each group.

Methods of Collection of Data

Preparation of the master model: A maxillary frasaco rubber mold was used to obtain a wax model. This wax model was invested and then processed with heat cure acrylic resin to obtain the master model. Tooth colored acrylic was placed in the region occupied by teeth and pink acrylic was packed in rest of the area. In case of mandibular model, mandibular right first premolar and first molar typhodont were positioned inversely in the frasaco rubber mold and a wax model was obtained. To induce flexure of the trays, a simulated mandibular torus which will displace the lingual flange in occlusal direction was added on the lingual side in the premolar area [9]. It was similarly processed like the maxillary model to obtain the mandibular master model.

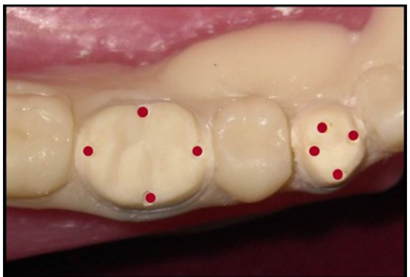
Articulating the master model: The maxillary and mandibular master models were mounted in maximum intercuspation position on a semi adjustable articulator (Hanau wide Vue series). Mandibular right first premolar and first molar were prepared to receive complete crown preparations, with approximately 1.5 mm occlusal reduction and with 0.75 mm supragingival chamfer finish line. The facial, lingual, mesial and distal margins were indexed using a round bur (1mm) for measurements [Table/Fig- 3]. In order to attain constant position of the impression tray and reproducibility



[Table/Fig-1]: Trays used for the study; a- metal dual arch tray, b- plastic dual arch tray, c- custom made acrylic tray.

	Group I	Group II
Group A	Metal dual arch (Temrex Bite Relator 2000) with medium body material/ monophase (3M Espe Imprint II Garant)	Metal dual arch (Temrex Bite Relator 2000) with combination of heavy body and light body impression material (3M Espe Imprint II Garant)
Group B	Plastic dual arch (Henry Schein Disposable Multi-Tray Posterior) with medium body material/ monophase (3M Espe Imprint II Garant)	Plastic dual arch (Henry Schein Disposable Multi-Tray Posterior) with combination of heavy body and light body impression material (3M Espe Imprint II Garant)
Group C	Custom made acrylic tray (M P Sai Enterprises, Mumbai) with medium body material/ monophase (3M Espe Imprint II Garant)	Custom made acrylic tray (M P Sai Enterprises, Mumbai) with combination of heavy body and light body impression material (3M Espe Imprint II Garant)

[Table/Fig-2]: Grouping for the study.



[Table/Fig-3]: Indexing for measurements. **[Table/Fig-4]:** Tray positioning jig attached to the articulator and 1.5 Kg weight placed on the top.

between the trials, a tray positioning jig was attached to the articulator [Table/Fig-4] [6].

Fabrication of custom trays: The master mandibular model was relieved with a 2.5 mm wax relief layer and custom tray was fabricated on top of this using acrylic resin tray material. Tray adhesive was applied on the inner surface of the trays prior to impression making [9].

Group IA Impressions: Metal dual arch trays were used to make the impressions using medium body impression material. It was checked that the typhodont could be closed into the maximum

Group I		Group II	Premolar			
			Bucco-lingual		Mesio-distal	
			Mean ± SD	Difference	Mean ± SD	Difference
Group I Medium body	IA Metal Dual Arch	Mean ± SD % difference p value	4.148± 0.058 - -	0.055± 0.058 1.3% 0.014, S	3.294± 0.054 - -	-0.027± 0.054 0.8% 0.15, NS
	IB Plastic Dual Arch	Mean ± SD % difference p value	4.146± 0.091 - -	0.058± 0.091 1.4% 0.08, NS	3.161± 0.069 - -	0.106± 0.069 3.3% <0.01, S
	IC Custom Tray	Mean ± SD % difference p value	4.198± 0.009 - -	0.005± 0.009 0.1% 0.11,NS	3.259± 0.026 - -	0.008± 0.026 0.2% 0.38,NS
	ANOVA F P	IA/IB/IC	-	2.28 0.12,NS	-	17.3 <0.01,S
	(Difference In Accuracy Amongst Various Tray Groups)	IA-IB IA-IC IB-IC	- - -	0.99,NS 1.19,NS 0.16,NS	- - -	<0.01,S 0.32,NS <0.01,S

[Table/Fig-5]: Comparison of dimensional accuracy of group I casts (Premolar site) with master model using three types of impression trays.
*Anova test

Group I		Group II	Molar			
			Bucco-lingual		Mesio-distal	
			Mean ± SD	Difference	Mean ± SD	Difference
Group I Medium body	IA Metal Dual Arch	Mean ± SD % difference p value	6.847± 0.078 - -	0.040± 0.078 0.6% 0.14, NS	8.741± 0.06 - -	-0.002± 0.06 0.02% 0.92, NS
	IB Plastic Dual Arch	Mean ± SD % difference p value	6.881± 0.074 - -	0.076± 0.074 1.1% 0.01, S	8.708± 0.033 - -	0.031± 0.003 0.4% 0.02, S
	IC Custom Tray	Mean ± SD % difference p value	6.864± 0.033 - -	0.023± 0.033 0.4% 0.05,S	8.730± 0.012 - -	0.009± 0.012 0.1% 0.03,S
	ANOVA F P	IA/IB/IC	-	1.72 0.20,NS	-	1.80 0.19,S
	(Difference In Accuracy Amongst Various Tray Groups)	IA-IB IA-IC IB-IC	- - -	0.43,NS 0.84,NS 0.18,NS	- - -	0.17,S 0.80,NS <0.01,S

[Table/Fig-6]: Comparison of dimensional accuracy of group I casts (molar site) with master model using three types of impression trays.
*Anova test

intercuspal position without any interference from the dual arch tray, as any interference during the closure could cause flexure of the tray [6]. Tray adhesive was applied on to the inner portion of the side walls extending onto the outer walls. It was allowed to dry for fifteen minutes according to the manufacturer's instructions. The application of adhesive on the tray results in higher material bond strengths for polyvinyl siloxanes [10].

The metal dual arch tray had a disposable interocclusal insert which could be easily changed after each impression; hence a single metal dual-arch tray was used to make all the impressions [11, 12]. The interocclusal insert separates the opposing occlusal

Group I		Group II	Premolar			
			Bucco-lingual		Mesio-distal	
			Mean ± SD	Difference	Mean ± SD	Difference
Group II Heavy +Light Body	IIA Metal Dual Arch	Mean ± SD % difference P value	4.196± 0.010 - -	0.008± 0.010 0.2% 0.04, S	3.254± 0.019 - -	0.013± 0.019 0.4% 0.06, NS
	IIB Plastic Dual Arch	Mean ± SD % difference P value	4.170± 0.047 - -	0.034± 0.047 0.8% 0.05, S	3.209± 0.072 - -	0.058± 0.072 1.8% 0.03, S
	IIC Custom Tray	Mean ± SD % difference P value	4.196± 0.010 - -	0.007± 0.010 0.2% 0.06,NS	3.257± 0.026 - -	0.010± 0.026 0.3% 0.25,NS
	ANOVA F P	IIA/IIB/IIC	-	2.82 0.08,NS	-	3.47 0.04,S
	(Difference In Accuracy Amongst Various Tray Groups)	IIA-IIB IIA-IIC IIB-IIC	- - -	0.12,NS 1.0,NS 0.11,NS	- - -	0.09,S 0.99,NS 0.05,S

[Table/Fig-7]: Comparison of dimensional accuracy of group II casts (premolar site) with master model using three types of impression trays.
*Anova test

Group I		Group II	Molar			
			Bucco-lingual		Mesio-distal	
			Mean ± SD	Difference	Mean ± SD	Difference
Group II Heavy +Light Body	IIA Metal Dual Arch	Mean ± SD % difference P value	6.868± 0.026 - -	0.019± 0.026 0.3% 0.04, S	8.726± 0.16 - -	0.013± 0.16 0.2% 0.03, S
	IIB Plastic Dual Arch	Mean ± SD % difference P value	6.821± 0.067 - -	0.066± 0.067 1% 0.01, S	8.691± 0.047 - -	0.048± 0.047 0.5% 0.01, S
	IIC Custom Tray	Mean ± SD % difference P value	6.874± 0.021 - -	0.013± 0.021 0.2% 0.09,NS	8.728± 0.011 - -	0.011± 0.011 0.1% 0.01,S
	ANOVA F P	IIA/IIB/IIC	-	4.56 0.02,S	-	4.92 0.015,S
	(Difference In Accuracy Amongst Various Tray Groups)	IIA-IIB IIA-IIC IIB-IIC	- - -	0.05,S 0.95,NS 0.03,S	- - -	0.03,S 0.99,NS 0.02,S

[Table/Fig-8]: Comparison of dimensional accuracy of group II casts (molar site) with master model using three types of impression trays.
*Anova test

surfaces in the impression and aided in retaining the impression material [12]. It was not paper or tissue, but a rayon fabric with good wet strength and porosity which allows a penetrating bonding of the impression materials. It was strong but thin to interfere with closure [11].

Single body material was simultaneously injected on the preparation area and on both sides of the metal dual arch trays. The dual-arch trays were seated onto the mandibular right quadrant, the articulator was closed until the unprepared teeth contacted which was confirmed by the closed position of the guide pin on the articulator table [8]. A 1.5 kg weight was placed on the top

Site	Tooth	Subgroup	Group I Mean ± SD	Group II Mean ± SD	I vs II		
					t-test Value	P Value c	
B-L	PM	A	0.055±0.058	0.008±0.010	2.57	0.03	S
		B	0.058±0.091	0.034±0.047	0.74	0.47	NS
		C	0.005±0.009	0.007±0.010	0.61	0.55	NS
		p-value[a]	0.015*	0.005*			
		Post-hoc comparisons[b]	A, B > C*	B > A, C*			
	M	A	0.04±0.078	0.019±0.026	0.80	0.44	NS
		B	0.076±0.074	0.066±0.067	0.30	0.77	NS
		C	0.023±0.033	0.013±0.021	0.83	0.42	NS
		p-value	0.038*	< 0.001*			
		Post-hoc comparisons	B > C*	B > A, C*			

[Table/Fig-9]: Comparison of discrepancy in B-L dimensions (in mm) of the two teeth between the two groups (I vs II).
a One-way ANOVA test, bTukey HSDtest, c Unpaired t test, * Significant difference

Site	Tooth	Subgroup	Group I Mean ± SD	Group II Mean ± SD	I vs II		
					t-test Value	P Value c	
M-D	PM	A	-0.027±0.054	0.013±0.019	2.19	0.05*	S
		B	0.106±0.069	0.058±0.072	1.54	0.14	NS
		C	0.008±0.026	0.010±0.026	0.22	0.82	NS
		p-value[a]	< 0.001*	0.002*			
		Post-hoc comparisons[b]	B > A, C*	B > A, C*			
	M	A	-0.002±0.060	0.013±0.060	0.77	0.46	NS
		B	0.031±0.033	0.048±0.047	0.90	0.38	NS
		C	0.009±0.012	0.011±0.011	0.40	0.70	NS
		p-value	0.037*	0.017*			
		Post-hoc comparisons	B > A*	B > A, C*			

[Table/Fig-10]: Comparison of discrepancy in M-D dimensions (in mm) of the two teeth between the two groups (I vs II).
a One-way ANOVA test, bTukey HSD test, c Unpaired t test, * Significant difference

to simulate a constant occlusal force. A tray positioning jig was used so that the position of the impression tray was constant and reproducible between trials [6].

To compensate for the temperature of the extraoral environment, the impressions were removed 12 minutes after the start of the mix which was twice of the manufacturer's setting time. The impressions were rinsed under tap water for 10 seconds, dried and poured in gypsum 60 minutes later [6]. A total of 10 impressions were made in this group.

Group IB Impressions: A plastic dual arch tray was used to make the impressions using medium body polyvinyl siloxane. Similar procedure as Group IA was followed and a total of 10 impressions were made in this group.

Group IC Impressions: Custom made full arch trays were used to make impressions of the mandibular model using medium body impression material. Three occlusal stops were made by removing the wax on the non functional cusps. Tray adhesive was applied on to the inner surface of the tray and was extended 2mm onto the outer walls. It was allowed to dry for fifteen minutes. Medium body material was then injected as mentioned in Group IA. A total of 10 impressions were made in this group.

Group IIA Impressions: Metal dual arch trays (Group IIA), plastic dual arch trays (Group IIB), custom made full arch trays (Group IIC) were used to make the impressions. Dual mix technique was used where tray and low-viscosity material were automixed simultaneously. The light body material was injected around and over the prepared teeth. Heavy body material was dispensed onto both sides of the tray and the tray was positioned over the posterior mandibular teeth. The impressions were poured similarly like the Group I impressions.

A total of 10 impressions were made in each group. Once the impressions were made, all the impressions were stored at room temperature for 60 minutes before being poured. Then all the casts were labeled as per group and subjected to measurements.

Measurements: The measurements of the master model as well as groups were done using a Profile Projector (Nikon, Japan) with an accuracy of 0.001mm or 1µm.

Measuring procedure: The teeth prepared in the master model were mandibular right first Premolar (P-M) and first Molar (M). To begin with, the measurements of the master model were made using profile projector. The Buccolingual (B-L) and Mesiodistal (M-D) dimensions were measured from one index to the other. Center point of the index was taken as the reference. Similarly, for each cast the dimensions were measured three times by the same operator and the mean values were recorded. The measurements of the master model obtained were tabulated and statistically analyzed.

STATISTICAL ANALYSIS

Descriptive statistics like mean, Standard Deviation (SD) were calculated for all the groups and for differences with Master Model (MM). One way analysis of variance (ANOVA) and Post hoc test was used for multiple group comparisons. Differences from the master model were analyzed by paired't' test. Unpaired't' test was used for intergroup comparison and a p-value of 0.05 or less was considered statistically significant.

RESULTS

The dimensions of the master model and the casts obtained by the various groups were tabulated as mentioned in [Table/Fig-5-8]. Intragroup comparisons were made using paired t-test. In general, the average size of the dies was smaller than the premolar and molar on the master model, with the exception of Group IA which was slightly larger in the M-D dimension as compared to the master model, but the difference was not statistically significant. Multiple group comparisons were made using one way ANOVA and the B-L and the M-D dimensions of the dies were significantly different among all the groups except Group I molar dies were not statistically significant in both M-D and B-L dimensions.

[Table/Fig-9-10] shows Post-hoc and unpaired t-test for the intergroup comparisons (group I vs group II). For the premolar the B-L and M-D dimensions were significantly different for the A subgroup. Whereas there was no discrepancy in the B-L dimension amongst the two groups for the molar. On the whole, the custom tray showed the least discrepancy in the B-L dimension followed by the metal dual arch tray.

DISCUSSION

In 1951, Getz reported that the dual arch impression can be made by using reversible hydrocolloid with water-cooled tray [13]. A dual arch impression technique characterizes a major advance in fixed prosthodontics and has many benefits over conventional impression techniques in the construction of single crowns [14]. They enable the dentist to use one tray and a single, double-sided impression to imprint the prepared tooth, the adjacent teeth and the opposing teeth, all in their normal, physiologic position of maximum intercuspation [3-5, 15].

Following conventional impression technique, the dentist has to take two separate impressions in two separate trays; one for the prepared tooth and adjacent teeth and one of the opposing arch for occlusion. Bite registration is also needed, unless the clinician elects to estimate the occlusal relationship by hand articulating the master casts. These multiple procedures need substantial chair side time and material, and also subject to more chances for error. Furthermore, if the dentist records the bite registration in a closed-mouth position and the impression of the mandibular arch in an open-mouth position, distortion and inaccuracy may result when the master cast is inserted into the bite registration [12].

Dual arch impression techniques can yield castings that require little occlusal adjustment. Accuracy is excellent as long as the dentist controls certain critical, manipulative variables [16]. Many authors have reported the advantages of the technique with reference to the reduced chairside time during the impression making, reduced impression material consumption, elimination of custom trays, reduced patient discomfort, and reduced need for occlusal adjustment at insertion [13, 14, 17].

The only clinical study reporting on the occlusal accuracy of the technique was provided by Douglass in 1975, who observed that crowns fabricated from the double arch system were 0.01mm high in occlusion compared to crowns from the mounted casts, which were 0.1mm high. He claimed that the superior accuracy of the closed mouth technique arose from tooth intrusion and the negation of mandibular flexure that occurs with this technique [13].

There have been few studies investigating the occlusal accuracy of the technique. An earlier study concluded that mounted casts resulted in significantly more precise maximum intercuspation than hand articulated full arch casts [13].

The objective of this investigation was to compare the accuracy of working dies produced from impressions made with metal and plastic dual arch trays and custom made acrylic trays for two different viscosities of impression materials. For the present study, polyvinyl siloxane impression material was used due to its outstanding physical properties, handling characteristic and dimensional stability [16].

Group I impressions were made using medium body materials. The advantage of using a monophasic impression system is that a medium viscosity material can be used like a wash as well as to line the tray [12]. Group II impressions were made using a dual mix technique where the tray material and low viscosity material was simultaneously auto mixed [6]. Light body material was injected onto the prepared teeth and heavy body material was injected into the tray.

It was observed that the B-L and M-D dimensions of the gypsum dies obtained with the three types of impression trays using two groups of impression material were smaller than the master models. Ceyhan et al., used a machined stainless steel crown instead of a typhodont tooth. In their study, the buccolingual dimension of the dies made from the rigid impression material was slightly larger than the standard [6], which is in contrast to the present study where the dies were smaller in all dimensions.

On comparing the discrepancy in dimensions between the master model and Groups I and II, it was observed that Group II showed less discrepancy than the Group I in the bucco-lingual dimension whereas Group I showed less discrepancy in the mesio-distal dimension. Amongst the various groups, it was observed that the dies made from custom trays were most accurate followed by those made by the metal dual arch trays. Plastic or the flexed trays produced dies which were the least precise amongst the three groups, though difference was statistically insignificant.

Although statistically significant differences were found in some of these parameters, the magnitude of these differences is clinically insignificant since the difference can be compensated by two coats of die relief [6]. A die spacer which is routinely used during the fabrication of full coverage restorations would mask small errors in the size of the die when the casting is placed back on the prepared tooth, except at the marginal area where no die spacer is placed [8].

These results can be correlated with a study conducted by Larson et al., where they stated that the undersized dies were produced with plastic dual arch trays; implying that several coats of die spacer should be used with this type of tray [9]. Similar results were quoted by Breeding and Dixon in their study, producing undersized dies using the metal dual arch trays. But surprisingly, the plastic trays produced tooth replicas that were larger than the tooth. One possible explanation for the increased dimensions seen with plastic dual arch trays may be due to the distortion caused by the weight of the stone when the impression is poured. The metal tray would resist any flexure due to the weight of the stone, but the flexible tray may distort [8].

It is of interest that flexure, the factor that disrupts the accuracy of the dual arch impressions, can be relatively difficult to control in an anesthetized patient, as the patient might be unaware of tissue impingement from the tray [14, 18]. Thus try-in of the tray prior to anesthesia and careful tray placement during the impression is certainly needed [9, 12].

However, to achieve the best results the dentist must carefully evaluate the patient before choosing the impression procedure and must select an appropriately sized impression tray that fits the arch and does not impinge on any anatomic structure that may produce a deflection of the tray wall [14, 19]. The dentist must also select impression materials and a dual arch technique (one step or two steps) that is appropriate for each case and will result in the greater chances of success [20-22].

LIMITATION

The use of dentoform model was the limitation of the study as it may understate the distortion risk and the absence of lips, tongue, and anatomical variants in individual patients (such as broad alveolar ridges), all of which could produce flexure of the tray.

CONCLUSION

The custom trays produced the most accurate dies followed by the metal dual arch trays. The plastic dual arch trays produced dies which were the least accurate amongst the three groups, but this difference was statistically insignificant. There was no significant difference in the die dimensions obtained using the two viscosities of impression materials.

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