Influence of Technique and Pouring Time on Dimensional Stability of Polyvinyl Siloxane and Polyether Impressions

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This study aimed to determine how impression technique and pouring time affect casts obtained using polyvinyl siloxane (PVS) and polyether (PE) impressions. A total of 480 impressions were taken using three techniques: single-step (SS), two-step (TS), and two-step with a spacer (TSS). Impressions were poured after 1 and 24 hours and 7 and 14 days. Significant differences ($P < .01$) were found between the TS technique and the SS and TSS methods as well as between PE and PVS ($P < .01$) in terms of the effects of pouring time. SS and TSS yielded similar dimensional results, while greater dimensional change was induced with TS. PE impressions had to be poured no later than 7 days after preparation to ensure dimensional stability. *Int J Prosthodont 2012;25:353–356.*

Accuracy is one of the most important requirements for fixed partial prostheses to ensure a predictable long-term performance, and two of the factors that can lead to dimensional flaws in gypsum casts are impression technique and pouring time. The objective of this study was to ascertain the effect of impression technique and pouring time on the dimensional accuracy of casts obtained with polyvinyl siloxane (PVS) and polyether (PE)—two impression materials generally accepted to produce reliable casts for fixed prostheses. The three preparation techniques tested (single-step [SS], two-step [TS], and two-step with a spacer [TSS][1]) combined materials of varying consistencies.

Materials and Methods

Zhermack Elite HD+ PVS (soft, fast-setting putty and fast-setting light body) and Impregum Penta DuoSoft Quick (3M ESPE) PE were used. Both materials were mixed according to the manufacturers' instructions. The master cast, a stainless steel cylinder measuring 5 × 5 mm with a 1-mm right-angle shoulder margin (Fig 1), was chosen because it simplified the precise determination of the diameters and heights of the resulting casts. Three impression techniques were used: SS, TS, and TSS. Since tray rigidity can contribute to impression accuracy, the material was placed in rigid, partial photo-polymerizable acrylic resin trays. Eighty impressions were taken with each technique and material and divided into four groups, one for each pouring time: 1 and 24 hours and 7 and 14 days.

The 480 casts were poured using type IV gypsum (Fujirock EP, GC) mixed in a vacuum machine. The cast dimensions were subsequently measured using digital micrometers with a precision of 0.001 mm (TESA IP54 for the diameter and TESA 60.30069 for the height). Four points were identified on each cast to measure the diameter and a further four to measure the height. The values found were then averaged for statistical analysis (Fig 2).

Results

Statistical analysis was based on two variables, diameter and height (Tables 1 and 2), comparing the mean values obtained with each impression technique and pouring time.

PVS

The Kruskal-Wallis test showed no significant differences in height or diameter from one pouring time to another ($P < .05$). By contrast, the multiple comparison test ($P < .01$) revealed significant intertechnique differences for height; SS proved to be the most accurate (4.985 mm), followed by TSS (4.963 mm), while the poorest performance was observed for TS (4.938 mm) (Fig 3a). Diameter measurements differed significantly ($P < .01$) between TS (4.953 mm) and the other two impression methods (Fig 3b).

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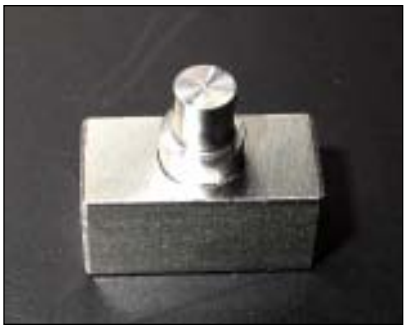


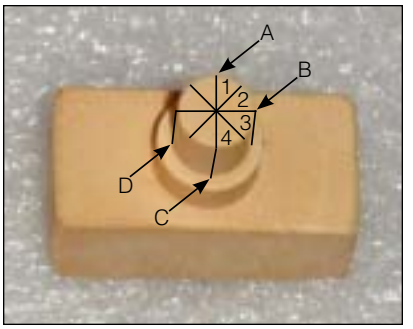


Fig 1 *(left)* Stainless steel master cast.

Fig 2 *(right)* Locations of diameter (1 to 4) and height (A to D) measurements taken on each cast.

Table 1 Mean Height (μm) of PVS and PE Casts

	1 h		24 h		7 d		14 d	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
PVS								
SS	4,975.53	12.91	4,985.38	12.93	4,988.69	15.02	4,988.31	13.42
TS	4,936.02	16.30	4,942.71	25.56	4,942.78	12.04	4,940.01	13.50
TSS	4,970.88	13.02	4,978.93	17.28	4,972.50	14.39	4,970.88	10.88
PE								
SS	4,977.55	13.61	4,972.68	11.29	4,970.91	10.36	4,965.08	20.09
TS	4,953.82	13.10	4,968.50	9.22	4,954.57	11.34	4,935.90	12.37
TSS	4,980.14	11.28	4,980.19	12.60	4,973.50	23.34	4,970.07	21.02

PVS = polyvinyl siloxane; PE = polyether; SD = standard deviation; SS = single-step technique; TS = two-step technique; TSS = two-step technique with a spacer.

Table 2 Mean Diameter (μm) of PVS and PE Casts

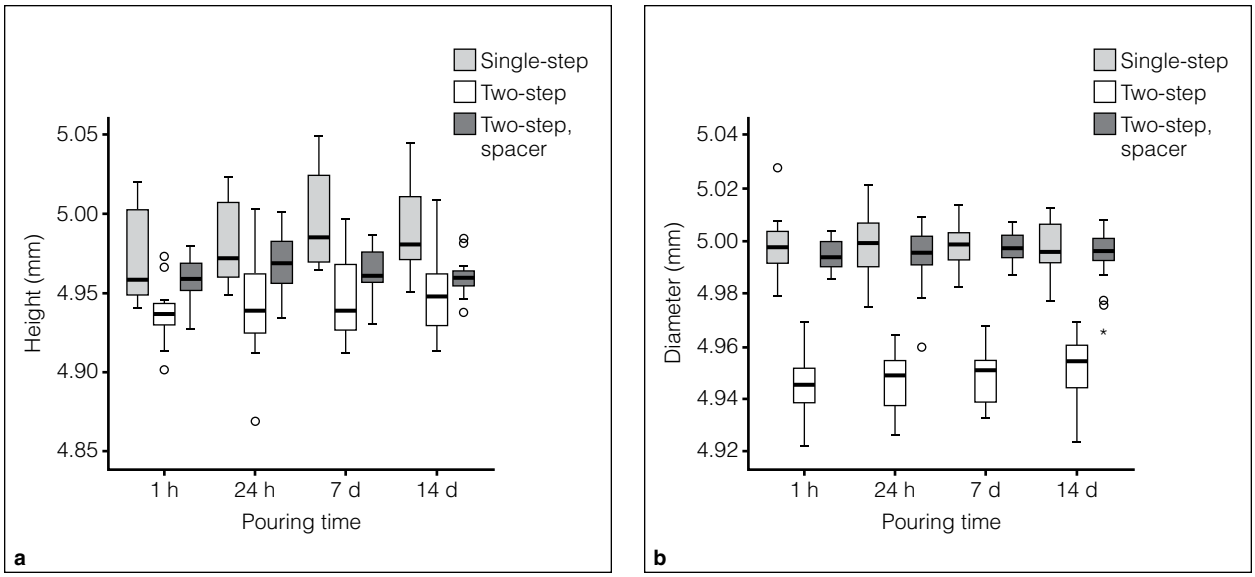
	1 h		24 h		7 d		14 d	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
PVS								
SS	4,997.83	10.51	4,998.89	11.39	4,998.90	8.24	4,996.78	10.11
TS	4,944.70	12.22	4,946.85	11.20	4,948.69	11.43	4,952.05	11.37
TSS	4,994.56	6.10	4,994.34	10.83	4,997.46	5.30	4,994.43	11.23
PE								
SS	5,000.99	8.09	5,009.45	6.49	5,021.71	7.65	5,028.71	10.21
TS	4,966.14	14.40	4,998.82	13.18	4,999.31	13.80	5,003.73	19.36
TSS	4,996.95	7.55	5,003.88	9.33	5,007.60	11.54	5,034.68	19.20

PVS = polyvinyl siloxane; PE = polyether; SD = standard deviation; SS = single-step technique; TS = two-step technique; TSS = two-step technique with a spacer.

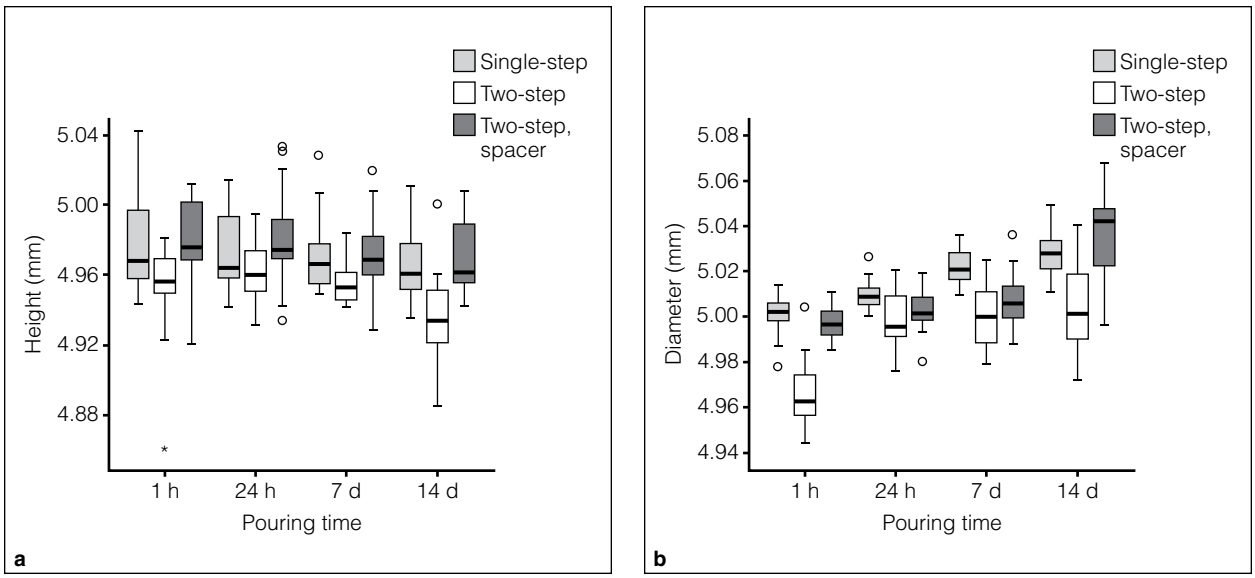
PE

According to the Kruskal-Wallis test, the differences between pouring times were significant ($P < .01$). In turn, the multiple comparison test revealed differences for height between the casts poured at 7 (4.560 mm) and 14 days (4.957) on the one hand and those at 1 (4.970 mm) and 24 hours (4.972 mm) on the other. Analysis of variance showed that the differences in the diameter readings were significant: Results for the SS and TSS techniques were poorer in the 7- and 14-day casts than in the 1- and 24-hour casts ($P < .01$).

Significant differences were also observed in both height and diameter regarding impression technique ($P < .01$). Height varied between TS (4.953 mm) and the other two techniques (SS: 4.971 mm, TSS: 4.975 mm) (Fig 4a). For diameter, analysis of variance showed differences regarding pouring time ($P < .01$): The poorest 1-hour findings were recorded for TS



Figs 3a and 3b Box plots depicting **(a)** height and **(b)** diameter measurements for each technique and pouring time combination using PVS. ° = outlier; * = extreme outlier.



Figs 4a and 4b Box plots depicting **(a)** height and **(b)** diameter measurements for each technique and pouring time combination using PE. ° = outlier; * = extreme outlier.

(4.966 mm), with a value lower than the reference, while at 14 days, SS (5.029 mm) and TSS (5.035 mm) exhibited the greatest dimensional variations (Fig 4b).

Discussion

Impression accuracy is an important issue in buccofacial prosthesis manufacturing. Any dimensional changes in this first step carry over to each subsequent stage of the procedure, to the detriment of the dimensional quality of the cast. Moreover, impression technique is one of the factors that can affect dimensional accuracy from the outset. The most popular impression technique with PVS and PE is SS because of its simplicity and reliability. However, a number of authors have criticized this procedure because of the absence of control over the amount or thickness of the light-body material, the greater introduction of bubbles, and the dimensional alteration of the heavy-body material setting included in the final impression.[2]

The TS technique also has shortcomings, such as the risk of nonpassive polymerization of the light-bodied material, which could cause distortions in the final impression. These factors can be minimized with the use of a spacer when taking the first impression, as done with the TSS technique.

While several studies have been conducted on the accuracy of different impression techniques, clinical data on this matter have seldom been reported. Good in vitro and in vivo results have been observed with the SS method. Some authors comparing SS and TSS have found higher accuracy with latter[1] and others with the former,[3] but most identified no difference between the two. The present findings, with similar results for SS and TSS, concurred with the third group of results. In terms of dimensional accuracy, when the materials used are PE and PVS, these two techniques can be regarded to perform equally well. The least accurate results were observed for TS.

The findings on dimensional stability reported in the literature for PVS and PE vary depending on pouring time. At very short pouring times, the results for the two impression materials are similar, and the overall conclusion is that both are suitable for taking impressions. However, this is not the case when pouring is delayed. PVS is found to be more dimensionally stable than PE in such circumstances, with no dimensional change when pouring is delayed for a full week or for longer than 7 days.[4] In turn, research on PE shows some, albeit very small, dimensional change when the impressions are poured in less than 1 week. When pouring is delayed for more than 7 days, the differences detected between the materials prove to be significant.[5] In this study, PE- and PVS-based casts were found to be similarly stable after 1 and 24 hours, while the 7- and 14-day findings differed.

Conclusions

While the single-step and two-step with a spacer methods yield similar results for impressions taken with PVS or PE as the impression material, greater dimensional change can be expected with the two-step technique. Pouring can be safely delayed in PVS impressions for up to 14 days, whereas PE impressions must be cast before 7 days to prevent the appearance of dimensional change.

References

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Literature Abstract

Oral health care in the USA

The United States Institute of Medicine published the report *Improving Access to Oral Health Care for Vulnerable and Underserved Populations*, which discussed solutions to help minimize heatlh care disparities in the US. It focused on age, ethnicity, and rural populations. It was estimated that approximately 10% of the US population has limited access to basic oral care due to limited government funding to the adult population. Approximately two thirds of retirees and 5 million citizens have limited or no dental care. Evidence is clear that poor oral health can lead to other medical ailments. It is recommended that dental screenings should be part of overall health care. The short fall of 9,900 dentists in the US should also be addressed, with emphasis on training underrepresented minorities and community dental care programs.

Editorial. *Lancet* 2011;378:290—*Ansgar C. Cheng, Singapore*