

# Clinical Evaluation of One-Step Impression Technique and Definitive Casts

## SUMMARY

**Background/Aim:** The purpose of this study was to evaluate the quality of impressions made with vinyl polysiloxane (VPS) material in clinical conditions by using the one-step impression technique, and the quality of casts generated from these impressions. The effect of operator, number and location of abutments, and presence of bleeding were also investigated. **Material and Methods:** A total of 150 fixed dental prosthesis (FDP) impressions were taken and considered acceptable by 3 experienced prosthodontists in a clinic in an institutional setting. The impressions were evaluated and rated by another experienced prosthodontist and respective casts were evaluated and rated by an experienced dental technician using a digital microscope with  $\times 200$  magnification. The defects observed were noted as bubbles, voids, tears, or other defects. A scale was structured for the impressions and casts with ratings of Alpha (excellent; no defects), Bravo (acceptable; small defects), Charlie (inadequate; defects that require remaking of impression), and Delta (unacceptable; substantial defects at preparation finish lines). The data were analyzed with the Chi-square test for inter-operator, number of abutments, and location of prepared tooth variables ( $\alpha=0.05$ ). **Results:** The scale ratings were 85 Alpha (57%), 52 Bravo (34%), 6 Charlie (4%), and 7 Delta (5%) for the impressions, and 81 Alpha (54%), 58 Bravo (39%), 4 Charlie (3%), and 7 Delta (5%) for the respective casts. Sixty-nine percent of the impressions and respective casts were rated with the same score. The scale rating results were not influenced by inter-operator variability or number of abutments. Location of the prepared tooth was significant for anterior/posterior ( $p=0.04$ ), but was not significant for maxilla/mandible ( $p>0.05$ ). Bleeding at the preparation site had a significant effect on the acceptability of the impression ( $p=0.003$ ). **Conclusions:** The acceptability of VPS impressions using one-step technique was independent of the operator, number of abutments, or whether the prepared tooth was in maxilla or mandible. Impressions of teeth in the anterior region were more acceptable than those located in the posterior. Bleeding negatively affected the acceptability of the impressions. Clinicians may use VPS impressions for the fabrication of FDPs using one-step dual-phase technique. However, clinicians should carefully evaluate their impressions when bleeding is present when using this technique.

**Key words:** Dental Impression Technique, Dental Impression Materials, Vinyl Polysiloxane, Impression Quality, Fixed Dental Prostheses

Işıl Özcan<sup>1</sup>, Ashhan Köroğlu<sup>2</sup>, Ediz Kale<sup>3</sup>,  
Tuncer Burak Özçelik<sup>1</sup>, Burak Yılmaz<sup>4</sup>

<sup>1</sup> Department of Prosthodontics, Başkent University Faculty of Dentistry, Ankara, Turkey

<sup>2</sup> Fatma Kemal Timuçin Oral and Dental Health Hospital, Adana, Turkey

<sup>3</sup> Private Dental Practice, Adana, Turkey

<sup>4</sup> Department of Reconstructive Dentistry and Gerodontology, School of Dental Medicine, University of Bern, Bern, Switzerland; Department of Restorative, Preventive and Paediatric Dentistry, School of Dental Medicine, University of Bern, Bern, Switzerland; Division of Restorative and Prosthetic Dentistry, The Ohio State University, Ohio, USA

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## Introduction

Impression-making is crucial for an optimal cast, as the goal is to obtain a dimensionally stable “negative”

of the mouth to serve as a cast. An impression must accurately reproduce the static condition of the oral structures for a working cast<sup>1</sup>. The precision of the final restorations mostly depends on the techniques and

materials used during impression-making<sup>2</sup>. Therefore, advances in materials and development of newer techniques are essential to improve the accuracy of impressions<sup>3-9</sup>.

Vinyl polysiloxane (VPS) has been commonly used in dental practices due to its favourable detail reproduction and elastic recovery properties<sup>3,10</sup>. Its main advantages are low polymerization shrinkage, long-lasting dimensional stability, endurance, and absence of toxic or allergenic behaviour<sup>3,10-13</sup>. These materials vary in viscosity, rigidity, and working and setting times. In addition, they are odourless and tasteless and therefore, appealing for patients<sup>14</sup>.

The techniques available for silicone impression materials can be categorized as mono-phase or dual-phase. The dual-phase technique can be accomplished in one or two steps<sup>14</sup>. The one-step dual-phase technique, in which 2 VPS materials with different viscosity polymerize simultaneously, reduces chairside time and provides comfort for the patients<sup>14,15</sup>. However, working time remains a limiting factor because the dental professionals have to accommodate both the low-consistency and high-consistency materials at the same time before their final setting<sup>16</sup>. Nevertheless, this technique is commonly used for definitive impressions<sup>3-5</sup>.

Currently, American Dental Association advocates fine detail reproduction of 25µm or less for elastomeric impression materials used to fabricate precise casts<sup>17</sup>. VPS impression materials are capable of reproducing details as small as 1-2µm<sup>18</sup>. That is why the use of conventional impression methods with high-quality impression materials still is the most common technique for dentists<sup>3</sup>.

There are many studies investigated the impression accuracy in the literature<sup>3,5,7,8,10-12,14,19-26</sup>. However, few have reported on the quality of the impressions made in clinical conditions<sup>9,27-33</sup>. It is crucial to know whether clinicians are critically evaluating their impressions before they are sent to the laboratory. In daily clinical practice, impressions are often assumed by the clinicians to be error-free or acceptable; however, these may be returned by the laboratory after the stone cast is poured with the comment that it is inadequate for the fabrication of an accurately fitting fixed dental prosthesis (FDP). The variations for the perceptions for the acceptability of the impressions between clinicians and the dental technicians may lead to problems in the workflow, fabrication of ill-fitting FDPs, and efficiency. It is not known at what level a correlation is present between an FDP impression taken and accepted by a clinician and the respective stone cast evaluated by the dental technician.

The aims of this study were to evaluate the quality of one-step, dual-phase VPS impressions for the fabrication of FDPs, to investigate the errors detected in the impression, and to determine the correlation between the quality of the impressions and their respective casts using a structured scale. The first null hypothesis was that the one-step

impression technique using VPS would be acceptable in clinical practice and the second null hypothesis was that there would be no correlation between the quality of an impression and its definitive respective cast.

## Material and Methods

A total of 150 FDP impressions were made using metal impression trays (Bosworth; Keystone Industries, Gibbstown, NJ, USA) by 3 experienced prosthodontists in a university institution clinic. Written informed consents were obtained from patients for clinical documentation for scientific research without violating privacy rights. University Ethics Committee was also consulted and no need for an ethical approval was confirmed. All impressions were made with a VPS material (65; Elite HD+; Zhermack SpA, Rovigo, Italy and 85; Variotime; Kulzer GmbH, Hanau, Germany) using the one-step dual-phase technique. The one-step dual-phase impression technique with VPS material is commonly used at the institution this study was conducted for FDP fabrication.

The preparation finish lines of the abutments were 0.5 mm subgingival and a single retraction cord (Ultrapak #1; Ultradent Products Inc., South Jordan, UT, USA) technique was applied before the impressions were made. The abutment teeth were thoroughly rinsed with water, and air-dried to eliminate any remnants of the haemostatic solution (Hemoliq; TechNew Com. Ind. Ltd., Rio de Janeiro, Brazil) applied before the impressions were taken. The putty and heavy viscosity VPS impression materials were mixed with an auto-mixing device (Pentamix 2; 3M ESPE AG, Seefeld, Germany) and corresponding mixing tips for VPS putty or heavy-body materials were used to fill the stock tray while light-body VPS was syringed around the prepared teeth. Maxillary/mandibular and anterior/posterior locations, number of abutment teeth, and presence of bleeding around the abutments were noted before the impression procedure. Special emphasis was put on avoiding premature removal of the impressions; accordingly, the impressions were kept in the mouth until the time recommended by the manufacturer for setting was reached.

The impressions considered acceptable by the clinicians who made the impressions were collected. These impressions were visually inspected by another prosthodontist who was not involved in the impression-making. All casts were poured in type IV dental stone (Elite Rock; Zhermack SpA, Rovigo, Italy) by means of a vibrator to prevent entrapment of air in the liquid/powder mixture, the ratio of which was prepared according to the manufacturer's instructions. To avoid potential bias, the casts were poured by a practitioner other than the evaluator, and the identity of the practitioner who took the impression was not shared with the cast pouring

practitioner. The respective definitive casts were inspected by an experienced dental technician. Both the impression-evaluating practitioner and cast-evaluating technician used a digital microscope with  $\times 200$  magnification (Aven 26700-300 ZipScope USB Digital Microscope; Aven Tools Inc., Ann Arbor, MI, USA) and they were blinded to each other's ratings (Figure 1-2). The evaluations were done according to a structured rating scale for readability of the impressions<sup>30</sup> and their respective casts (Table 1; Figure 3-6).



Figure 1. Evaluation of impression using digital microscope ( $\times 200$  original magnification)

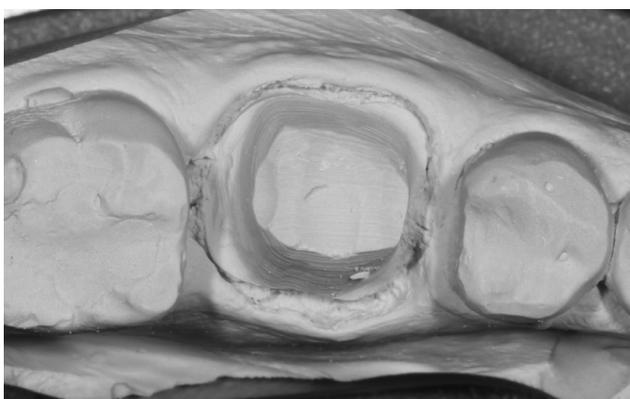


Figure 2. Stone cast after evaluation and before die preparation in laboratory

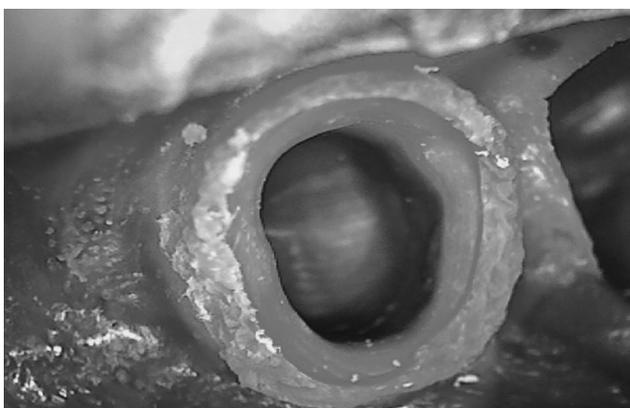


Figure 3. Alpha (excellent; no defects)

Table 1. Structured rating scale for impressions<sup>30</sup>, and their respective casts

	Code description
	Alpha: Excellent; no defects
	Bravo: Acceptable; small defects
1	Charlie: Inadequate; good reproduction of preparation finish line but other defects that require remaking of impression
	Delta: Unacceptable; substantial defects like at preparation finish lines
2	Tears (number and location)
3	Voids (number and location)
4	Bubbles (number and location)

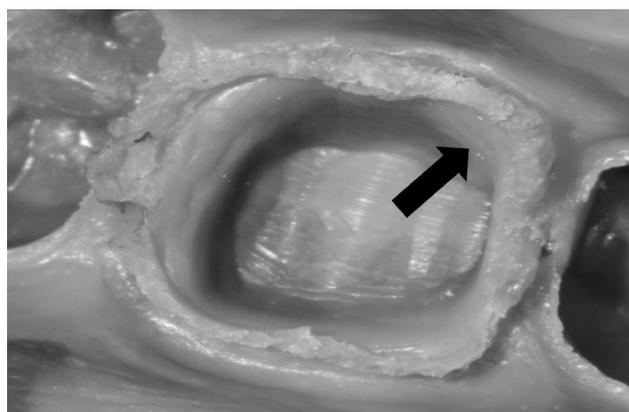


Figure 4. Bravo (acceptable; small defects)

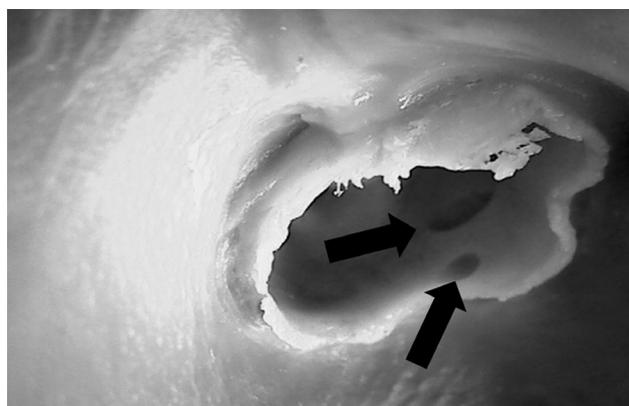


Figure 5. Charlie (inadequate; good reproduction of preparation finish line but other defects that require remaking of impression)

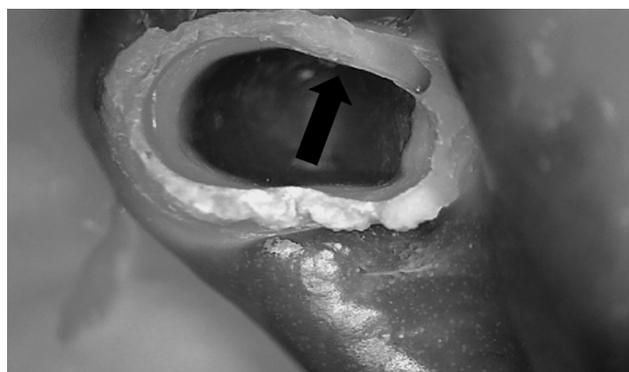


Figure 6. Delta (unacceptable; substantial defects at preparation finish lines)

When defects were observed on the impressions, those were documented as bubbles, voids, tears, or other defects, and their location was noted. Impressions with blood remnants around the prepared abutments were also noted, and the correlation between bleeding and impression rating was subsequently evaluated. Descriptive statistics were calculated for the results of the evaluations and the data were analyzed using the Chi-square test for inter-operator, number of abutments, and location of prepared tooth variables at a significance level of  $\alpha=0.05$ . Pearson correlation analysis was conducted to test the correlation of ratings between the VPS impressions and their respective dental stone casts.

Table 2. Clinical evaluator's and technician's rating results

	Alpha % (n)	Bravo % (n)	Charlie % (n)	Delta % (n)
Clinical evaluator's rating	57% (85)	34% (52)	4% (6)	5% (7)
Technician's ratings	54% (81)	39% (58)	3% (4)	5% (7)

n = number of samples.

One hundred and thirty-seven of the impressions (91%) were rated as Alpha or Bravo, which meant they were acceptable, and 13 were rated as Charlie or Delta (9%), accordingly were unacceptable. One hundred and thirty-nine of the definitive casts (93%) were rated as Alpha or Bravo and 11 were rated as Charlie or Delta (7%) by the dental technician (Table 3).

Table 3. Acceptable and unacceptable condition of impressions and casts

	Acceptable % (n)	Unacceptable % (n)
	(Alpha and Bravo)	(Charlie and Delta)
Clinical evaluator's rating	91% (137)	9% (13)
Technician's ratings	93% (139)	7% (11)

n = number of samples.

The defects observed on the impression surfaces were as follows: tears (34 [23%]), voids (21 [14%]), bubbles (1 [1%]), and other undefined defects (24 [16%]). Forty-three percent (65) of the impressions were affected at least by one defect (Table 4).

Table 4. Defects observed on impression surfaces

Tears % (n)	Voids % (n)	Bubbles % (n)	Other defects % (n)
23% (34)	14% (21)	1% (1)	16% (24)

n = number of samples.

Forty percent of all impressions were made in the presence of bleeding, and of those, 24 were rated as Alpha (40%), 25 as Bravo (42%), 5 as Charlie (8%), and 6 as Delta (10%) (Table 5). Of all the impressions, 7 were rated as Delta; 6 of those had bleeding at the marginal gingiva around the abutments and 6 of all impressions were rated as Charlie, 5 of which presented with bleeding at the preparation side.

## Results

The scale ratings were 85 Alpha (57%), 52 Bravo (34%), 6 Charlie (4%), and 7 Delta (5%) for the impressions and 81 Alpha (54%), 58 Bravo (39%), 4 Charlie (3%), and 7 Delta (5%) for their respective definitive casts. One hundred-three impressions (69%) and their respective casts were rated the same score by the evaluators (Table 2). The Pearson correlation test revealed a correlation between the scale ratings for the impressions and the definitive casts ( $r^2=0.651$ ).

Table 5. Rating scale of impressions made in bleeding environment

Alpha % (n)	Bravo % (n)	Charlie % (n)	Delta % (n)
40% (24)	42% (25)	8% (5)	10% (6)

n = number of samples.

The Chi-square test showed that the inter-operator variability or number of abutments had small influence on the scale rating. Whereas, the location of the prepared tooth was significant for anterior/posterior, but not for maxillary/mandibular. In the anterior, Alpha rating score was found to be predominant, whereas in the posterior, Bravo ratings were significantly more common ( $p=0.04$ ). Bleeding was also found to have a significant effect on the rating results ( $p=0.003$ ).

## Discussion

The results of the present study suggest that the one-step impression technique using VPS was acceptable (91%). Therefore, the first null hypothesis was accepted. The second null hypothesis that a correlation between the impressions and their respective casts would not be observed was rejected as a correlation was detected ( $r^2=0.651$ ).

It was found that 43% of the impressions (65) had at least one detectable error. Samet et al<sup>29</sup> reported that 89% of their impressions had observable errors, which is far more than that found in our study. This difference can be attributed to the different impression-making techniques and materials other than addition-type silicon used in the study by Samet et al<sup>29</sup>, and also to the fact that their study was based on review of

impressions by 41 different dental practitioners who were not specialized in prosthodontics. Whereas, in current study, the impressions were made by three experienced prosthodontists.

One reason for an inadequate impression using the one-step dual-phase method might be the entrapment of air between the impression material and the tooth. This is normally caused by inadvertently enclosing air while applying the light-body material with a syringe, especially when the tip of the syringe is lifted off during the procedure<sup>31</sup>. It can be speculated that the experience and skill of the clinician can be responsible for the quality of the results. This technique is relatively fast and often adopted by experienced practitioners to save chairside time; nevertheless, it cannot compensate for the errors potentially inherent in the two-step technique. In the present study, impressions were made by 3 experienced prosthodontists with an overall acceptability rate of over 91%, which is in accordance with Beier et al<sup>31</sup>, who reported a 97% rate of acceptable impressions.

Beier et al<sup>31</sup> also showed that the position of the teeth had no significant influence on the quality of the impression. They attributed this result to the small difference between impressions made on anterior/posterior or maxillary/mandibular teeth, also, to the high level of experience of the clinicians participating in the study. However, the current study identified a significant difference between anteriorly and posteriorly positioned teeth, despite the fact that the clinicians involved in the study were also experienced.

Blatz et al<sup>33</sup> reported an acceptability rate of only 76% when VPS impressions for FDPs were taken by undergraduate dental students using the one-step dual-phase technique. This report is also in correlation with the hypothesis that the clinical experience had an effect on the quality of one-step dual-phase impression method, which needs to be further investigated.

The Pearson correlation test revealed a correlation between the scale ratings of the impressions and the stone models ( $r^2=0.651$ ). One hundred and three (69%) impressions and their respective casts were rated with the same score by the evaluators. Only two of 47 pairs of impressions and casts were rated far out of correlation; the impressions were scored as Bravo, however, the stone models poured out of these impressions were considered to be clinically unacceptable and scored as Delta. This can be attributed to the difficulty in visually inspecting negative models (e.g., impressions) when compared with positive models (e.g., stone casts) of an original object, even when using a high-magnitude magnifier.

Forty percent of all impressions were made in the presence of bleeding and of all these impressions, 7 were rated as Delta while 6 of them had bleeding at the marginal gingiva around the abutments. Six of the impressions were rated as Charlie, 5 of which presented with bleeding at the preparation site. From these results,

it can be considered that 11 (85%) of the clinically unacceptable impressions were affected by bleeding, therefore, in the present study, bleeding had a significant influence on the rating of VPS impressions.

In the current study, putty and the heavy-body form of the impression materials used may have affected the results by causing a difference in the hydraulic pressure during impression-making. The difference between impression materials was not taken into account because the main goal of this study was not to evaluate differences in physical properties between the materials, but their tendency to errors in clinical use. It should be kept in mind that the impressions were made by prosthodontists who routinely implement the preparation and impression procedures in daily practice. It may be speculated that the results may change depending on the practitioner experience. The number of studies that have evaluated the clinical success of impression-making is limited. Further clinical studies comparing multiple materials, impression techniques, clinical conditions, and operators should be considered and should include larger sample sizes for complete assessment of VPS impressions.

## Conclusions

Within the limitations of this study, it can be concluded that;

1. The quality of the stone models was affected by VPS impressions.
2. Inter-operator variability, number of abutments, and whether the prepared teeth were in maxilla or mandible had a small effect on the impression's acceptability.
3. Bleeding at the preparation site and whether the prepared tooth was in anterior or posterior region affected the impression's acceptability.
4. Impressions made from VPS material for the fabrication of FDPs using the one-step dual-phase technique resulted in high acceptability.

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Correspondence

Ediz Kale  
Private ESTA Oral and Dental Health Polyclinic  
Bursa, Turkey  
e-mail: dtedizkale@yahoo.com