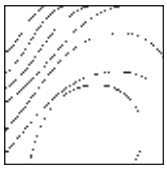
Effect of Various Putty-Wash Impression Techniques on Marginal Fit of Cast Crowns



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Marginal fit is an important clinical factor that affects restoration longevity. The accuracy of three polyvinyl siloxane putty-wash impression techniques was compared by marginal fit assessment using the nondestructive method. A stainless steel master cast containing three abutments with three metal crowns matching the three preparations was used to make 45 impressions: group A = single-step technique (putty and wash impression materials used simultaneously), group B = two-step technique with a 2-mm relief (putty as a preliminary impression to create a 2-mm wash space followed by the wash stage), and group C = two-step technique with a polyethylene spacer (plastic spacer used with the putty impression followed by the wash stage). Accuracy was assessed using a toolmaker microscope to measure and compare the marginal gaps between each crown and finish line on the duplicated stone casts. Each abutment was further measured at the mesial, buccal, and distal aspects. One-way analysis of variance was used for statistical analysis. P *values and Scheffé post hoc contrasts were calculated. Significance was determined at .05. One-way analysis of variance showed significant differences among the three impression techniques in all three abutments and at all three locations (*P < *.001). Group B yielded dies with minimal gaps compared to groups A and C. The two-step impression technique with 2-mm relief was the most accurate regarding the crucial clinical factor of marginal fit.* (Int J Periodontics Restorative Dent 2013;33:e37–e42. doi: 10.11607/prd.0713)

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Marginal fit of crowns is an important clinical factor at both the biologic and esthetic level that affects the survival of the restoration.[1–3] Clinically acceptable marginal fit varies from 50 to 120 μm.[4,5]

Accuracy is determined by the impressions, laboratory procedures (gypsum modeling, waxing, investment, and casting, which may be prevented by inspection of the internal surfaces of a cast for nodules and imperfections under microscopy), and the clinician during cementation.[6–10] The impression phase is influenced by the impression materials and techniques.[11–21] Polyvinyl siloxane (PVS), a widely used impression material for fixed partial denture fabrication, displays a high degree of detail reproduction, dimensional stability, and comfort.[22–24] The putty-wash technique is most commonly used to improve the accuracy of PVS impressions and includes multiple versions: a single-step, a two-step with controlled relief, or a two-step with a polyethylene spacer.[11–21,25,26] Of these three versions, the two-step with controlled relief is the most accurate.[17–21] A wash bulk thickness of up to 2 mm is the most

accurate for fabricating stone dies using PVS impression materials.[18]

There is little information regarding the relationship between these putty-wash impression techniques and the marginal fit of crowns. The nondestructive method accurately measures the marginal fit of cast restorations with precise measurements, as does statistical analysis of the results and cross-examination of the findings.[27–33] This study compared the influence of three PVS putty-wash impression techniques on the marginal fit of crowns using the nondestructive method. The null hypothesis was that there would be a significant difference in marginal fit resulting from the different impression techniques.

Method and materials

A metal master cast that contained three abutment teeth with full veneer crown preparations was fabricated using a computerized milling machine according to inserted data and was used as a positive control. A similar abutment design was used and validated in previous studies.[18,19] Three single metal crowns matching the three preparations were milled (2-mm thick) using the same computerized milling machine. A perforated tray was fabricated to match the master cast with a fixed position for each impression. From the master cast, 45 impressions were created and divided into three groups for each impression technique. Express PVS impression materials (7312 Standard Putty and 7301T Light Body, 3M ESPE) were used.

The three groups were as follows:

- Group A: single-step technique (putty and wash impression materials used simultaneously). An automatic mixing syringe dispensed the wash material. The impression was allowed to set on the master cast for 12 minutes.
- Group B: two-step technique with 2-mm relief. The metal crowns were placed on each abutment to create a uniform wash space. The putty impression was taken and allowed to set for 10 minutes. The crowns were removed and the wash material injected. The impression was reseated and allowed to set on the master cast for 12 minutes.
- Group C: two-step technique with a polyethylene spacer. A plastic spacer supplied by the manufacturer was placed over the master cast when the preliminary putty impression was made and allowed to set for 10 minutes. Wash material was then injected and the tray reseated and allowed to set on the master cast for 12 minutes.

Impressions were poured in improved die stone (type IV; Supra stone, Kerr). A metal index device was fabricated to create a uniform stone cast (Figs 1and 2). All materials were mixed in standardized proportions according to the manufacturer's recommendations. The tray adhesive supplied by the manufacturer was applied evenly over the tray's surface. Setting time was doubled compared to the manufacturer's recommendation to compensate for setting at room temperature instead of 37°C.[34]

All impressions were stored at room temperature (25°C) for 1 hour before pouring to ensure a similar humidity effect on the setting of the impression material. Since this was an in vitro study, no disinfection agents were used. The improved stone was mixed first by hand to incorporate the water and then mechanically under vacuum for 15 seconds. All mixes were poured into the impressions and allowed to set for 1 hour before separation. The prefabricated milled crowns were seated on each abutment of the stone cast using finger pressure. The insertion direction was controlled by the preparation. Marginal fit was measured using a toolmaker microscope (TM 300, series no. 176, Mitutoyo) attached to a two-dimensional data processor (Micro-Pack 5 MKII, series 264, Mitutoyo) with a measuring accuracy of 1 µm. The observer placed crosshairs on a starting point and recorded that position electronically. The crosshairs were then moved to the end point and again recorded electronically. The distance between these two points was displayed on a digital monitor (Fig 3).

The milled crowns were initially placed on the milled abutments and served as a baseline standard to ensure that any device discrepancy was not part of the sample measurements. Marginal fit was

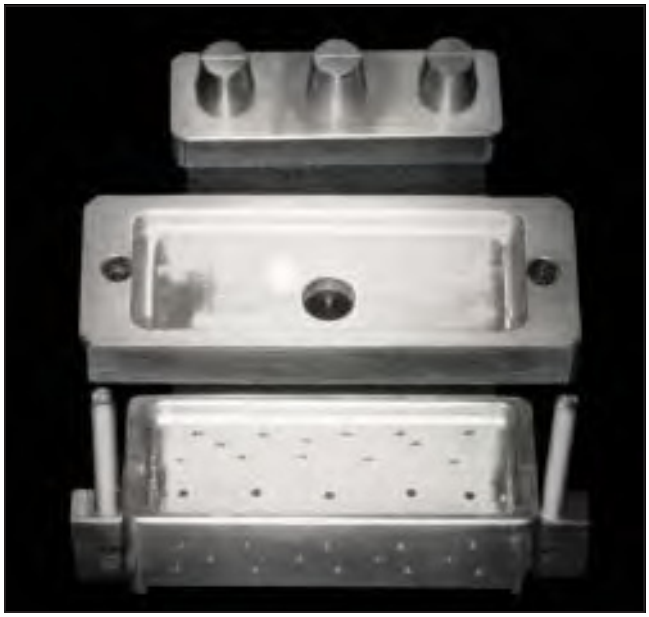

Fig 1 *Metal master cast containing three full crown–abutment preparations, perforated custom metal tray, and metal index device.*

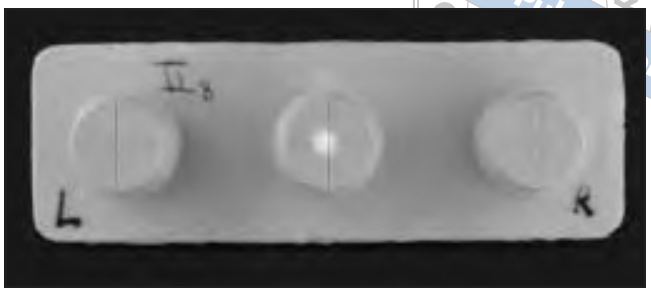

Fig 2 *Stone replica of the master cast.*

Fig 3 *Toolmaker microscope with electronic data processor.*

Table 1 **Mean ± SD distance (μm) between the cast margins and finish line at three aspects on the left abutment**

	Technique (group)			
	A	B	C	F*
Mesial	130.40 ± 3.64	77.07 ± 5.39	121.73 ± 3.01	717.25
Buccal	113.20 ± 10.25	42.00 ± 6.76	100.20 ± 7.06	322.45
Distal	123.87 ± 4.53	67.80 ± 7.67	110.53 ± 6.00	334.90
Combined	122.49 ± 3.61	62.29 ± 3.81	110.82 ± 3.44	1,165.84

SD = standard deviation
*$P < .001$.

assessed at three points along the crown margins for each abutment of the 3 milled and 45 stone casts: midmesial, midbuccal, and mid-distal. Measurements were repeated three times, and means and standard deviations were calculated. Visual inspection of the stone dies ensured lack of damage during the continual process of seating the crowns for measurement. Intraobserver variability for all measurements ranged from 5 to 9 μm, which equates to a measurement error of 0.01% to 0.08%.

Table 2 **Mean ± SD distance (μm) between the cast margins and finish line at three aspects on the middle abutment**

	Technique (group)			
	A	B	C	F*
Mesial	128.40 ± 5.44	69.60 ± 5.00	115.20 ± 7.19	403.11
Buccal	104.13 ± 4.34	44.27 ± 6.85	96.47 ± 3.54	609.82
Distal	125.27 ± 5.42	67.87 ± 4.53	110.07 ± 6.39	438.88
Combined	119.27 ± 2.32	60.58 ± 3.97	107.24 ± 2.36	1,620.79

SD = standard deviation.
*$P < .001$.

Table 3 **Mean ± SD distance (μm) between the cast margins and finish line at three aspects on the right abutment**

	Technique (group)			
	A	B	C	F*
Mesial	131.47 ± 3.34	71.00 ± 3.82	121.40 ± 4.53	1,021.51
Buccal	111.33 ± 3.48	47.60 ± 4.15	99.53 ± 3.60	1,222.13
Distal	123.73 ± 3.77	64.33 ± 4.08	112.33 ± 3.64	1,013.67
Combined	122.18 ± 2.64	60.98 ± 3.02	111.09 ± 2.41	2,184.61

SD = standard deviation.
*$P < .001$.

One-way analysis of variance was conducted to determine whether significant differences existed among the three techniques. *P* values and Scheffé post hoc contrasts were also calculated.

Results

Mean values of the gaps between the crown margin and finish line of the left, middle, and right abutments are presented in Tables 1 to 3. For each combination of abutment and location, a separate analysis of variance was conducted, which showed that in all combinations of abutments and locations, the differences in the marginal gaps were significant (Scheffé post hoc, $P < .001$). Gaps between the cast margin and finish line were smaller in group B compared to groups A and C. When the gaps in the three techniques were compared to the three abutments, the means were 121.31 ± 3.19 μm (group A), 61.28 ± 3.62 μm (group B), and 109.72 ± 3.24 μm (group C) (Scheffé post hoc, $P < .001$; Table 4).

Discussion

Marginal fit of a cast restoration is one of the factors that determines its long-term success. Marginal misfit could lead to coronal microleakage, secondary caries, and plaque accumulation resulting in gingival inflammation. This damage can initiate loss of the restored tooth.[1–3] Precise detail registration during impression taking is a crucial factor determining restoration fit and durability.[6–10] Putty-wash impressions can be made using

Table 4 **Mean ± SD distance (μm) between the cast margins and finish line at three aspects on all three abutments**

	Technique (group)			
	A	B	C	F*
Mesial	130.09 ± 4.33	72.56 ± 5.71	119.44 ± 5.92	1,462.41
Buccal	109.56 ± 7.67	44.62 ± 6.35	98.73 ± 5.17	1,297.05
Distal	124.29 ± 4.57	66.66 ± 5.77	110.97 ± 5.44	1,465.85
Combined	121.31 ± 3.19	61.28 ± 3.62	109.72 ± 3.24	4,047.69

SD = standard deviation.
*$P < .001$.

several techniques. Many studies have reported the importance of impression techniques, but with contradictory conclusions. Impression accuracy is not technique-dependent,[25,26] though the technique is a critical factor that influences the accuracy of the impression.[17–21]

This study examined the accuracy of three popular PVS putty-wash impression techniques through marginal fit assessment with the nondestructive technique by measuring the vertical discrepancy using a toolmaker microscope. This should further enhance knowledge regarding the accuracy of these specific impression techniques.[17–21] The nondestructive method used in this in vitro examination has been described as a safe, reliable, and precise system to assess the quality of marginal fit around crowns.[29]

Compared to groups A and C, the two-stage impression technique with a 2-mm relief (group B) exhibited smaller gaps between the cast crown margin and finish line in all stone cast abutments. The mean marginal gap in this group was approximately 60 μm, close to the minimal (favorable) distance measured between the crown margins and tooth.[4,5] Groups A and C yielded mean marginal gaps approaching 120 μm, making the marginal gap unfavorable as a result of the cementation stage along with several other distorting stages (metal casting and processing, porcelain firing, polishing, etc) that come later in restoration fabrication.

These results support previous findings[19] and are in agreement with other studies that showed that the putty-wash two-step impression technique, using a wash bulk of 2 mm, was more accurate than the one-step technique or the two-step technique with a polyethylene spacer. The latter two are characterized by uncontrolled wash bulks (either insufficient or excessive) and a high risk of capturing portions of the prepared margin in the putty material rather than the wash material.[17–21] However, additional clinical studies are necessary to determine the accuracy of the impression technique in the intraoral environment.

Conclusions

Within the limitations of this study, the two-stage impression technique with a 2-mm relief (group B) was the most accurate method for PVS impression taking compared to the one-step technique (group A) and two-step technique with a polyethylene spacer (group C). Using the two-stage technique with a 2-mm relief will ensure the best marginal fit of a cast restoration.

Acknowledgment

The authors reported no conflicts of interest related to this study.

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