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CLINICAL RESEARCH

Edentulous jaw impression techniques: An in vivo comparison of trueness

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ABSTRACT

Statement of problem. Simplified edentulous jaw impression techniques have gained popularity, while their validity has not yet been evaluated.

Purpose. The purpose of this clinical study was to compare the trueness of maxillary edentulous jaw impressions made with irreversible hydrocolloid (ALG), polyvinyl siloxane (PVS), PVS modified with zinc oxide eugenol (ZOE) (PVSM), and an intraoral scanner (TRI) with a conventionally border-molded ZOE impression (control).

Material and methods. Twelve edentulous maxillary impressions were made with the impression techniques. The analog impressions were scanned using a laboratory scanner, imported into 3-dimensional comparison software, and superimposed against the corresponding control. Trueness was evaluated by calculating the effective deviation known as root mean square (RMS) for the entire surface (ES) and for specific regions of interest such as peripheral border, inner seal, midpalatal suture, ridge, and posterior palatal seal. The secondary outcomes for this study were the patients' perception of the impression techniques. Statistical analyses with the Wilcoxon tests were carried out (α=.05).

Results. For ES, significant differences were found when comparing ALG (1.21 ±0.35 mm) with PVS (0.75 ±0.17 mm; *P*=.008), PVSM (0.75 ±0.19 mm; *P*=.012), and TRI (0.70 ±0.18 mm; *P*=.006) but not among the other groups. Significant differences were found for peripheral border when comparing ALG (2.03 ±0.55 mm) with PVS (1.12 ±0.32 mm; *P*=.006), PVSM (1.05 ±0.29 mm; *P*=.003), and TRI (1.38 ±0.25 mm; *P*=.008), as well as TRI and PVSM (*P*=.028). Significant differences were also found for inner seal when comparing ALG (0.74 ±0.36 mm) with PVSM (0.52 ±0.13 mm; *P*=.041), as well as TRI (0.8 ±0.25 mm) versus PVS (0.56 ±0.14 mm; *P*=.005) and PVSM (*P*=.005). The difference at the ridge was significant when comparing PVS (0.18 ±0.07 mm) with PVSM (0.28 ±0.19 mm; *P*=.015) but not among the other groups. A significant difference was also found for posterior palatal seal when comparing PVS (0.55 ±0.41 mm) with PVSM (0.60 ±0.43 mm; *P*=.034). Patient perceptions showed significantly better satisfaction scores for ALG (1.83 ±2.03) and PVS (3.17 ±2.40) than for TRI (4.08 ±2.71), PVSM (4.58 ±2.35), and ZOE (6.83 ±1.75).

Conclusions. Edentulous impressions made with PVS, PVSM, and TRI had similar deviations and may yield clinically acceptable results. Irreversible hydrocolloids are contraindicated for definitive impression making in completely edentulous jaws. (J Prosthet Dent 2019;121:623-30)

The impression technique and material used to fabricate a complete denture determine the degree of intimate contact with the denture-bearing tissues, both at rest and during function, and thus also determine denture retention.[1] Protocols for impression techniques and materials include registering the functional border and intaglio surface in 2 separate steps or in 1 single step.[2] A single-step protocol using elastomeric impression materials in an open-mouth

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Clinical Implications

Making impressions of the dentulous jaw with polyvinyl siloxane is a valid straight forward technique that is accepted by patients. Intraoral scans for edentulous jaws are feasible, but patient selection is still paramount. Irreversible hydrocolloid should not be used as a definitive impression material.

or closed-mouth technique is often used in dental practice or when computer-aided design and computer-aided manufacturing (CAD-CAM) milled dentures are being fabricated.[3-6] To date, the 2-step impression technique still remains the gold standard for complete dentures, with the first step comprising a functional border molding with modeling plastic impression compound and the second step for the impression of the entire intaglio surface with zinc oxide eugenol (ZOE) paste or polysulfide polymer.[7,8] Some clinicians add a third step (Utz[9]), a separate impression layer of ZOE for the inner seal (IS), aiming for a circumscribed compression of the tissues for improved denture retention. These conventional impression methods provide better patient satisfaction when compared with irreversible hydrocolloid or alginate (ALG) loaded in a stock tray.[10]

Nevertheless, a survey in the UK revealed that 94% of participating dentists used an irreversible hydrocolloid material for definitive impressions.[11] A randomized clinical trial comparing dentures fabricated based on either irreversible hydrocolloid or polyvinyl siloxane (PVS) impressions found that 67.9% of patients preferred the denture fabricated with the PVS impression, while 17.9% preferred the one with irreversible hydrocolloid. After denture adjustment, the trial was unable to detect a significant difference in the patients' assessment of comfort.[12] Cost and time reduction seem to influence the dentists choice of impression materials and techniques.[13-16] A notable discrepancy, therefore, exists between textbook teaching, scientific literature, and dental practice.[13,17]

Clinicians choose among different materials and techniques and select the most cost-efficient and comfortable technique for the patient, whose perceived burdens vary with respect to the chosen impression material and the different steps during impression making.[18] Contemporary techniques allow for digital scanning, thus avoiding physical contact with the denture-bearing tissues. A systematic review reported that patients assessed the intraoral scanner as more comfortable and causing less anxiety and nausea when compared with conventional impressions.[19]

Digital and conventional workflows can be combined, and because digital scanning of the edentulous jaw is not yet an established treatment, dentures are often fabricated based on a conventional impression which is then scanned locally or in a remote manufacturing center. The occlusal records are also scanned and then superimposed by using a best-fit algorithm to the impression. The appropriate software can design the definitive denture.[3] The complete denture or denture base can subsequently be milled. When an intraoral scan is made, the scan of the occlusal records can be superimposed.[20] The presence of large edentulous areas has been reported as problematic, as precision is reduced when stitching the individual images.[21] Lee[22] suggested drawing irregular shapes on the residual ridge to create landmarks for the IOS, thereby facilitating the stitching of the images. The use of resin markers on the palate has been reported to facilitate the IOS of a broad palate area.[23] The use of a land-marking technique improves the accuracy of impressions for fixed prostheses with long-span edentulous areas.[24]

The purpose of this clinical study was to assess the trueness of completely edentulous jaw impressions made with 4 different materials and techniques, namely irreversible hydrocolloid (ALG), PVS, PVS modified with ZOE paste (PVSM), and an intraoral scan (TRI) (TRIOS; 3Shape) when compared with a conventionally border-molded ZOE impression (control). The null hypothesis was that no difference would be found in the trueness of ALG, PVS, PVSM, and TRI impressions when compared with the ZOE control. This study also registered patient's perspectives on the different techniques and materials by means of a questionnaire.

MATERIAL AND METHODS

Approval was obtained from the local ethical committee (2016-01157). Patients attending the University Clinics of Dental Medicine of the University of Geneva for either a recall or treatment were recruited for this study. The inclusion criteria consisted of having a well-formed edentulous maxillary arch, being willing to participate in the study, and having signed the informed consent form. The exclusion criteria comprised excessive maxillary ridge resorption (Cawood degree 5/6),[25] having bony undercuts of the denture-bearing tissues of more than 2 mm, flabby ridges, poor neuromuscular control, and hyposalivation. Hyposalivation was assessed by means of the unstimulated salivary flow rate, and patients producing less than 0.3 mL/min to 0.5 mL/min were excluded.[26]

All patients had 2 appointments, with a total of 5 impressions all made by a single operator (N.C.). The first appointment was 20 minutes long and included an examination and an impression of the maxillary arch with an irreversible hydrocolloid impression material (Blueprint Xcreme; Dentsply Sirona) using a stock tray (Schreinemakers Kit; Clan Dental Products). In the

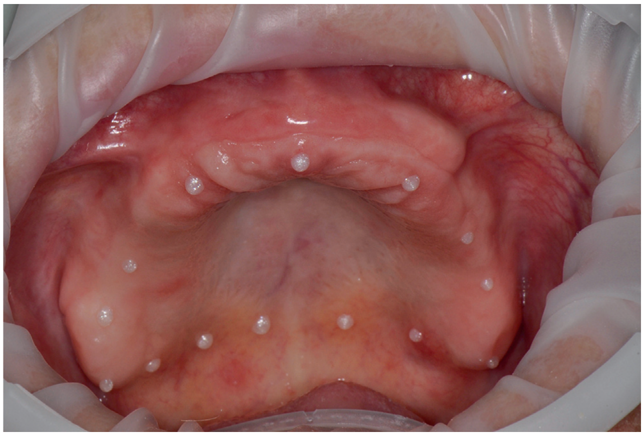

Figure 1. Land marking of edentulous ridge.

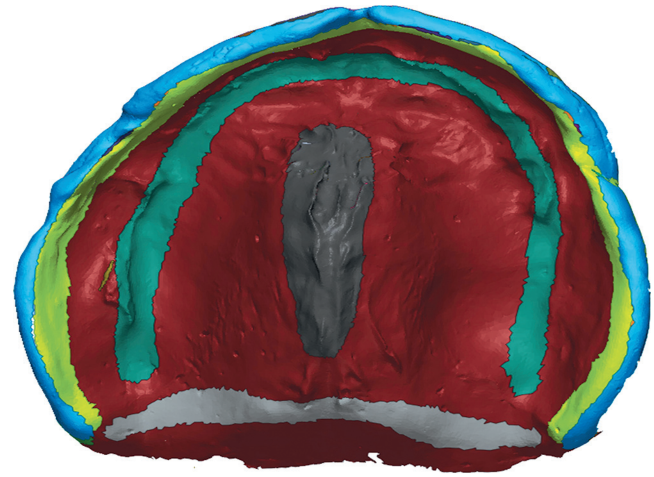

Figure 2. Five samples from important regions of interest delineated on reference model: midpalatal suture, peripheral border, inner seal, ridge, and posterior palatal seal.

laboratory, the impressions were sprayed with an anti-shine scanning spray (Helling 3D Scan Spray; Helling GmbH) and digitized with a high-resolution optical scanner with 6-μm precision (Iscan D103i; Imetric 3D SA).[27] These impressions (group ALG) were subsequently poured, and 2 sets of custom trays were fabricated in the laboratory with a light-polymerized acrylic resin material (Triad TruTray; Dentsply Sirona).

The second appointment took 60 minutes and comprised 3 additional impressions and an intraoral scan. Initially, the custom trays were evaluated and, if necessary, trimmed to remove muscle impingement. The control impression was border molded with thermoplastic modeling plastic impression compound (Impression Compound; Kerr Corp) and relined with a ZOE paste (SS White; SS White Group c/o Prima Dental Group). For the third impression (group PVS), a universal adhesive (Omnident; Dental-Handelsgesellschaft mbH) was applied to the second custom tray, and an impression was made with a medium-viscosity PVS (Aquasil Ultra Monophase; Dentsply Sirona). This impression was made without border molding with a thermoplastic material, and the patients were instructed to execute functional movements. The fourth impression (group PVSM) consisted of relining just the IS of the previously made PVS impression with ZOE paste. This supplementary layer was limited to just the IS area, and any excess material that flowed on the ridge area of the intaglio surface was removed manually. This was possible as there was no chemical bond between the 2 materials. The fifth and final impression (group TRI) consisted of an intraoral scan of the edentulous ridge. A flexible lip retractor (OptraGate; Ivoclar Vivadent AG) was used to facilitate access during scanning. The edentulous jaw was landmarked with small spots of light-polymerized gingival barrier material (OpalDam; Ultradent Products, Inc). The scanning path strategy recommended by the manufacturer was followed. The landmarks were also placed at the vibrating line as seen in Figure 1.

The patients were asked to complete a questionnaire after each impression to assess comfort, taste, gagging, and burning sensation during the procedure as well as subjective satisfaction on a visual analog scale.

All analog impressions were digitized using the extraoral laboratory scanner. The digital scans were transferred into the 3Shape design software, and all scan data were stored in a digital standard tessellation language format.

The scans of each individual patient were imported into comparison software (Geomagic Control X 64; 3D systems). Scanned areas beyond the clinically relevant peripheral border (PB) were trimmed. Each patient's ZOE control impression was considered as a reference scan. For the intraoral scans, the landmark spots were circled and removed with the Geomagic's "de-feature" tool. For each participant, 5 samples from important regions of interest were delineated on the reference model as shown in Figure 2, namely the midpalatal suture (MPS), the PB, the IS, the ridge (R), and the posterior palatal seal (PPS).

The software used the best-fit algorithm to match the scans from the 4 groups (PVS, PVSM, ALG, TRI) to the corresponding control; a 3D comparison was then performed for the entire intaglio surface and for each selected region. The threshold of acceptability was set to 100 μm.[28,29] A report comprising a color map of the comparison and deviation values was exported from the software. Furthermore, the distance measurements were imported into a spreadsheet (Excel 2013, v15.0; Microsoft Corp) to separate the positive and negative deviations.

The primary outcome measure analyzed in this study was the trueness of the impressions and is described as the deviation of each test impression from the control (ISO 5725), measured in millimeters.[30] The deviation calculated by the software is the root mean square (RMS), which is the square root of all squared deviations

Table 1. Mean and standard deviations of entire surface (ES), peripheral border (PB), inner seal (IS), ridge (R), midpalatal suture (MPS), and posterior palatal seal (PPS)

Regions of Interest	Trueness Mean ±SD, mm				Global *P* (Friedman)	Pairwise *P* (Wilcoxon Paired Tests)					
	ALG	PVS	PVSM	TRI		ALG-PVS	ALG-PVSM	ALG-TRI	PVS-PVSM	PVS-TRI	PVSM-TRI
ES	1.23 ±0.35	0.75 ±0.18	0.75 ±0.20	0.70 ±0.18	.009*	.008*	.012*	.006*	1.00	.64	.94
MPS	0.32 ±0.26	0.16 ±0.09	0.18 ±0.11	0.17 ±0.08	.36	.091	.14	.071	.21	.48	1.00
PPS	0.38 ±0.20	0.55 ±0.41	0.60 ±0.43	0.59 ±0.36	.082	.14	.060	.050	.034*	.43	.64
PB	2.03 ±0.55	1.12 ±0.32	1.05 ±0.29	1.38 ±0.25	.001*	.006*	.003*	.008*	.35	.071	.028*
R	0.25 ±0.12	0.18 ±0.07	0.28 ±0.19	0.18 ±0.04	.053	.13	.64	.10	.015*	1.00	.05
IS	0.74 ±0.36	0.56 ±0.14	0.52 ±0.13	0.80 ±0.25	.006*	.14	.041*	.48	.14	.005*	.005*

ALG, irreversible hydrocolloid or alginate; PVS, polyvinyl siloxane; PVSM polyvinyl siloxane modified with zinc oxide eugenol; SD, standard deviation; TRI, intraoral scanner. *Indicates a significant difference.

Table 2. Mean positive and negative deviations from control at peripheral border and percentage (%) of positive/negative differences per impression technique (mean from n=12)

	Region Peripheral Border							
	Positive Deviation From Control (mm)				Negative Deviation From Control (mm)			
n=12	Minimum (Mean ±SD)	Maximum (Mean ±SD)	Mean Positive	% Surface Positive	Minimum (Mean ±SD)	Maximum (Mean ±SD)	Mean Negative	% Surface Negative
TRI	0.69 ±0.44	1.74 ±1.18	1.17	55.18	-1.49 ±1.03	-0.58 ±0.38	-1.05	44.80
ALG	1.14 ±0.90	3.59 ±1.79	2.11	85.01	-1.35 ±1.61	-0.24 ±0.18	-0.66	14.95
PVS	0.09 ±0.06	1.24 ±1.29	0.49	33.84	-1.59 ±1.04	-0.63 ±0.45	-0.91	66.16
PVSM	0.39 ±0.41	1.01 ±0.60	0.67	50.58	-2.21 ±1.99	-0.45 ±0.35	-0.99	49.41

ALG, irreversible hydrocolloid or alginate; PVS, polyvinyl siloxane; PVSM polyvinyl siloxane modified with zinc oxide eugenol; SD, standard deviation; TRI, intraoral scanner.

divided by the number of all the deviations.[27,31-33] Trueness was evaluated by calculating RMS for the entire surface (ES), as well as for the specific regions of interest PB, IS, MPS, R, and PPS. The color maps were visually assessed to determine whether the deviation was positive or negative. A positive deviation is displayed in red and accounted for a tighter/compressive fit, whereas a negative deviation is displayed in blue and accounted for a space. Furthermore, the mean positive and negative deviations were calculated and reported specifically for the PB and IS.

The secondary outcomes for this study were the patients' perceptions from the results of the questionnaire. Mean and standard deviation (SD) were used to describe RMS and subjective visual analog scale scores. The Friedman and Wilcoxon tests were used for statistical analyses (α=.05). All statistical tests were performed with statistical software (IBM SPSS Statistics, v24.0; IBM Corp).

RESULTS

Twelve participants, 8 men and 4 women, with a mean ±SD age of 68.5 ±11.7 years took part in the study and completed the 2 clinical appointments. Sixty scans were assessed. The total impression surface comparison with the control impression revealed mean RMS values of 1.23 ±0.35 mm, 0.75 ±0.17 mm, 0.75 ±0.19 mm, and 0.70 ±0.18 mm for ALG, PVS, PVSM, and TRI, respectively. The trueness of the different regions, PB, IS, MPS, PPS, and R, is reported in Table 1. The mean positive and negative deviations for the PB and the IS are reported in Tables 2 and 3.

When the experimental impressions were compared with one another, there were significant differences in ALG versus PVS (*P*=.008), PVSM (*P*=.012), and TRI (*P*=.006) but no differences between the experimental impressions other than ALG. At the PB, a positive deviation, indicating longer borders, was observed for the ALG group, whereas a negative deviation, representing shorter denture flanges, was noted in the PVS and PVSM groups (Fig. 3). The PB was significantly different for TRI from PVSM (*P*=.028); the same applied to the IS (PVS; *P*=.005 and PVSM; *P*=.005). The mean scores for comfort, taste, gagging sensation, burning sensation, and overall satisfaction are presented in Table 4.

DISCUSSION

The purpose of this clinical study was to compare simplified impression techniques and the digital scan to conventional border molding and ZOE impression and to understand the locations of possible errors by a further analysis of regions. Mean RMS values for all the groups deviated from the control with the biggest variations for ALG (*P*=.009), thereby rejecting the null hypothesis.

ALG proved significantly less true than the other impressions and presented larger interindividual variability with the highest SDs, hence the lowest precision, for ES (SD ±0.35 mm), PB (SD ±0.55 mm), and IS (SD ±0.36 mm). This can be explained by the properties

Table 3. Mean positive and negative deviations from control at inner seal and percentage (%) of positive/negative differences per impression technique (mean from n=12)

	Region Inner Seal							
	Positive Deviation from Control (mm)				Negative Deviation from Control (mm)			
n=12	Minimum (Mean ±SD)	Maximum (Mean ±SD)	Mean Positive	% Surface Positive	Minimum (Mean ±SD)	Maximum (Mean ±SD)	Mean Negative	% Surface Negative
TRI	0.15 ±0.11	0.53 ±0.65	0.33	33.39	-1.11 ±0.61	-0.41 ±0.35	-0.67	66.61
ALG	0.22 ±0.20	1.32 ±1.29	0.60	60.55	-0.85 ±0.94	-0.15 ±0.15	-0.39	39.45
PVS	0.11 ±0.14	0.64 ±0.45	0.24	46.57	-0.64 ±0.66	-0.09 ±0.07	-0.42	53.43
PVSM	0.15 ±0.12	0.63 ±0.57	0.30	60.33	-0.61 ±1.12	-0.19 ±0.22	-0.47	39.67

ALG, irreversible hydrocolloid or alginate; PVS, polyvinyl siloxane; PVSM polyvinyl siloxane modified with zinc oxide eugenol; SD, standard deviation; TRI, intraoral scanner.

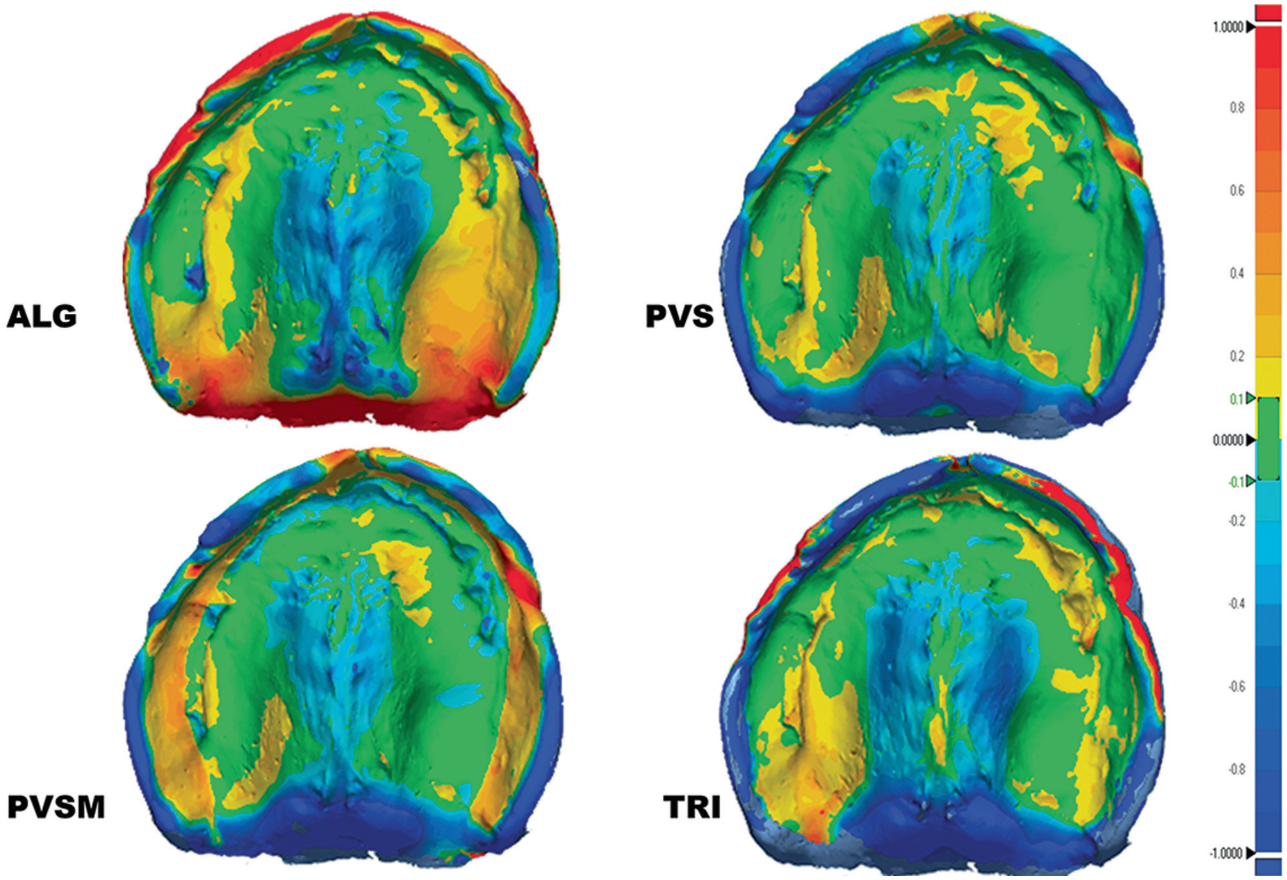

Figure 3. Color maps representative of 3D comparison for 4 groups (ALG, PVS, PVSM, and TRI). ALG, irreversible hydrocolloid or alginate; PVS, polyvinyl siloxane; PVSM, polyvinyl siloxane modified with zinc oxide eugenol; TRI, intraoral scanner.

of the material and the fact that the material was loaded into a stock tray instead of a custom tray. Furthermore, anatomic variations could influence the precision of the method. The largest deviations were located at the borders (mean RMS 2.03 ±0.55 mm), and a visual analysis of the color maps showed positive variations at the borders, with a mean positive deviation of 2.11 mm. The need for multiple border adjustment sessions for dentures made from irreversible hydrocolloid impressions would make the prosthetic end result inaccurate and therefore more costly.[14] Logistics may also influence the preference for one impression material over another; for example, minimizing the time before pouring the impression is essential for ALG, but less so for the other materials investigated.[34] Hyde et al[12] reported that patients preferred dentures made from a PVS impression to those made from irreversible hydrocolloid before any denture adjustments, which is consistent with the deviation measured in this study.

The PB and IS determine denture retention and comfort. The IS should be in intimate contact with the tissue to prevent the passage of air or other substances.

Table 4. Mean and standard deviation scores for comfort, gagging, taste, burning sensation, and satisfaction

Score	ALG	PVS	PVSM	TRI	ZOE
Comfort	0.33 ±0.78a	0.83 ±1.53a	2.17 ±3.10a,b	3.67 ±2.99b,c	4.33 ±3.52c
Taste	2.67 ±2.30b	3.67 ±1.50b	4.75 ±2.14b	0.00.000a	7.17 ±2.30c
Burning sensation	0.00 ±2.04a	1.25 ±2.40a	7.58 ±2.35b	0.00 ±2.71a	7.92 ±1.75b
Gagging	0.83 ±1.95	0.67 ±2.31	0.00 ±0.00	0.00 ±0.00	0.00 ±0.00
Satisfaction	1.83 ±2.04a	3.17 ±2.40a,b	4.58 ±2.35b,c	4.08 ±2.71a,b	6.83 ±1.75c

ALG, irreversible hydrocolloid or alginate; PVS, polyvinyl siloxane; PVSM, polyvinyl siloxane modified with zinc oxide eugenol; TRI, intraoral scanner. Same letter indicates absence of significant differences (*P*>.05).

At the IS, ALG impressions varied significantly from PVS and PVSM with a mean positive deviation of 0.60 mm. In a clinical context, a defective IS is observed more often with PVS impressions than ALG or ZOE impression materials. The selective relining of the PVS created a noticeable increase in the percentage of positive deviations at the IS (60.33%) and the PB (50.58%) but did not increase its trueness. In contrast, when the impression of bony structure such as the R and the MPS was recorded, all impression techniques had similar deviations (*P*=.053 for R, *P*=.36 for MPS). Furthermore, all impression methods captured the posterior area of the maxilla adequately. No physical compression of the highly compressible tissues in this area was found when scanned, which could reduce posterior retention. However, the need for compression and a PPS may be less relevant with a prepolymerized milled denture base, which does not undergo any resin retraction during polymerization; yet, evidence of this comes from in vitro studies.[29]

PVS performed similarly to PVSM and TRI when the entire scanned area was analyzed, the visual color maps indicating a negative deviation from the control, especially at the PB with a mean negative value of -0.91 mm. This may result in a complete denture that is not in intimate contact with the tissues. As for the digital scan, its trueness was not significantly different from that of PVS and PVSM. This indicates that digitizing maxillary edentulous jaws is feasible with the tested scanner and that the land-marking technique can be a useful tool to facilitate the scanning process and improve accuracy. This result confirms the suggestions of authors that resin markers are useful tools.[23,24] The resulting scans in this study did not reveal any mismatches at the palate as noted by Patzelt et al.[21] The pitfall of the digital scan is at the PB and the IS. As the cheeks and lips had to be substantially retracted during the scanning process, there was no recording of a functional border. The PB was either missing or difficult to interpret as shown in Figure 4. Improvements in digital scanning tools are, therefore, still needed, and hopefully, manufacturers will be able to fabricate fast scanners which are able to register the ridge and the vestibule while the patient is moving the lips and cheeks.

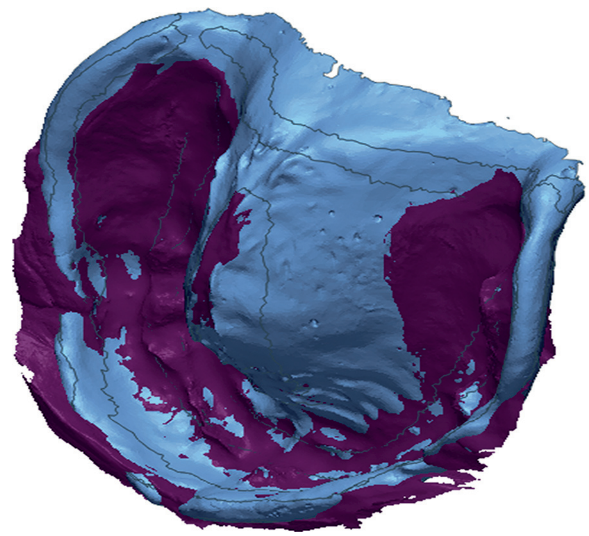

Figure 4. Stretched borders of intraoral scan shown in *purple* when superimposed with corresponding control impression.

Further progress would come from a scanning technology which would register the depths of the soft tissues to allow for localized compression where additional suction is needed. The clinical retention of the dentures made from the various impressions was not tested in this study. Such a test would have provided valuable information concerning the clinical performance of the corresponding dentures. A limitation of this study is inherent to its design, in that all materials and techniques were compared with a gold standard (ZOE), where the impression accuracy was not compared with the original anatomy. Nevertheless, this comparison could only be carried out in an in vitro experiment. Furthermore, this study did not compare only the different material performances as the control comprised a border molding with modeling plastic impression compound; this study is, therefore, limited to the comparison of different simplified impression techniques to the 2-step technique.

Concerning patient preferences for impression materials, the results of the present study are not consistent with those reported in a previous study that reported a preference for digital scanning.[19] In the present study, the level of comfort was higher with ALG impressions and PVS, the ZOE impression being the most uncomfortable (4.33 ±3.52). The ZOE also had the worst score concerning taste (7.17 ±2.29), whereas the burning sensation score for ZOE and PVSM was not significantly different (7.92 ±2.64, 7.58 ±2.15; P=1.0). It is generally assumed that only patients with a reduced salivary flow would experience a burning sensation with ZOE paste. However, this is apparently not the case, as patients who suffered from a dry mouth were excluded from the study.[26]

Unlike in the study of Tsirogiannis et al[18] where gagging was stated as a major issue by the participants, the gagging score was very low in the present study and was not significantly different among the 5 methods (P=.236). Nevertheless, a selection bias was present because the participants were already familiar with impression making, and those with an excessive gag reflex may have declined to participate in the study.

In a systematic review of 5 articles, Gallardo et al[19] reported that the digital scanning technique offered clinical advantages over conventional techniques, as well as reduced patient discomfort and nausea sensation. In the present study, even though the participants were interested in the intraoral scan and the digital technique, the comfort score (3.67 ±2.99) and the satisfaction score (4.08 ±2.71) were better than that of ZOE but lower than that of the simplified techniques (PVS and ALG). The disappointing comfort and satisfaction scores could be explained by the isolation technique that was used and the preparation time required to make the intraoral scan, as time was required to landmark and control the salivary flow before scanning the edentulous jaws. Improved scanning during functional movements would not only improve the border molding but also increase patient acceptance.

CONCLUSIONS

Based on the findings of this clinical study, the following conclusions were drawn:

1. Edentulous impressions made with PVS, PVSM, and the intraoral scanner had similar deviations and may yield clinically acceptable results.
2. Important deviations were present in the ALG and TRI group at the PB.
3. The relevance of these deviations needs to be interpreted in a clinical context in view of denture retention, patient comfort, and adjustment sessions.
4. ALG should be discouraged for definitive impression making for complete dentures.
5. Patient preferences for simplified techniques over conventional border-molding and ZOE paste impressions were confirmed.

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Noteworthy Abstracts of the Current Literature

Optimal sandblasting conditions for conventional-type yttria-stabilized tetragonal zirconia poly crystals

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Objective. To assess the influence of sandblasting conditions applied to conventional-type yttria-stabilized tetragonal zirconia poly crystal (Y-TZP) on surface roughness, phase transformation, and biaxial flexural strength.

Methods. Commercially available Y-TZP (Lava Frame, 3M Dental Products) disks were used after sintering (specimen dimensions: 14mm in diameter and 1.2mm in thickness). The surfaces of specimens were ground, and then sandblast treatments were conducted at different pressures (0.20, 0.25, 0.30, 0.35 and 0.40MPa) and distances (1, 5, 10 and 20mm) with 50μm alumina particles. Surface roughness measurements were performed and scanning electron microscopy (SEM) images were taken for surface characterizations. Phase transformation of Y-TZP was identified by X-ray diffraction (XRD). Biaxial flexural strength was measured using the piston-on-three-ball test.

Results. The surface roughness increased significantly by increasing the sandblasting pressure, and microcracks were observed at high sandblasting pressure at 0.40MPa. The shortest sandblasting distance (1mm) was not effective to increase the surface roughness compared with other sandblasting distances. A tetragonal to monoclinic phase transformation was observed after grinding. The degree of the phase transformation tended to increase with sandblasting pressure, and significant effect was independent of the sandblasting distance. The biaxial flexural test showed improved mechanical strengths for the samples after sandblasting at 0.20-0.35MPa, with the maximum strength at 0.25MPa. Sandblasting at 0.40MPa decreased the strength as compared with 0.25MPa.

Significance. The surface roughness increased with increasing the sandblasting pressure, whereas there was an optimal sandblasting pressure range to increase biaxial flexural strength of Y-TZP.

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