

Effect of variation of impression material combinations, dual arch tray types, and sequence of pour on the accuracy of working dies: “An *in vitro* study”

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Abstract

Aims: To evaluate the accuracy of dies made from dual arch impressions using different sectional dual arch trays, combinations of elastomeric impression materials, and the sequence of pour of dies.

Subjects and Methods: The dual arch impression materials were grouped into three groups depending on the combination of impression materials used and each group is subdivided into four subgroups. A sample size of 8 in each subgroup yielding a total 96 impressions will be made into three groups of 32 each (Group I, II, and III). Group I constitute impressions made using monophase (M) impression material, Group II constitute impressions made using combination of heavy body and light body (HL), and Group III constitute impressions made using combination of putty and light body (PL). Dies obtained were evaluated with a travelling microscope to measure the buccolingual width of the tooth at the margin by using the sharp corners of the notches as reference points.

Statistical Analysis Used: Descriptive analysis namely mean and standard deviation, one-way analysis of variance test.

Results: The results obtained in this study indicate that though not statistically significant, the metal dual arch trays performed better when compared to the plastic trays in reproducing die dimensions.

Conclusions: From the results obtained, dies poured from combination of heavy body and light body impressions using plastic or metal dual arch trays showed least variation in bucco-lingual dimension from master model.

Key Words: Dual arch impression materials, monophase impression material, putty and light body, travelling microscope

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INTRODUCTION

Accurate registration of oral structures is essential for the fabrication of any prosthesis. Making an accurate impression

in fixed prosthodontics is a challenging task. An accurate impression results in precise fitting of cast restoration.^[1] A

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detailed and dimensionally accurate impression is essential for the indirect fabrication of a fixed prosthesis.^[2] It is neither possible nor desirable to make patterns for fixed prosthesis directly in the mouth. Hence, an impression or negative likeness of the teeth and surrounding structures is always necessary to obtain a cast.^[3] Most impression materials are capable of yielding clinically acceptable impressions when manipulated correctly. Accurate registration of oral structures not only requires an accurate impression material but also a rigid impression tray to support the material and a precise impression technique. Several impression techniques have been reported to improve the accuracy of impressions used in making fixed partial dentures.^[4] One such advancement is the introduction of dual-arch impression technique which has major advantage of reduction in error and need for occlusal adjustment. Other proposed advantages are saving time and material, patient comfort, ease of use.^[5]

The credit for the introduction of this technique for fabricating indirect restorations goes to Wilson.^[6] Since then, the dual-arch impression technique has been in use in routine clinical practice.

The purpose of the present study is to compare the accuracy of intra-abutment distance of dies made from quadrant dual-arch impression trays with those made from plastic and metal and using commonly used combination of impressions.

Aims and objectives

- To evaluate the effect of type of quadrant dual arch tray on the accuracy of working dies obtained from quadrant dual arch impressions
- To evaluate the effect of various combinations of polyvinyl siloxane (PVS) impression materials on the accuracy of working dies obtained from quadrant dual arch impressions
- To evaluate the effect of the sequence of pour on accuracy of working dies obtained from quadrant dual arch impressions
- To evaluate the best possible partial dual arch tray and appropriate combination of PVS impression material.

SUBJECTS AND METHODS

The dual arch impression materials were grouped into three groups depending on the combination of impression materials used and each group is subdivided into four subgroups. A sample size of 8 in each subgroup yielding a total 96 impressions will be made into three groups of 32 each [Figure 1].

The following were the groups and subgroups:

- Group I: Consisted of impressions made using monophase (M) impression material
- Group II: Consisted of impressions made using combination of heavy body and light body (HL)

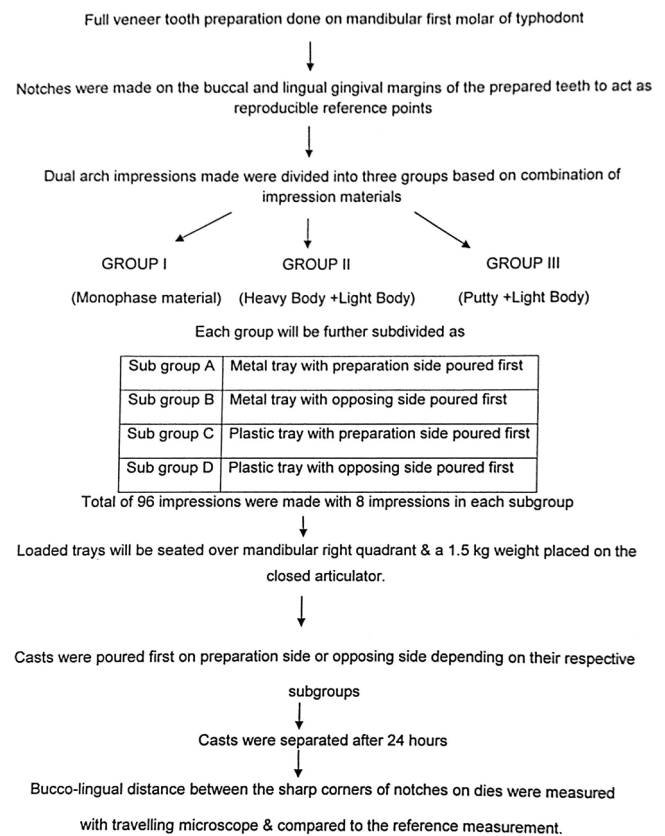


Figure 1: Flow chart depicting methodology of the study

- Group III: Consisted of impressions made using combination of putty and light body (PL)
- Subgroup A: Using metal tray with preparation side poured first
- Subgroup B: Using metal tray with opposing side poured first
- Subgroup C: Using plastic tray with preparation side poured first
- Subgroup D: Using plastic tray with opposing side poured first.

Preparation and articulating the master models

The typhodont teeth were embedded in the maxillary and mandibular Nissin model bases. The right mandibular first molar was prepared conservatively to receive full veneer retainers for a single unit fixed partial denture. Notches were made on the buccal-lingual gingival margins of the prepared teeth using a round bur (1 mm diameter) to act as reproducible reference points for the purpose of evaluation [Figure 2]. The bucco-lingual gingival margin was chosen because this is one of the least supported areas of the impression in most of the dual arch impression trays.^[7] Nissin models (maxillary and mandibular) were mounted in maximum intercuspation on a semi adjustable articulator (Hanau® Wide-View 183 series) using machined solid steel blocks. A tray positioning jig was attached to the articulator so that the position of the



Figure 2: Prepared molar to receive full veneer crown

impression tray was constant and reproducible between the trials [Figure 3].^[8,9]

Impressions in each group

Plastic dual-arch trays (alfa triple tray, dispodent) were used to make the impressions. The dual arch trays were assessed to ensure that the typhodont could be closed into the maximum intercuspal position without any interference from the tray. Any interference during the closure can cause flexure of the tray and in particular the plastic dual arch trays appeared to adversely affect accuracy due to flexure. Tray adhesive was applied on to the inner portion of the side walls and extending 2 mm onto the outer walls and allowed to dry for 15 min according to manufacturer's instructions. A metal dual-arch tray was used to make the impressions and the metal dual arch tray used a disposable inter occlusal insert which needed to be changed after each impression. The interocclusal insert separates the opposing occlusal surfaces in the impression and helps retain the impression material. It is not paper or tissue, but a rayon fabric with good wet strength and porosity that allows a penetrating bonding of the impression materials.

Group I

Monophase material was dispensed onto both the sides of the tray and the tray was positioned over the posterior mandibular teeth.

Group II

A dual mix technique was used where heavy and low viscosity materials were auto mixed simultaneously. The light bodied material was injected around and over the prepared teeth. Heavy bodied material was dispensed onto both the sides of the tray and the tray was positioned over the posterior mandibular teeth.

Group III

A preliminary putty impression was made on the master model which was relieved with one layer of base plate wax.

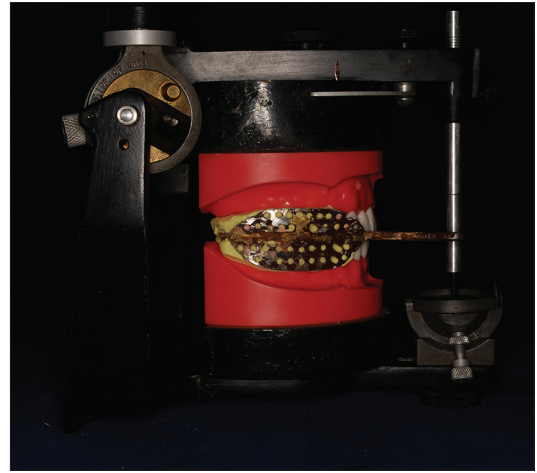


Figure 3: Tray positioning jig attached to semi adjustable articulator with nissin models articulated

Three occlusal stops were made by removing the wax on the nonfunctional cusps. Tray adhesive was applied on to the inner portion of the tray and extending 2 mm onto the outer walls and allowed to dry for 15 min. Equal amounts of putty base and catalyst were hand mixed without gloves. The mix was loaded into a metal and plastic tray and the impression of the relieved master model was made.

In the second step, light bodied impression material was dispensed from the auto mix cartridge onto the prepared teeth, adjacent teeth, the contra lateral teeth and into the putty tray. The putty-tray was reseated over the master model accurately and was held in place for 8 min for the material to set. After the setting time, the air seal was broken with light pressure and the impression was recovered with a snap.

A 1.5 kg weight of the machined block was used to articulate the maxillary Nissin base applied a constant force and the tray positioning jig maintained the position of the impression tray constant during the set of the impression material.

Preparation of the mater cast

A total of 32 impressions were made in each group. Once the impressions were made, all the impressions were stored at room temperature for 60 min before being poured. All the impressions were rinsed in tap water for 10 s and air dried. About 23 ml of distilled water was dispensed in the jar of a vacuum mixer and 100 g of improved dental stone (Type IV, Kalrock, Kalabhai, Karson-Mumbai) was weighed in an electronic measuring balance and was shifted gradually into the distilled water and allowed to soak for 30 s [Figure 4]. Later, the stone was mechanically mixed under vacuum in a vacuum mixer for 30 s. Small increments of stone mix were placed in the impression and a vibrator was used to remove air bubbles. Eight impressions which are made with metal tray were poured with dental stone on the preparation side of the impression

first and then the opposing side of the preparation. Another eight impressions which are made with metal tray, the opposing side was poured with dental stone first as recommended by the manufacturers of tray. After an hour has passed, the preparation side of the impression was poured. Similarly, impressions made with plastic trays were poured with dental stone on the preparation side of the impression first and then the opposing side to the preparation.

Impressions were removed 8 min after the start of mix, twice the manufacturers recommended setting time, to compensate for the temperature of the extra oral environment. The impression were rinsed under tap water for 10 s, dried and poured in gypsum 60 min later.

After pouring the casts, the impression trays were suspended in a tray holder to ensure that the impression was suspended for 60 min allocated for the gypsum to set [Figure 5].

For the dual arch impressions, one side of the impression was poured first and allowed to set for 1 h before the other side was poured with die stone. The casts which were obtained by pouring the preparation side of the impression first and then the counter impression were designated as preparation side casts. The casts obtained by pouring the counter side (opposing side) first and then the preparation side were called the opposing side casts. All casts were allowed to set for 24 h at room temperature before removal from the impressions [Figure 6].^[10,11]

All the casts were based with dental stone. A tripod device attached to the Ney surveyor was used to base all the casts in order to ensure that reference points for all the casts were located in the same spatial line. Once all the casts were based, they were labeled as per group and subjected to measurements.

Measuring procedure

A traveling microscope was used to measure the bucco-lingual width of the tooth at the margin by using the sharp corners of the notches as reference points. The tooth was measured 10 times and served as a control group (CG) and mean value was calculated. The measurements of the dies obtained from master models were tabulated and measurements obtained from stone casts with three types of impression materials were recorded 3 times by the same operator and the mean value was calculated.

RESULTS

A balanced design with independent samples was used to study these three variables. A sample size of 8 in each subgroup yielding a total 96 impressions will be made (32 Group I,



Figure 4: Electronic measuring balance used for weighing dental stone



Figure 5: Poured impressions suspended in tray holder

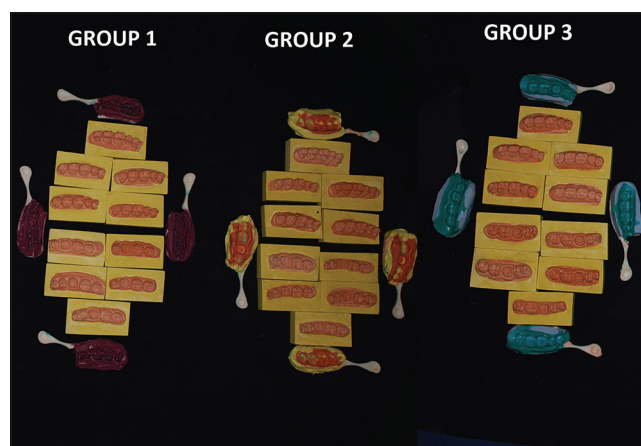


Figure 6: Dual arch impressions and poured casts of three groups

32 Group II, and 32 Group III). One-way analysis of variance are used to test the difference among the groups. Tabulating mean and standard deviation for all the samples [Table I]. From the above multiple comparison of groups, we notice

Table 1: Mean and standard deviation for all the samples

Groups	Sub groups	Mean	SD
Group I	Control group	0.954	0.014
	Total	0.954	0.014
	Group A	0.903	0.031
	Group B	0.851	0.043
	Group C	0.901	0.036
	Group D	0.914	0.017
Group II	Total	0.892	0.040
	Group A	0.941	0.012
	Group B	0.861	0.049
	Group C	0.943	0.015
	Group D	0.863	0.047
	Total	0.907	0.058
Group III	Group A	0.907	0.052
	Group B	0.863	0.053
	Group C	0.899	0.017
	Group D	0.875	0.014
	Total	0.886	0.041
	All groups	Group A	0.928
Group B		0.859	0.047
Group C		0.922	0.039
Group D		0.884	0.036
Total		0.901	0.048

SD: Standard deviation

that there is a significant difference between Group I and Group II ($P < 0.003$). However, no significant difference is noticed between Group I and Group III ($P > 0.05$). Significant difference is noticed between Group I and CG ($P < 0.001$). Similarly, there is a significant difference between Group III and CG ($P < 0.001$). However, no significant difference is noticed between Group II and CG ($P > 0.05$).

DISCUSSION

The dual-arch impression technique has several advantages over conventional impression techniques such as saving time and material as this technique can simultaneously record the prepared tooth, opposing teeth, interocclusal relation unlike conventional impression techniques which require three different steps. The currently popular disposable dual-arch impression tray, the triple tray (premier dental products), was first introduced in 1983. Since then the manufacturers have proposed several modifications in the design.^[12,13] Both metal and plastic dual-arch impression trays are used presently. Their continued use leads one to believe that clinically acceptable restorations can be obtained from both plastic and metal dual arch trays. There are several techniques for making an impression with dual-arch trays. Most popular are the single step or one step technique and a two-step technique.^[14,15] The purpose of this investigation was to compare the accuracy in intra-abutment distance of dies obtained from dual-arch plastic and metal trays. In the present study PVS impression materials have been used to make the impressions because of their excellent physical properties, handling characteristics, and reliable dimensional stability.^[16,17] The results of this investigation showed that the

buccal-lingual distance in Group I Subgroup A was found to be 0.903 cm and Subgroup B found to be 0.851 cm. Both the values were decreased in comparison to the master model which had a buccal-lingual distance of 0.954 cm, with significance statistically. The mean difference from the master model was -0.051 cm for Subgroup A and -0.103 cm Subgroup B indicating a decrease in the buccal-lingual distance, respectively. In Subgroup C and D readings were 0.901 cm and 0.914 cm, respectively, having a mean difference from the master model of -0.053 cm for Subgroup C and -0.040 cm for Subgroup D. Group II showed results with the buccal-lingual distance of 0.941 cm for Subgroup A and 0.861 cm for Subgroup B with a mean difference of -0.013 and -0.093 cm, respectively. In Subgroup C and D, results were 0.943 cm and 0.863 cm with a mean difference of -0.011 cm and -0.091 cm, respectively. For Group III, results for Subgroup A and B were 0.907 cm and 0.863 cm with a mean difference of -0.047 cm and -0.091 cm, respectively, for Subgroup C and D results were 0.899 cm and 0.875 cm with mean difference of -0.055 cm and -0.079 cm, respectively. The inter group comparison revealed no significance statistically between CG and Group II but a significant difference observed between CG and Group I, and also significant difference observed between CG and Group III indicating that the heavy light combination produces dies that coincide with standard tooth that is taken as control. These results were in agreement with the previous studies conducted by Kaplowitz GJ.^[18] The common observation in all the three groups was that the buccal-lingual distance decreased compared to CG. The altered dimension might be attributed to the polymerization shrinkage in the PVS impression material. The PVS impression material shrinks toward the center of mass during polymerization. The use of a tray adhesive would redirect this shrinkage toward the walls of the tray, resulting in increasing the buccal-lingual dimension. These findings are in agreement with the results obtained by Werrin SR and Obrein WJ that the buccal-lingual dimension increased and mesio-distal dimension decreased.^[19,20] In Subgroups A, B, C, and D, it can be observed that though the sequence of pouring did not have statistical significance, the mean difference indicates that pouring the preparation side first resulted in more accurate casts than pouring the opposing side first. This can be due to the compensation of polymerization shrinkage by the die stone expansion. These findings are similar to the results from a study conducted by Cox *et al.* regarding the dimensional accuracy of dual arch and complete arch impressions.^[8] The buccal-lingual distance of dies made from the metal and plastic dual arch trays did not show any statistical significance. However, in between the metal and plastic dual arch trays, the metal trays showed more accuracy in comparison to the plastic dual arch trays. The variation between plastic and metal dual-arch groups could be attributed to the relative

flexibility of the plastic dual arch trays in comparison to the metal dual arch trays. The stock plastic dual arch trays with heavy light body combination showed accuracy when compared to metal dual arch in that group; but overall metal arch trays showed close results to the CG. The results obtained in this study indicate that though not statistically significant the metal dual arch trays performed better when compared to the plastic trays in reproducing die dimensions. Keeping in mind the various advantages of the dual arch trays and the results of this present study, we can suggest that the dual arch impression technique is a valid method for making impressions in fixed prosthodontics.

Limitations of study

- Only bucco-lingual parameter of the prepared typhodont tooth was considered in the study, overall dimensional changes of the impressions have to be evaluated
- As this is an *in vitro* study parameters such as effect of saliva on polymerization of impressions is not considered.

CONCLUSION

Based on the study results the following conclusions may be drawn:

- The bucco-lingual distance for the Groups I, III showed a statistically significant result, but insignificant difference found between Group II and CG. The least amount of variation was noted with impressions made with heavy and light body using plastic dual-arch trays and metal dual-arch trays
- The bucco-lingual dimension of dies made from the metal and plastic dual arch trays are statistically insignificant, but based on results obtained metal trays showed more accuracy in comparison to the plastic dual arch trays
- The sequence of pouring the dual-arch impression, i.e. preparation side first or opposing side first did not show significance statistically though pouring the preparation side first resulted in more accurate buccal-lingual distance.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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