



Tam Dişsiz Hastaların İmplantüstü Protezlerle Rehabilitasyonunda Kullanılan Geleneksel Ölçü Maddelerinin Boyutsal Stabilitesinin Değerlendirilmesi Dimensional Accuracy of Conventional Impression Materials on Full-Arch Implant Impression

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ABSTRACT

Objective: The purpose of this in vitro study was to compare conventional impression materials for close tray implant impressions of maxillary full arch with 5 implants. **Material and Method:** The edentulous maxilla model and custom impression trays were fabricated from auto-polymerizing acrylic resin. 5 implant analogs (Moment Dental Implant Systems, Turkey) representing implants were placed in the midline on the edentulous maxilla model, on both sides canine and first molar region. The study consisted of 4 groups (n=10). Study groups were as follows: group C1 polyvinyl siloxane (Elite HD+ Tray Material; Zhermack Italy); C2 polyvinyl siloxane (Hydrorise Implant Heavy&Light NS; Zhermack, Italy); C3 condensation silicone (Zetaplus Putty and Oranwash L; Zhermack, Italy) and C4 polyether (3M ESPE (Soft) Monophase, USA). Conventional impressions were performed with custom-made close trays and casts were made by type IV dental stone. Casts were scanned with the laboratory-type scanner. Whether the data of four separate groups showed a normal distribution was analyzed at the significance level (p = 0.05) using one-way ANOVA analysis using the SPSS 27 program. **Results:** As a result of the ANOVA analysis, a statistically significant difference was found between the groups (p<0.05). According to the Tukey HSD multiple comparison test results, a statistically significant difference was found between the C4 group and the other groups. The dimensional stability of the Polyether material constituting the C4 group was found to be higher than that of the other groups. **Conclusion:** Polyvinyl siloxane impression material provides reliable results for impressions of implant-supported prostheses. Rigidity and polymerization shrinkage are thought to reduce the accuracy of polyether impression material.

Keywords: Dental implant, conventional impression materials, dimensional accuracy

ÖZ

Amaç: Bu çalışmanın amacı, dişsiz üst çene arkına yerleştirilen 5 implantın kapalı ölçü kaşığıyla alınan ölçülerde ölçü maddesinin ölçü doğruluğuna etkisini değerlendirmektir. **Materyal ve Metod:** Dişsiz üst çene arka ve ölçü kaşıkları otopolimerizan akrilik reçineden üretilmiştir. İmplantları temsil eden analoglar dişsiz üst çene modelinde orta hatta, her iki tarafta kanin bölgesine ve birinci molar bölgelerine yerleştirilmiştir. Çalışma 4 gruptan oluşmaktadır (n=10). Çalışma grupları şu şekildedir: grup C1 polivinil siloksan (Elite HD+ Tepsi Malzemesi; Zhermack İtalya); C2 polivinil siloksan (Hydrorise Implant Heavy&Light NS; Zhermack, İtalya); C3 kondensasyon silikonu (Zetaplus Putty ve Oranwash L; Zhermack, İtalya) ve C4 polieter (3M ESPE (Soft) Monophase, ABD). Geleneksel ölçüler bu çalışma için hazırlanan bireysel kaşıklarla alınmış ve tip4 alçıdan modeller elde edilmiştir. Bu modeller laboratuvar tipi tarayıcıyla taranmış ve ölçümler yapılmıştır. Ölçümler SPSS 27 programı kullanılarak tek yönlü ANOVA analizine tabi tutulmuştur (p=0,05). **Bulgular:** ANOVA analizi sonucunda gruplar arasında istatistiksel olarak anlamlı fark bulunmuştur (p<0,05). Tukey HSD çoklu karşılaştırma testi sonuçlarına göre C4 grubu ile diğer gruplar arasında istatistiksel olarak anlamlı farklılık tespit edilmiştir. C4 grubunu oluşturan Polyether materyalinin boyutsal stabilitesi diğer gruplara göre daha yüksek bulunmuştur. **Sonuç:** Polivinil siloksan ölçü malzemesi, implant destekli protezlerin ölçüleri için güvenilir sonuçlar sağlar. Sertlik ve polimerizasyon büzülmesinin polieter ölçü malzemesinin doğruluğunu azalttığı düşünülmektedir.

Anahtar Kelimeler: Dental implant, geleneksel ölçü maddeleri, boyutsal stabilite ve doğruluk

INTRODUCTION

Implant-supported prosthetic restorations are a commonly preferred treatment option for the rehabilitation of partially and completely edentulous patients. (1,2). For the success of implant-supported prosthetic restorations, they must provide the most achievable passive fit (3) for the success of implant-supported prosthesis (4). Optimizing the passive fit of implant-supported prosthesis reduces the biological and mechanical complications by minimizing stresses of the implants, bone, and prosthesis interfaces (4,5). On the other hand, lack of passivity may lead to screw loosening, fracture of the screw or other implant components, and occlusal disharmony (3).

Therefore, the most important step to achieve passive fit is the accurately transfer a copy of the three-dimensional implant position and angulation to the cast by digital or conventional implant impression (6). Impression technique, type of the tray, physical properties of the impression materials such as dimensional disparities, splinting of impression copings, number and angle of implants, depth of implants, and the experience of dentist affect the accuracy of implant impression (3). The type of impression material is a very important factor affecting the accuracy of impressions (7). The conventional physical impression with trays and materials (alginate, silicone, polyether) is still being widely used in many cases (8). The impression material chosen must have sufficient hardness to prevent movement of the impression copings (9). Therefore, polyvinylsiloxane, vinylsiloxanether, polyether, and condensation silicone are considered the choice implant impression materials (10). Polyvinyl siloxane (addition silicone) impression material is one of the most preferred impression materials in prosthetic dentistry due to its excellent properties. Impression made from polyvinyl siloxane reflects the details well and its tear resistance is high (8). Since polyether is a hydrophilic impression material, it can also be used in a moist environment in the mouth. With this feature and good wetting, it is easy to produce cast models. In the past, polyether materials on the market were harder, but those currently on the market are more flexible and can be easily removed from the mouth (8). Polyether presents dimensional stability, rigidity, and tear resistance; while polyvinyl siloxane presents higher dimensional stability and better hydrophilicity (7).

The aim of the current study was to compare the accuracy of conventional impressions of the maxillary full arch implants. The null hypothesis was that the type of impression material would not affect the dimensional accuracy of full arch implant impressions.

MATERIAL and METHOD

The edentulous maxilla model and custom impression trays were fabricated from auto-polymerizing acrylic resin for this in-vitro study. 5 implant analogs (Moment Dental Implant Systems, Turkey) representing implants were placed in the midline on the edentulous maxilla model, on both sides canine and first molar region. The conical impression copings were fastened to the analogs and torqued at 12 N/cm for standardization (Fig 1).



Figure 1. Master model and fastened impression copings

This in vitro study consisted of 4 groups of 10 for each specimen (Table 1). Study groups were as follows: group C1 polyvinyl siloxane (Elite HD+ Tray Material; Zhermack Italy); C2 polyvinyl siloxane (Hydrorise Implant Heavy&Light NS; Zhermack, Italy); C3 condensation silicone (Zetaplus Putty and Oranwash L; Zhermack, Italy) and C4 polyether (3M ESPE (Soft) Monophase, USA).

Table 1. Study Groups

Group	Material	Brand
C1	Polyvinyl siloxane	Elite HD+ Tray Material; Zhermack Italy
C2	Polyvinyl siloxane	Hydrorise Implant Heavy&Light NS; Zhermack, Italy
C3	Condensation silicone	ZetaplusPutty and Oranwash L; Zhermack, Italy
C4	Polyether	3M ESPE (Soft) Monophase, USA

Ten impressions of a master model were performed for each group (n=10). Impression materials were mixed by an auto-mixing cartridge and all impressions were performed in a temperature-controlled environment ($23 \pm 1^\circ\text{C}$) according to specification number 19 of ADA. 6 minutes was the waiting time for the polymerization of the impression material. After the polymerization of the impression material, custom impression trays were removed from the maxilla model. Then transfer impression copings were removed from the maxilla model and fastened to the implant analogs. Analog and impression coping units were inserted in the custom impression trays. After impression protocols, casts were made from type IV dental stones (Herostonel Vigodent Inc., Rio de Janeiro, RJ, Brazil). According to the manufacturer's instructions, the powder/water ratio was 30 g/7 mL, and the dental stone was vacuum mixed. 120 minutes was the waiting time for pouring then the impression was separated from the cast. These laboratory procedures were repeated for each impression and all procedures were performed by the same operator. All casts were scanned with the laboratory-type scanner (D15; Camcube, Montreal, Canada). Scanning data were transferred to the measurement program (UP3D Manager) to assess and compare inter-implant distance deviation (Fig 2).

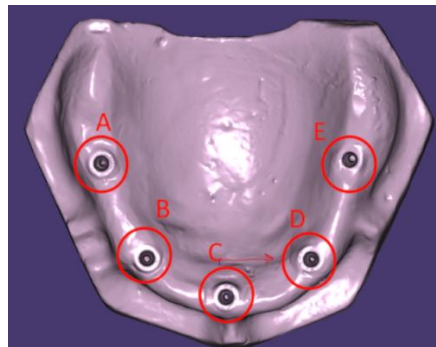


Figure 2. Digitalized master model for measurements

Statistical Analysis

The dimensional stability values of impression materials used in the treatment of completely edentulous patients with implant-supported prostheses were statistically evaluated. Analyses were performed using the SPSS 27 statistical package program. One-way ANOVA analysis was applied to determine the difference between the groups (Table 2-3).

Table 2. Normality test results for the groups. The suitability of the groups for normal distribution was evaluated using the Kolmogorov–Smirnov and Shapiro–Wilk tests. A p-value of > 0.05 was found in all groups, indicating that the data conformed to a normal distribution.

Group	Kolmogorov-Smirnov	df	p	Shapiro-Wilk	df	p
C1	.235	10	.123	.849	10	.056
C2	.240	10	.109	.879	10	.127
C3	.251	10	.111	.717	10	.129
C4	.221	10	.181	.883	10	.141

Table 3. Homogeneity of variance between groups was assessed using the Levene test. $p > 0.05$ indicates that the variances are homogeneously distributed.

Levene Statistic	df1	df2	p
.894	3	36	.454
.681	3	36	.569
.681	3	31.148	.570
.904	3	36	.449

RESULTS

As a result of the ANOVA analysis, a statistically significant difference was found between the groups ($p < 0.05$). According to the Tukey HSD multiple comparison test results, a statistically significant difference was found between the C4 group and the other groups. The dimensional stability of the Polyether material constituting the C4 group was found to be higher than that of the other groups (Table 4-5).

Table 4. One-way ANOVA results for intergroup comparison.

Source	Sum of Squares	df	F	p
Between Groups	59093.900	3	1.288	.029
Intragroups	550352.000	36		
Total	609445.900	39		

Table 5. A Tukey HSD post-hoc test was applied to determine which groups were responsible for the differences between the groups. According to the analysis results, a statistically significant difference was found between group C4 and the other groups (C1, C2, and C3).

Group	N	Average Subgroup
C1	10	-102.8000
C2	10	-53.4000
C3	10	-45.2000
C4	10	5.6000

DISCUSSION and CONCLUSION

The null hypothesis was rejected that the type of impression material would not affect the dimensional accuracy of full arch implant impressions. According to the results, the highest deformation values were found in the polyether group.

To achieve the passive fit in implant-supported prostheses, implant positions must be transferred to the master model by accurate impression (9). In order to have accurate impression, it is important to use highly sensitive impression material. In the present study, the effect of different impression materials was evaluated for maxillary full-arch implants. Implants were placed parallel to each other. Angulated implants were not evaluated in this study.

According to previous research, there is no difference found in accuracy between polyvinyl siloxane and polyether for full arch implant impression (11). According to another study, polyether impression material gave the most accurate results for completely edentulous multiple-implant restorations. Also, high-consistency polyvinyl siloxane and medium-consistency polysulfide materials could be considered use for implant impressions (9).

Polyether materials, the first highly accurate impression material introduced into clinical practice, are preferred in implant impressions because of mechanical properties such as stability and

hydrophilicity. However, polyvinyl siloxane impression material has also developed in recent years. The performance superiority of polyether and polyvinyl siloxane materials has not yet been proven. Some studies have found that the accuracy of polyvinyl siloxane impression material is higher. In a study using the same small plastic tray (Size Small, Hi-Tray; ZhermackSpA) for all impressions to standardize the amount of impression material and reduce polymerization shrinkage of the polyether, polyvinyl siloxane impression material showed higher accuracy than polyether. In this study, it was thought that the long hardening time, rigidity, and polymerization shrinkage of the polyether negatively affected its performance. Hydorise Implant, monophasic (medium body) polyvinyl siloxane, 2-phase (light body+ heavy body) polyvinyl siloxane impression materials showed higher accuracy than polyether, just like in this study. Higher viscosity impression materials are thought to stabilize the impression copings and provide a more accurate result, but their disadvantage is their limited ability to reproduce fine details. They cannot flow well around the transfer copings and these areas remain incomplete. This may reduce the accuracy of implant impression if a technique without splinting is used (12).

The main limitation of this study is that it was conducted under in vitro conditions (13). The presence of saliva, blood, and gingival crevicular fluid in the mouth affects the accuracy of the impression. These conditions cannot be simulated in vitro environment.

Additionally, in this study, the implants were placed parallel, and the angled implant impression was not simulated. The length and geometry of the scan bodies used are standardized and titanium scan bodies were used because they are resistant to deformation (14).

Apart from this, many factors such as shrinkage of impression materials, impression technique, expansion of plaster, and plaster pouring technique may affect the result of this study. Some deviation may occur at every stage in obtaining conventional casts produced from impression materials. Additionally, the clinician's experience is also very. In this study, all experiments were carried out by a single operator (15,16). Further studies are needed to support the current findings.

According to findings obtained from this in-vitro study, polyvinyl siloxane impression material provides reliable results for impressions of implant-supported prostheses. Rigidity and polymerization shrinkage are thought to reduce the accuracy of polyether impression material.

DECLARATION of ETHICAL CODE

In this study, we undertake that all the rules required to be followed within the scope of the "Higher Education Institutions Scientific Research and Publication Ethics Directive" are complied with, and that none of the actions stated under the heading "Actions Against Scientific Research and Publication Ethics" are not carried out.

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