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To compare the dimensional accuracy of dies obtained by using different impression techniques - An in vitro study

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Abstract

Introduction: This in-vitro study was undertaken to compare the dimensional accuracy of dies obtained with different impression techniques.

Objectives

1. To compare dimensional accuracy of dies obtained with putty reline technique.
2. To compare dimensional accuracy of dies obtained with multiple mix technique.
3. To compare dimensional accuracy of dies obtained with medium body technique.

Materials and Methods: Vinyl polysiloxane in putty, heavy body, medium body and light body consistency were used. A stainless steel die with specific dimensions was used for making the samples. Two indentations were made on the top and lateral side of the die. 60 samples were made with putty reline technique, multiple mix technique and medium body technique. Three readings were recorded for each sample and average of

the three were compared amongst themselves. Linear measurements were done using profile projector. Data was collected and analysed statistically.

Results: Study showed that the dimensional accuracy of dies obtained from monophase technique showed least significant difference from the master die followed by the multiple mix technique and putty reline technique.

Keywords: Putty Reline, Multiple Mix, Medium Body, Dimensional Accuracy, Impression Techniques, Fpd

Introduction

The fixed partial prosthesis is found to be one of the well accepted and developed options of treatment under the field of prosthodontics. The fabrication of an accurately fitting fixed prosthesis is a highly precise work. This work usually begins at the very beginning that is from tooth preparation, impression making, cast/die preparation, wax pattern fabrication, casting, finishing and cementation. Any inadequacy at any step is carried forward to the final prosthesis[1].

The process of making a fixed partial prosthesis is an indirect technique with the prosthesis processed in the laboratory, tried into the patients mouth and finally cemented into the oral cavity. For the final restorations to be accurately fitting and serving the defined purpose one most critical requisite is making an accurate impression which in turn is dependent upon the selection of the impression material to be used, the receptacle for making the impression i.e. the impression tray and finally the technique which is to be used to record the area of concern. Over past few decades huge progress has been made in the area of making impressions for fixed prosthesis. The search for making accurate impressions led to the development of a vast variety of impression materials as well as techniques. Many studies had undergone which depicted that elastomeric impression materials provided impressions that were more accurate as well as dimensionally stable[1].

For making a precisely fitting prosthesis the utmost requisite is making an adequate impression of the dentoalveolar and dental structures. This makes out to be the essential requirements determining the durability of restorations[1,2].

Recording the marginal finish lines and the gingival displacement while making an impression are two other critical steps. For making an effective impression gingival sulcular fluid, gingival bleeding from the sulcus and collapsing forces of the marginal gingiva needs to be controlled.

The impression materials which have been found to be most precise and stable dimensionally are addition- type silicone impression materials, polyvinyl siloxanes (PVS).[3] Various ongoing studies are discussing the impact on the fit of the cast restoration using various impression techniques. To improvise the precision of PVS impressions various techniques are being suggested, the most frequently used techniques are putty/wash 1- step technique, putty/wash 2- step technique and putty/wash 2- step with polyethylene spacer. In putty/wash technique various factors needs to be controlled but the most critical factor is to control the bulk of the wash material used. The bulk can be controlled in case of two- step putty wash technique but it is much difficult to keep a control of the bulk of wash material in case of one- step putty wash technique. The two step putty/wash with 2mm spacer was found to be showing the most accurate results[2].

The type of tray used and the material used also depicted different results. Some authors while doing their research found that dies made from elastomeric impressions materials using custom impression trays over the time became shorter in length and larger in the

diameter due to the polymerization shrinkage. While using putty/wash technique inadequate bonding of the impression material to tray and comparatively increased bulk over the palatal side of stock trays lead to distortion as well as polymerization shrinkage[3].

The struggle for an adequate impression is hampered with the increasing number of the abutments due to the associated difficulties while maintaining the tissue fluids and saliva, which is required during simultaneous flow of the free flowing impression material. The search for most precise impression material continues and addition silicones are found to be the most adequate and dimensionally stable impression materials[2,4] as compared to other silicones.

Before selecting a technique for making an impression a dentist should have a thorough knowledge regarding the impression material used and its interaction within the technique which is used, this can lead to a more successful duplication of the structures of oral cavity and can lead to lesser failures in recording the structures.

In view of above this in vitro study was carried out to compare the dimensional accuracy of dies obtained by using different impression techniques.

Materials and Method

This in vitro study was conducted in Department of Prosthodontics, Bhojia Dental College and Hospital (Bhud) Baddi.

60 samples were made using each technique and the samples were poured in Type IV dental stone.

Materials

To conduct this study following materials were used

1. Poly siloxane putty (Aquasil soft putty, Dentsply DeTrey GmbH De-Trey-Str. 1 78467 Konstanz Germany) (Fig.1a)
2. Vinyl poly siloxane -heavy- body consistency (regular flow) (Aquasil ultra smart wetting impression material, Dentsply DeTrey GmbH De-Trey-Str. 1 78467 Konstanz Germany) (Fig. 1b)
3. Vinyl poly siloxane– light - body consistency (Aquasil ultra smart wetting impression material, Dentsply DeTrey GmbH De-Trey-Str. 1 78467 Konstanz Germany) (Fig. 1b)
4. Vinyl poly siloxane – monophase (Aquasil ultra smart wetting impression material monophase, Dentsply Caulk 38 west Clarke Avenue Milford, DE 19963 USA) (Fig. 1b)
5. Polyethylene separating sheets (DPI, Dental Products of India Trading Corporation Ltd., Mumbai, India)
6. Tray acrylic resin material (DPI, Rudrapur, Uttrakhand, India) (Fig. 1c)
7. Tray adhesive (Coltene Adhesive Polysiloxane, Coltene Whaledent Pvt. Ltd., Switzerland)
8. Dental stone (Type IV) (Kalabhai Karson Pvt. Ltd., Mumbai, Maharashtra, India) (Fig. 1d)
9. Aluminium foil
10. Separating media – cold mould seal (DPI, Uttrakhand, India)

Armamentarium

1. Stainless steel die (Fig. 2a)
2. Perforated metal stock trays (Fig.3a)
3. Perforated autopolymerising resin custom trays (Fig. 3b)
4. Dispensing gun (Dentsply) (Fig. 1b)
5. Glass slab
6. Mixing tips (Fig. 1b
7. Rubber bowl
8. Mixing spatula (stainless steel straight, metal cement)
9. Water measuring jar
10. Bard Parker handle no.4 and blade no. 20
11. Finishing stones, mandrel and sand paper

12. Lacron carve
13. Camel hair brus
14. Spacer sheet

Equipments

1. Vibrator
2. Lathe
3. Profile Projector (Sipcon Instrument Industries, Ambala Cantt, India) (Fig. 4a)
4. Dental Vaccuforming machine (Fig. 4b)

Method

1) Preparation of master model

A stainless steel die (Fig. 2a) resembling single prepared posterior tooth was used as a master model for the impression techniques used in this study. The die was fabricated to simulate full - crown preparation. A horizontal indentation was marked on top of the die (Fig. 2a & 2b) and a vertical indentation was marked above the shoulder finish line and below the top on lateral surfaces of the die (Fig. 2a & 2b).

2) Fabrication of tray

The perforated metal stock trays were prefabricated with the help of a milling machine (Fig. 3b). The custom acrylic trays were fabricated using autopolymerizing acrylic resin material (Fig. 3a) and the spacer of 3.5 mm thickness was adapted over the master die coated with cold mould seal using vaccum forming sheet onto which the aluminium foil was adapted. The custom acrylic trays were left for 24 hrs for final setting of the material and then they were trimmed and polished before use. The impressions were made with using different impression materials (Fig. 1a &1b) and were poured with type IV dental stone (Fig. 1d).

3) Grouping of samples

Three groups were made for each technique. Total 60 samples were made and 20 samples were made for each group.

a. Group I- samples made using putty reline technique (Fig. 5a)
b. Group II- samples made using multiple mix technique (Fig. 5b).
c. Group III- samples made using monophase technique (Fig. 5c).

4) Preparation of samples

A total of 60 specimens were fabricated, 20 for each group. Each tray(custom/stock) was painted on with tray adhesive and allowed to dry as per manufacturer's instructions.

For putty reline technique- A putty impression was made with a stock tray painted with tray adhesive and then air dried, after the tray was prepared, polyethylene spacer sheet was adapted over the putty impression material to provide space for the light body impression material and was allowed to set. The spacer sheet was then removed. The light body was then injected into the set putty material and the final impression was made. The impression was then poured in type- IV dental stone.

For multiple mix technique- A custom tray was fabricated using a spacer sheet of 3.5mm thickness (Fig. 6a) using vaccuforming machine (Fig. 6b) and loaded with heavy body impression material while the light body was injected over the stainless steel die simulating the prepared tooth and then the tray was impressed against the model. The impression was then poured in type IV dental stone.

For monophase technique- Monophase impression material was injected simultaneously into the stock tray as well as over the surface of the die and the tray was then impressed over the model. The impressions made were then poured in type IV dental stone.

Measurement of samples

The testing of the samples was done using profile projector (Fig. 7a & 7b) For dimensional accuracy the horizontal and vertical distance on the die were measured. Three readings were recorded for each sample and average of the three readings was compared amongst themselves for the final results.

5) Statistical analysis

Data collected was subjected to statistical analysis using one-way ANOVA and post hoc test.

Results

Comparison of horizontal and vertical distance on die between different techniques is depicted in Table 1 and Graph 8a & 8b. The mean and standard deviation values of horizontal and vertical distance on the die between different techniques was computed and presented in the table. The mean value of horizontal distance in Master die, Putty reline technique, Multiple mix technique and Monophase technique was found to be 8.49600, 8.29990, 8.42325 and 8.47045 respectively. The mean value of vertical distance in Master die, Putty reline technique, Multiple mix technique and Monophase technique was found to be 9.30900, 9.20615, 9.22270 and 9.26410 respectively. Further, comparison between different techniques was done using ANOVA test which revealed statistically significant difference between values obtained using different techniques. (P-value<0.05)

Table 2 depicts multiple comparisons of horizontal and vertical distance on die between different techniques using post hoc test. The mean difference values and statistically significant and non-significant values of comparison of one group with other had been compiled in the table. The comparison between horizontal distance was found to be statistically significant between Putty reline technique vs Multiple mix technique, Putty reline technique vs Monophase technique and Multiple mix technique vs Monophase technique. (P-value <0.05). The comparison between vertical distance was found to be statistically significant between Putty reline technique vs Monophase technique. (P-value <0.05)

Table 3 and Graph 8c & 8d shows comparison of absolute change of horizontal and vertical distance from master die. The mean and standard deviation values of absolute change of horizontal and vertical distance from the master die was computed and presented in the table. The mean value of absolute change of horizontal distance in Master die, Putty reline technique, Multiple mix technique and Monophase technique was found to be .19610, .07275 and .02555 respectively. The mean value of absolute change of vertical distance in Master die, Putty reline technique, Multiple mix technique and Monophase technique was found to be .1028, .0863 and .0449 respectively. Further, comparison between different techniques was done using ANOVA test which revealed statistically significant difference between absolute change of values obtained using different techniques. (P-value<0.05)

Table 4 enlists multiple comparisons of absolute change of horizontal and vertical distance from master die between different techniques using post hoc test. The mean difference values and statistically significant and non-significant values of comparison of one group with other had been compiled in the table. The comparison between absolute change of horizontal distance was found to be statistically significant between Putty reline technique vs Multiple mix technique, Putty reline technique vs Monophase technique and Multiple mix technique vs Putty reline technique. (P-value <0.05) The comparison between absolute change of vertical distance was found to be statistically significant between Putty

reline technique vs Monophase technique. (P-value <0.05)

Discussion

Fabricating a fixed prosthesis commences with making a refined impression involving all the details followed by the processing of the impression in the laboratory and further evaluation of the fabricated prostheses in the patient's mouth. Impression making begins with the selection of impression trays, followed by selection of impression material and the technique to be used. Several factors affect the procedure of impression making. During past few years vast variety of techniques and impression materials have been developed in the field of prosthodontics. The recent trends for making clinical impressions involves simpler techniques for making precise impressions[5]. For making precise impressions recognition of the viscosity of the impression material reciprocates its ability to record detail as lower viscosity impression materials flows better into fine details[5].

Various impression techniques involving one stage and two stage techniques have been popularized in the fields of prosthodontics. The additional silicone impression materials are most commonly used in dentistry due to their better accuracy, easy manipulation, and patient acceptance[6]. According to the researchers, the impression methods significantly influence the accuracy compared to the material used during the impression. The results from one of the study done by Caputi et al[7] presented that the accuracy of dies varied significantly between different impression methods. The monophase technique is considered to be the easiest to perform, although many in vitro studies including studies done by Gonclaves et al[8] and Millar BJ et al[9] reported this to be the worst technique in terms of dimensional accuracy and surface defects like incorporation of air bubbles of the impressions thus formed respectively.

There are certain advantages of using monophase as it requires lesser time for mixing which eventually reduces the wastage and eventually reduced chair side and laboratory time[9].

A clinically acceptable impression can be obtained with the use of rigid or monophase impression materials either in plastic trays or in metal dual arch trays. Another reason for this was shrinkage in the putty impression material towards the perforated tray as it sets so that the perforations engage the putty material[10]. In general, the small differences in dimensional accuracy among the polyvinyl siloxane materials can be attributed to the variability in the composition of each brand name, mainly in the matrix-filler ratio, which can provide the material with different levels of polymerization shrinkage and elastic recovery[11].

It was seen that there was no significant difference in dimensional changes, when hand and cartridge-mix techniques of polyvinyl siloxane were compared which can be attributed to the monophase technique in our study and hand mixing for putty reline technique as studied by Lampe I et al[12]. Comparisons of the monophase and two-stage putty-wash techniques in relation to the one-stage putty-wash technique which was done by Luthardt et al[13] showed a significantly better correspondence of the three-dimensional reproduction of the prepared teeth by one stage techniques which corresponds to the result obtained in our result.

The effect of surface moisture on detail reproduction of elastomeric impressions had been studied and Polyether produced the best detail under moist conditions compared to polyvinyl siloxane (PVS) materials[14,15].

Reddy NR et al[16], studied that the heavy body and light body combination is more accurate than monophase impression material in buccolingual dimension and they also prioritise the sequence of pouring for reproduction of accurate dies. While making single- mix technique impressions using addition silicones the impression material is usually under relatively higher shear stress during spatulation, syringing of the impression material, and insertion of tray in mouth and decreases in viscosity[17].

The impression making can be done using various techniques, in this in vitro study the dimensional accuracy of dies obtained by using putty reline technique, multiple mix technique and monophase technique was compared. Statistically significant differences from the master die were obtained for different techniques. The results of the study depicts that the dies obtained by monophase technique showed least deviation from the master die followed by multiple mix technique and putty reline technique.

The dies obtained in this study were relatively smaller than the master die which is in contrast to the results depicted by Garg Sakshi et al[18] as after comparing three different types of impression techniques they found that the resultant casts were significantly larger in height as well as in diameter and also the study revealed that two-step impression technique produced the most accurate results in terms of the resultant casts.

For the fabrication of most of the indirect restorations the selection of impression technique is a prerequisite and it can affect the dimensional accuracy of the subsequent dies or models thus obtained. In the study done by Bakri I A AL et al[19] monophase technique demonstrated most irregular results and heavy/wash technique showed no significant differences for all the measurements when compared with the standard model.

The present in-vitro study suggested that monophase technique provides the best results followed by multiple mix which is a one-step technique. One step technique has the advantages of simplicity and reasonable economy; however, in this technique, the putty tends to push the light-body wash off the prepared tooth and thus, critical areas, such as the finish line, can be covered by the putty, which cannot record details to a satisfactory level[20] whereas Caputi and Varvara et al[9] thus found that the monophase technique yielded the lowest cast accuracy in every dimension considered, as compared to all of the other techniques ($P < .01$) whereas in our study least deviations from master were seen while using monophase technique.

Summary and Conclusion

A total of 60 samples, 20 in each group, were prepared using three different impression techniques. Three techniques used were putty reline, multiple mix and monophase and each were grouped into Group I, Group II & Group III respectively. Dimensional accuracy was measured by measuring the linear distance on the line marked on top and lateral surface of the master die. The measurements were done using a profile projector and the data collected was then statistically analysed using one way ANOVA and post hoc Tukey test.

The findings of this study showed statistically significant difference was found between putty reline technique and multiple mix technique, putty reline technique and monophase and multiple mix technique and putty reline technique (P-value <0.05). The comparison between absolute change of vertical distance was found to be statistically significant between putty reline technique and monophase (P-value <0.05).

Based on the observations of the study, it can be concluded that the dimensional accuracy of dies obtained from monophase technique showed least significant

difference from the master die followed by the multiple mix technique and putty reline technique.

Legends

Fig.1a Polyvinyl siloxane impression material (putty), 1b. Dispensing gun, vinyl polysiloxane impression material (heavy body regular flow, light body, monophase), mixing tips, 1c. Tray acrylic resin material, 1d. Type IV dental stone

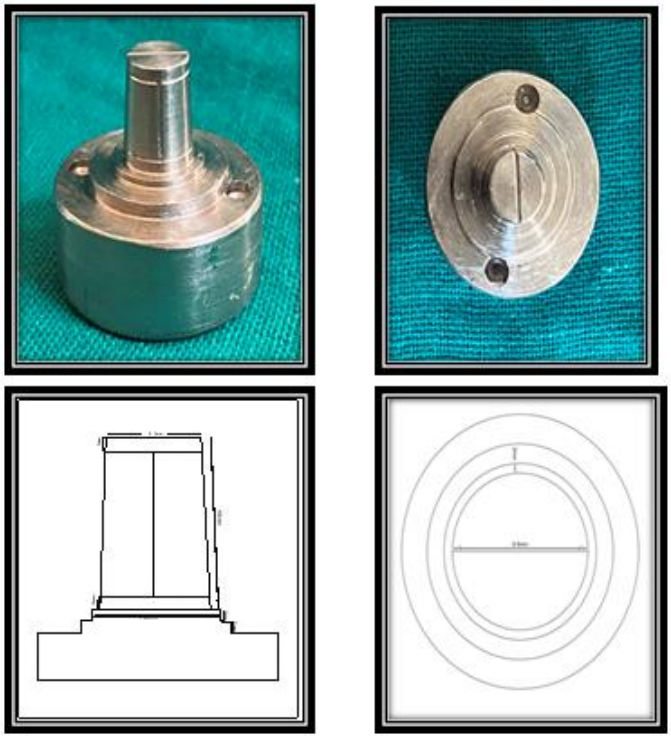


Fig. 2a Stainless steel die, 2b Stainless steel die with dimensions (frontal and top view)

Fig. 3a Perforated autopolymerizing resin custom tray, 3b Metal stock tray placed over the master die

Fig. 4a Profile Projector, 4b Vaccuforming Machine with master die in place

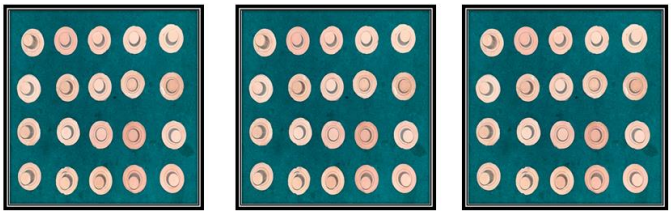


Fig. 5a Samples from Group I (using putty reline technique)

5b Samples from Group II (using multiple mix technique)

5c Samples from Group III (using monophase technique)

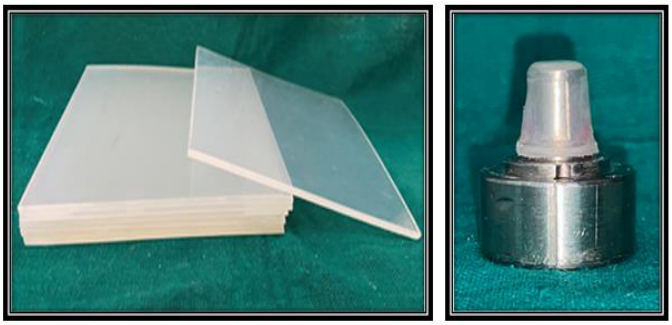


Fig. 6a Spacer sheets (thickness 3.5 mm)

6b Adapted spacer sheet over the die

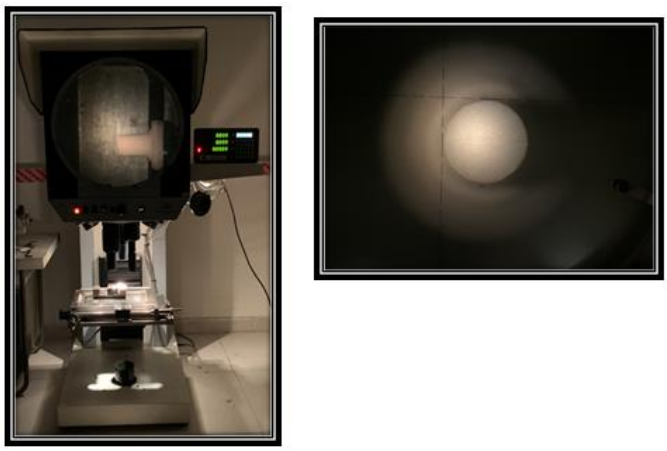


Fig. 7a Die placed on the profile projector and its view on the profile projector(laterally), 7b Top view of the die on the profile projector

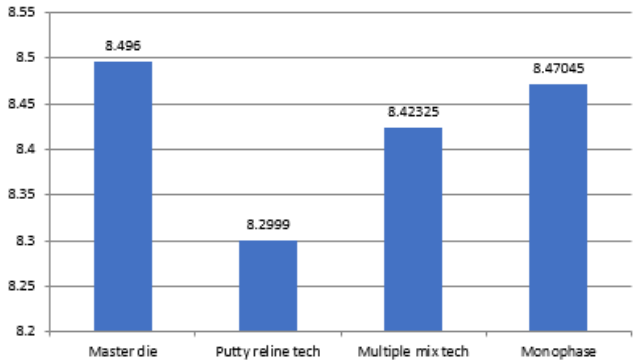
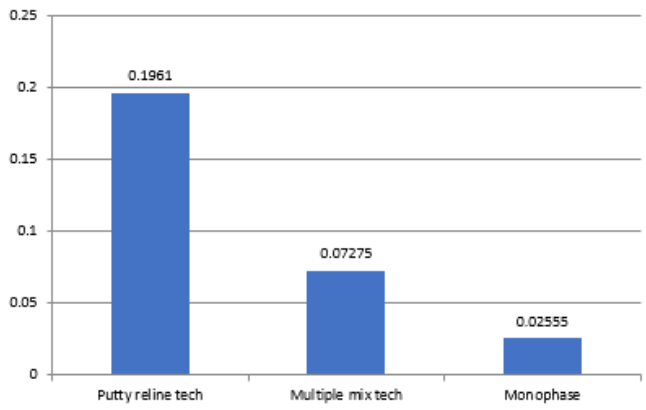
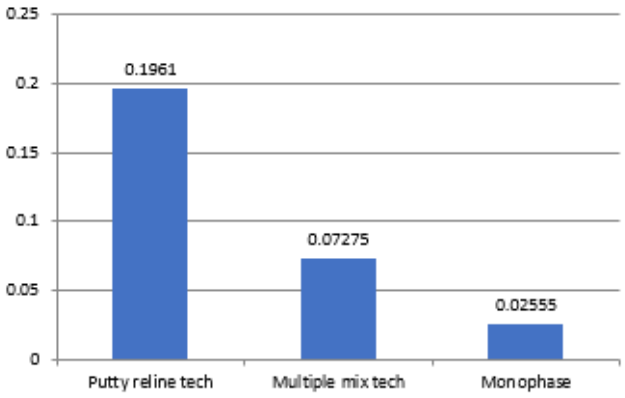


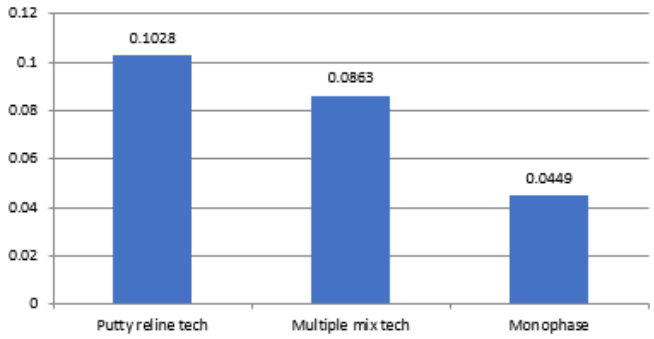
Fig. 8a Comparison of horizontal distance on the die



8b Multiple comparison of absolute change from master die



8c Comparison of absolute change of horizontal distance from master die



8d Multiple comparison of absolute change from master die

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