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# EVALUATION AND COMPARISON OF ACCURACY OF CASTS OBTAINED FROM DUAL ARCH TRAYS USING DIFFERENT TYPES OF IMPRESSION MATERIALS. AN IN- VITRO STUDY.

Dental Science

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## ABSTRACT

**AIM:** This study aims to evaluate the definiteness of the casts made by making impressions with different impression materials in two types of double arch trays.

**MATERIALS AND METHOD:** A total of 60 impressions obtained were grouped into three classes according to impression material studied with two type of trays used i.e. Class A, class B & class C consisted of impressions obtained from heavy+ light body (n=20), putty + light body (n=20) and Polyether respectively. Class A, B and C were further divided into Subclass I and II depending upon the metal (n=10) and plastic (n=10) dual-arch trays used. The measurements were obtained using digital microscope and statistical analysis was done for interpretation of results.

**RESULTS:** All the three classes when compared to the master model showed decreased **inter- abutment distance** (p> 0.05) The statistical analysis showed that PVS heavy- light body, & polyether loaded dual arch metal tray are more accurate than plastic tray. Anova shows inter-abutment distance with plastic dual arch tray within different impression material found to be statistically significant (p<0.05) whereas in relation to metal dual arch tray it was found to be statistically insignificant (p> 0.05).

**CONCLUSION-** For measuring the inter-abutment distance, If metal tray is to used, **polyether** is found to be more accurate, and if plastic tray is used, PVS putty-light body is more accurate, whereas **PVS (heavy-light body)** loaded in a **plastic dual arch tray** should not be used as it is found to be least accurate.

## KEYWORDS

Metal dual arch trays, Plastic dual arch trays, elastomeric impression materials, inter-abutment distance.

## INTRODUCTION

The accurate impression is the prerequisite tool to obtain a well-fitting and functional prosthesis. To obtain a good quality impression, it is important to select an appropriate impression material and a tray that records precisely and is able to overcome the challenges offered by moist oral tissues.The technique for making the impression with a particular impression material is also important. Dual arch impression is one such technique, It was first reported by Getz in 1951[1] who used water cooled trays with a reversible hydrocolloids. This technique was later popularized for fabricating indirect restorations by Wilson and Werrin in 1980's.[2]

Dual arch technique is used from many years because of its added advantages of reducing chair side time, occlusal errors and cost. Unlike the conventional impression technique utilizing two trays for making two separate impressions along with the bite registration, all three record are made simultaneously in one procedure with dual arch impression.[2] Dual arch trays are available in both anterior and posterior designs to record both the arches simultaneously making the patient more comfortable.[3] It is also a successful alternative in patients who are apprehensive and exhibit exaggerated gagging. However, use of them is limited to the impression of single or possibly three units restoration.[4] It should also be ensured that the patient should have a definite maximum intercuspation position before using dual arch trays.[5]

Davis and Schwartz [6,7] compared intra and inter abutment dimensions on a prepared typhodent model. Dual arch technique found to be more accurate than custom trays, and metal trays were found to be superior to plastic trays. Whereas, Ceyhan [8] found that plastic dual-arch tray produced less distortion than metal tray, however both the tray produced cast with acceptable dimensions for clinical success. Dual arch impression can be made with either a plastic or metal tray, and there is little evidence that one is more accurate than other.[9]

Christensen et al [10] compared the impressions of the polyether and polyvinyl siloxane in dual arch and the full arch trays. He showed that putty or the heavy consistency materials gave better results with the dual arch trays. This study was contradicted by Cox et al [11] who showed that with the dual arch trays the putty consistency was better than the heavy body material.

With dual arch trays there is a lack of consensus in literature about which impression tray and impression materials should be used. Thus, this study was planed to evaluate the accuracy of casts acquired from Polyvinylsiloxane and Polyether impression materials utilizing plastic and metal double arch trays.

## MATERIALS AND METHODS

The typhodont teeth were embedded in the API model bases. The right mandibular second premolar was removed from API model base to simulate a three-unit fixed partial denture case. A conservative preparation was done on the right mandibular first premolar and right mandibular first molar for a three-unit fixed partial denture. Reference points were made to calculate the inter-abutment. Dimples were made on the occlusal surface of both the abutment units with a round bur in full length (BR-S46, Mani, Japan)

The API models were then mounted on a semi-adjustable articulator in maximum intercuspation and the constant reproducible position of the impression trays for all the impressions were ensured by attaching the custom-tray positioning jig to an articulator.

60 impressions were made using polyether and addition silicone (putty, heavy body and light body) impression material using single step impression technique with plastic and metal dual arch impression trays.

Sixty impressions were divided into 3 classes (Class A, B, and C) consisting of 20 impressions in each class, were grouped as follows :

**Class A:** Impressions were made with heavy body and light body in quadrant dual arch trays.

**Class B:** Impressions were made with putty and light body in quadrant dual-arch trays.

**Class C:** Impressions were made with polyether in quadrant dual-arch tray

In each class 10 impressions were made with metal dual arch termed as Sub-class (A1, B1, C1) and 10 impressions were made with plastic dual tray termed as Sub–class (A2, B2, C2) as shown in Table/Fig 1.

The trays were double coated with tray adhesive applied on the inner side of the walls and extending it onto the outer walls by 2mm followed by drying it for fifteen minutes to aid in better mechanical retention for the material. In metal tray, impression material is retained with the help of rayon insert which doesn't interfere with the closing of model bases and has a good wet strength.

### i) Impression making:

**In class A**, an elastomeric impression material used was heavy & light body polyvinyl siloxane (Dentsply Aquasil). Two auto mixing dispensing guns were used to mix the impression material with the help of two operators. Heavy body impression material was dispensed from auto mixing cartridge on both sides of the tray with an intraoral tip. Similarly, the another operator would dispense the, light body from the dispensing gun on the prepared tooth surface as well as on the impression side of the tray. A constant pressure of 1.5 kg was applied on the articulator to attain maximum intercuspation during typodont closure and was confirmed seeing the guide pin in a closed position. Then the tray positioning jig was used to stabalized the tray. Material was allowed to set. The impressions were removed after 12 minutes (after the start of mix) and then rinsed for about 10 seconds under normal tap water and dried. Thereafter pouring of the impression was done after an hour.

**In class B**, elastomeric impression material used was Putty and Light body, Polyvinyl siloxane (Dentsply Aquasil) following the single step impression technique. Firstly, putty was mixed by kneading two equal scoops of base and catalyst until the uniform mix was obtained and it was then loaded on both the sides of the tray. Meanwhile the another operator dispense Light body in an auto mixing gun directly on the prepared tooth as well as to putty material loaded tray. Further procedure is same as explained above in Class A.

**In class C**, elastomeric impression material used was Polyether (3M ESPE Impregum Penta Soft MB) following the single step impression technique. Two equal lengths of medium-consistency base and catalyst paste were dispensed on to the mixing pad in the ratio of 5parts of base and 1 part of catalyst and mixed with spatula for 1 minute until the paste emerge in uniform color. For impression making the material was loaded in to the syringe and was dispensed on the prepared tooth surface and both sides of the tray. Further procedure remains same as explained in Class A.

**Table/fig1.**

| Class A (heavy body + light body) | | Class B (putty + light body) | | Class C (Polyether) | |
|---|---|---|---|---|---|
| Sub-class A1 (Metal tray) | Sub – class A2 (Plastic tray) | Sub- class B1 (Metal tray) | Sub- class B2 (Plastic tray) | Sub – class C1 (Metal tray) | Sub – class C2 (Plastic tray) |
| 10 | 10 | 10 | 10 | 10 | 10 |

**Pouring of the impressions with type IV gypsum (Ultrarock)**

All the impressions were poured in Type IV dental stone. Type IV gypsum (Ultra rock) was used in the ratio of 100 g of powder, hand mixed for about 10 seconds with 20 ml distilled water followed by 40 seconds of vacuum mix before the samples were poured. All 60 impressions were poured utilizing 35 g of stone on the non-working side first while being vibrated to avoid air entrapment followed by pouring on the working side after an hour using 35 g stone. The poured impressions were allowed to set at room temperature and were retrieved after 24 hours.

**Measurement of the samples to evaluate linear dimensional change**

The measurements were done using a digital microscope with a Biowizard software (4.2). For measuring the inter abutment distance cursor was dragged from mesial of premolar to mesial of molar and length was assessed on the computer screen.

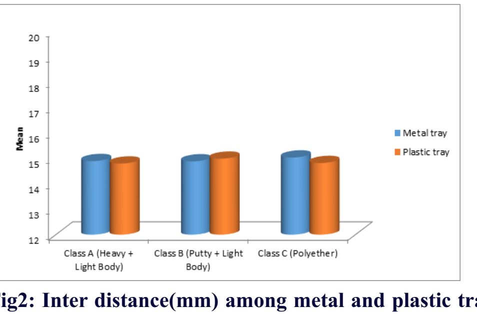
Results obtained were statistically analyzed. For comparison between trays, t test was used and for multiple group comparisons for materials One Way Analysis Of Variance (ANOVA) test was used and the data was evaluated using SPSS Software 16.0 followed by an application of a Turkey Post Hoc contrast for evaluating the overall percentage change. The statistical analysis was conducted at the 95% level of confidence and the significance of the linear dimensional changes was analyzed at 5%.

## RESULTS

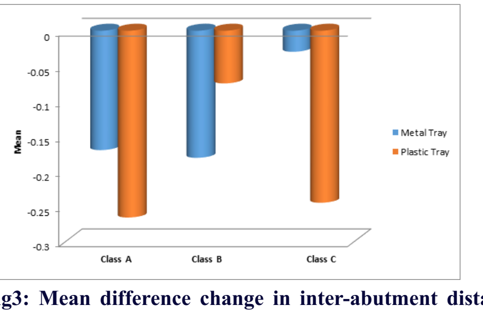
The results showed in **Table/fig2,4** reveals the Mean inter abutment distance of class A was 14.890±0.189, 14.794±0.123, for class B was 14.879±0.168, 14.985±0.077 and for class C was 15.030±0.172, 14.815±0.158 respectively among metal and plastic tray.

All the three classes when compared to the master model showed decreased **inter- abutment distance (Table /fig 3,5,6)**.

The statistical analysis showed that PVS heavy- light body, & polyether loaded dual arch metal tray are more accurate than plastic tray. Whereas with putty - light bodied impression plastic tray are more accurate although statistically insignificant. Significant inter abutment distance between metal and plastic tray was found only polyether (class C) $p<0.05$(table/fig 7). Anova shows that inter-abutment distance in relation to metal tray was compared statistically between class A, class B and class C was found to be statistically insignificant as $p>0.05$ (table/fig 8). Whereas inter-abutment distance in relation to plastic tray was compared statistically between all the classes using Anova test, it was found to be statistically significant ($p<0.05$). (Table/fig 9).




**Table/Fig2: Inter distance(mm) among metal and plastic tray of Class A (Heavy + Light Body), Class B (Putty + Light Body) and Class C (Polyether).**




**Table/fig3: Mean difference change in inter-abutment distance from master model for class A, B and C**

**Table/fig 4. One Way Descriptive Analysis Of class A, B and C along with their Sub- Class for Inter-Abutment Distance (in mm).**

| Classes | Sub- Classes | Mean | Standard deviation | Standard error | Maximum | Minimum | 95% Confidence Interval | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Lower Bound | Upper Bound |
| A Heavy body + light body | Sub – Class A1 Metal Tray | 14.890 | .189296 | .05968 | 15.054 | 14.423 | 14.754 | 15.025 |
| | Sub- Class A2 Plastic Tray | 14.794 | .123646 | .03910 | 14.981 | 14.625 | 14.705 | 14.882 |
| B Putty +light body | Sub – Class B1 Metal Tray | 14.879 | .168304 | .05322 | 15.125 | 14.587 | 14.759 | 14.999 |
| | Sub – Class B2 Plastic Tray | 14.985 | .077180 | .02440 | 15.076 | 14.872 | 14.930 | 15.040 |
| C Polyether | Sub-Class C1 Metal Tray | 15.029 | .171926 | .05436 | 15.216 | 14.660 | 14.906 | 15.152 |
| | Sub-Class C2 Plastic Tray | 14.814 | .157948 | .04994 | 15.017 | 14.537 | 14.701 | 14.927 |

**Table/fig5: Mean and mean difference change in Inter-abutment distance from master model for class A, B and C (Metal tray)**

| Master model | Groups | Mean±SD | Mean difference | % difference | t test | p value |
|---|---|---|---|---|---|---|
| 15.060 | Class A (Heavy + Light Body) | 14.890±0.189 | 0.17 | 1.129 | 2.844 | 0.01* |
| | Class B (Putty + Light Body) | 14.879±0.168 | 0.181 | 1.202 | 3.407 | 0.003* |
| | Class C (Polyether) | 15.030±0.172 | 0.03 | 0.199 | 0.552 | 0.588 |

*: statistically significant

**Table/fig6: Mean and mean difference change in inter-abutment distance from master model for class A, B and C (Plastic tray).**

| Master model | Groups | Mean±SD | Mean difference | % difference | t test | p value |
|---|---|---|---|---|---|---|
| 15.060 | Class A (Heavy + Light Body) | 14.794±0.123 | 0.266 | 1.766 | 6.839 | <0.01* |
| | Class B (Putty + Light Body) | 14.985±0.077 | 0.075 | 0.498 | 3.08 | 0.007* |
| | Class C (Polyether) | 14.815±0.158 | 0.245 | 1.627 | 3.162 | 0.005* |

*: statistically significant

**Table/fig 7: Comparison of Inter-abutment distance in (mm) among metal and plastic tray of Class A (Heavy + Light Body), Class B (Putty + Light Body) and Class C (Polyether).**

| Classes | Metal tray | | Plastic tray | | t test | p value |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | | |
| Class A (Heavy + Light Body) | 14.890 | 0.189 | 14.794 | 0.123 | 1.341 | 0.197 |
| Class B (Putty + Light Body) | 14.879 | 0.168 | 14.985 | 0.077 | 1.807 | 0.095 |
| Class C (Polyether) | 15.030 | 0.172 | 14.815 | 0.158 | 2.916 | 0.009* |

*: statistically significant

**Table/fig8: Comparison of Inter-abutment distance between the three classes in relation to metal tray.**
**ANOVA**

| | Sum of Squares | Df | Mean Square | F | p value |
|---|---|---|---|---|---|
| Between Groups | .141 | 2 | .070 | | |
| Within Groups | .843 | 27 | .031 | 2.251 | 0.125 |
| Total | .984 | 29 | | | |

**Table/fig9: Comparison of inter-abutment distance between the three groups in relation to plastic tray**
**ANOVA**

| | Sum of Squares | Df | Mean Square | F | p value |
|---|---|---|---|---|---|
| Between Groups | .220 | 2 | .110 | | |
| Within Groups | .416 | 27 | .015 | 7.15 | 0.003* |
| Total | .636 | 29 | | | |

*: statistically significant

## DISCUSSION

**Decrease in inter-abutment distance** for **metal dual arch tray** is .19 - 1.12 percent & for plastic dual arch tray .49 - 1.76 percent. Cox[11] recorded 1.17% - .32% mean dimensional changes in their study. This decrease in inter-abutment distance might be a result of polymerization shrinkage of elastomeric impression material mostly occurring towards the centre. The application of tray adhesive is usually more toward the walls and not inter proximally which results in stretching of the material like rubber band in bucco-lingual dimension that will eventually results in decreased mesio-distal dimension and hence decreased inter abutment distance. The studies conducted by **Bansal S**[12] **& Reddy JM**[13] also showed **decreased inter- abutment** distance in agreement to the current study.

The comparison between the plastic & metal dual arch trays showed that the metal dual-arch trays produced dies with dimensions closer to the master model with heavy body & polyether impression materials. This could have been a result of an excessive application of tray adhesive since plastic dual arch trays have an increased surface area thereby excessive material shrinkage towards the walls leading to a decreased inter-abutment distance. This might also be due to the lack of rigidity of plastic tray and rebound that will results in distortion of impression. These results were in agreement with the studies conducted by cox,[11] Reddy JM[13] & Ceyhan JA.[9] cox [11] & Reddy JM[13] metal dual arch tray loaded with heavy body founds to be insignificantly more accurate than plastic trays in measuring inter-abutment distance. Although Ceyhan JA[9] measured mesiodistal dimension of single tooth.

Plastic dual arch trays were more accurate than metal trays with putty-light body impression materials although statistically insignificant. Wostmann conclude that dual arch tray, especially when flexible-are an acceptable alternative to conventional impression taking technique. [14] Results from this study & study and a clinical trial by cox [11,15] supported the use of putty over heavy consistency material with plastic dual arch tray. Cox reported .32 percent dimensional change with double arch putty loaded plastic tray & 1.17 with double arch heavy bodied loaded plastic tray.

Based on results of the present study, plastic tray loaded with heavy-bodied material may not be a clinically reliable impression technique as the most inaccurate inter-abutment dimensions were obtained from these impressions. Flexibility of tray may result in deformation of material. Cox JR[11] concluded PVS heavy- light body in plastic tray founds to be least accurate.

With metal dual arch trays any impression material among all the three materials i.e. PVS heavy-light body, Putty- light body & Polyether can be used, as results are found to be non- significant. Polyether impression material to be most accurate material with a metal dual arch tray. Jhonson GH[16] conducted a study on full arch and dual arch plastic trays with ployether and polyvinyl siloxane (medium body) and concluded that there is high success rate with polyether for multiple tooth preparations. However VPS medium consistency was compared instead of heavy body and putty consistency in our study. De Lima LM [17] also found polyether in metal dual tray to be more accurate for width measurement. Breeding and Dixon[4] found least changes in polyether impression in metal dual arch tray, although they measured buccolingual dimension only.

Non-working side was poured first Reddy JM[13] and Cayouette MJ [18] revealed that pouring the non-working side first resulted in better accuracy. The reason lies in the compensation of the polymerization shrinkage by the weight of the die stone that results in a little deflection of the impression material at the unsupported terminal end of the tray stretching the material mesio-distally thus helping in the formation of more precise dies.

The change in dimensions are not only because of the tray deformation or impression material /technique but is also attributed to the linear expansion of stone. The reported expansion in type IV stone is 0.08% - 0.1%.[19,20] That expansion of stone brings a positive effect by compensating the shrinkage of the impression material.

International dental standards state that 1.5 % is the maximum linear dimensional change of elastomeric impression material.[21] It is important to check weather the statistical difference is clinically relevant. The dimensional change of 90um is clinically acceptable.[22]

However, the difference can be compensated by coating the surfaces that are narrower with a die spacer. Thickness of single coat of die spacer has been shown to vary between 8-40 µm.[20] To mask the undersized dimensions especially in the mesio-distal direction, where two coats can be applied for better fit and results of the fabricated prosthesis.

Authors [6,7,8,23,24] found in their study that dual arch to be equally or more accurate than custom impression technique. Lane DA [24] in their study supported the use of double-arch impressions, as time and material saving for clinician with this technique provide reductions in economical and environmental cost. Patients also prefer this technique over complete arch impression with stock tray. However Cox JR,[15] Kaplowitz GJ [25] have revealed a major difficulty in using dual arch trays and inferred that these can only be used efficiently for short span FPDs. It is a challenge to evaluate if the patient has closed in to maximum intercupastion. Their use is limited in cases where the patient has class I occlusion & canine disocclusion as during excursive movements the relationship of the cusp to the condyle is lost.

The influence of saliva, tongue, cheeks, vestibule and the bite pressure exerted on the dual arch trays are assessed better in an in vivo setup. As this was an in vitro study, these parameters affecting the dual arch tray were not possible to assess. This study investigates only one phase of linear relationship of the one side of the arch. Cross arch relationship, occluso-cervical & bucco-lingual aspect should also be investigated for which further clinical trials are recommended.

## Clinical Significance

When exploring the data to the clinical implications, it involves the preparation of three – unit bridge, but not to one involving single preparations. If impression is to be made with metal dual arch tray polyether is the material of choice. However, with plastic dual arch tray putty- light body poly vinyl siloxane elastomer is preferred. Whereas **PVS (heavy-light body)** loaded in a **plastic dual arch tray** should not be used as it is found to be least accurate.

## CONCLUSION

**Within limitations of this study, following conclusions can be drawn:**

1. All the classes showed decreased inter- abutment distance, when compared to the master model.
2. The most accurate inter-abutment distance was obtained by Polyether /metal tray followed by PVS putty - light body /plastic tray > PVS heavy body - light body /metal tray > PVS putty - light body / metal tray > Polyether /metal tray > PVS heavy body - light body /plastic tray.
3. Polyether impression material in metal dual arch tray is found to be the most accurate material and PVS (heavy -light body) in plastic dual arch tray is least accurate.
4. Metal dual arch trays are more accurate with polyether and heavy body PVS impression materials than plastic dual arch tray.
5. Whereas plastic dual arch trays are more accurate with putty light body PVS than metal dual arch tray.
6. With metal dual arch tray any material i.e PVS and Polyether can be used to make impression as $p > 0.05$.

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