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Dimensional Stability of Two Polyvinyl Siloxane Impression Materials in Different Time Intervals

Aalaei Sh[a], Rezaei Adli A[a], Mansoorali MR[b], Gholami F[a]

[a]Department of Prosthodontics, School of Dentistry, Qazvin University of Medical Sciences, Qazvin, Iran
[b]General dentist, Tehran, Iran.

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Corresponding Author:
Fatemeh Gholami,
Department of Prosthodontics,
Qazvin University of Medical Sciences, School of Dentistry,
Qazvin, Iran
Email: dr.gholami11@gmail.com
Tel: +98-9123845902
Fax: +98-28-33353061

Abstract

***Statement of the Problem*:** Dental prosthesis is usually made indirectly; therefore dimensional stability of the impression material is very important. Every few years, new impression materials with different manufacturers' claims regarding their better properties are introduced to the dental markets which require more research to evaluate their true dimensional changes.

***Objectives*:** The aim of this study was to evaluate dimensional stability of additional silicone impressionmaterial (Panasil® and Affinis®) in different time intervals.

***Materials and Methods*:** In this experimental study, using two additional silicones (Panasil® and Affinis®), we made sixty impressions of standard die in similar conditions of 23 °C and 59% relative humidity by a special tray. The die included three horizontal and two vertical lines that were parallel. The vertical line crossed the horizontal ones at a point that served as reference for measurement.

All impressions were poured with high strength dental stone. The dimensions were measured by stereo-microscope by two examiners in three interval storage times (1, 24 and 168 hours).The data were statistically analyzed using t-test and ANOVA.

***Results*:** All of the stone casts were larger than the standard die. Dimensional changes of Panasil and Affinis were 0.07%, 0.24%, 0.27% and 0.02%, 0.07%, 0.16% after 1, 24 and 168 hours, respectively. Dimensional change for two impression materials wasn't significant in the interval time, expect for Panasilafter one week ($p = 0.004$).

***Conclusions*:** According to the limitations of this study, Affinis impressions were dimensionally more stable than Panasil ones, but it was not significant. Dimensional change of Panasil impression showed a statistically significant difference after one week. Dimensional changes of both impression materials were based on ADA standard limitation in all time intervals (< 0.5%); therefore, dimensional stability of this impression was accepted at least until one week.

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Introduction

For registration or production of forms and relations of the teeth and related oral tissues, impression materials can be used; indeed, as a critical step in processing and fitting of a dental prosthesis, an impression must be taken [1,2]. Several types of impression materials are produced. These include silicones, polyether, polysulfide and alginate which are available for crowns and fixed partial denture impressions. Silicone impression materials are considered to be suitable impression materials to be used for fixed prostheses [3]. Also, it has been reported that silicone has the ability to resist deformation procedures and save its dimensional stability during disinfection procedure [4]. Among silicone impression materials, one type, called polyvinyl siloxane (PVS), is reported to have precise detail reproduction, dimensional accuracy and stability, low creep, a relatively short setting time, moderate to high tear resistance, and elastic recovery from undercuts [5].

Because of PVS's dimensional accuracy and stability, it is used in implant, operative dentistry and fixed or removable prosthesis [6]. There are numerous factors which can affect dimensions of subsequent casts on repetitive pouring. These include the process of polymerization [7], temperature [1], and the material used to fabricate the replica or working cast [1]. Although PVS impression materials have demonstrated superior dimensional stability when compared with other elastomeric materials due to lack of release of by-products [8], it had been reported that the time of storage affects the dimensional accuracy and just after initial polymerization, the accuracy is higher than different storage times [9,10]. In the recent years, Panasil® and Affinis® were used commonly all around the world, but their dimensional stability in different storage times is fairly evaluated and compared.

Therefore, the aim of the present study was to investigate whether the dimensional stability of Panasil® and Affinis®, as PVS impression materials, is significantly altered after 1, 24 and 168 hours. A comparison was also made between the two materials in each time period.

Materials and Methods

In this in vitro study, dimensional stability of two PVS impression materials after different time periods was compared. The used materials were Panasil® (Kettenbach Dental Co., Germany) and Affinis® (Coltene Whaledent Co., Switzerland).

Standard die preparation and impression making

Standard die was made as a stainless steel cylinder with 3 mm height on 31 mm metal base and 38 mm diameter described in ANSI/ADA specification no.19 [11]. The die had a very smooth surface with three horizontal and two vertical 500 µm deep grooves in the upper surface [9,12-13]. This die was assembled on the top of metal base with round cross section. The diameter of this base was 68mm and had two 8 mm slender axis in each side. These axes were used for prevention of tray rotation during multiple casting (Figure 1).

Then, 10 polyvinyl chloride trays with 3 mm thickness were made. The distance between all

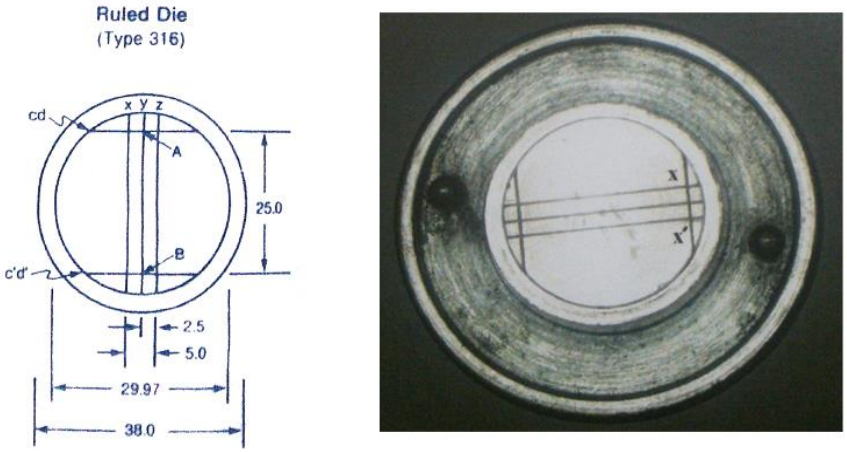

Figure 1: Real and schematic structure of stainless steel die.

trays and the die was 2 mm and they were fixed in all sides of the trays. This distance was made by a uniform 2 mm thick modeling wax adapted on the master die. Some holes with 2 mm diameter were induced in the tray for prevention of excess pressure on the casting materials. The internal diameter of the opening of the tray was set as 42 mm and 2 fovea were applied to match with 2 slender axes. Colten (Coltene Whaledent Co., Switzerland) and Panasil adhesive (Kettenbach Dental Co., Germany) were used as a tray glue for Affinis® and Panasil®, respectively and applied on the internal surface of the tray 10 minutes before taking impression.

Pouring of the impression

Sixty impressions were produced in similar conditions of 23°C and 59% relative humidity. In each time, 5 trays were poured by each impression material using a special impression gun (Kettenbach Dental Co., Germany) and mixing tip (Figure 2A). All impressions were made by one trained technician to prevent any interfering variables. For fixing the tray on the die, one 10 kg sinker was used for time similar to the setting time of each impression which was 150 sec for Panasil® and 210 sec for Affinis® (Figure 2B). After 10 minutes, the trays were separated from the standard die. High strength dental stone (Elite Rock Zermach Co., Germany) was used in this study and mixed with water in 23°C by using vacuum automatic mixer according to the manufacturer's instructions (Krupp Vacudent Co., Germany) (Figure 2C).

Impression evaluation

All impressions were checked for the lack of any bubbles and amorphous spaces. The casts were separated from impression after 45 minutes. All impressions of each PVS material were divided into three groups poured after one, 24 and 168 hours. The casts were coded blindly and the distance between X and X' was measured [11-14] by stereomicroscope (Moc2, Russian) (Figure 2C), using scaled slide (Japan, Olampious Co.) with 0.01 mm precision and × 32 magnification factor. The distances were evaluated three times by two persons who were blinded about the type of impression and the time of casting.

Statistical analysis

All data were expressed as mean and standard deviation (SD). The difference between the two impressions and between different times was analyzed by t-test and one way ANOVA respectively using SPSS, version 18.0.LSD (less significant difference) was and $p < 0.05$ was considered as significant difference.

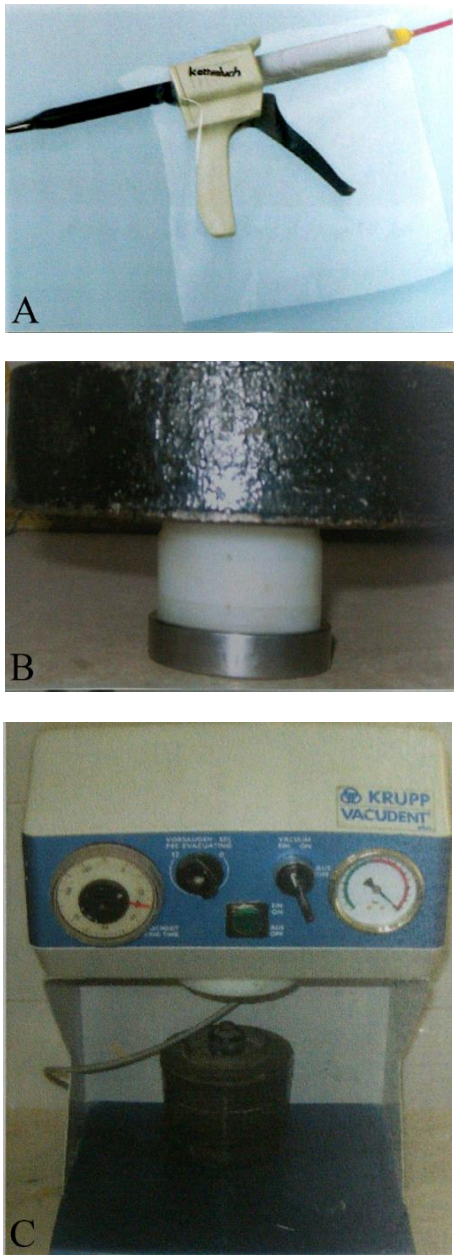

Figure2: Apparatuses used in this experimental study. A, special casting gun; B, one 10 kg sinker; C, vacuum automatic mixer

Results

The percentage of dimensional changes of two impression materials in comparison to stainless steel

Table 1: Mean and SD of cast size plus percentage of dimensional changes in three different times (Comparison between two impression materials with standard die)

Impression type	Times (h)	Cast size (mm)	Dimensional changes (%)	*p* value*
Panasil®	1	4.812 ± 0.018	0.07	0.524
	24	4.820 ± 0.015	0.24	0.370
	168	4.822 ± 0.011	0.27	0.004
Affinis®	1	4.810 ± 0.013	0.02	0.760
	24	4.812 ± 0.009	0.07	0.241
	168	4.816 ± 0.011	0.16	0.053

*p value < 0.05 was considered significant. (t- test analysis)

die is presented in Table 1. All stone casts had higher dimensions than stainless steel die. The mean of die size was similar in all three times and fixed at 4.8 mm. As demonstrated, the percentage of dimensional changes showed no differences between Affinis® and Panasil® with standard stainless steel in all time periods ($p > 0.05$), but the only significant difference was detected for Panasil® standard stainless steel die after 168 hour ($p = 0.004$). Also, no significant differences existed between the two impressions in none of the time periods ($p = 0.481$, $p = 0.579$ and $p = 0.684$ for 1, 24 and 168 hours, respectively) (Table 2).

Discussion

In the present study, the dimensional stability of two PVS impression materials, Panasil® and Affinis®, was evaluated and compared with stainless steel die and each other. Our analysis revealed that Affinis® had more dimensional stability in comparison to Panasil®. In impressions made by Panasil®; the percentage of dimensional change was significant after 168 hours. However, dimensional changes in all of the evaluation times were in the American Dental Association (ADA) standard range (< 0.5 %) [11,14]. Therefore, these materials had acceptable clinical dimensional stability for approximately 168 hours. In the present report, stainless steel dies and the ADA specification for impression materials were used for impressions making. Also, this reported protocol can be easily followed by other dentists and oral researchers.

In a previous study by Williams and colleagues, the dimensional stability of 11 different materials including three polysulfide, one condensation-cured silicone, six addition-cured silicones, and one polyether was evaluated in different time periods, im-

Table 2: Comparison of dimensional changes of Affinis and Panasil in different storage times

Impression type	Times (h)	Cast size (mm)	*p* value*
Panasil®	1	4.812 ± 0.018	0.481
Affinis®		4.810 ± 0.013	
Panasil®	24	4.820 ± 0.015	0.579
Affinis®		4.812 ± 0.009	
Panasil®	168	4.822 ± 0.011	0.684
Affinis®		4.816 ± 0.011	

*p value < 0.05 was considered significant. (ANOVA analysis)

mediately after taking impression, after 1, 4 and 24 hours storages. Their finding demonstrated that delayed pouring of polyether and PVS impressions should result in very little change in theaccuracy, but delayed pouring results in a rapid loss of accuracy in polysulfide and condensational silicon [8]. Previous researchers expressed that five properties including dimensional accuracy, ease of handling, stability, ability to produce multiple casts and good detail reproducibility are the most reasons for the widespread use of PVS materials in prosthodontics [15-16]. In several previous reports, the dimensional changes of impression materials were evaluated by means of stone casts and different devices such as three-dimensional Zeiss meter, digital caliper, microscope, and stereomicroscope [17-19]. So, we used stone cast and stereomicroscope for evaluation, due to the higher precision.

Thickness of impression materials, setting time and time length between making impression and pouring can affect the dimensional changes of impression [7]. In addition, thickness, hydrophilicity, shrinkage due to polymerization and thermal alteration, mishandling, incomplete elastic recovery and adhesion of the material to the tray are important factors in the dimensional changes of elastic materials [20-22]. Although in several studies the dimensional stability of some impression materials has been evaluated and compared, the number of studies about PVS is scarce. Previous reports demonstrated that PVS impression materials remain dimensionally stable up to 7 days [23-25]. It has been found that the casts made from silicon impression materials are in aclinical range [26]. Our findings are in line with all previous reports and could be attributed to the good elastic recovery of the polyvinyl siloxanes; this confirms the results of the other studies [21,25-26].

The stainless steel die used in the present study was similar to the standard die used to evaluate dimensional stability [14]. The surface of this die is smooth and shiny; therefore, it is easier to evaluate dimensional changes compared to tooth surface with cusps and fossa. On the other hand, this results in elimination of confounding factors such as dimensional changes of the impression due to movements on the undercuts. In the standard ADA dies, the diameter and angles of the flutes are important for evaluation of the accuracy of impression materials (the tree horizontal flutes are 25, 50 and 75 μm in diameter, with smooth and regular margins and an internal angle of 90º). Since the aim of the study was to register dimensional stability rather than details reproduction [12] and since it was not possible to create such flutes given the facilities available in the country, the flutes were created with greater dimension (500 μm).

Attempts were made to use the results of other studies to improve the study, including the use of custom-made trays and adhesives [27], use of 10 kg force similar to the impression taking force [28], a 2 mm distance between the tray and die [29-30], removal of the tray from the die after 10 minutes [7, 31], use of higher strength dental stone [28-29, 31-32], creation of ideal moisture and temperature [33], and use of a standard die.

Our study has some limitations such as one dimensional and linear measurement. Also, difference in height and volume were not evaluated and the results were not generalizable to dental fix bridge.

Conclusions

Neither Affinis® nor Panasil® showed a change in dimension greater than 0.27% in comparison to standard die and both PVS materials showed good dimensional stability over the time period of the study that offer dimensional stability over a time span long enough for most courses of treatment involving provision of fixed and removable prostheses.

Conflict of Interest

The authors of this manuscript declared that they have no financial or other competing interest concerning this article.

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