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ORIGINAL RESEARCH

Accuracy of casts obtained from putty wash impression material using different types of spacers - An Invitro Study

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ABSTRACT

Aim: The aim of this study was to evaluate the accuracy of casts obtained from two stage putty wash impression material employing three different types of spacers.

Setting and design: An in vitro comparison of accuracy of two stage putty wash impression using three different spacers

Material and method: A master metal die was fabricated to simulate a three unit fixed partial denture and a custom metal tray was made. Two stage putty wash was made using three different spacers-conventional polyethylene sheet, vacuum formed sheet and micropore tape. Fifteen impressions were made using each of the three spacers and casts poured. The resultant casts were assessed for dimensional accuracy using the coordinate measuring machine, with the master metal die as control. The data obtained were statistically analysed using one way ANOVA and Student t test.

Statistical analysis used: The data was subjected to statistical analysis using SPSS version 21.0 software. The intergroup comparison was done using sample t-test, and the study models were analyzed using ANOVA statistical analysis.

Results: The results obtained showed that casts obtained from two stage putty wash impression technique using the micropore tape spacer produced least dimensional variation of 0.20% at inter-abutment distance and -1.08%,-0.67% at intra-abutment distance 1 and 2 respectively when compared to other two spacers used.

Conclusion: Two stage putty wash impression technique using micropore tape spacer yielded casts that have better dimensional accuracy when compared to the conventional polyethylene spacer technique

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INTRODUCTION

An accurate impression is crucial for the success of any restoration. An impression should accurately reproduce the surrounding hard and soft tissues to obtain biologically, mechanically, functionally and esthetically acceptable restorations. Accuracy of an impression depends on various factors such as impression material, impression technique used, spacer technique, type of impression trays, thickness of impression material, excessive seating pressure, timing of removal of impression from the mouth and storage conditions. Due to the fact that indirect restorations are classically produced in the dental laboratory, it is inevitable that an optimal precise fit of the laboratory-made appliance is only given if the model exactly matches the original situation. An accurate impression produces the stone casts with minimal dimensional change in regard to the vertical and horizontal dimension between the prepared abutments. Clinical success of fixed prosthodontic procedure largely depends on the dimensional accuracy of elastomeric impression material and impression procedures.[1]

Today, the most commonly used impression materials for precise reproductions are the non-aqueous elastic impression materials. Polyvinyl siloxane impression materials have the best detail reproduction and elastic recovery of all available materials.[2] They possess remarkable dimensional stability and are odorless, tasteless and pleasant for patients. They are provided in wide range of viscosities, rigidities, and working and setting times. Many techniques have been described for making definitive impression in fixed prosthodontics. The most commonly used putty-wash impression techniques are single stage technique and putty wash

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two stage technique with polyethylene spacer.[3]

For an impression to register the entire details of oral structures, it requires uniform thickness of impression material. This uniform thickness is provided by the use of a spacer in two stage putty wash impression. The space for the light body wash material is provided by various means like cutting sluiceways with a putty cutter, using different spacers such as polyethylene spacer foils, resin copings, metal copings, vacuum formed sheets or temporary crowns. Light body being less viscous has good flow to record the fine details resulting in an accurate impression.[4] The spacer in the two-stage technique ensures that there is enough space available for the light body material to record the fine details. An uncontrolled thickness of wash material can result in dimensional changes proportional to the thickness of the material during setting. A consistent layer of 2 mm is the recommended optimal thickness for the wash material. This 2mm space is provided by using a spacer of suitable thickness.

Polyethylene sheets have been used traditionally to provide this space during the first step of the process. Difficulty to adapt the sheet and a highly crinkled surface are the main drawbacks of this material. Some authors have used modified metal spacers in studies to provide uniform space for the wash material. All these types of spacers have a thickness of more than or close to 2mm which is higher than the recommended film thickness of light body (20µm). Hence this study describes a unique way of using the micropore tape as a spacer which has a thickness of 0.2mm during the putty wash technique. The null hypothesis is that there is no significant difference between the casts obtained using different types of spacers for two stage putty wash impression technique.

MATERIALS AND METHOD

A master model consisting of stainless steel die with preparation for a short span fixed dental prosthesis (maxillary right first premolar to first molar) simulated to receive porcelain fused metal crown was fabricated.(*Fig.1*) The stainless steel master model consisting of two abutments and one pontic area was fabricated. The stainless steel abutments were with uniform shoulder finish line and 6-degree taper. The first abutment was 8.5 mm in height and 7 mm in diameter at the occlusal surface. The measurement at the same location for the second abutment was 7.5 mm and 10 mm, respectively.[5] The inter abutment distance was 14 mm. The occlusal surface of the abutment was flat with two perpendicular cross grooves on the occlusal surface as reference points for taking measurements. It consisted of rectangular serrated slots on the stainless steel die for accurate placement of the custom tray during impression making. A perforated, rectangular custom steel tray was fabricated which could be placed on to the platform of the metallic model accurately with the help of grooves and depressions engraved on the horizontal platform for the purpose of orientation, thus preventing the rotation of the tray. The serrated slot on the stainless steel die guides the custom tray in accurately seating on the stainless steel die during impression making.

Figure 1: Master metal die and custom tray

Impressions of the master model were made by dual step impression techniques using putty and light body material (Flexceed vinyl polysiloxane, GC India Dental Pvt Ltd). The impressions were categorized into three groups as follows:

Group I: using polyethylene sheets spacer

Group II: using vacuum formed sheets spacer

Group III: using micropore tape as spacer

Equal amount of putty base and catalyst (Flexceed vinyl polysiloxane, GC India Dental Pvt Ltd) was hand mixed without gloves and loaded onto the perforated custom tray after applying tray adhesive (3M ESPE). The tray adhesive was allowed to dry for 15 minutes. For Group I, primary impression with putty was made with 2mm thick polyethylene sheet placed over the abutments. Once the putty has set, polyethylene sheet was removed to create a uniform wash space. Wash impression material was syringed using automatic mixing syringe and light body gun around the abutments and the primary putty impression was seated to get a complete two-step putty wash impression and held in place for 8 minutes for the material to set.(*Fig.2*)

For Group II and Group III, the above technique was followed using vacuum formed sheets and micropore tape respectively.(*Fig.3&4*) Fifteen impressions were made using each of the above technique. After the impressions were completed, they were stored at room temperature for 30 minutes before being poured. All the impressions were sprayed with surfactant (Begosol) and casts were poured following manufacturers instruction. After pouring the casts, the stone was allowed to set for 1 hour before separating the casts from the impression. The obtained casts were checked for voids and the defective casts were discarded. Each cast was trimmed and labeled according to the group.

Figure 2: Putty wash impression made using polyethylene

Figure 3: Putty wash impression made using vacuum

All forty five experimental casts were measured and examined for dimensional accuracy by means of a coordinate measuring machine (CMM) connected to computer.(*Fig.5*) The coordinate measuring machine (three-dimensional measurement machine) with an accuracy of up to 0.001 mm is a mechanical

Figure 4: Putty wash impression made using micropore

Figure 5: Study models

system designed to move a measuring probe to locate reference points on the occlusal and horizontal platform.(*Fig.6*) It consists of four components: the machine itself, measuring probe, the control or computing system and measuring software. The vertical distance (intra- abutment) and horizontal distance (inter-abutment) distance of the master metal die and stone casts were measured. Three measurements were obtained for every single cast, and the mean values were computed. While measuring the coordinates, the reference model and experimental casts were secured to the base. Intra-abutment measurements included lower diameter, upper diameter, and height whereas inter-abutment measurements were calculated using the center of each abutment as a reference.(*Fig.7*) The measuring of the master metal die was done and the values were then compared with those of the study casts.

Figure 6: Coordinate measuring machine

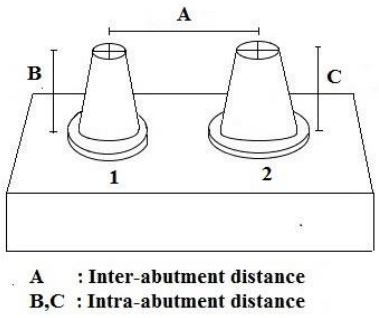

Figure 7: Dimensions measured in the study

RESULTS

The measurements obtained for all three groups were tabulated and statistically analyzed using one way ANOVA and Student t test. All collected data was analyzed using SPSS (statistical package for the social sciences, version 21.0) with statistical significance set at α =0.05. The difference between the mean of stone model (MSM) and mean of master metal die (MMD) divided by mean of master metal die multiplied by 100 was expressed as percentage deviation from master model for each impression technique of each measurement location:

$$\text{Percentage of deviation} = \frac{(MSM - MMD)}{MMD} \times 100$$

The one-way ANOVA revealed that the horizontal and vertical dimensions on the master metal die and stone models were significantly different. Of the three groups, Group III (micropore tape spacer) produced least dimensional changes in relation to inter-abutment distance with the percentage deviation of 0.205.(Table 1) Group III (micropore tape spacer) had the least dimensional changes in relation to intra-abutment distance at both Height 1 and Height 2 with the percentage deviation of -1.08 and -0.67 respectively.(Table 2) Student t test revealed that there was a statistically significant difference between Group I and III.(Table 3)

On comparison of inter abutment distance between the stone model and the master metal die, Group III yielded the least deviation of 61.3µm followed by Group II (94.2µm) and Group I(102.1 µm). On comparison of intra abutment distance between the stone model and the master metal die, Group III yielded the least deviation (-138.9 µm; -91.1 µm) followed by Group I(-117.8 µm; -58.6 µm) and Group II(-73.3 µm; -86.2 µm).respectively. Statistical analysis revealed least dimensional changes in relation to inter-abutment and intra-abutment distance by Group III (micropore tape spacer) with a percentage deviation of 0.2 and -1.08; -0.67 respectively followed by Group II (0.3; 0.52 and -0.64) and Group I (0.34 ; -0.91and -0.43) respectively. Student t test revealed that there was statistically significant difference only between Groups I and III (P<0.05).

S. No	Values	Group I Distance 1-2 (A)	Group II Distance 1-2 (A)	Group III Distance 1-2 (A)
1	Mean	29.966	29.958	29.925
2	Std. Deviation	0.039	0.046	0.040
3	Variance	0.002	0.002	0.002
4	Deviation from master model (mm)	0.102	0.094	0.061
5	Deviation from master model (µm)	102.1	94.2	61.3
6	Percent of deviation	0.342	0.315	0.205

Table 1: Mean values, Standard Deviation, Deviation of inter-abutment distances from master metal die of all the groups

S. No	Values	Group I		Group II		Group III	
		B	C	B	C	B	C
1	Mean	12.737	13.390	12.781	13.363	12.716	13.358
2	Std. Deviation	0.1563	0.0749	0.1043	0.1585	0.1060	0.1398
3	Variance	0.024	0.006	0.011	0.025	0.011	0.02
4	Deviation from master model (mm)	-0.118	-0.059	-0.073	-0.086	-0.139	-0.091
5	Deviation from master model (µm)	-117.8	-58.6	-73.3	-86.2	-138.9	-91.1
6	Percent of deviation	-0.916	-0.436	0.5159	-0.641	-1.081	-0.677

Table 2: Mean values, standard deviation, deviation of intra-abutment distances from master metal die of all the groups

Paired Samples Test		Mean	Correlation	Sig.	't' value
Pair 1	Group I A	29.966	0.426	0.399	0.515
	Group II A	29.958			
Pair 2	Group I A	29.966	0.235	0.024	-2.541
	Group III A	29.925			
Pair 3	Group II A	29.958	0.518	0.436	1.885
	Group III A	29.925			

Table 3 - Mean values and results of paired samples 't' test

DISCUSSION

An ideal impression material should accurately reproduce oral structures without distortion and dimensional changes. The viscoelastic properties of elastomeric impression materials play a major role in their successful application as highly accurate impression materials.[6] Among the elastomeric impression materials available, polyvinyl siloxane are widely used because of their combination of excellent physical properties, handling characteristics and dimensional stability. The putty wash technique was originally developed for condensation silicone to minimize the polymerization shrinkage and was later employed for addition silicone. The most common impression techniques followed are one stage and two stage putty wash technique.

Two stage technique involves making of a putty impression followed by wash impression with a light body. The single stage procedure involves simultaneous loading of putty and light body material in a single step. The main disadvantage with this one stage technique is that the putty material will displace less viscous wash material resulting in poor reproduction of critical areas of the tooth preparation. This is the critical point to be considered because the putty is too viscous to replicate the required details. Moreover, distortion and incomplete detail reproduction can occur because of excessive pressure applied to the setting putty resulting in shrinkage.

This polymerization shrinkage is compensated by a second material with a reduced shrinkage and hence two stage putty wash technique is a more accurate method of recording impressions to overcome the shortcomings of a one stage impression technique. The controlled bulk compensates for this contraction with minimum dimensional changes. Barry Marshak and David Assif[7] in their study concluded that uncontrolled wash bulk may cause differential contraction and uneven dimensional changes. Idris B et al[8] stated that there is tendency for more bubbles to be produced in the one step technique and this error can be reduced with the two-step technique. However, Mitchell and Damele[9] in their study stated that the distortion was produced not because of the impression technique but because of shrinkage of impression material towards the attachment of tray.

According to ISO 4823, the minimal thickness required of a light body material for detail reproduction is 20µm. In two stage technique sufficient space is to be provided for the second material, and this spacer thickness should be equivalent to the thickness of light body material so that low viscosity silicone can be equally polymerized. Nissan J et al[10] infers that wash thickness is an important factor that impacts the accuracy of elastomeric impression materials. De Araujo and Jorgensen[11] stated that the amount of thickness of impression material is more relevant as compared to the technique used. They found that an increase in thickness from 1 to 4 mm causes a greater distortion. Haralur et al[12] concluded that better results are achieved when the impression layer is of moderate thickness and evenly distributed resulting in insignificant permanent deformations in the silicones.

Apart from the conventional polyethylene sheets, various other spacers have been employed in the form of metal copings, acrylic coping, vacuum formed sheets and aluminum foil to evaluate two stage putty wash impression. Karsten Mann[13] compared the traditional cut out technique and a spacer foil and concluded that the use of a foil resulted in greater dimensional accuracy compared to the cut-out technique. Mohammad Altaf Tantray et al[14] concluded that 2mm and 3mm acrylic copings resulted in more acceptable and accurate impressions. Pradeep Samuel et al[15] showed that double thickness aluminium foil spacer provided ideal space for the wash material. Sunil Kumar Mishra et al[16] concluded that wax sheet spacer provided putty impression with a uniform thickness of light body in quick time. Dugal et al[17] concluded that the double-phase two stage technique with 1 mm metal coping showed the slightest dimensional variation compared to other impression techniques. Chugh et al[1] concluded that controlled wash space was provided by 1 and 2mm thick metal copings and uncontrolled wash bulk was seen in one-stage impression technique and two-step impression technique with polyethylene spacer.

The wash thickness of 1–2 mm was reported to be the most accurate for fabricating stone dies when using polyvinyl siloxane impression materials with the two-step putty-wash impression technique. Ahmed Syed Mubashir et al[18] showed that impression made with 2mm thickness of light body showed lesser dimensional changes compared with impression made with 3mm and 4mm thickness of light body.

When stone casts and the master metal die were compared, the vertical dimension (intra-abutment) of stone dies decreased, whereas the horizontal aspect (inter-abutment) increased. This phenomenon occurred because of the contraction of the impression material toward the tray walls, making the stone dies wider in the horizontal aspect and

shorter in the vertical one. During reseating of the tray, the wash induces tension on the high-viscosity material, thus instigating deformation on the already set impression. On removal of the impression after setting, the high-consistency material is likely to exhibit elastic recovery, returning to its original position resulting in smaller dies. Similar finding was observed in the study conducted by Petersen and Asmussen.[18]

From various studies it is evident that ideal space required for two stage putty wash impression varied from 1 to 2 mm. So, in this study, Micropore tape was opted because of its easy availability, minimal thickness and easy adaptability to any surface. Pankaj Kaushik et al[19] reported that the spacer which is closely adapted to the abutments and the edentulous area rather than bridging over the abutments resulted in maximum dimensional accuracy.

There was statistically significant difference in the casts obtained using the three different spacers as determined by student t test. The null hypothesis that no significant difference would be found among the casts obtained from two stage putty wash impression using different types of spacers was thus rejected. The micropore tape spacer (Group III) produced more dimensionally accurate casts in relation to inter-abutment and intra-abutment distance among the three groups, so it can be considered as a viable alternative to the conventional polyethylene sheet spacer that produced the least accurate casts.

CONCLUSION

Two stage putty wash impression technique resulted in lowest percentage deviation from master model, when micropore tape was used as a spacer compared to conventional polyethylene sheet spacer. Thus, micropore tape can be considered as an alternative spacer material due to its least dimensional changes and ready availability.

CONFLICT OF INTEREST

There is no conflict of interest

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