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Accuracy of Different Elastomeric Impression Materials Using Dual Arch Impression Trays: An In Vitro Study

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ABSTRACT

Aim: This study was done to evaluate the accuracy of dies obtained after pouring different elastomeric impression materials in different viscosities using dual arch/ triple trays.

Materials and Method: Tooth preparation was done on mandibular left first molar in a typodont. Fifty impressions each of condensation silicon (putty and light body), vinyl polysiloxane (putty and light body), monophase vinyl polysiloxane and monophase polyether were made in dual arch/triple trays. These impressions were poured in Type IV gypsum. The buccolingual width of the prepared tooth was calculated and was compared with the dies prepared using stereomicroscope. The data was subjected to ANOVA test.

Results: The dies obtained from impressions made with monophase vinyl polysiloxane in triple trays were most accurate followed by monophase polyether, condensation silicon (putty and light body) and vinyl polysiloxane (putty and light body).

Conclusion: Triple trays when used in conjunction with proper impression material and technique may prove to be a simplified yet accurate method of impression making.

Keywords: Silicone elastomers, Dental occlusion, Viscosity.

INTRODUCTION

Chemically, there are four kinds of elastomers used as impression materials: polysulfide, condensation-polymerizing silicone, addition-polymerizing silicone and polyether. Impression materials of this type are called nonaqueous elastomeric impression materials with ANSI/ADA Specification No. 19[1]. Initially they were named as 'Rubber impression materials', but nowadays with constant research and evolution they are known as 'Nonaqueous elastomeric impression materials[2].

Although polysulfides were the first synthetic elastomeric impression material introduced (1950), the latter three types form the vast majority of elastomeric impressions used worldwide today. Condensation silicones were made available to the dentists in 1955, polyether in 1965 and addition silicones in 1975. Changes in recent years have provided greater choice of consistency and new mixing techniques. Elastomeric impression materials have simplified restorative procedure in

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recent years as compared to inelastic impression materials. Surface detail reproduction of these materials has also been improved in recent years with evolution from reversible hydrocolloid (Agar) to polysulfide, then to condensation silicone and finally to polyether and addition silicone or Vinyl polysiloxane (VPS) impression materials[3].

But for any impression material to be successfully used in dental practice, it must be dimensionally stable over an extended period of time in an acceptable temperature range and most importantly be able to record fine tissue details. Accurate reproduction of the prepared tooth or the edentulous arch is of utmost importance in fabrication of either removable or fixed prosthesis. Inaccuracies in the replication process will have an adverse effect on the fit and function of the final prosthesis[4].

The dual arch impression technique using triple tray can be considered a significant advancement when one or two posterior teeth are prepared to receive indirect restorations[5]. The primary advantage of this technique is that it captures the prepared teeth, the opposing arch and the occlusal relationship of teeth in maximum intercuspation simultaneously. Besides, this technique provides a simple and accurate method for fabricating restorations using the conformative maxillo-mandibular relation [6,7,8]. Since it captures three records at the same time in a single tray, hence the term 'triple tray' is used. This technique also reduces patient discomfort and can reduce gagging. Also, this closed mouth technique of impression making eliminates any mandibular flexure that might be associated with opening[9]. This reduces errors and the need for occlusal adjustment at the stage of cementation. Currently, trays are available in both anterior and posterior design and consist of an outer rim that is spanned by a mesh fabric. Wilson and Werrin advocated that the 'counter impression' (opposing side) should always be poured first, followed by the working side (preparation side) impression; however, there are no references that support these claims[10]. The accuracy of casts generated from this technique remains in question because there is little information available in the literature.

This study was carried out to compare the accuracy of casts obtained by using four elastomeric impression materials [Condensation silicone putty-light body, addition silicone putty-light body, monophase addition silicone and monophase polyether (Table 1)] with dual arch impression trays. It is difficult to remove the impression made in polyether from patient's mouth because of the stiffness of the material. Impregum Soft material has been reformulated with less silica filler to reduce stiffness to facilitate impression removal. In contrast to Polyether, Polyvinylsiloxane is inherently hydrophobic and this is overcome by incorporation of increased amounts of surfactants by the manufacturers. These materials are marketed as hydrophilic or ultrahydrophilic VPS. Vinyl polysiloxane materials have widespread use in dentistry because of their exceptional dimensional stability and ability to record fine tissue details accurately.

AIMS AND OBJECTIVES

The aims and objectives of this study were to compare the accuracy of the casts obtained with triple trays by using elastomeric impression materials, i.e. condensation silicone, addition silicone and polyether in different viscosities.

MATERIALS AND METHODS

A typodont (API, Germany) was mounted in maximum intercuspation on an articulator. The mandibular left first molar was prepared to receive a full cast metal crown, with approximately 1.5 mm occlusal reduction on functional cusps and 1 mm on nonfunctional cusps and with chamfer finish lines approximately 0.5 mm in width placed supragingivally. Notches were placed in the margin buccally and palatally. Tooth preparation was done with the aid of tapered round ended diamond point, torpedo diamond and needle diamond (Shofu Company, Japan). A stereomicroscope (Figure 1) was used to measure the bucco-lingual width of the tooth at the margin. Plastic dual-arch impression trays (Figure 2) were used to make impressions. The light-viscosity condensation silicone impression material was injected around and over the prepared molar. Both sides of triple tray were filled with the heavy body material according to the manufacturer's instructions. Then the tray was placed over the posterior mandibular teeth and the articulator was closed until the unprepared teeth contacted.

Fig 1: Stereomicroscope.

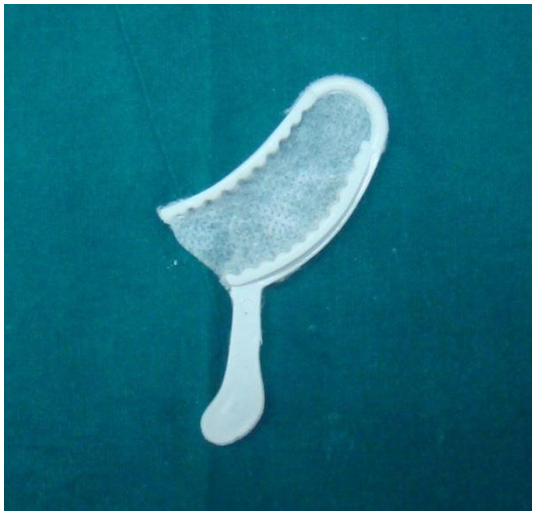

Fig 2: Plastic dual arch impression tray.

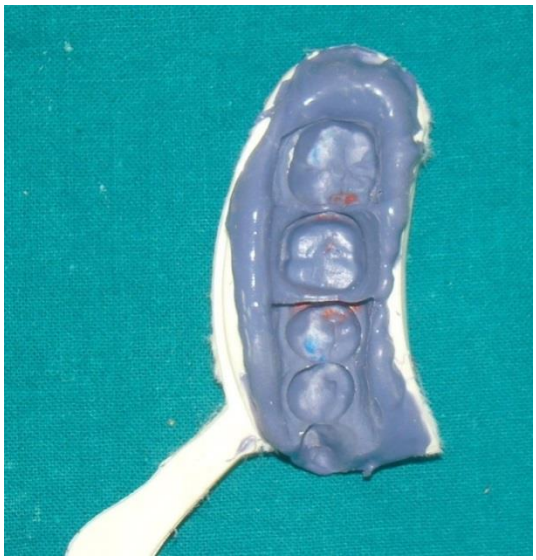

Fig 3: Polyether impression made in dual arch tray.

This was confirmed by the closed position of the guide pin on the articulator table. Elastic bands were used to hold the in maximum intercuspation. The tray was positioned so that the back of the tray did not impinge on the simulated gingiva distal to the 2nd molar. The impression material was allowed to set according to manufacturer's instructions, then it was removed from the typodont. After 30 minutes, the impression was poured in class IV die stone (Kalrock, Kalabhai Karson Pvt. Ltd., Mumbai). Dies were then cut using Pindex system. The opposing arch was not poured in the dual arch impressions. 50 such impressions were made. The addition silicone impression material was also used to make 50 impressions with putty wash single step technique. Then, the monophase VPS material was injected around the tooth and placed in the tray using the same technique previously described. The casts were poured with Type IV gypsum product. The impressions were made with polyether (Figure 3) with similar technique. So a total of 200 samples were prepared for the study. The typodont tooth was measured three times buccolingually at the margins where grooves were prepared and served as the control. The bucco-lingual width of the prepared tooth on each cast was measured 3 times with the stereomicroscope.

The sample size for Group A, B, C and D (Table 2) was 50 each (Total 200). The dimension of the original preparation was compared to the dimension of the dies. The data was subjected to the ANOVA test. The statistical analysis was done and p values were calculated.

RESULTS

The values for bucco-palatal width obtained for each die and typodont using the stereomicroscope were calculated. The mean value for the bucco-palatal width of the prepared tooth at the gingival margin (Mean = 7982.4212 µm) was subtracted from each of the 200 cast measurements.

To compare the accuracy of the impression materials and techniques used, the ANOVA test was done and the mean and standard deviation was calculated. Based on this the 'p' value was derived which showed that monophase polyvinyl siloxane (Mean = 7936.364µm) was more accurate than monophase polyether (Mean = 7829.291µm) (Table

3). Condensation silicone in putty light body produced least accurate dies.

DISCUSSION

The Monophase materials have been formulated with sufficient shear thinning to be used both as low viscosity and high viscosity materials. The monophase addition silicone was found to be more accurate than monophase polyether. According to American Dental Association specification #19, elastomeric impression materials used to fabricate precision castings must be able to reproduce fine detail of 25 µm or less. PVS impression materials are the best in this regard [11]. This specification for gypsum die materials is 50 µm. Most die materials do considerably better than this but fall far short of the impression materials in their ability to reproduce fine detail[12].

Table 1: Showing details of all the products used in the study.

Product	Manufacturer	Type	Viscosity
Speed ex	Coltene whaledent	Condensation silicone	Putty and light body
Aquasil putty & Aquasil LV	Dentsply / Caulk, Milford, DE	Vinylpolysiloxane	Putty and light body
Aquasil Ultra Monophase	Dentsply / Caulk, Milford, DE	Vinylpolysiloxane	Medium
Impregum Soft	3M ESPE, St Paul, MN	Polyether	Medium

Table 2: Showing samples divided into four groups.

Groups	Dies made from impression made in (with dual arch tray)
Group A	Putty and light body Condensation silicone
Group B	Putty and light body Vinylpolysiloxane
Group C	Monophase Vinylpolysiloxane
Group D	Monophase polyether

Table 3: Buccolingual Dimensions of dies at gingival margin using different materials with different techniques.

	Condensation silicone (Putty-light body)	Addition silicone (Putty-light body)	Addition silicone (Monophase)	Polyether (Monophase)
Mean	7364.126	7611.526	7936.364	7829.291
S.D.	63.157	60.303	30.699	41.929
Mean of difference	-618.295	-370.895	-46.057	-153.130
' p' value	4.357E-09	3.432E-07	0.732E-02	1.789E-06
Inference	Highly Significant	Highly Significant	Highly Significant	Highly Significant

The detail reproduction is also affected by the viscosity of the material. In general, higher the viscosity of impression material, poorer is the detail. The putty materials cannot reproduce fine detail at the 25-µm level and are required only to record detail of 75 µm[13]. The greatest drawback with some of putty/wash techniques is that the critical areas of the tooth preparation, including

cervical margins, are usually recorded in putty material as the light viscosity is pushed aside by putty. This makes the gypsum die less accurate. Hence the accuracy of impression with monophase materials is more than that of putty wash single step technique.

These findings are in agreement with the study conducted by Ceyhan J. A. et al[10] who found out that the monophase material, when compared with the rigid impression material, was most accurate for the occlusogingival and mesiodistal dimensions, although not as accurate in the bucco-palatal.

The dies poured from condensation silicone were least accurate because of the poor dimensional stability of the material owing to release of ethyl alcohol as a by-product. VPS materials exhibit superior dimensional stability because they do not release any polymerization by-product. In addition it has some excellent physical properties such as fine elastic recovery, easy manipulation, ability of multiple pours from single impression without distortion and fine detail reproductively[2,4]. Polyether has been shown to be unstable under conditions of high humidity in aqueous solutions. They are hydrophilic in nature and disinfection procedures may affect their physical properties[14].

The dual-arch technique can be used successfully as long as the operator understands the indications and contraindications of the procedure. This technique should not be used with more than two prepared teeth. There is a possibility of nonworking interferences if there is no anterior guidance. The patient should be able to close in maximum intercuspal position with triple tray in mouth and this should be confirmed visually and with Mylar strips. The presence of third molars, a rapidly ascending ramus, or excess soft tissue distal to the molars often prevents complete closure with the tray in place. The double-bite technique should not be used in these patients[12].

The advantages of the dual arch technique include its clinical simplicity and the accurate recording of the maximal intercuspal position. However, the laboratory procedures are little complicated and require some experience on part of laboratory technician.

Dual arch impression techniques represent a significant advancement in fixed prosthodontics and have many advantages over conventional impression techniques in the fabrication of single crowns and fixed partial dentures. The disadvantage of this technique is the absence of the contralateral teeth, which may lead to the incorporation of eccentric occlusal interferences in the final restoration[15].

In a study done by Cox J.R, et al[16] it was found out that the plastic double-arch tray loaded with the putty-viscosity addition silicone and a low-viscosity wash produced the most accurate combination. This study utilized monophase consistency too. Hence direct comparison is not feasible. The same study by Cox J.R. et al compared the effect of the plastic and metal triple trays with the putty impression material, it was found that the plastic tray produced more accurate dies ($p \leq 0.005$) than metal tray. In the present study the monophase addition silicone was found to be more accurate than monophase polyether followed by addition silicone putty and light body impression material combination. The condensation silicone impression on a dual arch tray was least accurate out of four. Measurements made on stone casts are potentially affected not only by the impression material and tray type, but also by the expansion of the dental stone used. In this study, a low-expansion, improved die stone with a reported expansion of 0.10% was used. The limitation of this study was that the impressions were not made in oral environment where saliva would have affected the impression material accuracy and its chemistry of setting.

CONCLUSION

When using plastic triple trays for impression making, Monophase Polyvinysiloxane impression material produced more accurate dies as compared to the monophase polyether impression material. The putty-light viscosity polyvinysiloxane produced the dies that were not as accurate as monophase materials. The least accurate were dies obtained from condensation silicone.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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