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Effect of Impression Trays and Materials on the Accuracy of Open Tray Implant Impressions: An in Vitro Comparative Study

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Abstract:-

Aim: One of the most important steps in achieving passive fit of a prosthesis is making precise impressions. The aim of the present study was to evaluate the accuracy of open tray implant impression made with two different impression trays and impression materials.

Methodology: The study was carried on a simulated acrylic resin model with two implants placed at premolar and molar region. Open tray implant impressions were made using two different impression trays and materials as follows: Group 1: Polyether custom tray impression, Group 2: Polyether stock tray impression, Group 3: Polyvinylsiloxane custom tray impression and Group 4: Polyvinylsiloxane stock tray impression. Total of Forty impressions were made, making ten for each, and all casts were made with type IV die stone. The accuracy was determined by measuring the inter-implant distance from four impression technique study casts using a profile projector. The stone casts' dimensions were compared to the dimensions of the reference model, which served as a control. To evaluate group means, oneway ANOVA was used to analyse the significant difference between the two implant analogues of each group with the reference model, followed by Tukey's post hoc test for multiple comparison procedures.

Results: The results showed the mean deviation from reference model for inter-implant distances for group 1,2,3 & 4 casts were .005 mm, .018 mm, .011 mm, and .026mm, respectively. The four groups that were tested in our study revealed notable variations between them with p-value of 0.005.

Conclusion: The custom tray proved to be more accurate than stock tray impression. Whereas casts produced by polyether impression material were comparable with polyvinyl siloxane impression material.

Keywords:- *Implant, Impressions, Polyether, Polvinylsiloxane, Trays.*

I. INTRODUCTION

Since ancient times, it has been thought that a person's first impression is their appearance, which lasts a long time. The appearance of one's teeth is a crucial aspect of facial beauty[1]. In industrialized nations, established standards for facial and dental appearance are widely accepted and do not vary significantly[2].

In today's dental practice, patients have extremely high expectations. In recent decades, a number of treatment methods have developed in order to meet the needs of patients and reach higher objectives. Dental implants are one such treatment method that has been successful. The treatment options in dentistry have advanced dramatically since Per Ingvar Branemark introduced implants[3]. The various limitations of the conventional prosthetic treatment procedure have been circumvented by the implant treatments[4,5]. The patient's functional issues and psychological requirements have been met perfectly by it[6].

Successful implant treatment depends upon numerous elements namely appropriate diagnosis and treatment planning, properly executed surgical procedures, precise impression making, passively fitting prosthesis, perfect occlusion, and recall maintenance[7,8,9]. One of the cause of implant failure is lack of passive fit of the restoration which causes stress at implant abutment interface resulting in adverse biomechanical problems such as component fatigue failure, peri-implant bone loss, and later osseointegration loss[10,11]. An accurate impression is required to ensure that an implant prosthesis fits properly[12]. Various factors influence impression accuracy, including impression materials, impression trays, impression technique, and impression level (implant or abutment level)[13]. According to various studies, open tray implant level impressions are the preferred impression technique over closed tray and abutment level impressions[14].

The precision of the impression is also impacted by the type of impression tray utilised. Impression trays can generally be divided into two categories: stock trays that are created by the manufacturer in a range of sizes, or custom trays made especially for a patient. In order to avoid fabrication of custom acrylic resin tray and performing an earlier impression with irreversible hydrocolloid, the typical plastic tray is frequently utilised in daily clinical practise[15,16]. Custom resin trays have been used in elastomeric impression techniques because in these trays there is uniform, thickness of 2 to 3 mm impression material which allows uniform shrinkage of material[17].

Impression materials play a pivotal role in the accuracy of impression making. Elastomeric impression materials, particularly addition silicone and polyether, have grown in popularity over the last decade. These materials popularity stems from their excellent physical properties, handling characteristics, and adequate dimensional stability[18]. Because

of its favourable modulus of elasticity, the use of addition silicone as an impression material allows for easy removal once the impression is set[19]. In the late 1960s, polyether impression material was developed for use as a dental impression material. Polyether impression materials are extremely precise and simple to pour with gypsum products with adequate tear strength[20].

Although several studies have performed to evaluate accuracy of impression materials and trays regarding conventional tooth supported prosthesis, literature regarding implant supported prosthesis is still sparse. This study aimed to evaluate the accuracy of implant impression made with two different impression trays and impression materials.

II. MATERIALS AND METHODS

A. Study Design

The present study was conducted in vitro to evaluate the accuracy of open tray implant impression made with different impression trays and impression materials. The study design comprised of forty samples that were divided into four different groups of ten each. Impressions were made on reference mandibular model with two implants placed. Two impression materials namely vinylpolysiloxane and polyether were compared and evaluated. These two groups were further subdivided into four experimental subgroups by comparing two different impression trays: custom trays and stock trays. All the impressions were poured in type IV die stone. The experimental casts were then assessed for accuracy by comparing with the reference model using profile projector.

B. Fabrication of Reference Mandibular Model

A prefabricated rubber mould was used for the fabrication of dentulous wax model with missing teeth at the first premolar, second premolar, first molar and second molar in both sides of each model corresponding to kennedy class I . Using a pressure forming machine, a surgical guide for implant placement was created. A milling machine was used to drill two parallel holes in the mandibular posterior region of the template. Two standard length implants of 11 mm and 3.7 mm in width were placed at predetermined implant positions in a wax model by physio-dispenser and inserted in the prepared sites parallel to each other at the premolar and molar region. By investing the wax models in flasks to make moulds, the wax models were replicated in heat cure resin models using compression moulding technique. In the study, the model served as a reference model (Fig 1).

C. Fabrication of Custom Trays

Wax spacer of total thickness of about 2mm was applied to the reference model and tissue stops (2mm x 2mm) were cut to allow consistent thickness of impression material and prevent over seating of custom tray. An impression of the reference model was made and poured in type IV dental stone. The trays were constructed using the duplicated cast. A layer of autopolymerising PMMA resin was applied uniformly after a layer of separating medium was applied. The trays were kept for 24 hours. Window was created in the region of the implants with a tungsten carbide bur to allow access for the impression coping (Fig 2,3). Separate tray was made for each impression.

D. Preperation of Stock Trays

The most appropriate tray was selected for impression making as they are obtained from the manufacturer. The stock tray is formed of many panels connected to each other particularly made for implant impressions. The panels were removed at the site of impression copings. Then the trays were placed on reference model and checked for interferences (Fig 5)

E. Impression Making

Before impression making, open tray impression copings were attached to the impant fixtures and hand tightened (Fig 2). Complete seating of impression copings were ensured.

The impressions were made using two different impression trays and materials as follows:
Group 1: Polyether custom tray impression
Group 2: Polyether stock tray impression
Group 3: Polyvinylsiloxane custom tray impression
Group 4: Polyvinylsiloxane stock tray impression

Total of Forty impressions were made, making ten for each and all impressions were made by same operator. For groups 1& 2, the polyether tray adhesive was applied to both the trays, custom as well as stock, on the tissue surface and beyond the borders of the trays and allowed to dry for 5 minutes as per manufacturers instructions. Heavy bodied polyther impression material was mixed using automatic dispensing machine and loaded in tray. Light body material was injected around the copings followed by seating of loaded tray. Continuous finger pressure was maintained for 6 minutes. Tray was removed after unscrewing the coping and impression was checked for inaccuracies(Fig 4,6). For groups 3 & 4, Polyvinylsiloxane impressions were made according to the manufacturer’s directions using one-step method of impression making. Before each impression, the impression trays were coated with tray adhesive per the manufacturer's instructions. The impression tray was loaded with heavy consistency polyvinylsiloxane impression material, and the impression coping was meticulously syringed with light consistency polyvinylsiloxane impression material to ensure complete coverage of the coping. The impression tray was lowered over the reference resin model until it was fully seated and held in place during the polymerization time (Fig 7,8).

F. Fabrication of Experimental Casts

The transfer coping was then screwed together with the implant analogue while holding the analogue in place to prevent rotation of the impression coping. Type IV improved die stone was used to make the impression. The die stone was mixed in accordance with the manufacturer's instructions (30ml water and 100 gm powder). The master casts were removed from the impressions after one hour of setting (Fig 9). As a reference, the ADA ANSI 19 elastomeric impression material specification was used. All casts were kept at room temperature for at least 24 hours before being measured. All master casts were inspected for pouring and removal defects. All clinical and laboratory procedures were performed by the same operator to avoid any inter operational error.

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G. Testing of Experimental Casts

Using a profile projector, all the forty experimental casts were measured and examined for linear dimensional accuracy. All of the measurements were taken by the same person. For each cast, five measurements were taken, and mean values were computed. The linear distance between the two implant fixtures was measured with a profile projector capable of measuring 0.001mm at original magnification x 10. The abutments were secured on the implant fixtures on the reference model and experimental casts (Fig 10,11,12). Sharp groove was made on abutment for precise measurement of interim plant distances. Mean and standard deviation values were calculated. The dimensions of the reference model which served as control were compared to those of the experimental casts.

III. RESULTS

The collected data was compiled and entered into a spreadsheet, which was then exported to the data editor of SPSS version 20.0. For intragroup comparison, each set of data was subjected to one way ANOVA, followed by Tukey's post-hoc test for intergroup comparison. The comparison was made using the "p" values obtained from the Anova test. Each technique was evaluated in comparison to the master model. The results showed the mean deviation from reference model for inter-implant distances for group 1,2,3 & 4 casts were .005 mm, .018 mm, .011 mm, and .026mm, respectively (**Table 1, Graph**). Out of the impression techniques compared polyether custom tray impression was closest to master model followed by polyvinylsiloxane custom tray impression. Statistically significant result was obtained only in polyvinylsiloxane stock tray impression. Group comparison is given in Table 2.

Table 1 Mean and Standard deviation of distances between premolar and molar implants of reference model and group 1, 2, 3 and 4 on experimental casts

Models	Mean ± SD (mm)	Difference from Reference Model	P-value	Sig
Reference model	18.590	---	---	---
Group 1: Polyether custom tray impression	18.584 ± 0.0144	.005	.867	NS
Group 2: Polyether stock tray impression	18.571 ± 0.02483	.018	.064	NS
Group 3: Polyvinylsiloxane custom tray impression	18.578 ± 0.01662	.011	.352	NS
Group 4: Polyvinylsiloxane stock tray impression	18.563 ± 0.01748	.026	.049*	S

Graph comparing four group means

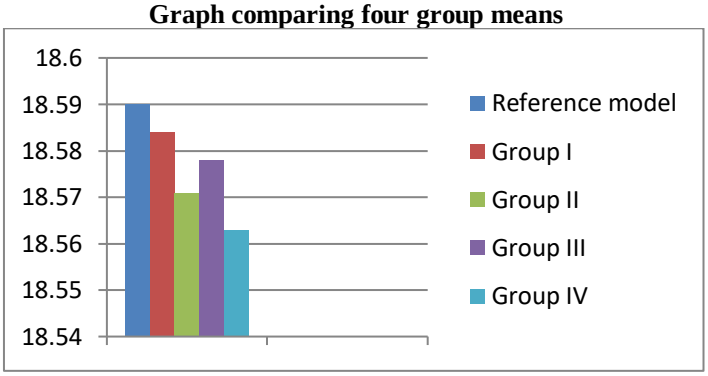

Table 2 Group comparison based on interim plant distance of four different groups when compared with reference model

Models	Inter-implant distance			
	Mean SD	F-value	P-value	Significance
Reference model	18.590	4.214	.005	S
Group 1: Polyether custom tray impression	18.584 ± 0.01440			
Group 2: Polyether stock tray impression	18.571 ± 0.02483			
Group 3: Polyvinylsiloxane custom tray impression	18.578 ± 0.01662			
Group 4: Polyvinylsiloxane stock tray impression	18.563 ± 0.01748			

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IV. DISCUSSION

The results showed the mean deviation from reference model for inter-implant distances for group 1,2,3 & 4 casts were .005 mm, .018 mm, .011 mm, and .026mm, respectively (**Table 1, Graph**). Even under standardized conditions, it was found through comparing the group means of the four different impression techniques that it was impossible to replicate the precise placement of implants in a cast model. The four groups that were tested in our study revealed notable variations between them with p-value of 0.005. Out of four groups, the mean values of polyether custom tray impression showed results more close to reference model with mean value of 18.584mm. This was followed by impression made with polyvinylsiloxane custom tray and polyether stock tray with mean value of 18.578mm & 18.571mm respectively. As found in the result of this study, polyvinylsiloxane stock tray has shown most of the variation compared to the other study groups with the mean value of 18.563 mm. Also statistically significant result have been observed only in group 4.

The casts obtained from polyether impression material were more accurate than polyvinylsiloxane. These findings were similar to study conducted by Del'acqua et al[21], siadat et al[22]. These authors suggested polyether as material of choice for implant impression. Better flow properties along with higher tensile strength make the impression more accurate and predictable. According to the authors, material rigidity prevents displacement of impression copings within the impression material. According to Baig et al[23], the accuracy of the VPES impression material was comparable to that of PE for multi-implant abutment level. Kurtulmus et al[24] and Vojdani et al[25] compared the accuracy of VPS, VPES, and PE impression materials in angulated implants and found no significant differences. Due to elastic recovery, the accuracy of PVS was marginally higher.

In the present study vinypolysiloxane when used with custom tray showed no significant difference and was even superior than polyether stock tray impression. However, when vinypolysiloxane when placed in stock tray showed significant result from reference model. This shows that proper selection of impression tray is equally important to produce clinically acceptable result. In the present study, acrylic custom tray was compared with plastic stock tray. From the results it was inferred that custom trays produced more accurate results than stock trays. Burns et al[26] tested the accuracy of stock and custom trays on open tray implant impressions and discovered that custom trays outperformed stock trays. In their study, Cho and Chee[27] assessed the stiffness and resistance to distortion of six disposable plastic stock trays and a metal stock tray. The reason for accurate result with custom trays can be credited to their excellent adhesion to the impression material, dimension stability, uniform thickness of the impression material, and adequate rigidity to withstand distortion. However, Del'acqua et al[28] found that stock metal trays performed better than plastic, especially when a high viscosity impression material was used. In the present study, stock plastic trays were used, the reason was that in routine clinical practice plastic trays are commonly used because for open tray implant impression it becomes easy to trim the plastic tray rather than metal tray.

Open tray impression technique was chosen over closed tray since it is more accurate as proven by many studies[29]. One limitation of this study is the difference between making impressions in vivo and in vitro. The ability to conduct an in-vivo study under exact environmental conditions is its most significant advantage. To reduce the possibility of error, the sample size can be increased. In our study, a profile projector was used to measure only one dimension; however, more parameters (three dimensional variations such as Yaxis, and Zaxis) are required to investigate significant differences between groups.

V. CONCLUSION

Within the scope of this study, it is possible to conclude that polyether custom tray and polyvinylsiloxane custom tray impressions outperformed respective stock tray impressions. However, polyether impression material outperformed polyvinylsiloxane material slightly more.

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Fig 1. Reference Mandibular Model

Fig 2. Impression copings attached on Model

Fig 3. Custom Tray

Fig 4. Polyether custom tray impression

Fig 5. Stock Tray

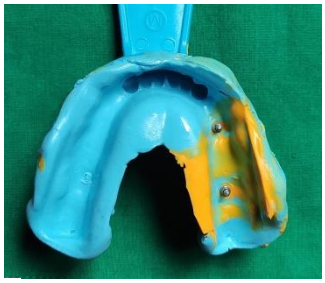

Fig 6. Polyether stock tray impression

Fig 7. Polyvinylsiloxane custom tray impression

Fig 8. Polyvinylsiloxane stock tray impression

Fig 9. Cast obtained

Fig 10. Abutments attached on reference model for measurement

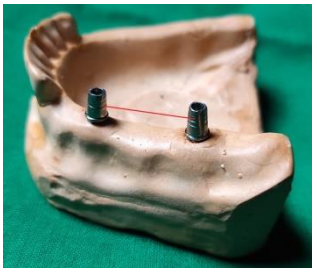

Fig 11. Abutments attached on study casts for measurement

Fig 12. Profile projector for measurement of interimplant distance