doi: 10.30934/kusbed.744376 **e-ISSN:** 2149-8571

Kocaeli Üniversitesi Sağlık Bilimleri Dergisi

Özgün Araştırma / Original Article

http://dergipark.gov.tr/kusbed

THE EFFECT OF POURING TIME ON DIMENSIONAL ACCURACY OF POLYVINYL SILOXANE IMPRESSION MATERIALS

MODEL ELDE ETME SÜRESİNİN POLİVİNİL SİLOKSAN ÖLÇÜ MALZEMELERİNİN BOYUTSAL DOĞRULUĞU ÜZERİNE ETKİSİ

Hilal Ekşi Özsoy[1*], Lamia Najafova[2], Hayal Boyacıoğlu[3], Hüseyin Kurtulmuş[2]

[1]Beykent University, Faculty of Dentistry, Department of Prosthodontics, İstanbul, Turkey, [2]Aydın University, Faculty of Dentistry, Department of Prosthodontics, İstanbul, Turkey, [3]Ege University, Department of Statistics, İzmir, Turkey

ORCID iD: Hilal Ekşi Özsoy: 0000-0003-2061-9081; Lamia Najafova: 0000-0003-2164-7818; Hayal Boyacıoğlu: 0000-0003-0887-0302; Hüseyin Kurtulmuş: 0000-0001-5013-3766

***Sorumlu Yazar / Corresponding Author:** Hilal Ekşi Özsoy, **e-posta / e-mail:** hilaleksi@gmail.com

Geliş Tarihi / Received: 28.05.2020 **Kabul Tarihi / Accepted:** 23.12.2020 **Yayım Tarihi / Published:** 05.01.2021

Abstract

Objective: The aim of this study was to evaluate of the dimensional accuracy of Polyvinylsiloxane (PVS) impression materials (Spirias, Imicryl, Konya, Turkey and Variotime, Heraeus, Hanau, Germany) by using stone models after different pouring time (1 hour and 24 hours).
Methods: A standard maxillary dentulous acrylic model was selected as master model. Two linear measurements were selected on each sample for the evaluation of the models (x: 13-23 distance, y: 13-26 distance). A total of 40 samples were divided into 4 groups according to the impression brands and pouring time (n=10). All of measurements were made with CEREC SW 4.2.3 software (Sirona Dental System, GmbH, Bensheim, Germany) using "distance" tools of the programme. Statistical analysis was performed by using the IBM SPSS Statistics, Version 25 (IBM SPSS Statistics for Windows, IBM Corporation, Armonk, NY). A value of $p<0.05$ was considered statistically significant.
Results: The relationship between different pouring times (1 hour and 24 hours) was not statistically significant ($p>0.05$). When the paired relations with the master model are evaluated, t test and p values show that there is statistically significant difference ($p<0.05$).
Conclusion: When compared with the main model, PVS materials for both brands show dimensional distortion. For PVS impression materials, the pouring of the impressions does not make any difference.

Keywords: *Impression materials, polyvinylsiloxane, dimensional accuracy*

Öz

Amaç: Bu çalışmanın amacı, Polivinilsiloksan (PVS) ölçü malzemelerinin (Spirias, Imicryl, Konya, Türkiye ve Variotime, Heraeus, Hanau, Almanya) farklı döküm sürelerinden sonra (1 saat ve 24 saat) alçı modeller kullanılarak boyutsal doğruluğunun değerlendirilmesidir.
Yöntem: Ana model olarak standart maksiller akrilik model seçildi. Modellerin değerlendirilmesi için her numune üzerinde x ve y mesafesi adıyla iki lineer ölçüm noktası belirlendi (x: 13-23 nolu dişler arası mesafe, y: 13-26 nolu dişler arası mesafe). Ölçü markalarına ve dökme süresine göre toplam 40 örnek 4 gruba ayrıldı (n=10). Tüm ölçümler "mesafe" araçları kullanılarak CEREC SW 4.2.3 (Sirona Dental System, GmbH, Bensheim, Germany) yazılımı ile yapıldı. İstatistiksel analiz, IBM SPSS Statistics, Sürüm 25 (Windows için IBM SPSS Statistics, IBM Corporation, Armonk, NY) kullanılarak gerçekleştirildi. $p<0,05$ değeri istatistiksel olarak anlamlı kabul edilmiştir.
Bulgular: Farklı dökme süreleri (1 saat ve 24 saat) arasındaki ilişki istatistiksel olarak anlamlı bulunamamıştır ($p>0,05$). Ana model ile eşleştirilmiş markaların ilişkileri değerlendiriliğinde, t testi ve p değerleri istatistiksel olarak anlamlı bir fark olduğu gösterilmiştir ($p<0,05$).
Sonuç: Ana modelle karşılaştırıldığında, her iki marka için PVS malzemeleri boyutsal değişim göstermektedir. Ancak bu değişim PVS ölçü malzemeleri için, alçı modellerin dökülme süreleri arasında herhangi bir fark yaratmamaktadır.

Anahtar Kelimeler: *Ölçü malzemeleri, polivinil siloksan, boyutsal stabilite*

Bu eser, Creative Commons Atıf-GayriTicari 4.0 Uluslararası Lisansı ile lisanslanmıştır. Telif Hakkı © 2020 Kocaeli Üniversitesi Sağlık Bilimleri Enstitüsü

Introduction

The main part of prosthetic dentistry is to copy the condition of the teeth and the surrounding tissues by using impressions materials. It must provide precise information for indirect restorations for an impression to be acceptable.[1] Although a successful dental prosthesis depends on many factors associated with dentist, material and patient, the impression is the most critical step.[2] Making impression is a critical clinical step to record accurately the three-dimensional intraoral relationships among teeth, and surrounding structures.[3] The main reason for laboratory errors that lead to incompatibility in indirect restorations is the inaccuracies that occur during the impressions.[4] Many factors such as the experience and skill of clinicians, proper material handling, the choice of impression materials and technique, working time, and the patient's combined compliance affect the acceptable impression.[5-7]

Polyvinyl siloxane (PVS), in other words, additional silicone impression materials were first introduced to the market in the 1970s. Now PVS is one of the most widely used impression materials for indirect prosthetic restorations in dentistry.[8] They have many advantages, such as low polymerization shrinkage, virtually ideal dimensional stability and durability, good detail reproduction, non-toxic or non-allergic behavior, adequate tear resistance and quick elastic recovery.[9,10]

The good performance in their stability makes it possible to pour the molds up to several days after they have been removed from the mouth. PVS is the best choice among elastic impression materials if there is likely to be a delay in pouring to make molds.[11] Innovations in PVS impression materials aim to enhance precision and limit some clinical handicaps such as bubbles, voids, tears, and pulls.[12] On the other hand, PVS are inherently hydrophobic and because of their hydrophobic behavior, their applications are limited to dry conditions. Nowadays, the new formulation 'hydrophilic' polyvinyl siloxanes have been produced which can better penetrate moist dental surfaces.[8,13]

PVS impression materials can be used in several techniques in accordance with the manufacturer's recommendations,[7,14] taking into account their viscosities: dual-viscosity one-step impression technique, the single-viscosity monophase impression technique, and the putty-wash two-step impression technique.[15-18]

The purpose of this study was to evaluate the dimensional accuracy of Polyvinyl siloxane impression materials (Spirias, Imicryl, Konya, Turkey and Variotime, Heraeus, Hanau, Germany) using stone models after different pouring time. The research hypothesis is that pouring time after 1 hour and 24 hours will change dimensional accuracy.

Methods

A standard maxillary dentulous acrylic model (Integra, Ankara, Turkey) was selected as master model. The teeth left canine (13), right canine (23) and right first molar (26) were performed according to accepted universal guidelines for tooth preparation (15). The position of the preparation finish line located epigingival. The peak of teeth number of 13 and 23 and the peak of the mesiobuccally tubercle of the teeth number of 26 were marked with a very small rond bur. In this way, it has been ensured that this point is certain in the models obtained.

As control groups, Variotime (Heraeus, Hanau, Germany) was selected as PVS impression materials. In tested groups, a novel PVS impression material (Spirias, Imicryl, Konya, Turkey) was used. The viscosity of the new PVS brand Type 3 Extra Light Body Spirias (rheometer, at shear stress of 100 Pa) is 10 PaS. Sharp fin test and Consisstency test results are 16 mm and 42-45mm respectively (ISO 4823 Consistency test).

A total of 40 samples were divided into groups according to pouring time and the impression technique recommended by the manufacturer:

- Group I: n = 20 (Variotime / one-step technique)
- Group Ia: 10 samples made using Variotime putty-light body / pouring time:1 hour,
- Group Ib: 10 samples made using Variotime putty-light body / pouring time:24 hours.
- Group II: n = 20 (Spirias / two-step technique)
- Group IIa: 10 samples made using Spirias putty-extra light body / pouring time:1 hour,
- Group IIb: 10 samples made using Spirias putty-extra light body / pouring time: 24 hours.

The stock trays were used for impressions of all groups. For standardization of impression loading, a square metal plate weighting 1.5 kg was placed on the impression trays. The storage time for the impressions was 1 hour and 24 hours before pouring into type IV-improved stone. The ratio of water powder according to instruction is 25ml water to 100ml powder mixed by vacuum mixer (Renfert, GmbH, Hilzingen, Germany) for one minute. The impressions were stored at the room temperature.

Two different linear measurements were selected on each sample for the evaluation of the models:

x: 13-23 distance

y: 13-26 distance

All of measurements were made with CEREC Omnicam CAD/CAM System (Sirona Dental System, GmbH, Bensheim, Germany). After the stone models were scaned with application using CEREC SW 4.2.3 software, linear points were determined and measured using “distance” tools of the programme as shown in Figure 1.

Descriptive statistics were calculated for data sets. The independent samples t test and paired sample t test were used to compare the means between two groups. Statistical analysis was performed using the IBM SPSS Statistics for Windows, Version 25 (IBM SPSS Statistics for Windows, IBM Corporation, Armonk, NY). A value of $p < 0.05$ was considered statistically significant.

Results

Table 1 showed that if the average values of all groups were examined, they showed smaller values than the dimensions of the master model. If the paired relations with the master model are evaluated, t test and p values show that there is statistically significant difference.

According to the independent sample t test analysis, the different brands showed statistically significant difference:

The difference between GI-x (Variotime/1hour/13-23 distance) and GII-x (Spirias/1hour/13-23 distance) is statistically significant $p = 0.009$ ($p < 0.05$)

The difference between GI-y (Variotime/1hour/13-26 distance) and GII-y (Spirias/1hour/13-26 distance) is statistically significant $p = 0.002$ ($p < 0.05$) (Table 2).

The relationship between different pouring times of the same brand was not statistically significant. Correlations (correlations) were analyzed by Pearson correlation analysis. (Table 3) In models obtained with variotime, there was no difference between 1 hour and 24 hour pouring times. The same is true for models obtained with Spirias.

Table 1. Case summaries

	Group I-X	Group I-Y	Group II-X	Group II-Y	Master Model-X	Master Model-Y
Mean	34.65	47.91	34.53	47.63	34.92	48.20
Median	34.66	47.92	34.46	47.56	34.87	48.15
Minimum	34.38	47.47	34.31	46.71	34.7	47.91
Maximum	34.81	48.31	34.96	48.23	35.19	48.52
Std. Error of Mean	.02552	.04246	.03631	.07081	.05437	.07169
Std. Deviation	.11413	.18990	.16239	.31665	.17193	.22669
Kurtosis	1.629	.877	1.034	2.952	-139.631	-155.445
Skewness	-1.227	-.065	1.075	-.825	.37571	.13063

Group I-x: Variotime / one-step technique, 13-23 distance
Group I-y: Variotime / one-step technique, 13-26 distance
Group II-x: Spirias / two-step technique, 13-23 distance
Group II-y: Spirias / two-step technique, 13-26 distance

Table 2. Comparison of linear measurements of two brands PVS impression materials.

Independent Samples Test									
	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	*p**	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Group I – Group II (X)	3.242	.080	2.738	38	**.009***	.12150	.04438	.03165	.21135
Group I – Group II (Y)	2.964	.093	3.397	38	**.002***	.28050	.08256	.11336	.44764

*p< 0.05
Group I: Variotime / one-step technique
Group II: Spirias / two-step technique
x: 13-23 distance
y: 13-26 distance

Table 3. Paired comparisons within the same brand according to the pouring time.

Groups	N	Correlation	*P**
Group Ia & Group Ib (X)	10	.517	.126
Group Ia & Group Ib (Y)	10	.107	.769
Group IIa & Group IIb (X)	10	-.310	.384
Group IIa & Group IIb (Y)	10	.189	.601

*$p < 0.05$
Group Ia: Variotime / one-step technique, pouring time:1 hour
Group Ib: Variotime / one-step technique, pouring time:24 hours
Group IIa: Spirias / two-step technique, pouring time:1 hour
Group IIb: Spirias / two-step technique, pouring time:24 hours
x: 13-23 distance
y: 13-26 distance

Figure 1. Sample measurements of the stone models and master model.

Discussion

The research hypothesis was rejected because of the pouring time of PVS impressions 1 hour and 24 hours did not make any difference. The ideal impression material should have high dimensional stability, which is critical for the correct replication of intraoral structures. Polyvinylsiloxane has been used as impression materials for many years and has gained popularity due to its excellent accuracy and dimensional stability.[9] Pereira et al. found that the dimensional stability of the additive silicone did not change significantly even after 96 hours after measurement (linear size changes did not exceed 1%).[16] These results are consistent with previous researchers' previous work.[17] In this study, the precision of two measurement techniques was investigated using two different brands of additional silicone materials. Out of the two addition silicone impression materials, Variotime and Spirias showed the minimal dimensional changes.

According to a study by Franco and his friends, the delay in pouring will allow the material to heal elastically and release by-products that can affect the accuracy of the stone models, but the delay time should not be too long, otherwise there will be the impression of deterioration.[18] In our the current study, when the spill times were compared, there was no difference.

According to the literature, the one-step technique with vinyl polysiloxanes leads to very accurate impressions.18 The one-step technique is quite simple, cost-effective, less time consuming and protects the impression material. However, this technique has several disadvantages. First, there is absolutely no stack control. With this technique, more bubbles are produced and included in the set impression. In this study, single stage Variotime impression compared to double stage Spirias impression. The both techniques and brands showed that dimensional distortion compared to the master model.

The working time and the patients' adaptation and comfort, may influence the accuracy of an impression.[1] In this study, impressions were taken using an acrylic model. These limitations may have contributed to bias in the study.

Conclusion

The following conclusions were reached in this study:

1. Compared with the main model, PVS materials for both brands (Spirias and Variotime) showed dimensional distortion.
2. For PVS impression materials, the pouring of the impressions does not make any difference after different times.

For more precise results, many new studies were needed on different PVS impression materials, different techniques and different pouring times.

Acknowledgments

The authors thank to Spirias, Imicryl, Konya, Turkey for material support of this study.

Conflict of Interest

No conflicts of interests to disclose.

Author Contributions

HEO: collected data and contributed data; HB: performed analysis; LN: conducted and designed the research; HEO and HK: wrote the manuscript; All authors: read the manuscript.

References

1. Dogan S, Schwedhelm ER, Heindl H, et al. Clinical efficacy of polyvinyl siloxane impression materials using the one-step two-viscosity impression technique. *J Prosthet Dent* 2015;114(2):217–22. doi:10.1016/j.prosdent.2015.03.019
2. Garg S, Kumar S, Jain S, et al. Comparison of dimensional accuracy of stone models fabricated by three different impression techniques using two brands of polyvinyl siloxane impression materials. *J Contemp Dent Pract*. 2019;20(8):928–34. doi:10.5005/jp-journals-10024-2629

3. Conrad HJ, Pesun IJ, DeLong R, et al. Accuracy of two impression techniques with angulated implants. *J Prosthet Dent*. 2007;97(6):349–56. doi:10.1016/S0022-3913(07)60023-7
4. Lee H, Ercoli C, Funkenbusch PD, et al. Effect of subgingival depth of implant placement on the dimensional accuracy of the implant impression: An in vitro study. *J Prosthet Dent*. 2008;99(2):107–13. doi:10.1016/S0022-3913(08)60026-8.
5. Caputi S, Varvara G. Dimensional accuracy of resultant casts made by a monophase, one-step and two-step, and a novel two-step putty/light-body impression technique: An in vitro study. *J Prosthet Dent*. 2008;99(4):274–81. doi:10.1016/S0022-3913(08)60061-X
6. Raigrodski AJ, Dogan S, Mancl LA, et al. A Clinical Comparison of Two Vinyl Polysiloxane Impression Materials Using the One-Step Technique. *J Prosthet Dent* 2009;102(3):179–86. doi:10.1016/S0022-3913(09)60143-8.
7. Levartovsky S, Zalis M, Pilo R, et al. The effect of one-step vs. two-step impression techniques on long-term accuracy and dimensional stability when the finish line is within the gingival sulcular area. *J Prosthodont*. 2014;23(2):124–33. doi:10.1111/jopr.12062
8. Chee WWL, Donovan TE. Polyvinyl siloxane impression materials: A review of properties and techniques. *J Prosthet Dent*. 1992;68(5):728–32. doi:10.1016/0022-3913(92)90192-d
9. Clancy JMS, Scandrett FR, Ettinger RL. Long-term dimensional stability of three current elastomers. *J Oral Rehabil*. 1983;10(4):325–33. doi:10.1111/j.1365-2842.1983.tb00127.x
10. Lacy AM, Fukui H, Bellman T, et al. Time-dependent accuracy of elastomer impression materials. Part II: Polyether, polysulfides, and polyvinylsiloxane. *J Prosthet Dent*. 1981;45(3):329–33. doi:10.1016/0022-3913(81)90400-5
11. Hung SH, Purk JH, Tira DE, et al. Accuracy of one-step versus two-step putty wash addition silicone impression technique. *J Prosthet Dent*. 1992;67(5):583–9. doi:10.1016/0022-3913(92)90151-y
12. Leão MP, Pinto CP, Sponchiado AP, et al. Dimensional stability of a novel polyvinyl siloxane impression technique. *Brazilian J Oral Sci*. 2014;13(2):118–23. doi:10.1590/1677-3225v13n2a08
13. Donovan TE, Chee WWL. A review of contemporary impression materials and techniques. *Dent Clin North Am*. 2004;48(2):445–70. doi:10.1016/j.cden.2003.12.014
14. Ozsoy HE, Najafova, L, Kurtulmus H. Quality of impressions using two different brands of polyvinyl siloxane impression materials. *Sanamed*. 2020;15(2):111–114. doi:http://dx.doi.org/10.24125/sanamed.v15i2.409
15. Shillingburg, H.T., Hobo, S., Whitsett, L.D., et al. (1997) Fundamentals of fixed prosthodontics, 3rd Edition, Quintessence, Chicago, 185.
16. Pereira JR, Murata KY, do Valle AL, et al. Linear dimensional changes in plaster die models using different elastomeric materials. *Braz Oral Res*. 2010;24(3):336–41. doi:10.1590/s1806-83242010000300013
17. Franco EB, Da Cunha LF, Benetti AR. Effect of storage period on the accuracy of elastomeric impressions. *J Appl Oral Sci*. 2007;15(3):195–8. doi:10.1590/s1678-77572007000300008
18. Franco EB, da Cunha LF, Herrera FS, et al. Accuracy of Single-Step versus 2-Step Double-Mix Impression Technique. *ISRN Dent*. 2011;2011:1–5. doi:10.5402/2011/341546