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Dimensional Accuracy of Polyvinyl Siloxane Impression Materials Considering Impression Techniques– A Literature Review

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Objectives Impression accuracy is the main determinant of the fit, form and function of prosthetic restorations. Polyvinyl siloxane (PVS) is the material of choice in most clinical situations. The purpose of this paper is to provide an up-to-date review of scientific articles which discuss the dimensional accuracy of PVS impression material using various impression techniques, tray types and spacers. Besides, the procedure, advantages and disadvantages of commonly used impression techniques, technique modifications and innovations are also reviewed.
Method An electronic search of scientific papers from 1990 to 2018 was carried out using MEDLINE and Google Scholar databases using the search terms “accuracy and polyvinyl siloxane and impression technique” and “accuracy and addition silicone and impression technique”.
Results Searching the key words yielded a total of 312 articles. By application of inclusion and exclusion criteria, the obtained results were further reduced to 35 citations.
Conclusion Impression technique is a critical variable in the accuracy of PVS impressions. Dual-phase 2-step technique with 1 to 2 mm space for the light body is proven to be highly accurate and is still considered as the standard technique. The use of 2-step technique without providing a space for the wash material is rejected by the literature. Triple-phase 2-step techniques including “matrix impression system” have also functioned well and even superior to traditional dual-phase 2-step technique. Papers suggest that custom trays do not significantly improve the accuracy of impressions and rigid stock trays are suitable alternatives.
Keywords Vinyl Polysiloxane; Dental Impression Technique; Dimensional Measurement Accuracy

Introduction

In the 1970s, polyvinyl siloxane (PVS) impression material appeared in the market and became very popular, in part because of its combination of excellent physical properties, handling characteristics, dimensional accuracy and dimensional stability.[1-3] Currently, PVS is the material of choice in many clinical situations.[4-6]

Several techniques have been suggested to improve the accuracy of PVS impressions. Routinely used impression techniques are categorized as single-phase or dual-phase.[7-9] Techniques that use monophase materials are accomplished in a single-step procedure, usually by materials of medium viscosity.[9-11] Two variations of the dual-phase technique are commonly used: (I) the dual-phase one-step technique, in which both materials polymerize in one stage, and (II) the dual-phase two-step technique, in which a putty or a heavy consistency material is used alone as the initial step to function as a custom tray, and then a final impression is made by use of a silicone with lower viscosity.[12, 13] Some novel techniques have been introduced to improve the accuracy of impressions. An example of these innovations is the triple-phase 2-step technique which consists of a primary impression by putty and light body materials and a secondary step for injection of extra light body material into the impression.[10, 14] The “Matrix impression system” is another triple-phase 2-step technique introduced by Livaditis to overcome the limitations of previous techniques. This technique requires three viscosities of impression materials.[15]

A variety of variables in making an impression such as the technique, tray type, amount of space and spacer type cause indecisiveness in clinical practice. Despite the fact that PVS material has absolute dimensional accuracy, Samet et al. reported that nearly 90% of the cast models had one or more visible errors.[16] This comprehensive review aims to summarize, criticize and discuss the traditional and novel impression techniques and relevant issues. Besides, the procedures, advantages and disadvantages of the techniques will be discussed.

Materials and Methods

A comprehensive search was made through MEDLINE and Google Scholar databases using the following search terms: “accuracy and polyvinyl siloxane and impression technique” and “accuracy and addition silicone and impression technique". Search filters were applied for English language and publication dates from 1990 to 2018. A total of 312 articles were retrieved. The inclusion criteria were any article with available abstract, exactly relevant to the search terms and concerning the field of fixed prosthodontics. Editorials, manufacturer-supported publications and studies in the field of implant dentistry were excluded. Titles were screened to remove the duplicate records and to select the studies that exactly met all the aforementioned criteria. Records further decreased to 56 articles. Abstracts and full-texts were reviewed thoroughly and cross-matched with the predefined inclusion criteria. Reference lists of the included articles were scanned for additional relevant articles. In total, 35 articles formed the basis of this review (Figure 1).

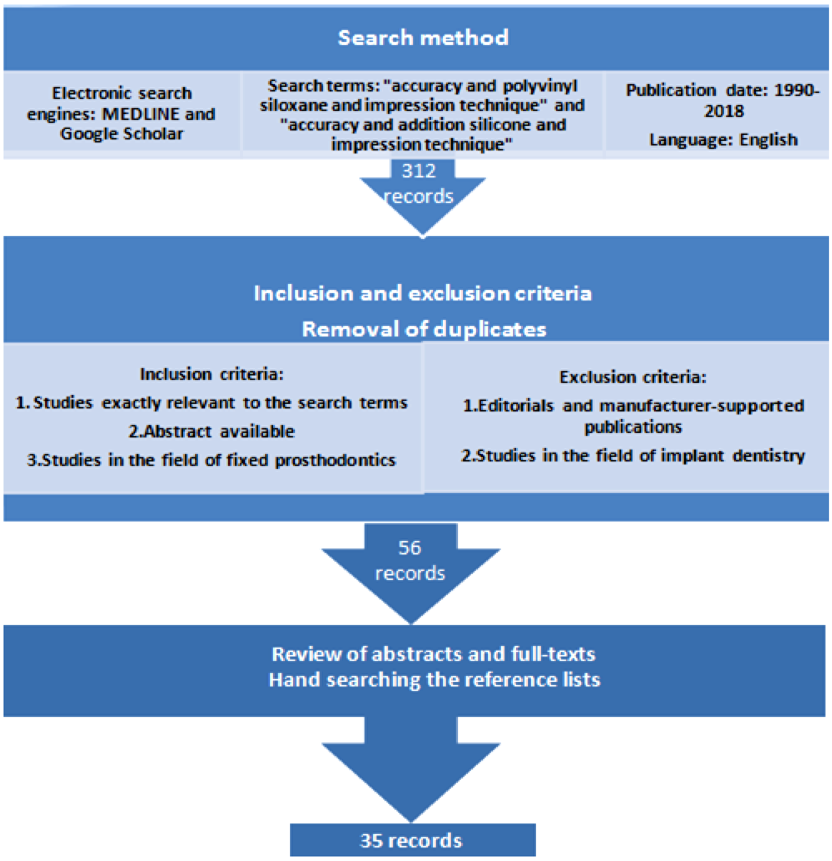

Figure 1- Method of searching and selecting the articles

Results

The retrieved studies concerning different impression techniques are summarized in Table 1.

Table 1- Summary of articles evaluating the impression techniques, considering the author's name, sample size, impression technique, material consistency, tray type and the result of the studies. (*: Polyethylene, **: Not specified)

Author (year)	Sample size	Impression technique	Wash space	Material consistency	Tray	Result
Pande (2013)	N=15	1-Dual-phase 1-step 2-Dual-phase 2-step	1-3.5 mm tray relief 2-1.5 mm relief for wash	1-Heavy/light 2-Putty/light	1-Custom 2-Stock metal	Dual-phase 1-step technique in custom tray was more accurate.
Vitti (2013)	N=5	1-Single-phase 2-Dual-phase 1-step 3-Dual-phase 2-step	1-2mm relief 3-2mm polypropylene spacer	1-Light 2-Putty/light 3-Putty/light	1-Custom 2-Stock metal 3-Stock metal	No significant difference was found.
Dugal (2013)	N=15	1-Dual-phase 1-step 2-Dual-phase 2-step	1-0.5mm metal cap 2-1mm metal cap 3-1.5 mm metal cap	1-Putty/light 2-Putty/light	Custom	2-step technique was more accurate. The best spacer thickness was 1 mm, followed by 1.5 and 0.5.
Shiozawa (2013)	N=5	Dual-phase 2 step	1-1mm resin coping 2-2mm resin coping	1-Putty/light 2-Putty/medium	NS**	Thinner wash space and putty/light body combination resulted in better

			3-25 microns PE* foil			sulcus depth reproduction.
Millar (1998)	N=50	1-Single-phase 2-Dual-phase 1-step		1-Medium 2-Medium/light	1-Stock 2-Custom	More voids were detected in single-phase group.
Idris (1995)	N=15	1-Dual-phase 1-step 2-Dual-phase 2-step	2-2mm wide sluiceways	1-Putty soft/light 2-Putty soft/light	NS	No significant difference was found.
Hung (1992)	N=5	1-Dual-phase 1-step 2-Dual-phase 2-step	2-Plastic spacer	1-Putty/light 2-Putty/light	Stock metal	No significant difference was found.
Caputi (2008)	N=15	1-Single-phase 2-Dual-phase 1-step 3-Dual-phase 2-step 4-Triple-phase 2-step (2-step injection)	3-2mm resin coping	1-Medium 2-Putty/light 3-Putty/light 4-Putty/light/ extra-light	Stock metal	Group 4 was the most accurate, followed by groups 3, 2 and 1.
Basapogu (2016)	N=10	1-Single-phase 2-Dual-phase 1-step 3-Dual-phase 2-step	3-PE spacer	1-Medium 2-Putty soft/light 3-Putty soft/light	NS	Dual-phase 2-step technique was the most accurate technique.
Kumari (2015)	N=10	1-Dual-phase 1-step 2-Dual-phase 2-step	2-1.5 mm Brass metal plate	1-Heavy/light 2- Heavy/light	NS	2-step technique was more accurate.
Varvara (2014)	N=10	1-Single-phase 2-Dual-phase 1-step 3-Dual-phase 2-step 4-Triple-phase 2-step (2-step injection)	3-2mm resin coping	1-Medium 2-Putty/light 3-Putty/light 4-Putty/light/ extra-light	Stock metal	Surface defects were mostly detected in group 1, followed by groups 2, 3 and 4.
Levartovsky (2013)	N=15	1-Dual-phase 1-step 2-Dual-phase 2-step	2-Plastic foil and relief grooves	1-Putty/light 2-Putty/light	Custom	2-step technique was more accurate.
Nissan (2013)	N=15	1-Dual-phase 1-step 2-Dual-phase 2-step 3-Dual-phase 2-step	2-2mm crown 3-PE spacer	1-Putty/light 2-Putty/light 3- Putty/light	Custom	2-step with 2mm relief technique was the most accurate.
Singh (2012)	N=5	1-Single-phase 2-Dual-phase 1-step 3-Dual-phase 1-step 4-Dual-phase 2-step 5-Dual-phase 2-step 6-Dual-phase 2-step	4-Sluiceways 5-0.3 mm PE spacer 6-2mm plastic spacer	1-Medium 2-Medium/light 3-Putty/light 4-Heavy/light 5-Putty/light 6-Putty/light	1-Custom 2-Custom 3-Stock 4-Custom 5-Stock 6-Stock	Group 4 was the most accurate, followed by group 6.
Franco (2011)	N=10	1-Dual-phase 1-step 2-Dual-phase 2-step (without relief)	NS	1-Heavy/light 2-Heavy/light	NS	Dual-phase 2-step technique (hydraulic technique) was less accurate.
Mishra (2010)	N=10	1-Single-phase 2-Dual-phase 1-step 3-Dual-phase 1-step 4-Dual-phase 2-step	1-2mm tray space 3-2mm tray space 4- PE spacer	1-Medium 2-Putty/light 3- Heavy /light 4- Putty /light	1-Custom 2-Stock 3- Custom 4- Stock	Group 2 was not accurate. Other techniques were almost similarly accurate in the order of: 3, 1 and 4.
Nissan (2000)	N=15	1-Dual-phase 1-step 2-Dual-phase 2-step 3-Dual-phase 2-step	2-PE spacer 3-2mm coping	1-Putty soft/light 2-Putty/light 3-Putty/light	Custom	Group 3 was the most accurate. The least accuracy was recorded for group 1.
Patil (2008)	N=10	1- Dual-phase 2-step 2- Single-phase 3- Dual-phase 1-step	1-PE spacer	1-Putty/light 2-Medium 3-Heavy/light	1-Stock 2-Custom 3-Custom	No significant difference was found.

I. Pattern of dimensional changes of PVS impressions

A common design for master models among the reviewed studies was a steel model of single crown or bridge preparation. Using different techniques, impressions were made and poured. The resultant stone casts were studied and the dimensions of each preparation and the distance between the preparations were compared with the dimensions of the master model.[17]

In most of the reviewed articles, when stone casts and the master model were compared, the vertical dimension (intra-abutment) of stone dies decreased; whereas, the horizontal dimension (inter-abutment) increased.[1,2,18] This phenomenon might have occurred due to the contraction of the impression material toward the tray walls.[19] Adhesion of the impression material to the adhesive-coated tray is another possible reason. Because of the constraint imposed by the adhesive on uniform shrinkage upon setting, abutments in the resultant cast may tend to be a greater distance apart than they were actually in the model.[20] Moreover, in the multi-step techniques, the wash material may hydraulically displace the preliminary putty impression during impression seating, and the putty may then exhibit some elastic recovery upon removal of the impression and result in a tendency towards smaller dies and therefore larger inter-abutment distances.[12]

II. Impression techniques:

II.A. Single-phase impression technique

Single-phase technique was introduced to simplify the procedure of impression making. Medium consistency is used as monophase material in the majority of the studies.[10,14,21-24]

Single-phase impressions are at great risk of presence of voids and surface defects.[21] It is anticipated that monophase materials are used predominantly in stock trays as it is claimed that it is not necessary to use monophase materials in custom trays.[22] Nevertheless, evidence supports the contradictory idea that monophase PVS materials are not sufficiently accurate in stock trays, although they provide acceptable accuracy in custom trays.[10,14,21-26] Trays might have an effect on the number of surface voids because of the pressure exerted on the impression material in the close-fitting custom tray.[22] The increased viscosity of monophase materials, necessary to prevent large masses of material from slumping, adversely affects the flow of the material over the preparation. This might be the reason for the high frequency of surface defects and voids in the impressions of single-phase technique.[22]

II.B. Dual-phase 1-step impression technique

Studies about the accuracy of dual-phase 1-step impression technique are controversial. Some studies report that the dual-phase 1-step technique is more accurate than the single-phase technique.[10,14,21-24] Furthermore, a large number of investigations indicate that this technique is not as accurate as the dual-phase 2-step technique.[1,10,14,21,23,24,27-30] Contrary to these findings, some studies claim that dual-phase 1-step impression technique is more accurate than dual-phase 2-step technique.[20,23,27]

Dual-phase 1-step technique has shorter chair-time and saves impression material.[27] Although, in this technique the putty tends to push the light-body wash off the preparation and critical areas. The finish lines may be covered by the putty, which cannot reproduce the fine details to the satisfactory level.[1,10,23] For this reason, even in the studies that dimensional accuracy of 1-step technique was equal to 2-step technique, concerns about the reproduction of fine details when using 1-step technique are not eliminated.[10] Occasional ledges at the junction of the putty and wash material and presence of voids and bubbles are among other shortcomings of this technique.[31] A prerequisite for an accurate impression is the controlled wash bulk, which is not fulfilled in the 1-step technique.[32] Dual-phase 1-step technique requires mixing of the putty material and the syringe material at one stage. Thus, setting distortion of the putty is included in the overall distortion of the impression.[23] The need for a second person to aid the simultaneous handling of the two materials is another factor to be considered.[26] Moreover, in the 1-step technique, once the light body material is on the preparation, the putty needs to be brought into position and seated. During this critical phase, the patient's tongue or the elevated floor of the mouth can remove the light-body material from the tooth.[10]

II.C. Dual-phase 2-step impression technique

Dual-phase 2-step technique is widely accepted as the standard technique for PVS impressions.[25,28] There are many studies that state the higher dimensional accuracy of this technique over the single-phase and dual-phase 1-step techniques.[1,10,14,21,33-36] In the putty/wash two-step impression technique, preparations are recorded with the wash material, which results in better detail reproduction. Amongst all modifications of 2-step technique, the ones which precisely define the bulk of wash material by using copings or temporary crowns are more accurate.[27] Despite the accuracy of this technique, distortion, extra chair-time, and extra material needed should be considered.

II.D. Triple-phase 2-step impression technique

Occlusal matrix technique

One modification of the current impression techniques was introduced and studied by Caputi and Varvara.[10, 14] Triple-phase 2-step technique consists of a primary impression by simultaneous use of putty and light body material in a stock tray. In the second step, a hole is made in the preparation site of impression and extra-light body material is injected through this hole to record the fine details. The results of both studies showed that this technique was more accurate than the dual-phase 2-step, dual-phase 1-step and single-phase techniques.[10, 14]

This finding can be related to the reduced wash bulk obtained through the use of the extra-light body material. By diminishing the volume of the polymerizing material at each stage, the final contraction will be reduced, as well and the accuracy of the impression can be improved.[10, 14]

The other triple phase technique namely the "matrix impression technique" attempts to overcome the deficiencies of the older systems while incorporating their best features. A matrix of occlusal registration with putty consistency of polyether or PVS material is made over the tooth preparations. Facial and palatal sides of the matrix are trimmed. A definitive impression is made in the matrix of the preparations with a high viscosity elastomeric impression material. After the matrix impression is seated, a stock tray filled with a medium viscosity elastomeric impression material is seated over the matrix and remaining teeth to create an impression of the entire arch. The matrix impression system showed higher accuracy when compared with dual-phase 1-step and dual-phase 2-step techniques in both intra-abutment and inter-abutment dimensions.[15, 37, 38]

III. Tray type

III.A. Plastic stock tray

Tray type is a critical variable in the choice of impression techniques.[39] Stock trays are popular as they are affordable and convenient, and can be selected, adapted, and used in a single visit.[23,40] When a stock tray is selected, usually a high-viscosity impression material is used. High-viscosity materials can result in pressure while seating the tray. This force may cause distortion of the tray if it is not sufficiently rigid. This will cause tray rebound on removal from the mouth.[39]

III.B. Metal stock tray

Rigid (metal) stock tray requires additional care to block out any existing undercuts on the adjacent teeth or areas where the material could flow and cause problems on removal, such as pontic sites. If clinicians fail to take such precautions, the rigidity of contemporary impression materials may create an unpleasant clinical situation in which the metal tray is locked into the mouth; its removal requires a significant amount of time and effort, causing severe discomfort to the patient as well.[3] Studies by Balkenhol et al.,[41] and Hoyos and Soderholm[42] showed that disposable plastic trays resulted in less accurate impressions compared with metal trays. Another study conducted by Abuasi et al. concluded that combination of putty/light body in plastic tray is unsatisfactory regarding die distortion. Metal trays were shown to reduce die distortion.[43]

III.C. Custom trays

Custom trays are believed to increase the accuracy of impressions as the pressure exerted on the impression material to record the details of the preparation is higher in the close-fitting custom trays. They allow uniform impression material thickness, minimizing material waste, and are also more comfortable for patients. Custom trays permit placing suitable stops, to ensure the correct sitting of impressions.[44] However, making a custom tray is costlier and requires planning, a study model, laboratory time, a curing interval, and finishing time.[3, 22, 23] Studies suggest that custom trays do not significantly affect the accuracy of 2-step putty/light body impressions and stock trays with proper spacing and sufficient rigidity are acceptable.[45] Following a survey of almost 4000 American dentists, Shillingburg et al. reported that around 75% of the respondents used stock trays routinely.[46]

Investigations about the amount of space necessary for monophase materials in a custom tray or the required space for light-body in the second step of dual-phase 2-step technique are summarized in Table 2.

Table 2- Summary of articles evaluating the space for impression materials, considering the author's name, sample size, spacer type, amount of space, impression technique, material consistency, tray type and the result of the studies. (*: Polyethylene, **: Not specified)

Author (year)	Sample size	Spacer	space	Impression technique	Material consistency	Tray	Result
Tjan (1992)	N=5	Silicone spacer	1-2mm 2-4mm 3-6mm	Single-phase	Medium	Custom	No significant difference was found.
Mann (2014)	N=10	1-Cut-out technique 2-Spacer foil		Dual-phase 2-step	Putty/light	Stock metal	Spacer foil was more accurate.
Nissan (2002)	N=15	Prefabricated stainless steel coping	1-1mm 2-2mm 3-3mm	Dual-phase 2-step	Putty soft/light	Custom	1 and 2 mm wash thicknesses were more accurate.
Shiozawa (2013)	N=5	1-Resin coping 2-Resin coping 3-PE* foil	1-2mm 2-1mm 3-25microns	Dual-phase 2-step	1-Putty/light 2-Putty/medium	NS**	Thinner wash space resulted in better reproduction of sulcus depth.
Dugal (2013)	N=15	Metal cap	1-0.5mm 2-1mm 3-1.5 mm	Dual-phase 2-step	Putty/light	Custom	The best spacer thickness was 1 mm, followed by 1.5 and 0.5.
Rajapur (2012)	N=5	NS	1-2mm 2-4mm 3-6mm	Single-phase	Medium	Custom	2 or 4 mm tray spaces were more accurate.
Fenske (2000)	N=15	1-Cut-out technique 2-Plastic sheet	2-1mm	Dual-phase 2-step	Putty/light	NS	No significant difference was found.
Nissan (2000)	N=15	1-PE foil 2-Stainless steel coping	2-2mm	Dual-phase 2-step	Putty/light	Custom	2mm wash space resulted in more accuracy.
Kumar (2012)	N=5	Space designed in the master model	1-2mm 2-4mm 3-6mm	Single-phase	NS	Custom	2mm and 4 mm tray spaces were more accurate respectively.
Sayed (2015)	N=7	1- Aluminum foil 2- Escape grooves 3- No modification 4- Ant-posterior rocking motion 5- Temporary crowns		Dual-phase 2-step	Putty/light	Stock	Antero- posterior rocking movement technique showed the most accurate results, followed by Aluminum foil technique.

IV.Material space requirements

IV.A. Tray space for single-phase impression technique

Three studies concerning this issue compared 2, 4 and 6 mm space in custom trays for single-phase medium-body PVS. Tjan et al. concluded that tray space did not affect the accuracy.47 However, studies by Rajapur et al. and Kumar et al. showed that 2 or 4 mm space is more accurate than 6 mm space.[48,49]

IV.B. Necessity of wash space for dual-phase 2-step impression technique

Dual-phase 2-step technique without any relief for the light body, known as hydraulic technique, was introduced in order to eliminate the need for packing retraction cord or use spacers. According to this technique, the high consistency material is supposed to generate a hydraulic pressure that propels the low-consistency material into the sulcus and all the internal aspects of the preparation. Franco et al. and Sayed et al. investigated the efficacy of this technique and reported that it was not an efficient method.[27, 50] The significant strain induced by the wash material to the high-consistency material, might cause deformation in the already set impression. After setting and on removal, the high consistency material is likely to exhibit elastic recovery, returning to its original position. Therefore, hydraulic technique is not recommended as the standard method for 2-step PVS impressions.[27, 50]

IV.C. Methods of preparing wash space for dual-phase 2-step impression technique

Different methods are suggested for making wash space such as grinding away some of the putty impression material after the first step of impression making, recording the putty before tooth preparation, application of different spacers such as polyethylene spacer foils, resin copings, metal copings, cutting-out sluiceways, polypropylene spacers or temporary crowns.[1, 25, 29, 30, 33, 47, 48, 51-54]

The conventional cut-out technique is criticized by some researchers. Using the cut-out technique, distortion of the putty material during final impression making is probable as the light body material is compressed while seating the tray. Furthermore, the position of the tray during definitive impression making may deviate slightly from its original position. Cutting sluiceways also results in a great amount of debris in the clinical environment. These shortcomings have led researchers to introduce a modified reline technique. Leao et al. proposed that before completion of the putty polymerization, the impression was removed and putty was compressed using the handle of a dental cement spatula for wash space and re-inserted on the preparations.[55]

Plastic spacers and spacer foils result in higher accuracy compared with the cut-out technique. With the use of spacer foil, the flexible foil deforms and creates a space between teeth and impression material during the primary impression. This allows for drainage and pressure is decreased on the first impression material during the definitive impression making. Thus, less compensative elastic recovery of the impression material upon removal is expected.[30] However, spacers do not provide controlled wash bulk and the space made by these techniques is insufficient. The most accurate method is proven to be the use of temporary crowns or copings in the first step of impression; as wash bulk is precisely controlled in these techniques.

IV.D. Amount of wash space for dual-phase 2-step impression technique

The amount of space necessary for the wash material is still controversial. Nissan et al. suggested 1 or 2 mm thick temporary crowns to prepare the wash space.[51] Likely, in a study conducted by Dugal et al, 1 mm wash space was recommended.[33] However, dimensional accuracy is not the only issue affected by the wash space. Shiozawa et al. reported that thinner wash space prepared by 25 μm thick polyethylene spacer foils resulted in better reproduction of sulcus depth. This might be the result of the heavy consistency material forcing the wash body intensely so it cannot escape easily.[52]

V. Studies refusing the effect of impression techniques on the accuracy of PVS impressions

Despite all the findings that propose the significant effect of impression techniques on the dimensional accuracy of PVS impressions, few studies claim that impression technique is not a critical variable in the accuracy of PVS impressions.[12, 26, 31] Vitti et al. reported that the accuracy of single-phase light body impressions in custom trays was statistically equal to putty/light body 1-step impressions in stock trays and putty/light body 2-step impressions in stock trays with 2 mm space for light body material.[26] Studies by Idris and Hung were also in favor of the idea that dimensional accuracy was not affected by the impression technique. They claimed that impression materials were more effective than the techniques on the accuracy.[12, 31]

Conclusion

Impression technique is a critical variable in the accuracy of PVS impressions. Monophase materials act better in custom trays. They are prone to surface defects and voids. Dual-phase 2-step technique is proven to be highly accurate and is still the method of choice for most clinical conditions. Triple-phase 2-step techniques including "matrix impression system" are also claimed to be highly accurate. Among various methods of creating space for the wash material in 2-step technique, 1 or 2 mm space created by the use of temporary crowns or copings results in higher accuracy. Custom trays do not significantly increase the accuracy of impressions and rigid stock trays are suitable alternatives.

Conflict of Interest

None declared.

References

1. Nissan J, Laufer BZ, Brosh T, Assif D. Accuracy of three polyvinyl siloxane putty-wash impression techniques. J Prosthet Dent. 2000 Feb;83(2):161-5.
2. Amini P, Rahpeyma A, Hejazi M. Comparative analysis of dimensional accuracy of two types of silicone impression materials: Optosil and Elite-HD. J Dent Mater Tech. 2017 Mar;6(1):1-6.
3. Punj A, Bompolaki D, Garaicoa J. Dental impression materials and techniques. Dent Clin North Am. 2017 Oct;61(4):779-796.
4. Donovan TE, Chee WW. A review of contemporary impression materials and techniques. Dent Clin North Am. 2004 Apr;48(2):vi-vii, 445-70.
5. Rubel BS. Impression materials: A comparative review of impression materials most commonly used in restorative dentistry. Dent Clin North Am. 2007 Jul;51(3):629-42.
6. Garrofé AB, Ferrari BA, Picca M, Kaplan AE. Linear dimensional stability of elastomeric impression materials over time. Acta Odontol Latinoam. 2011;24(3):289-94.
7. Jamshidy L, Mozaffari HR, Faraji P, Sharifi R. Accuracy of the one-stage and two-stage impression techniques: A comparative analysis. Int J Dent. 2016;2016:7256496.

8. Naumovski B, Kapushevska B. Dimensional stability and accuracy of silicone - based impression materials using different impression techniques - a literature review. Pril (Makedon Akad Nauk Umet Odd Med Nauki). 2017 Sep;38(2):131-8.
9. Pandey A, Mehtra A. Comparative study of dimensional stability and accuracy of various elastomeric materials. IOSR- JDMS. 2014 Mar;13(3):40-5.
10. 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 Apr;99:274-81.
11. Prithviraj D, Pujari M, Garg P, Shruthi D. Accuracy of the implant impression obtained from different impression materials and techniques. J ClinExp Dent. 2011;3(2):106-11.
12. Idris B, Houston F, Claffey N. Comparison of the dimensional accuracy of one and two-step techniques with the use of putty/wash addition silicone impression materials. J Prosthet Dent. 1995 Nov;74(5):535-41.
13. Amini P, Tavallaei M. Effects of rewash on the accuracy of stone dies produced by putty-wash technique. J Kerman Univ Med Sci. 2013;20(2):169-78.
14. Varvara G, Murmura G, Sinjari B, Cardelli P, Caputi S. Evaluation of defects in surface detail for monophase, 2-phase, and 3-phase impression techniques: an in vitro study. J Prosthet Dent. 2015 Feb;113(2):108-13.
15. Livaditis GJ. The matrix impression system for fixed prosthodontics. J Prosthet Dent. 1998 Feb;79(2):208-16.
16. Samet N, Shohat M, Livny A, Weiss EI. A clinical evaluation of fixed partial denture impressions. J Prosthet Dent. 2005 Aug;94(2):112-7.
17. Shah S, Sundaram G, Bartlett D, Sherriff M. The use of a 3D laser scanner using superimpositional software to assess the accuracy of impression techniques. J Dent. 2004;32(8):653-8.
18. Amini P, Rahimi M. Accuracy and dimensional stability of two polysiloxane putty-wash impression techniques. J Dent (Shiraz). 2009;9(4):338-43.
19. Haralur SB, SaadToman M, Ali Al-Shahrani A, Ali Al-Qarni A. Accuracy of multiple pour cast from various elastomer impression methods. Int J Dent. 2016 Nov; 2016:1-6.
20. Pande NA, Parkhedkar RD. An evaluation of dimensional accuracy of one-step and two-step impression technique using addition silicone impression material: an in vitro study. J Indian Prosthodont Soc (July-Sept 2013) 13(3):254-9.
21. Basapogu S, Pilla A, Pathipaka S. Dimensional accuracy of hydrophilic and hydrophobic vps impression materials using different impression techniques - An Invitro Study. J Clin Diagn Res. 2016 Feb;10(2):ZC56-9.
22. Millar BJ, Dunne SM, Robinson PB. In vitro study of the number of surface defects in monophase and two-phase addition silicone impressions. J Prosthet Dent. 1998 Jul;80(1):32-5.
23. Mishra S, Chowdhary R. Linear dimensional accuracy of a polyvinyl siloxane of varying viscosities using different impression techniques. J InvestigClin Dent. 2010 Aug;1(1):37-46.
24. Singh K, Sahoo S, Prasad KD, Goel M, Singh A. Effect of different impression techniques on the dimensional accuracy of impressions using various elastomeric impression materials: an in vitro study. J Contemp Dent Pract. 2012 Jan-Feb;13(1):98-106.
25. Millar B. Dental know how: How to make a good impression (crown and bridge). Br Dent J. 2001Oct;191(7):402-5.
26. Vitti RP, da Silva MA, Consani RL, Sinhoreti MA. Dimensional accuracy of stone casts made from silicone-based impression materials and three impression techniques. Braz Dent J. 2013 Oct;24(5):498-502.
27. Franco EB, da Cunha LF, Herrera FS, Benetti AR. Accuracy of single-step versus 2-step double-mix impression technique. ISRN dentistry. 2011;2011:1-5.
28. Sayed ME, Sayed M, Al-Makramani B, Al-Sanabani F, Mohamed M. Effect of intermixing brands on the dimensional accuracy of master cast using putty-wash impression technique. J Contemp Dent Pract. 2016 Sep;17(9):734-9.
29. Fenske C. The influence of five impression techniques on the dimensional accuracy of master models. Braz Dent J. 2000;11(1):19-27.
30. Mann K, Davids A, Range U, Richter G, Boening K, Reitemeier B. Experimental study on the use of spacer foils in two-step putty and wash impression procedures using silicone impression materials. J Prosthet Dent. 2015 Apr;113(4):316-22.
31. Hung SH, Purk JH, Tira DE, Eick JD. Accuracy of one-step versus two-step putty wash addition silicone impression technique. J Prosthet Dent. 1992;67(5):583-9
32. Chugh A, Arora A, Singh VP. Accuracy of different putty-wash impression techniques with various spacer thickness. Int J Clin Pediatr Dent. 2012 Jan;5(1):33-8.
33. Dugal R, Railkar B, Musani S. Comparative evaluation of dimensional accuracy of different polyvinyl siloxane putty-wash impression techniques-in vitro study. J Int Oral Health. 2013 Oct;5(5):85-94.
34. Kumari N, Nandeeshwar DB. The dimensional accuracy of polyvinyl siloxane impression materials using two different impression techniques: An in vitro study. J Indian Prosthodont Soc. 2015 Jul-Sep;15(3):211-7.
35. Levartovsky S, Zalis M, Pilo R, Harel N, Ganor Y, Brosh T. 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.
36. Nissan J, Rosner O, Bukhari MA, Ghelfan O, Pilo R. Effect of various putty-wash impression techniques on marginal fit of cast crowns. Int J Periodontics Restorative Dent. 2013;33(1):37-42.
37. Kumar MP, Patil SG, Dheeraj B, Reddy K, Goel D, Krishna G. A Comparison of Accuracy of Matrix Impression System with Putty

Reline Technique and Multiple Mix Technique: An In Vitro Study. J Int Oral Health. 2015 Jun;7(6):48-53.

38. Livaditis GJ. Comparison of the new matrix system with traditional fixed prosthodontic impression procedures. J Prosthet Dent. 1998;79:200-7.
39. Gonçalves F, Popoff D, Castro C, Silva G, Magalhães C, Moreira A. Dimensional stability of elastomeric impression materials: a critical review of the literature. Eur J ProsthodontRestor Dent. 2011;19(4):163-6.
40. Gordon GE, Johnson GH, Drennon DG. The effect of tray selection on the accuracy of elastomeric impression materials. J Prosthet Dent. 1990;63(1):12-5.
41. Balkenhol M, Ferger P, Wostmann B. Dimensional accuracy of 2-stage putty-wash impressions: influence of impression trays and viscosity. The International J Prosthodont. 2007 Nov;20(6):573-5.
42. Hoyos A, Soderholm KJ. Influence of tray rigidity and impression technique on accuracy of polyvinyl siloxane impressions. Int J Prosthodont. 2011;24(1):49-54.
43. Abuasi HA, Wassell RW. Comparison of a range of addition silicone putty-wash impression materials used in the one-stage technique. Eur J Prosthodont Restor Dent. 1994 Mar;2(3):117-22.
44. Rathee S, Eswaran B, Eswaran M, Prabhu R, Geetha K, Krishna G, et al. A comparison of dimensional accuracy of addition silicone of different consistencies with two different spacer designs - In-vitro Study. J Clin Diagn Res. 2014 Jul;8(7):ZC38-41.
45. Saunders WP, Sharkey SW, Smith GM, Taylor WG. Effect of impression tray design and impression technique upon the accuracy of stone casts produced from a putty-wash polyvinyl siloxane impression material. J Dent. 1991;19(5):283-9.
46. Shillingburg HT, Hatch RA, Keenan MP, Hemphill MW. Impression materials and techniques used for cast restorations in eight states. J Am Dent Assoc. 1980 May;100(5):696-9.
47. Tjan AH, Nemetz H, Nguyen LT, Contino R. Effect of tray space on the accuracy of monophasic polyvinylsiloxane impressions. J Prosthet Dent. 1992 Jul;68(1):19-28.
48. Rajapur A, Dixit S, Hoshing C, Raikar SP. The influence of tray space and repeat pours on the accuracy of monophasic polyvinylsiloxane impression. J Contemp Dent Pract. 2012 Nov-Dec;13(6):824-9.
49. Kumar V, Aeran H. Evaluation of effect of tray space on the accuracy of condensation silicone, addition silicone and polyether impression materials: an in vitro study. J Indian Prosthodont Soc. 2012 Sep;12(3):154-60.
50. Sayed NM, Aly NH, Rayyan MM. The effect of different double-step impression techniques on accuracy of stone dies. Egypt Dent J. 2015 Jan;61:641-50.
51. Nissan J, Gross M, Shifman A, Assif D. Effect of wash bulk on the accuracy of polyvinyl siloxane putty-wash impressions. J Oral Rehabil .2002;29(4):357-61.
52. Shiozawa M, Takahashi H, Finger WJ, Iwasaki N. Effects of the space for wash materials on sulcus depth reproduction with addition-curing silicone using two-step putty-wash technique. Dent Mater J. 2013 Jan;32(1):150-5.
53. Chaimattayompol N, Park D. A modified putty-wash vinyl polysiloxane impression technique for fixed prosthodontics. J Prosthet Dent. 2007 Dec;98(6):483-5.
54. Nejatidanesh F, Koopaee H, MoniriFard R, Savabi O. Dimensional accuracy of three polyvinyl siloxane putty – wash impression techniques. J Dent Sch. 2009 winter ;26(4):412-9.
55. Leão MP, Pinto CP, Sponchiado AP, Ornaghi BP. Dimensional stability of a novel polyvinyl siloxane impression technique. Braz J Oral Sci. 2014 Apr-Jun ;13(2):118-23.

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