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Research Article

CLINICAL COMPARISON OF QUALITY OF VINYL POLYETHER SILICONE IMPRESSIONS WITH POLYVINYL SILOXANE IMPRESSIONS USING ONE-STEP IMPRESSION TECHNIQUE

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A B S T R A C T

Aim: The purpose of this clinical study was to compare the quality of vinyl polyether silicone impressions (VPES) with polyvinyl siloxane (PVS) impressions using one-step impression technique. ***Methods and Material:*** Two master impressions of 15 subjects with 22 crowns were made with experimental group (VPES) and control group (PVS) impression material using one-step impression technique. Total 30 impressions were evaluated visually for surface quality and were scored by the dentist according to the rating scale. Impressions which scored alpha or bravo were sent to a dental technician for assessment of the quality and the handling properties of impression by pouring type IV gypsum. ***Statistics:*** Chi-square test used for comparison of categorical data. Results: The experimental group produced better impressions rated as alpha or bravo compared to control group. Comparison of technician's assessment of the quality and handling properties between experimental and control group showed no statistical difference except for tear resistance upon removal from the cast which showed statistically significant. The tear resistance upon removal from cast for the experimental group was rated better than the control group. ***Conclusion:*** The new hybrid material vinyl polyether silicone displayed acceptable surface quality and handling properties for clinical use using one-step impression technique.

INTRODUCTION

Impression making is an important step in the fabrication of a definitive prosthesis which includes careful transfer of the patient's soft and hard tissues to laboratory. Good dimensional accuracy, surface detail reproduction and mechanical properties such as tear strength, tensile strength, and elastic recovery are prerequisites for an ideal impression material. These properties helps to withstand the stresses under various clinical challenges and minimizes voids, bubbles and tears.[1-4] The accuracy of impression is influenced by certain factors such as impression technique, impression tray, properties of the impression material, operator's experience and skill, periodontal status, gingival health and soft tissue management, moisture control, and location of preparation finish line.[5,6]

Currently, various impression materials are commercially available of which Polyvinyl siloxane (PVS) being the most commonly used for indirect restorations such as crowns, fixed partial dentures, veneers, onlays, implant supported restorations, and removable partial and complete dentures.[2,3] The various improvements in accuracy, dimensional stability, surface quality, elastic recovery, flowability and tear strength of PVS impression materials contributes to clinically acceptable impressions and good handling properties and their adaptation to soft and hard tissues.[7]

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PVS's are known to be inherently hydrophobic in nature, which can results in defects such as voids at the margins of tooth preparation in the impression and bubbles in gypsum cast and it may inhibit the initial ability of the material to penetrate the narrow spaces in a moist environment immediately after mixing.[2,4] Newer PVS impression materials have been introduced and are labelled as hydrophilic or hydrophilized PVS by addition of surfactants which enhances the wettability of the material. This improved the surface quality of impressions and produced fewer defects and better stone dies.[2]

Recently a newer impression material Vinyl polyether silicone (VPES) has been introduced which is a combination of polyether and PVS impression materials. It consists of vinyl dimethyl polysiloxane (10%-50%), methyl hydrogen dimethyl polysiloxane (3%-10%), silicone dioxide (30%-65%) and smaller portion of polyether (5%-20%). VPES is available in various consistencies and setting times.[8,9,10] It possesses good mechanical and flow properties and wettability and increased hydrophilicity which enhances the accuracy of impression made on moist dentinal surfaces and area of gingival sulcus, thus resulting in making a final impression more successful where humidity is of concern.[1,8]The clinical efficacy of impression materials are evaluated through subjective evaluation of master impressions and resultant definitive casts. Literatures regarding the accuracy, dimensional stability and

surface detail reproduction of PVS impression material is readily available, little information is available on the properties of VPES and the number of studies evaluating the clinical efficacy of impression is also limited[1-3,8] Therefore, this clinical study intends to compare the quality of VPES impressions with PVS impressions using one-step impression technique. The null hypothesis of this study was that there would be no difference in clinical outcome measured by the quality of the master impressions and casts with the experimental and the control group.

SUBJECTS AND METHODS

In this study 15 subjects between the ages of 18 and 55 years were selected after obtaining their informed consent as approved by Institutional Review Board of Coorg Institute of Dental Sciences. The subjects were selected among the patients treated in Department of Conservative Dentistry and Endodontics at Coorg Institute of Dental Sciences. The subjects older than 18 years of age and with the need of 1 or 2 full metal, metal-ceramic and all-ceramic crowns per arch were included in the study. Subjects with a history of adverse reaction to the materials used in the study, subjects in need of master impressions for fixed partial dentures and implant supported prosthesis, subjects with tooth preparation finish lines located ≤2mm below the free gingival margins and subjects who refused to give informed consent were excluded from the study. Prior to making the impressions a brief case history about oral hygiene, periodontal status, location of the finish lines were documented.

Two master impressions were made for each subject, using a recently introduced impression material Vinyl Polyether silicone (EXA'lence monophase, regular set) defined in the study as experimental group and the second with another polyvinyl siloxane impression material (Aquasil Ultra Heavy regular set and Aquasil Ultra LV regular set combination) defined as the control group. All impressions were made using one-step impression technique and were performed by several post graduate students of Department of Prosthodontics, Crown and bridge, Implantology at Coorg Institute of Dental Sciences. Thus a total of 30 master impressions were made. Impression materials used in the study are listed in (table 1), (fig.1).

Table 1 Impression materials evaluated

Brand	Material type	Lot number	Manufacturer
EXA'lence Monophase	Medium-body VPES impression material	1703221	GC America Inc. Alsip, IL 60803, USA
Aquasil Ultra Heavy	Heavy-body PVS impression material	180313	Dentsply Caulk, Dentsply International Inc. Milford, DE 19963-0359
Aquasil Ultra LV	Light-body PVS impression material	180111	Dentsply Caulk, Dentsply International Inc. Milford, DE 19963-0359

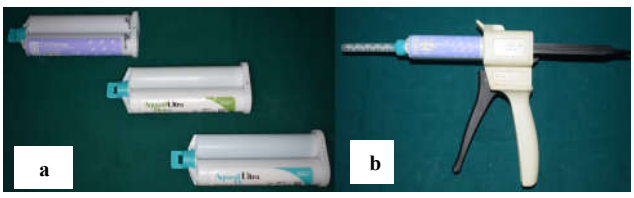

Fig 1 a) Impression materials evaluated. b) VPES impression material loaded on automix cartridge dispenser

Impressions were made using acrylic (DPI-RR cold cure, The Bombay Burmah Trading Corporation Ltd, Mumbai) custom trays. Tray adhesive (VPS tray adhesive, 3M Deutschland GmbH, Germany) was applied for 15 minutes on tray following manufacturer instructions to allow adequate bond strength between impression material and tray. Single non-impregnated gingival retraction cord (Ultrapak; Ultradent Products, Inc., South Jordan, Utah) were placed around the prepared teeth prior to making impressions. According to the clinicians preference hemostatic agent (Botroclot, Juggat Pharma, Bengaluru, India) were used and the prepared teeth were thoroughly rinsed with water and dried to avoid any contamination resulted by hemostatic agent. Both of the impression material combinations were used in a randomized manner according to randomization list obtained using software (Research randomizer, Version 4.0 Computer software). All the impression materials were mixed using automix cartridge dispenser (3M ESPE, Seefield, Germany) and the corresponding mixing tips. Monophase material was loaded on to the tray and syringed around the prepared teeth and impressions were made. Heavy body material was loaded on to the tray and light body impression material was syringed around the prepared teeth and impressions were made. Thus two master impressions were obtained for each subject using the experimental (fig.3) and control group (fig.4). Following the impression making procedure, all impressions were disinfected using 2.45% glutaraldehyde solution (Endox, Becta Laboratories, Gujarat, India) for 10 minutes.

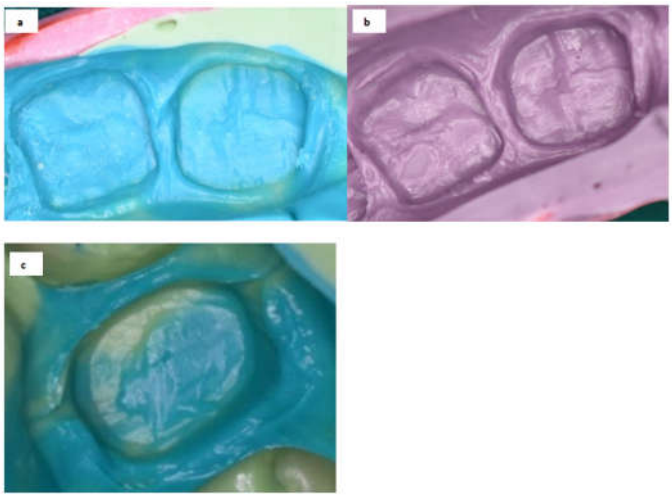

Fig 2 a) PVS impression (control group scored as alpha), b)VPES impression (experimental group scored as alpha). c) PVS impression scored as Charlie.

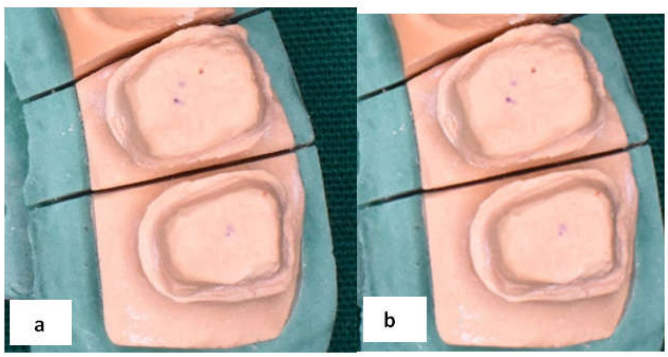

Fig 3 a) Definitive cast- control group, b) Definitive cast- experimental group

The impressions were visually inspected for 22 crowns by a clinical evaluator, who was not involved in the impression

making process, according to a rating scale for the readability of the finish line of abutment teeth in the impression.[2,3] The defects observed in the impression such as bubbles, voids, tears or other defects were examined and location were documented (Table 2). Impressions rated atleast alpha or bravo were sent to a dental technician for his assessment of surface quality of impression using the same evaluation criteria. All impressions were stored at room temperature for 1 hour before pouring with type IV stone (GC Fujirock EP; GC Europe NV, Leuven, Belgium) and mixed according to the manufacturer's instructions, with a water/powder ratio of 10ml/100g. The definitive casts (fig.5) obtained were evaluated by the dental technician for the quality and the handling properties using the 1 to 10 numerical rating scale (1= excellent, 5= acceptable, 10= poor)(table 3).

Table 2 Rating criteria for evaluation of impression.

(a) Overall evaluation (alpha to delta score): _____.
Alpha: No defects. Impression is useable.
Bravo: Small defects such as tears, voids, bubbles which do not affect finish line to prevent use of impressions. Impression is useable.
Charlie: Good reproduction of preparation finish line. Other defects require impression to be remade.
Delta: Defects at preparation finish line, impression needs to be remade.
(b) Tears (number and location) _____.
(c) Voids (number and location) _____.
(d) Bubbles (number and location) _____.

Table 3 Quality rating criteria for the definitive cast by dental technician.

(1=excellent, 5=acceptable, 10=poor)
(a) Ease of wetting of impression by stone
(b) Ease of removal from stone cast
(c) Tear resistance upon removal from cast
(d) Potential of multiple pouring as related to presence of tears after removal of cast of impression
(e) Visibility of full 360-degree finish line on cast
(f) Visibility of air bubbles in cast, especially finish line
(g) Overall satisfaction

The data was collected coded and fed in SPSS (IBM version 23) for statistical analysis. The descriptive statistics included mean, standard deviation, frequency and percentage. The overall rating of each impressions (alpha to delta) and surface defects such as bubbles, tears, and voids were described by frequency and percentage for each material. Numeric ratings of quality, handling properties, and overall assessment were summarized by means and standard deviations for each material. Inferential statistics included non-parametric test, i.e.; chi square test for comparison of categorical data. The level of significance was set at 0.05 at 95% confidence interval.

RESULTS

Fifteen (68.2%) of the experimental group and nine (40.9%) of the control group impressions were rated as alpha by dentist and fourteen (63.6%) and eleven (50%) respectively by the technician. Also, seven (31.8%) of experimental and twelve (54.5%) of control group were rated as bravo by the dentist and eight (36.4%) and ten (45.5%) by the technician respectively. The experimental group produced better impressions rated as alpha or bravo compared to control group, but values were found to be not statistically significant (experimental group p=1.0 and control group p=0.826) (Table 4). Among the control group impressions, one impression was rated as Charlie by both the dentist and the technician. None of the impressions rated delta score. Comparison between the dentist's (p=0.148) and technician's (p=0.453) ratings alpha, bravo, charlie or delta for defects on the impressions showed no significant differences between the experimental and control group (Table 5).

Table 4 Surface quality ratings between experimental and control impressions by dentist and technician

		Surface quality			Chi square value	Significance
		Alpha n (%)	Bravo n (%)	Charlie n (%)		
Experimental group (VPES)	Dentist	15(68.2)	7(31.8)	0(0)	0.101	1.000 (N.S)
	Technician	14(63.6)	8(36.4)	0(0)		
Control group (PVS)	Dentist	9(40.9)	12(54.5)	1(4.5)	0.382	0.826 (N.S)
	Technician	11(50)	10(45.5)	1(4.5)		

*n- frequency, *N.S- not significant

Table 5 Surface quality ratings between dentist and technician for experimental and control groups

		Surface quality			Chi square value	Significance
		Alpha n (%)	Bravo n (%)	Charlie n (%)		
Dentist	VPES	15(68.2)	7(31.8)	0(0)	3.816	0.148 (N.S)
	PVS	9(40.9)	12(54.5)	1(4.5)		
Technician	VPES	14(63.6)	8(36.4)	0(0)	1.582	0.453 (N.S)
	PVS	11(50)	10(45.5)	1(4.5)		

*n- frequency, *N.S- not significant

However the technician tended to report more bubbles (22.72%) and tears (13.63%) in experimental group and voids (36.36%) in the control group compared to dentist (Table 6).

Table 6 Surface quality ratings for defects found on the experimental group and control group impressions by the dentist and technician

Surface quality of impressions		Experimental group (VPES) n (%)	Control group (PVS) n (%)
Bubbles	Dentist	4(18.18)	6(27.27)
	Technician	5(22.72)	6(27.27)
Tears	Dentist	2(9.09)	5 (22.72)
	Technician	3(13.63)	5 (22.72)
Voids	Dentist	3(13.63)	7 (31.81)
	Technician	3 (13.63)	8 (36.36)

*n- frequency

Comparison of technician's assessment of the quality and handling properties between experimental and control group showed no statistical difference for the ease of wetting of impression by stone, ease of removal from stone cast, potential of multiple pouring, visibility of 360-degree finish line on the definitive cast and overall laboratory satisfaction, except for tear resistance upon removal from the cast which showed statistically significant difference (p=0.044).

Table 7 Quality and handling properties between experimental and control groups rated by dentist and technician

Measure	Numerical rating	Experimental group (VPES) n (%)	Control group (PVS) n (%)	Chi square value	Significance
a	1	18(81.8)	17(77.3)	0.140	0.500 (N.S)
	5	4(18.2)	5(22.7)		
b	1	16(72.7)	11(50)	2.397	0.215 (N.S)
	5	6(27.3)	11(50)		
c	1	19(86.3)	13(59.1)	4.125	0.044(S)
	5	3(13.6)	9(40.9)		
d	1	20(90.9)	17(77.3)	1.529	0.412(N.S)
	5	2(9.1)	5(22.7)		
e	1	15(68.2)	11(50)	1.504	0.358 (N.S)
	5	7(31.8)	11(50)		
f	1	22(100)	22(100)	-	-

*n- frequency, *S- significant, *N.S- not significant

The tear resistance upon removal from cast for the experimental group was rated better than the control group. The quality and handling property rating for visibility of air bubbles in cast showed excellent rating for all impressions of both experimental and control groups (Table 7).

DISCUSSION

As mentioned, making of impression is an important step in fabrication of definitive prosthesis and accurate impression is undoubtedly necessary for the same.[1-4,6] One of the common method to evaluate the surface quality clinically is by the visual inspection of the surface defects such as voids, tears and bubbles on the impression.[2,3,11,12]Using a minimal number of variables, this study attempted to establish knowledge on the clinical behaviour of a new hybrid material VPES with PVS by one-step impression technique. The results of the study showed no significant differences in surface quality between the experimental and control groups. Comparing the quality and handling properties of impressions, no significant differences were observed for the ease of wetting of impression by stone, ease of removal from the stone cast, potential of multiple pouring, visibility of 360-degree finish line on the definitive cast and overall laboratory satisfaction, except for the tear resistance while removal from the cast which showed statistically significant. Therefore the null hypothesis of the study was not rejected.

The accuracy of the impression is greatly influenced by the factors like impression technique, the type of impression tray, properties of the impression material, clinician's experience and skill, periodontal status, soft tissue management, and location of preparation finish line.[6] Several studies have shown different results in terms of accuracy related to use of one-step one viscosity (monophase), one-step two viscosity and two-step two viscosity impression techniques.[2,3,5,6,13]For addition silicone impressions same accuracy was obtained for putty-wash, single mix, and double mix techniques.[4] Also, many studies have shown that the use of custom trays produced more accurate impressions compared to stock trays.[9,13-21]And in a study comparing the surface defects between the monophase and the two-phase addition silicone impressions, the use of monophase system in stock tray produced more voids compared to two-phase techniques used with custom trays.[20] The use of stock tray results in need of insertion of large amount of monophase material and thereby causing layering patterns and trapping of air.[11] In the present study all impressions were made using acrylic custom trays and one-step monophase (VPES) and one-step two viscosity (PVS) impression technique. The impressions produced are more accurate, if 1.5 to 2.5mm uniform bulk of impression material present. So, two layers of baseplate wax on diagnostic cast with desired relief were given and occlusal stops were used to orient the tray thus optimum thickness of material was obtained.[15] The experimental and control group impressions evaluated in the present study expressed alpha or bravo rated by both dentist and the technician. Twenty two of the experimental and twenty one from control group impressions were rated alpha or bravo by both the dentist and the technician. The experimental group produced more impressions with alpha score compared to control group. Only one impression in the control group rated charlie. In order to prevent any negative effects due to gingival inflammation on the impressions, a brief case history was recorded and oral prophylaxis were carried out prior to the tooth preparation. Also, the subjects with preparation finish line located ≤ 2.0 mm below the free gingival margins were excluded from the study.[2,3,7]

VPES which composed of 5-10% of polyether which contributes to its hydrophilicity and helps to produce better impressions where humidity is of concern.[8,22]The hydrophilic materials exhibits lower contact angle and flows better in areas which are humid, such as subgingival areas and moist teeth surfaces. Also, they present higher precision and shows reduced risk of trapping air bubbles on the stone casts.[13,15]Studies have shown that polyether produced more accurate impressions compared to PVS.[13,23,24]Aquasil ultra used in the present study is marketed as hydrophilic PVS impression material which can wet the moist oral tissues. The hydrophilic property of an impression material describes two different properties, that is one aspect is the ability of the material to wet the moist tooth surface while making the impression and the other one is the wettability of polymerized impression material with the gypsum.[13,25] It has seen that hydrophilic PVS materials remains hydrophobic in the un-polymerized liquid state which results in their inability to produce accurate impressions under moisture. However the addition of surfactants resulted in improved wettability with gypsum.[25] The results of this study showed that VPES maintained its hydrophilicity both in un-polymerized and polymerized state whereas PVS failed to maintain its hyrophilicity in un-polymerized state. That is, both the impressions (100% for both experimental and control casts) expressed excellent rating for the evaluation of visibility of air bubble on the cast and also no significant differences were found for wetting the impression by stone.

In a study comparable results were observed between polyether (Impregum) and PVS (Aquasil) which were able to record deep grooves.[23] The results of present study showed that VPES produced better impressions which rated alpha or bravo compared to PVS evaluated by both dentist and technician. However, statistically significant differences were not found between the materials. VPES impressions showed less number of tears and voids compared to PVS impressions, resulted due to the hydrophilic nature and better tear strength of the VPES material.[4,8,22,25] Ratings of the impression by the technician showed more bubbles, voids and tears for both VPES and PVS than the ratings by the dentist. However no statistical difference between evaluations could be observed.
The impression material should withstand the forces associated with removal from the mouth without affecting its original dimensions is termed as elastic recovery. Therefore impression materials should exhibit good elastic recovery and tear strength in order to produce more accurate impressions.[4,15]In a study comparing the mechanical properties of various elastomeric impression materials demonstrated high tear strength values for VPES with light and medium body viscosities.[4]In another study comparing the tear resistance of VPES with PVS containing nanofillers with conventional polyether and PVS impression material showed that VPES and PVS containing nanofillers exhibited higher tear resistance.[26] Mohammed et al compared the wettability, tear strength and dimensional accuracy of three elastomeric impression materials and has showed that compared to PVS impression material, higher tear strength values were observed for polyether and vinyl siloxane

ether (hybrid material).[27]The results of the present study is consistent with the above mentioned studies, that is VPES exhibited better tear resistance in mouth as well as on removal from the cast. The results of this study were contradictory with Lawson et al, were a hybrid material similar to VPES expressed the least elastic recovery compared to five PVS materials, possibly due to the polyether content.[28] Overall, no statistically significant difference in quality and handling properties were observed between experimental and control groups except for the tear resistance upon removal from cast. Also, excellent rating were expressed by all the impressions of both experimental and control groups for visibility of air bubbles in cast. The results observed in this clinical study were in accordance with other studies that the definitive cast evaluation might be more clinically relevant than evaluating the impressions.[2,3]

This clinical study were limited to impressions of only 1 or 2 units and did not evaluate the multiple abutment teeth impressions such as impressions for fixed partial prosthesis, implant supported prosthesis. Also, the operators involved in making of impressions, and the clinical evaluator and dental technician involved in the evaluation of impressions were not blinded to the type of impression material due to the difference in colour among the impression groups. The sample size used in this study, 22 abutments may not be adequate to demonstrate the clinical efficacy of both the impression groups. Also, the VPES consistency used in the study was monophase, which was compared to heavy body and light body combination of PVS and this may not be the only consistency to be compared. Further clinical studies using different VPES consistencies, impression techniques, multiple abutment teeth with larger sample size should be considered for the clinical assessment of definitive impressions and definitive casts.

CONCLUSION

Considering the limitations of this clinical study, it was shown that new hybrid material Vinyl polyether silicone (VPES) displayed acceptable surface quality and handling properties and thus comparable with the PVS material, and, in particular:

1. PVS. However least surface defects compared to PVS, However, no statistically significant difference for surface defects on the impressions were found between the experimental (VPES) and control group (PVS).
2. The evaluation by the dental technician for quality and handling properties did not reveal a statistically significant difference between VPES and PVS excluding the tear resistance upon removal from the cast, which was significantly better for the VPES.
3. Excellent rating were demonstrated by the both VPES and PVS for visibility of air bubble on the cast especially on the finish line.

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