Quality of Impressions Using Hydrophilic Polyvinyl Siloxane in a Clinical Study of 249 Patients

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Purpose: This study aimed to evaluate the clinical success of a hydrophilic polyvinyl siloxane impression material for fixed dental restorations under various clinical conditions. ***Materials and Methods:*** A total of 1,466 preparations for fixed restorations in maxillary and mandibular anterior and posterior teeth were evaluated. The study contained inlay, onlay, crown, veneer, post, and adhesive-wing preparations and implants for gold, porcelain-fused-to-metal, and ceramic restorations. The preparation finish line relative to the crest of the marginal gingiva, type of restoration, and position of the teeth were recorded. Three categories were established to rate impression quality: perfect impressions, with an absence of any voids or bubbles and perfect reproduction of the preparation finish line, were rated Criteria I; acceptable impressions, with minimal defects (≤ 2 mm) not involving the preparation finish line, were rated Criteria II; and unacceptable impressions, with larger voids or bubbles (> 2 mm) or defects involving the preparation finish line, were rated Criteria III. ***Results:*** Overall, 96.86% of the final impressions were clinically acceptable, 89.43% of which were rated Criteria I and 7.43% of which were rated Criteria II. Only 3.14% of the impressions were unacceptable and rated Criteria III. A significant influence on impression quality was found when the preparation finish line was more than 2 mm subgingival ($P < .004$), as well as when a beveled preparation was used ($P < .004$). The position of the teeth ($P > .404$) had no significant effect. ***Conclusion:*** Surface-activated polyvinyl siloxane impression material offers high predictability to avoid bubbles and voids in the final impression. *Int J Prosthodont 2007;20:270–274.*

Obtaining an optimal impression for fixed restorations is still considered one of the most challenging procedures in dentistry, especially in subgingival preparations, which have an increased risk of blood and sulcus fluid contamination during impression taking.

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Polyvinyl siloxane (PVS) impression materials represent the state of the art in elastomeric impression materials in prosthodontics and restorative dentistry.[1–4] Their main advantages are low polymerization shrinkage, long-lasting dimensional stability and endurance, and an absence of toxic or allergenic behaviors.[5–10] Further, PVS materials have the best fine detail reproduction and elastic recovery of all available materials.[11] However, because of their hydrophobic nature, PVS applications are limited to dry environments. To achieve higher compatibility of these materials with moist surfaces, manufacturers add tensides to almost all products in the market.[12–15] Today, the vast majority of dental impression materials claim to be hydrophilic, which is usually documented by the contact angle of water on the cured silicone surface.[3] However, this only represents the situation when a gypsum cast is poured, which is important for fabrication but has little value for clinical work. The most interesting parameter for the practitioner

is wetting and flow behavior of the mixed uncured silicone on the dental tissues. Therefore, current research on dental impression materials focuses on improvement of these parameters. The PVS impression material used in this study (Affinis, Coltène/Whaledent) may offer some improvements regarding flow and affinity to humid environments, which will facilitate better impressions and clinical handling. In a study on the wetting ability of this material, Rupp et al[16] showed that the wettability was maintained at a constant range during the whole working time. Blatz et al[17] showed that the PVS impression material used in their study produced fewer failures and voids than other products.

The purpose of the present study was to evaluate the clinical success of Affinis PVS impression material under various clinical conditions.

Materials and Methods

A total of 249 patients treated over a 3-year period were included in this study. All patients were recruited through the departments of prosthetic and restorative dentistry, Innsbruck Medical University, Austria. The patients required various types of indirect fixed restorations in anterior and posterior teeth. As preliminary treatment, all patients took part in the dental hygiene program at the clinic. Prior to preparation, all teeth had to be free of active periodontal inflammation and show probing depths less than 3 mm with no bleeding on probing.

The preparations and impressions were carried out by experienced dental clinicians at the departments of prosthodontics and restorative dentistry.[18]

The impression taking of 1,466 preparations for fixed restorations in anterior and posterior teeth in the maxilla and mandible was performed according to accepted universal guidelines for tooth preparation.[19] The study contained inlay, onlay, crown, veneer, post, and adhesive-wing preparations and implants for gold, porcelain-fused-to-metal, and all-ceramic restorations. The type of preparation and position of the teeth were recorded. A distinction was made between shoulder and beveled preparations. Beveled preparations were done for gold and porcelain-fused-to-metal restorations. Adhesive restorations were done with shoulder preparations.

The position of the preparation finish line was measured with a periodontal probe in respect to the crest of the marginal gingiva and recorded using the following classification:

- Level I: Preparation finish line located supragingival
- Level II: Preparation finish line located epigingival
- Level III: Preparation finish line located ≤ 2 mm subgingival
- Level IV: Preparation finish line located > 2 mm subingival

To arrest capillary bleeding from minor injuries of the gingiva, a hemostatic solution containing aluminum chlorate (Orbat, Lege Artis) was applied by pressing soaked cotton pellets to the wounds. In some cases, a ferric sulfide–based hemostatic solution (Visco Stat, Ultradent) was used.[4]

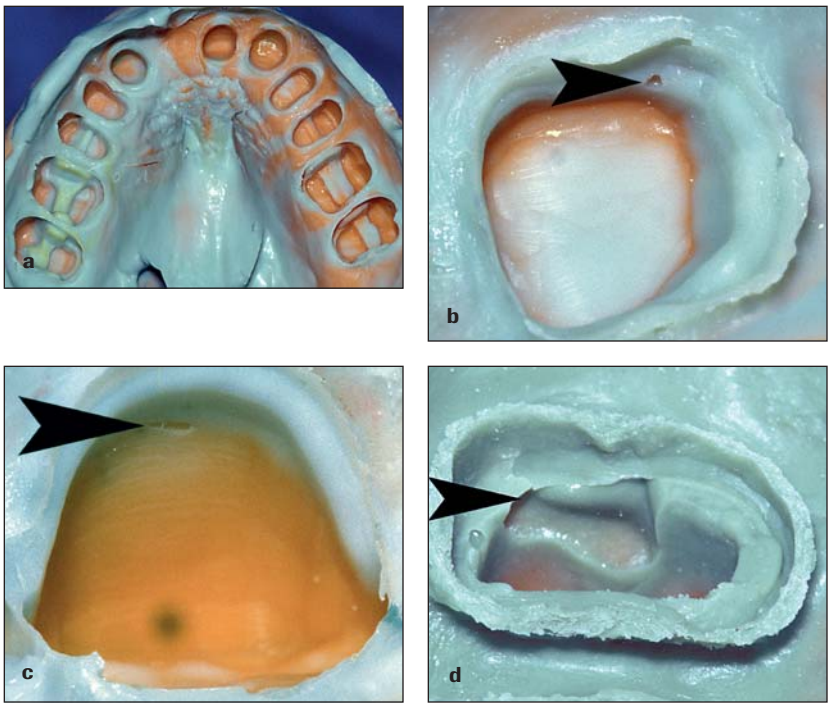
The impression-taking procedure followed a standardized protocol. Only full-arch impressions were carried out using individual trays (Pekatray, Heraeus Kulzer).[2] For perfect adhesion, a thin layer of adhesive (Adhesive, Coltène/Whaledent) was applied to the tray 10 to 15 minutes before taking the impression to permit adequate bond strength of the impression material to the tray.[20] One retraction cord (Ultrapack, Ultradent) was placed around each prepared tooth for gingival displacement if the preparation finish line was situated epigingivally or subgingivally. The retraction cord was left in place for about 10 to 15 minutes. After the cord was removed, the abutment teeth were thoroughly rinsed with water and air dried to prevent any interaction of the astringent with the impression material. If bleeding continued, the procedure was applied again as described above. The impression was taken only when the area was completely dry. For moisture control, cotton rolls and pads were used. The 1-step double-phase impression technique was used. Heavy-body and light-body materials were mixed simultaneously using automixing systems.[2] After the light-body material was applied to the abutment teeth, the individual tray filled with the heavy-body material was seated in place in the mouth.

Light finger pressure was used to stabilize the impression tray. The manufacturer's recommendations for working and polymerization times were followed strictly.

Quality Evaluation Protocol

The quality of each impression was evaluated by visual inspection by 1 dental clinician and the laboratory technician responsible for the restoration. The impression was examined using a laboratory microscope (Opmi Pico, Zeiss) and lenses with 2× to 6× magnification for the presence or absence of bubbles or voids and the complete reproduction of the preparation finish line. Bubbles were defined as a globular or half-globular space caused by air entrapments in the impression material. Irregular defects in the impression material with a glossy surface were classified as voids.

Three possible categories were established to rate the impression quality (Figs 1a to 1d). Perfect impressions, with an absence of voids or bubbles and perfect reproduction of the preparation finish line, were rated Criteria I. Minimal defects in the impression up to 2 mm in diameter not involving the preparation finish line that



Figs 1a to 1d Three categories were established to rate the quality of the final impressions: **(a)** Criteria I: perfect impression, with no voids or bubbles; **(b and c)** Criteria II: acceptable impression, minimal voids or bubbles not involving the preparation finish line; **(d)** Criteria III: unacceptable impression, with large voids and bubbles.

Table 1 Classification of Impressions (No. and %) According to Level of Preparation Finish Line*

	Level I	Level II	Level III	Level IV	Total
Criteria I	289 (97.3)	421 (92.7)	493 (86.5)	108 (74.5)	1,311 (89.43)
Criteria II	8 (2.7)	27 (5.9)	52 (9.1)	22 (15.2)	109 (7.43)
Criteria III	0	6 (1.3)	25 (4.4)	15 (10.3)	46 (3.14)
Total	297	454	570	145	1,466

*Level I = supragingival; II = epigingival; III = ≤ 2 mm subgingivally; IV = > 2 mm subgingivally.

Table 2 No. (%) of Classified Impressions According to Preparation Finish Line

	Shoulder preparation	Beveled preparation	Total
Criteria I	812 (91.2)	499 (86.6)	1,311 (89.43)
Criteria II	60 (6.7)	49 (8.5)	109 (7.43)
Criteria III	18 (2.0)	28 (4.9)	46 (3.14)
Total	890	576	1,466

could be corrected by the technician on the casts were considered acceptable and rated Criteria II. If impressions showed bigger voids or bubbles (more than 2 mm in diameter) or defects involving the preparation finish line, they were categorized as unacceptable and rated Criteria III.

Statistical Analyses

The data were tabulated using SPSS 13.0 software (SPSS), and Kruskal-Wallis nonparametric statistical tests were carried out. The level of significance was set at 5%.

Results

The impressions of 1,466 prepared teeth were examined and evaluated. Overall, 96.86% of the final impressions were acceptable, 89.43% of which were rated perfect (Criteria I) and 7.43% of which were rated acceptable (Criteria II). Only 3.14% of the impressions were unacceptable (Criteria III). The frequency of acceptable and unacceptable final impressions according to the level of the preparation finish line is presented in Table 1.

The Kruskal-Wallis test revealed significant associations between level of the preparation finish line ($P < .004$) and quality of the final impression. Also, the beveled preparations showed significantly worse results ($P < .004$) than the shoulder preparations (Table 2). All of the impressions were acceptable when the preparation finish line was supragingival, or when the preparations were made for veneers, implants, or adhesive wings.

Table 3 shows the number and distribution of teeth in the maxilla and mandible. No significant association was found between quality of the impression and

Table 3 No. of Prepared Teeth According to Tooth Position*

Prepared teeth (n)	7	57	74	62	59	51	46	60	52	46	46	67	63	62	53	9	814
Maxilla	18	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28	
Mandible	48	47	46	45	44	43	42	41	31	32	33	34	35	36	37	38	
Prepared teeth (n)	17	87	86	66	40	26	15	16	15	15	22	40	57	73	65	12	652

*FDI tooth-numbering system.

anterior or posterior teeth ($P < .404$) or teeth in the maxilla or mandible ($P < .280$).

Discussion

This clinical study aimed to evaluate the clinical success of impressions made with the PVS material Affinis (Coltène/Whaledent), as determined by the presence or absence of bubbles or voids and the complete reproduction of the preparation finish line. To improve the clinical procedure, the reasons for failure were evaluated. Therefore, the level of the preparation finish line, type of preparation, and position of teeth in the mouth were compared. The critical area for success was mainly the finish line of the preparation, which is often situated subgingivally. This increases the risk of blood and sulcus fluid contamination during the impression-taking procedure, especially when the gingival tissue is injured during preparation or application of the retraction cord. The situation is even worse if gingival inflammation is present. To prevent any negative effects of gingival inflammation on impression taking, all teeth had to be free of active gingival and periodontal inflammation with probing depths less than 3 mm and no bleeding on probing prior to preparation. A more compromised oral environment may have produced different results.

Another reason for inadequate impressions is the entrapment of air bubbles between the impression material and the tooth.[21] This may be caused by inadvertently enclosing air while applying the light body material with the syringe, especially when the tip of the syringe is lifted off during the procedure.

In the present study, there was a significantly higher failure rate ($P < .004$) when the preparation finish line was situated more than 2 mm subgingivally. Also, when the border of the preparation had been beveled, the risk of gingival injury was obviously increased and the results were significantly worse ($P < .004$). In this study, 2 different hemostatic agents were used, depending on the personal preference of the clinician. No differences in the clinical success of the impressions were found between the 2 agents.

The experience and manual skill of the clinician are responsible for the quality of the results.[18] In this study, the preparations and impressions were carried out by experienced clinicians, with an overall success rate of 96.86%. In a clinical trial using the same impression material on 65 teeth, Blatz et al[17] reported a 92.30% rate of acceptable impressions. The clinical procedure in that study was performed by third-year undergraduate dental students, which may explain the difference between the results. The experience of the clinician may also be responsible for the lack of difference between impressions made on anterior or posterior teeth or teeth in the maxilla or mandible.

In addition, the physical properties of the impression material will influence the success. The PVS material used in this study offers good wettability and flow behavior on dental tissue. For PVS materials in general, some guidelines regarding handling must be observed. As shown by Darvell,[22] the astringents may interact with the ingredients of the impression material by inhibiting polymerization through the metal ions within the astringents. Therefore, the tissue must be rinsed carefully with water after the use of this material before the impression is made. A similar problem may be caused by sulfur on the surface of rubber gloves or rubber dam, which may contaminate the chloroplatinic acid in the catalyst and inhibit polymerization.[22–25] The use of polyvinyl gloves is therefore recommended.

Conclusions

This clinical study of a surface-activated PVS impression material revealed a high rate (96.86%) of acceptable final impressions. Significantly worse results were found when the preparation finish line was beveled or situated more than 2 mm subgingivally. When these results are compared to other studies, it appears that the experience and manual skill of the dental clinician is also influence the success of the impression.

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Literature Abstract

Short dental implants as a treatment option: Results from an observational study in a single private practice

The objectives of this prospective observational study were *(1)* to establish that short implants (6 to 8 mm in length) could produce comparable clinical results with those achievable with longer implants, and *(2)* to demonstrate that short implants could be used in situations in which longer implants could not be used because of limited available bone, unless additional bone grafting or augmentation procedures were carried out. Patient exclusion criteria included uncontrolled diabetes mellitus, alcoholism, and systemic immune disorders. Smoking was not considered a contraindication, but patients were forewarned that smoking was associated with an increased risk of implant failure. A total of 630 Straumann implants placed in 264 patients by a single private practitioner between April 1994 and December 2003 were included in this study. Five hundred thirty-six were placed in partially edentulous jaws and 94 were placed in completely edentulous jaws. Thirty-five (5.6%) of these implants were 6 mm long, 141 (22.4%) were 8 mm long, and the remaining 454 (72.1%) were 10 to 16 mm long. All 6-mm-long implants were placed in posterior mandibular sites. Of the 10- to 16-mm-long implants, 82.2% were placed in the mandible, along with 90.1% of the 8-mm-long implants. Tthe remaining implants were placed in various sites in the maxilla. More than half of the 6-mm implants were placed in type 4 bone. All implants were placed at least 6 months postextraction and loaded 3 to 5 months following surgery. Implants situated in adjacent sites were routinely splinted, regardless of length. All clinical data were subjected to calculation of 2-year absolute success rates, as well as life table analyses. Absolute success rates at 2 years were 94.3%, 99.3%, and 97.4% for 6-mm, 8-mm, and 10- to 16-mm implants, respectively. Life table analysis revealed cumulative success rates of 94.2%, 99.2% and 97.0% at 2 years, respectively. There was a high dropout rate, with only 7 of the 6-mm implants evaluated after 2 years. Limitations of this study were the lack of a clear distinction between success and survival definitions, a short follow-up period of only 2 years, and a high dropout rate for the 6- and 8-mm implants. Nevertheless, this study seems to suggest that 6- and 8-mm Straumann implants may be a viable treatment option in patients with limited available bone in the short term.

Arlin ML. *Int J Oral Maxillofac Implants* 2006;21:769–776. **References:** 28. **Reprints:** Dr Murray L. Arlin, 1436 Royal York Road, Suite 209, Toronto, Ontario M9P 3A9, Canada. E-mail: murray.arlin@utoronto.ca—*Elvin W.J. Leong, Singapore*