

Comparative Evaluation of Dimensional Accuracy and Surface Detail Reproduction of Elastomeric Impression Material when Treated with Three Retraction Cord Medicaments : An In Vitro Study

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ABSTRACT

INTRODUCTION

The purpose of this vitro study was to determine the effect of three retraction cord medicaments on dimensional accuracy and surface detail reproduction of polyvinyl-siloxane and polyether impression-material.

MATERIALS AND METHODS

Standardized stainless die was prepared according to the ADA specification No. 19, with three horizontal lines and two vertical lines on the top of impression surface. The distance between two horizontal lines was 2.5 mm and between two vertical lines was 20 mm. All 3 of the commercially available retraction cord medicaments used in this study are 25% Aluminium chloride, 12.7% Ferric sulphate , 12.7% Ferric sub-sulphate. They were applied on to the surface of die with the help of brush for 30 seconds. For the control specimens, no medicament was placed on the die. Polyvinylsiloxane impression material and Polyether impression material were dispensed onto the dies with the impression syringe on the impression surface of the die. 20 impressions of control group, 10 impressions of polyvinylsiloxane and polyether each treated with three retraction cord medicaments were made. Thus, a total of 80 impressions were made and evaluated following the criteria of ADA specification-19.

RESULTS

The differences in the mean values of dimensional accuracy among the treatment groups are not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference ($P = 0.089$). With regard to evaluation of surface detail reproduction, none of the specimen fulfilled the criteria specified by ADA specification 19 and all specimens were unsatisfactory.

CONCLUSION

Within the limitations of this study, the surface detail reproduction of both the material was deteriorated by three retraction cord medicaments. On the contrary, dimensional accuracy was in the limits of ADA specification no. 19, although there was some shrinkage in all impression specimens of both the material. The study also revealed that each of the three medicaments had its specific characteristic effect on the surface detail of the impression material.

KEYWORDS: Dimensional accuracy, Polyether, Polyvinylsiloxane, Retraction, Surface detail.

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INTRODUCTION

Polyvinylsiloxane, Polyether, are the state of art impression material which are leading the foray. The success of these impression materials is attributed to several of their properties, including dimensional stability leading to excellent surface detail reproduction.¹

But the fact that polyvinylsiloxane impression material are hydrophobic in nature, which proves to be their greatest drawback.^{2,3} The hydrophobic nature of these material compromises their application in areas where moisture control is difficult.³ This in turn demands that clinician pay particular attention to techniques and reagents responsible for moisture control in problematic areas such as gingival sulcus. In contrary to this, polyether impression materials are considered more hydrophilic than polyvinylsiloxane impression material due to difference in chemical structures.⁴

Retraction cord with or without chemical medicaments are commonly used to improve access to the margins of the preparation. But various local factors severely compromise the ability of impression material to accurately register margins.⁵

Commonly used retraction cord medicaments include racemic epinephrine, 25 % buffered aluminium chloride, aluminium sulphate, aluminium potassium sulphate, ferric sulphate, ferric subsulphate.⁶ It has been reported that these medicaments especially those containing sulphur may retard or inhibit the set of impression material.⁷ Few investigators suggested the inhibited polymerization is attributable to inadvertent contamination by latex rubber gloves rather than to exposure to retraction cord medicament.⁸ However, the

effect of retraction medicaments on these impression materials remains controversial.

Keeping the above fact in mind, an in vitro study was carried out to determine the effect of three retraction cord medicaments: aluminium chloride, ferric sulphate, ferric subsulphate on dimensional accuracy and surface detail reproduction of polyvinylsiloxane and polyether impression material.

MATERIAL AND METHODS

Standardized stainless die were prepared according to the ADA specification No. 19 containing a cylindrical stainless steel block of 38 mm outer diameter and 30 mm inner diameter with 5mm high mould.⁹ Height of the die was 50mm.(Figure No.1).

Dies were scored with three horizontal lines and two vertical lines on the top of impression surface with the help of ND-YAG laser treatment, having the width of 0.016 mm. The horizontal lines were numbered as 1, 2 and 3 and the vertical lines were numbered C1 and C2 for ease in making measurements of the impression. The distance between two horizontal lines was 2.5 mm and between two vertical lines was 20 mm.⁹ (Figure No.2)



Figure No.1

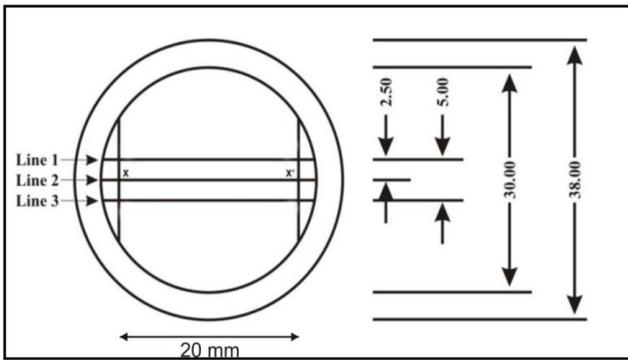


Figure No.2: Both Figure No.1 & 2 show Standardized Stainless Steel Die and its Schematic Representation (ADA Specification No: 19)

All 3 of the commercially available retraction cord medicaments used in this study are 25% Aluminium chloride ("Viscostat Clear": ULTRADENT), 12.7% Ferric sulphate ("Viscous coagulative": ULTRADENT), 12.7% Ferric subsulphate ("Astringent-X": ULTRADENT). They were applied on to the surface of die with the help of brush for 30 seconds. For the control specimens, no medicament was placed on the die (Figure No.3).



Figure No.3: Retraction Cord Medicaments

The standardized stainless steel die was thoroughly cleaned and air dried with dry air to ensure that standardized stainless steel die were free of any surface contaminants after each impression sample was made.

Polyvinylsiloxane impression material (Medium body: monophase: "3M-ESPE ExpressTM Batch

no: 7322) and Polyether impression material (Medium body: 3M-ESPE "ImpregumTM Soft" Batch no: 31755) were dispensed onto the dies with the impression syringe on the impression surface of the die.

PREPARATION OF THE TEST SPECIMEN

Polyvinylsiloxane and polyether were manipulated under ideal condition and were loaded in the prepared die in accordance with ADA specification no. 19. The entire assembly that is, die, weight, flat glass slab and polyethylene was removed from water bath after 10 minutes.⁵ The impression material was allowed to set according to the manufacturer's instructions.⁹ As recommended by ADA specification No.19 the medium body polyvinylsiloxane impression material was recovered from water bath 9 minutes after it was first applied onto the die surface. The polyvinylsiloxane material was recovered from water bath 8 minutes after it was first dispensed onto the die surface. Both the materials were allowed to set for an additional 3 minutes of time before the impression was removed from the die.¹⁰ Once the material was set, the impression was removed from the die with the help of raiser and the impression was allowed to air-dry and was labeled representing its particular specific group.

GROUPING

A total of 80 impressions were made. They were grouped into 8 groups having 10 impressions of each group. (Group A, B, C, D, E, F, X1, X2).

20 impressions of control group (Group X) were made. (10 impressions of polyvinylsiloxane X1 and polyether X2 each)

Group-X1:Control group (Metal die untreated and 10 impression specimens of polyvinylsiloxane were made)

Group-X2:Control group (Metal die untreated and 10 impression specimens of polyether weremade)

Group-A:(Metal die treated with 25%Aluminium Chloride and 10 impression specimens each of polyvinylsiloxane were made).

Group-B:(Metal die treated with 12.7% Ferric sulphate and 10 impression specimens each of polyvinylsiloxane were made).

Group-C:(Metal die treated with 12.7% Ferric subsulphate and 10 impression specimens each of polyvinylsiloxane were made).

Group-D:(Metal die treated with 25%Aluminium Chloride and 10 impression specimens each of polyether were made).

Group-E:(Metal die treated with 12.7% Ferric sulphate and 10 impression specimens each of polyether were made).

Group-F:(Metal die treated with 12.7% Ferric subsulphate and 10 impression specimens each of polyether were made).

EVALUATION OF DIMENSIONAL STABILITY AND SURFACE DETAIL REPRODUCTION

Dimensional stability: Dimensional accuracy was evaluated 1 hour⁵ after making each impression by measuring the length between the points C1 and C2 at the intersection of horizontal and vertical lines with the help of Digital Vernier Caliper.(Figure No.4) Each measurement was taken for three times and averaged to minimize measurement errors.

Surface Detail Reproduction: Surface detail reproduction for each impression was evaluated for 1 hour⁵ after the impression was removed

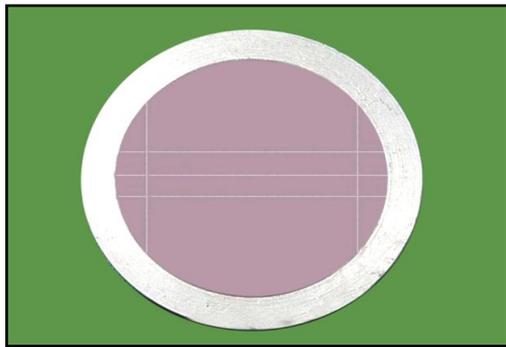
from the die with help of Stereomicroscope.



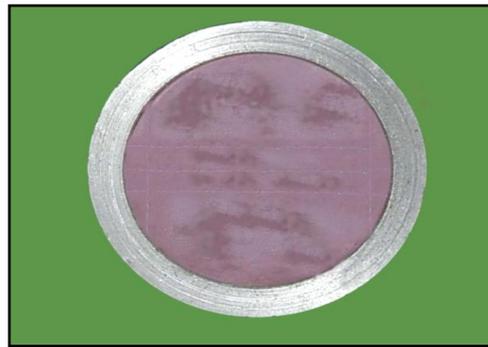
Figure No.4: Digital Vernier Caliper measuring the distance between lines C1 and C2 on the impression samples of polyvinyl and polyether.

SURFACE DETAIL WAS EVALUATED BY TWO METHODS:

- First method involved assessment of continuity of lines reproduced on to the impression surface. All the three lines on the impression surface were assessed and according to the ADA specification No. 19, if two out of three lines were replicated continuously between the cross points, the impressions were considered satisfactory. Rests of the impressions were considered unsatisfactory.
- Second method involved assessment of the additional smooth surface evaluation of the impressions. If the impressions were considered satisfactory in previous method, and it contains voids or pits on to it is considered unsatisfactory, because if this voids comes in the critical margin finish areas of the prepared tooth it will lead to failure of prosthesis. For this additional microscopic evaluation was done in which impressions were considered satisfactory only if they had smooth, shiny surface without any voids or pits.⁹ (Figure No.5,6).



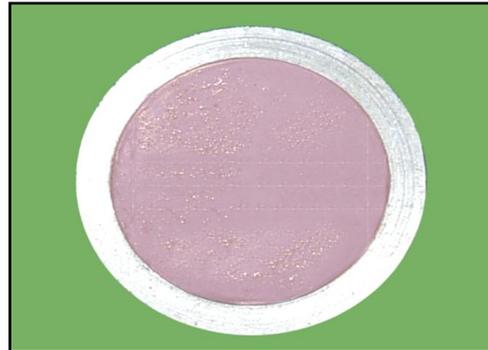
Polyvinylsiloxane Impression Sample (No Treatment)



Polyvinylsiloxane Impression Sample treated with 25% aluminium chloride

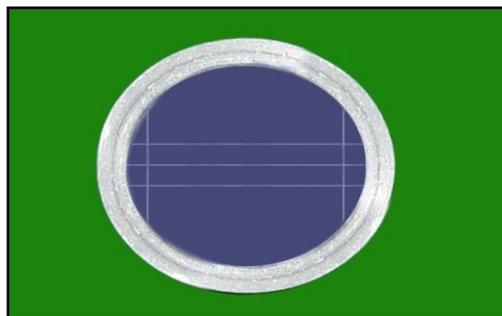


Polyvinylsiloxane Impression Sample treated with 12.7% Ferric Sulphate



Polyvinylsiloxane Impression Sample treated with 12.7% Ferric Sub-sulphate

Figure No.4: Digital Vernier Caliper measuring the distance between lines C1 and C2 on the impression samples of polyvinyl and polyether.



Polyether impression Sample (No Treatment)



Polyether impression sample treated with 25% aluminium chloride



Polyether impression Sample treated with 12.7% Ferric Sulphate



Polyether impression sample treated with 12.7% ferric sub-sulphate

Figure No.6: Surface detail reproduction in Polyether impression material treated with various medicaments.

RESULT

In the present study dimensional stability and surface detail reproduction of the Polyvinylsiloxane and Polyether impression material is evaluated under the treatment of retraction cord medicaments. Surface detail reproduction is assessed by analyzing surface of the impression for accurate reproduction of the scribed lines of the die and the presence of

surface voids or defects with the help of stereomicroscope (Table 1 and 2). Dimensional stability was evaluated by measuring the distance between two lines C1 and C2 of each impression sample of specific group with the help of digital vernier caliper (Table 3). All the samples were tabled and statistically analysed using ANOVA test (Table 4).

Result	Control (Group X1)	Aluminum chloride (Group A)	Ferric sulphate (Group B)	Ferric subsulphate (Group C)	Total
Satisfactory	10	0	0	0	10
Unsatisfactory	0	10	10	10	30
Total	10	10	10	10	40

Table No.1: Comparative evaluation of surface detail reproduction of Polyvinylsiloxane impression material in various designated groups treated with various medicaments (Refer Fig: 6)

Result	Control (Group X2)	Aluminum chloride (Group D)	Ferric sulphate (Group E)	Ferric sub-sulphate (Group F)	Total
Satisfactory	10	0	0	0	10
Unsatisfactory	0	10	10	10	30
Total	10	10	10	10	40

Table No.2: Comparative evaluation of surface detail reproduction in Polyether impression material in various designated groups treated with various medicaments.

Group Name	N	Mean	Std Dev
Gp X1	10	19.65	0.13
Gp X2	10	19.68	0.14
Gp A	10	19.62	0.13
Gp B	10	19.56	0.11
Gp C	10	19.57	0.14
Gp D	10	19.55	0.12
Gp E	10	19.66	0.15
Gp F	10	19.68	0.11

Table No.3: Dimensional accuracy (Distance between two vertical lines C1 and C2.) (Refer Fig :4)

Source of Variation	DF	SS	MS	F	P
Between Groups	7	0.21	0.0299	1.857	0.089
Residual	72	1.16	0.0161	Difference is not significant	
Total	79	1.37			

Table No.4: The differences in the mean values among the treatment groups are not great enough to exclude the possibility that the difference is due to random sampling variability; statistically insignificant difference (P = 0.089).

DISCUSSION

The overall quality of the impression and the surface detail was clearly affected. Dimensional accuracy did not appear to be affected by any of the retraction cord medicaments used in this study. Though shrinkage occurred in all impressions including the control but these were within the ADA specifications limits for these materials. Aluminium chloride treated impression specimens exhibited extremely rough, melted appearance and the whole sections of the lines were completely obliterated uneven changes in the color of the die were seen. Ferric sulphate and ferric subsulphate were associated primarily with the pooling of residual medicaments around the edges of lines, often resulting in destruction of the integrity of the lines, uneven changes in the color of the die and stains of the impression specimens thus hampering the details of the impression. The findings in our study is in conjunction with the study carried out by Aisling O 'Mahony et al and Cynthia S Petrie et al which stated that there was no statistically significant difference in dimensional accuracy among any of their specified groups.^{5,11} The results of this study were in contradiction with conclusions presented by few previous authors such as De Camargo et al, who concluded that the chemical medicaments like aluminium chloride, epinephrine, aluminium sulfates and ferric sulfate do not have any inhibitory effect on the polymerization of PVS impression materials.⁷ Several criteria's were used to define "inhibition" in their study, including an obvious lack of detail reproduction on the surface of the impression material. Similarly, Kahn RL et al have anecdotal clinical reports to discount the possibility of the interaction between aluminium chloride and did not investigate further.^{12,16} Although it cannot be stated that these medicaments inhibit the set of PVS impression material, the manner in which they

were used in the present study suggests that these materials adversely affects the surface detail reproduction. One explanation to these contradictory results is the methodology used in this study is different. The earlier study by De Camargo et al evaluated impression materials injected over 1" segment of retraction cord and 1cm² of cotton.⁷ The retraction cord and cotton were impregnated with the medicaments and blotted dry and the impression was recorded and evaluated under 10X magnification. Whereas our study used impressions of the standardized dies similar to those specified in ADA specification 19. the quantity of material is carefully controlled. Surface detail reproduction was evaluated by examination of depth, width and character of 160um lines. In this study the medicaments were not washed off completely before the impression were made. This was to simulate the most severe clinical situations i.e where clinician fails to rinse off the medication prior to impression recording. According to a study by Browning GC et al, gloves were found to inhibit the set of the material. The only effective method for completely removing the inhibiting particles from the tooth or die was mechanical removal of any trace of material with the toothbrush or prophylaxis head and pumice. Simple rinsing with mouthwash, hydrogen peroxide, or an air water syringe was ineffective at removing the inhibitor particles.^{13,14,17}

CONCLUSION

Within the limits of this study the following conclusions were derived from the results:

1. There was statistically significant difference in surface detail reproduction between all the retraction cord medicaments groups and the control group investigated in this study.
2. Surface detail reproduction in polyvinyl

siloxane impressions was adversely affected by all of the retraction cord medicaments.

3. There was no statistically significant difference in dimensional accuracy among any the groups. All of the impression material exhibited shrinkage that was within the ADA's specification limits for type I non aqueous elastomeric dental impression materials i.e less than 0.5% shrinkage.

The result of this study suggests that clinician must be diligent in his or her efforts to remove retraction cord medicaments prior to recording an impression. Further investigations are needed to determine if rinsing with air and water is sufficient to remove retraction cord medicaments. Additional studies are required to determine the effects of other medicaments used in this study on the wide variety of commercially available impression materials.

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