Short Communication

Dimensional Accuracy of 2-Stage Putty-Wash Impressions: Influence of Impression Trays and Viscosity

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The aim of this in vitro study was to evaluate the influence of the impression tray and viscosity of the wash material on the dimensional accuracy of impressions taken using a 2-stage putty-wash technique. Identically shaped metal stock trays (MeTs) and disposable plastic stock trays (DiTs) were used for taking impressions (n = 10) of a mandibular cast (4 abutments) with 2 different impression materials. Dies were poured and the relative diameter deviation was calculated after measurement. Zero viscosity of the materials was determined. Dimensional accuracy was significantly affected when DiTs were used. Lower-viscosity wash materials led to more precise impressions. *Int J Prosthodont 2007;20:573–575.*

Impression taking with disposable plastic stock trays (DiTs) is becoming increasingly popular for daily impression procedures. Rising awareness of the need to prevent cross contamination[1] and save time when cleaning and sterilizing are possible reasons. The use of DiTs, however, may affect the dimensional accuracy of impressions due to elastic rebound[2] during impression taking, especially when putty viscosities are used.[3–5]

Therefore, the aim of this study was to test the following null hypothesis: The dimensional accuracy of impressions taken in a 2-stage putty-wash technique is not affected by the viscosity of the wash material or by the tray material, if identically shaped trays are used.

Materials and Methods

Two polyvinyl siloxane impression materials were used with their respective tray adhesives (Table 1). Impressions were taken with highly rigid DiTs (Border-Lock, Clan BV) and the corresponding steel Schreinemakers trays (MeTs) of the same shape and size (size 54, mandibular; Clan BV). All experiments were carried out at ambient laboratory atmosphere (23°C).

Determination of Dimensional Accuracy

Four conical, standardized master abutments (convergence angle: 10 degrees) with parallel-sided areas at the base (buccal and lingual, width: 8 mm)—simulating abutment teeth—were fixed on a metal plate and completed with an acrylic resin mask to simulate a mandible. This master cast and the impression trays were mounted in a Zwick universal testing device (UTD) to standardize the impression procedure (Fig 1). Impressions were taken (n = 10) in random order using a 2-stage putty-wash technique at a constant crosshead speed (250 mm/min) in the UTD. The material was allowed to set for 10 minutes after each stage.

Dies were poured with type IV stone (Fuji-Rock, GC; linear expansion < 0.08%) 1 hour after impression taking. The casts were kept for 7 days prior to measuring the diameters of each of the 4 stone abutments 3 times using a micrometer screw (Mitutoyo; accuracy: 1 µm). Subsequently, the mean percentage of deviation (Δd [%]) between the stone abutments and master abutments was calculated.

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Table 1 No. of Impressions Taken with the 2 Impression Materials and Tray Types in the Test Groups*

Putty viscosity	Wash viscosity	Abbreviation	MeT	DiT
Panasil Putty	Panasil Contact Plus	Pan-P / Pan-CP	10	10
Panasil Putty	Provil Novo Light CD	Pan-P / ProN-LB	–	10
Provil Novo Putty	Provil Novo Light CD	ProN-P / ProN-LB	10	10
Provil Novo Putty	Panasil Contact Plus	ProN-P / Pan-CP	–	10

*Panasil is manufactured by Kettenbach; Provil is manufactured by Heraeus Kulzer. All materials (normal set) were used according to the manufacturers' instructions.
MeT = metal stock tray; DiT = disposable plastic stock tray.

Fig 1 *(left)* Disposable plastic impression tray fixed in a standardized position in the Zwick 1454 universal testing device (bottom). Master cast with the 4 metal master abutments and an acrylic mask representing a mandible fixed opposite to the tray in a reproducible position (top). The assembly is ready for impression taking. *(right)* Second stage of the 2-stage putty-wash impression.

Determination of Shore-A Hardness

The Shore-A hardness of the putty materials was determined 10 minutes after mixing using a HPSA Shore-A hardness gauge (Schmidt).

Determination of Zero Viscosity

The zero viscosity (η_0 [Pa·s]) of the wash materials was determined using an RS80 rheometer (Thermo Fisher Scientific) equipped with serrated 20-mm plates (distance: 0.5 mm). η_0 was determined at $\tau = 1$ Pa in the controlled stress mode (volume: 0.5 mL; $n = 6$).

Statistical Analysis

The data were subjected to parametric statistics ($P = .05$) since they were normally distributed (Kolmogorov-Smirnov test: $P > .05$).

Results

The results of the Shore-A hardness measurement and determination of η_0 are shown in Table 2. Figure 2 shows the results of the dimensional accuracy test, including the results of the statistical analysis. The use of MeTs significantly increased the dimensional accuracy ($P < .001$) and significantly reduced scattering of data (Levene test, $P < .05$). The use of the higher-viscosity wash material (Panasil Contact Plus) led to an increase in Δd ($P < .05$).

Discussion

This study was conducted to test the influence of the impression tray and the viscosity of the wash material on impression accuracy when using a 2-step putty-wash technique. The results suggest that the use of plastic trays significantly affects the dimensional accuracy of the impressions, despite the high rigidity of the DiTs used. The median Δd values represent a diameter deviation between 92 and 130 µm in the buccolingual plane. Taking into consideration the differential distortion[4] of the impression, the marginal discrepancies of restorations made on the affected stoned dies would inevitably rise. The results are in agreement with reports on 1-stage putty-wash impressions.[3,4] Hence it is hypothesized that, depending on the complexity of the

Table 2 Means and SDs for the Shore-A Hardness (n = 10) and Zero Viscosity (Pa•s) (n = 6)*

Material	Shore-A hardness	Zero viscosity
Pan-P	$68.5^{a} \pm 0.6$	-
ProN-P	$71.4^{b} \pm 0.4$	-
Pan-CP	-	$3{,}619^{a} \pm 365$
ProN-LB	-	$2{,}415^{b} \pm 205$

*Values with the same superscript letters are not significantly different (*t* test: $P < .05$) within each material parameter.

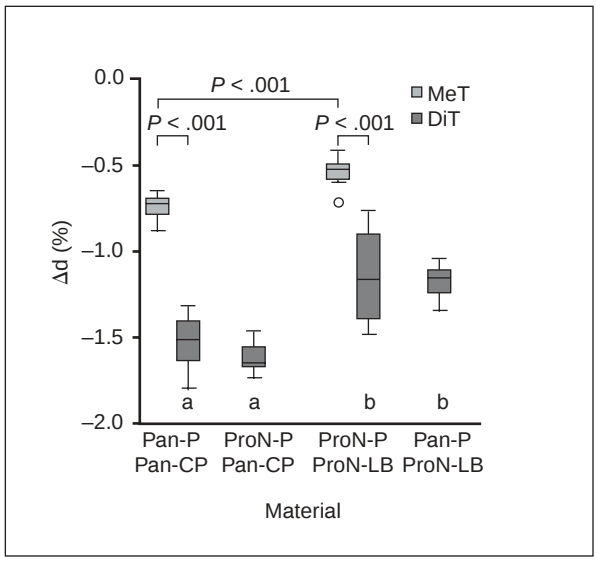

Fig 2 *(right)* Box-whisker diagram representing differences in diameter (Δd [%]) between the stone abutment and the steel master abutment. One percent deviation equals 80 µm. The ends of the boxes represent the 25th (lower) and 75th percentile (upper). Whiskers denote maximum and minimum values excluding extremes (o) and outliers (*). Same lowercase letters at the bottom of the box plot denote material combinations within the DiT group that are not significantly different (Games-Howell test: $P > .05$). *P* values denote results of the pairwise comparison of the respective groups (*t* test).

tooth preparation, accuracy may be clinically affected, resulting in poor fit of the final restoration. Impressions taken with Provil Novo Putty/Provo Novo Light CD in MeTs showed the highest dimensional accuracy and confirm the results of previously published data.[4]

An increase in scattering of Δd was noted for all DiT groups, indicating that impression taking is less reliable with this tray type. The viscosity of the wash material significantly affected the impression's accuracy. A possible explanation is the elastic deformation of the set putty material and tray,[2] caused by reduced flow of the higher-viscosity wash material during the second stage of impression taking. Summarizing the results, the null hypothesis was rejected.

Conclusions

Based on the findings of this in vitro study, the following conclusions can be drawn for 2-stage putty-wash impressions:

1. The use of metal trays is superior regarding the dimensional accuracy and reliability of impression taking, and should therefore be preferred.
2. A lower-viscosity wash material contributes to more precise impressions.

References

1. Connor C. Cross-contamination control in prosthodontic practice. Int J Prosthodont 1991;4:337–344.
2. Cho GC, Chee WW. Distortion of disposable plastic stock trays when used with putty vinyl polysiloxane impression materials. J Prosthet Dent 2004;92:354–358.
3. Carrotte PV, Johnson A, Winstanley RB. The influence of the impression tray on the accuracy of impressions for crown and bridge work—An investigation and review. Br Dent J 1998;185:580–585.
4. 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;2:117–122.
5. Thongthammachat S, Moore BK, Barco MT 2nd, Hovijitra S, Brown DT, Andres CJ. Dimensional accuracy of dental casts: Influence of tray material, impression material, and time. J Prosthodont 2002;11:98–108.

Erratum

In *IJP* issue 5, 2007, two numbers were printed incorrectly in the abstract of the article by Berg et al. The sentence should have read: "When assessed for bacteriological growth, the median cfu/mL of the untreated casts was between 10^5 and 10^6..." The publisher regrets this error.