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Effect of Different Types of Gloves on Polymerization of Polyvinyl Siloxane Impression Material: An in Vitro Study

[1]Dr. Swatantra Agarwal,
Professor and Head,
Department of Prosthodontics and Crown & Bridge,
Kothiwal Dental College & Research Centre,
Moradabad-244001, Uttar Pradesh, India

[2]Dr. Siddhi Tripathi*,
Reader,
Department of Prosthodontics and Crown & Bridge,
Kothiwal Dental College & Research Centre,
Moradabad-244001, Uttar Pradesh, India

[3]Dr. Ruchi Gupta,
Post graduate student,
Department of Prosthodontics and Crown & Bridge,
Kothiwal Dental College & Research Centre,
Moradabad-244001, Uttar Pradesh, India

[4]Dr. Dipti Nayak
Post Graduate student
Department of Prosthodontics and Crown & Bridge,
Kothiwal Dental College & Research Centre,
Moradabad-244001, Uttar Pradesh, India

Abstract:-

- ***Purpose:***

Polyvinyl siloxane impression material is the most routinely used impression material in Prosthodontics. However controversial findings regarding its compatibility with disposable gloves (especially latex gloves) have been reported. Hence, the present study was taken up to evaluate the effect of non-latex gloves and latex gloves on the polymerization of the polyvinyl siloxane impression material.

- ***Materials and Methods:***

A total number of three groups were employed for the study. Group I comprised of 30 non-latex gloves. Group II comprised of 30 latex gloves. Group III was the control group (n=10) in which no gloves were used. The putty material was manipulated and its homogenous mix was placed under the arm of the oscillating disc rheometer. For each group, ten recordings of setting time were taken. The results obtained were statistically analyzed using one way ANOVA, Post Hoc Tukey, Dunnett test and subjected for comparative evaluation.

- ***Results:***

Least setting time of the polyvinyl siloxane putty impression material was reported in group III (control) followed by group I (non-latex gloves) and maximum in group II (latex gloves). The results were found to be statistically significant ($p<0.05$) when group II was compared with group III. However insignificant differences ($p>0.05$) were found on comparing the group I with group III.

- ***Conclusions:***

Polyvinyl siloxane putty impression material showed significant variation in the setting time when mixed with two out of three latex gloves. Therefore latex gloves should not be worn while mixing or handling polyvinyl siloxane putty impression material. Instead non-latex gloves should be employed during their manipulation.

Keywords:- *Polyvinyl Siloxane Putty Impression Material, Latex Gloves, Non-Latex Gloves.*

I. INTRODUCTION

The success of prosthodontic treatment is governed by multitude of factors including accurate impressions and the corresponding models from which a restoration can be manufactured in the laboratory.[1] Polyvinyl siloxane (PVS) impression materials represent the state of the art in impression materials used in a variety of clinical situations in fixed and removable prosthodontics, operative and implant dentistry owing to their accuracy, favorable handling properties, excellent elastic recovery and less permanent deformation in comparison to other elastomers.[2-4] Inspite of their advantages, they have manipulative variables that may adversely affect its properties.[5]

Polymerization of the PVS impression material can be altered by several factors like temperature, humidity, viscosity, glove lubricants, rubber dam, zinc-oxide eugenol temporary cements and luting agents, surfactants, alum type gingival retraction cords, sulfur containing hemostatic agents like ferric sulfate and aluminum sulfate, glass-ionomer cements, light cured composite, unset residues of temporary crown materials (methacrylates) and petroleum jelly lubricants.[1,4,5-7] Partial or incomplete polymerization of an impression has a detrimental effect on the dimensional accuracy and surface definition of resultant casts used for restorative procedures leading to production of distorted casts and inaccurate prosthesis.[8]

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Various authors such as Niessen et al.,[9] Burke and Wilson,[10] Reitz et al.,[11] Kahn et al.[12] and Rosen et al.[13] have also observed that wearing latex gloves while mixing PVS putty impression material inhibits the setting time of the material. However, several authors such as Kimoto et al.,[8] Kahn and Donovan,[14] Kahn et al.,[12] Reitz et al.[11] and Rosen[13] have stated the potential polymerization inhibition of low viscosity addition-cured silicone impression material by indirect or direct contact with latex gloves and vinyl gloves demonstrated no inhibitory effect.

Owing to the controversial findings regarding the compatibility between disposable gloves and PVS impression materials, the present study was taken up to evaluate the effect of latex and non-latex gloves on the polymerization of the PVS impression material. The null hypothesis of the present study was that there was no effect of latex and non-latex gloves on the polymerization of PVS putty impression material.

II. MATERIALS AND METHODS

A total number of three groups were employed for the study. The test groups comprised of 30 non-latex gloves (ten each of neoprene gloves, nitrile gloves and polyisoprene gloves) in Group I and 30 latex gloves (ten each of examination gloves, powder free gloves and surgical gloves) in group II. Group III was the control group in which no gloves were used for manipulation of PVS putty impression material. The base and catalyst pastes of PVS putty impression material were dispensed in equal quantity with scoops and measured with the help of weighing machine. This was done to avoid unequal proportion of base and catalyst paste which could have altered the setting time of PVS impression putty impression material and led to false results. Following this, both the pastes were kneaded together using fingers and palm of both hands for 30 seconds. For all three groups, hands were washed thoroughly with water and dried well with paper towel after each mix. Before starting the experiment the Oscillating Disc Rheometer was adapted to let the material set at 37º C temperature (oral temperature). The maximum time allowed for the material to set was 10 minutes. The homogenous mix of PVS putty impression material was placed under the arm of the oscillating disc rheometer which tested the viscosity changes in the setting material from soft to rigid consistency. The machine was cleaned well after each test. For each group, ten recordings of setting time were taken. The data was statistically analysed using SPSS (21.0 version). Analysis was performed using the parametric tests i.e. one way ANOVA, Post Hoc Tukey and Dunnett test.

III. RESULTS

The mean setting time (ST) of different types of gloves is presented in table 1 and figure 1.

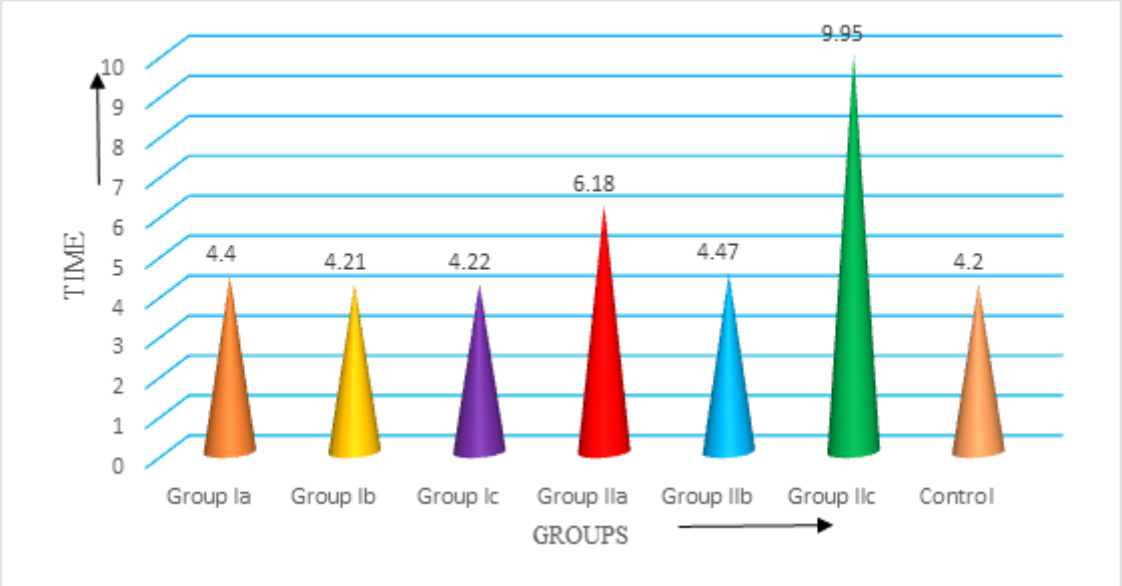

Fig 1:- Mean setting time of polyvinyl siloxane putty impression material amongst different groups

When subjected to One-way ANOVA, the intra-group differences in mean ST In Group I (non-latex gloves) were found to be (table 2) statistically insignificant (p=0.772). Likewise, when Tukey HSD test (table 3) was applied, intra-group comparison of Group Ia (neoprene) versus Group Ib (nitrile), Group Ia versus Group Ic (polyisoprene) and Group Ib versus Group Ic showed statistically insignificant results (p>0.05).

In Group II (latex gloves) it was found that when One-way ANOVA was applied, the intra-group differences in mean ST (table 4) were found to be statistically significant (p<0.05). Likewise, when subjected to Tukey HSD test (table 5), intra-group comparison of Group IIa (examination gloves) versus Group IIb (powder free gloves), Group IIa versus Group IIc (surgical gloves) and Group IIb versus Group IIc showed statistically significant results (p=0.001).

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S. No.	Group Ia	Group Ib	Group Ic	Group IIa	Group IIb	Group IIc	Group III
1	4.41	4.16	4.23	6.19	4.48	10	4.20
2	4.46	4.13	4.19	6.19	4.49	9.5	4.21
3	4.40	4.26	4.27	6.18	4.40	10	4.20
4	4.18	4.17	4.26	6.20	4.45	10	4.22
5	4.35	4.25	4.30	6.19	4.48	10	4.20
6	4.16	4.24	4.21	6.20	4.48	10	4.20
7	4.40	4.19	4.22	6.19	4.49	10	4.21
8	4.35	4.30	4.19	6.18	4.47	10	4.21
9	4.38	4.27	4.18	6.18	4.48	10	4.20
10	4.47	4.20	4.20	6.17	4.48	10	4.20
Mean (minutes)	4.40	4.21	4.22	6.18	4.47	9.95	4.20
SD	0.10	0.05	0.03	0.009	0.027	0.15	0.007
Maximum	4.47	4.30	4.30	6.20	4.49	10	4.22
Minimum	4.16	4.13	4.18	6.17	4.40	9.5	4.20

Table 1:- Setting time of polyvinyl siloxane putty impression material amongst different groups
SD = Standard deviation

Groups	Gloves	Mean (Minutes)	SD	F Value	p Value
Group Ia	Neoprene	4.40	0.04	0.261	0.772
Group Ib	Nitrile	4.21	0.09		
Group Ic	Polyisoprene	4.22	0.03		

Table 2:- Intra-group Comparison of the effect of non-latex gloves on the setting time of polyvinyl siloxane impression material using One way ANOVA
F = Variance of the mean group, p = Level of significance

Comparison	Group Ia	Group Ib	Group Ic
Group Ia	-	0.999	0.998
Group Ib	-	-	1.000
Group Ic	-	-	-

Table 3:- Intra-group Comparison of the effect of non-latex gloves on the setting time of polyvinyl siloxane impression material using Tukey HSD test

Groups	Gloves	Mean (minutes)	SD	F Value	p Value
Group IIa	Examination gloves	6.18	0.009	74.423	0.00
Group IIb	Powder free gloves	4.47	0.027		
Group IIc	Surgical gloves (powdered)	9.95	0.15		

Table 4:- Intra-group comparison of the effect of latex gloves on the setting time of polyvinyl siloxane impression material using One way ANOVA

Comparison	Group IIa	Group IIb	Group IIc
Group IIa	-	0.001*	0.001*
Group IIb	-	-	0.001*
Group IIc	-	-	-

Table 5:- Intra-group comparison of the effect of latex gloves on the setting time of polyvinyl siloxane impression material using Tukey HSD test

When subjected to One-way ANOVA for inter-group comparison of the effect of latex and non-latex gloves on the mean ST of the PVS impression material, least setting time (table 6) was reported in Group III (control) followed by Group I and maximum in Group II. Statistically significant differences between all the groups were reported ($p<0.05$). When Dunnet test was applied for inter-group comparison of all three groups, statistically significant ($p<0.05$) differences in mean ST was seen on comparing Group III with Group IIa, Group IIb and Group IIc. However statistically insignificant differences ($p>0.05$) in mean ST was seen on comparing Group III with Group Ia, Group Ib and Group Ic (table 7).

Groups	Mean (Minutes)	SD	F Value	p Value
Group I	4.28	0.002	46.321	0.00*
Group II	6.86	0.05		
Group III	4.20	0.007		

Table 6:- Inter-group comparison of the setting time of polyvinyl siloxane putty impression material using One-way ANOVA

Comparison	Group I			Group II		
	Group Ia	Group Ib	Group Ic	Group IIa	Group IIb	Group IIc
GROUP III	1.000	0.997	0.997	0.001*	0.001*	0.001*

Table 7:- Inter-group comparison of setting time of putty impression material mixed with the gloves and ungloved hands (control) using Dunnett test

IV. DISCUSSION

The null hypothesis of the present study that there was no effect of latex and non-latex gloves on the polymerization of PVS putty impression material was partially rejected, since significant polymerization inhibition was found with the use of latex gloves. However statistically insignificant difference in setting time was found with non-latex gloves while manipulating PVS putty impression material.

Out of the non-latex gloves used in the study, neoprene is a synthetic rubber glove made up of chloroprene and is primarily used as surgical glove. Nitrile synthetic glove is made up of nitrile butadiene rubber and is used primarily as an examination glove. Polyisoprene glove is a synthetic glove material that is structurally similar to natural rubber latex, but without the allergic proteins.[15]

As documented in literature, the mean ST of PVS has been reported to be 3-5 minutes.[16] When neoprene gloves (Group Ia) were used for manipulation of PVS, the mean ST of PVS was found to be 4.40 (±0.10) minutes. This was in accordance with the previous studies conducted by the Baumann[17] who stated that the no significant influence was seen in setting reaction of PVS when mixed with the dermaprene (neoprene) gloves. However, Pajares et al.[18] reported that out of different brands, one brand of neoprene gloves from the same company caused surface polymerization inhibition of PVS. This could have been because of the fact that some neoprene products are manufactured with xanthogen disulfides and others use thiuram disulfides as peptization agents which could lead to surface inhibition of PVS.

The mean ST of PVS when manipulated with nitrile gloves (Group Ib) was reported as 4.21 (±0.05) minutes. Similar results were confirmed by Filho et al.[19] who stated that the mean ST of PVS was 4.3 (±0.3) minutes. However, Pajares et al.[18] reported that the nitrile gloves caused the polymerization inhibition of the PVS impression material. This can be attributed to the fact that various chemicals used in the manufacturing of nitrile gloves (including aluminum sulphate) are same as those used in the manufacturing of latex gloves. This might be the reason of polymerization inhibition of the PVS impression materials in direct contact with the latex-free products.

When polyisoprene glove (Group Ic) were used for manipulation of PVS, the mean ST was found as 4.22 (±0.03) minutes. Therefore, it did not cause polymerization inhibition of the PVS. However the results cannot be compared with other studies as no previous study has been conducted to evaluate the effect of polyisoprene gloves on the polymerization of PVS impression materials.

The latex gloves used in the present study included examination gloves, powder free gloves and surgical gloves. They are highly elastic, have excellent barrier protection, are produced from a renewable resource (H. brasiliensus tree) and demonstrate fewer defects in manufacture as compared to non-latex gloves.[3,8,15,20] However, these gloves should not be worn by those individuals allergic to natural rubber latex proteins. They come unpowdered or powdered with talc, corn starch and lycopodium to lubricate the gloves, making them easier to put on the hands.[21]

Amongst the various types of latex gloves used, it was seen that when examination gloves (Group IIa) were used, the mean ST of PVS was found to be 6.18 (±0.009) minutes. This was in accordance to previous studies done by Matis et al.,[22] Pajares et al.,[18] Ravikumar et al.[23] and Kahn et al.[12] whereby it was reported that polymerization inhibition of PVS occurred with these types of gloves. However, Qahtani et al.[24] and Filho et al.[19] documented the mean ST of PVS, when manipulated with examination

gloves, as 4.6.(±0.16) minutes and 5.0 (±0.0) minutes respectively. Likewise few authors such as Neissen et al.,[9] Rosen et al.,[13] Reitz et al.,[11] Tomaszewska[25] and Causton et al.[21] stated that not all brands of the examination gloves caused inhibition of PVS impression material.

For powder free gloves (Group IIb), mean ST of PVS was found to be 4.47 (±0.027) minutes. These results were similar to the studies conducted by the Baumann[17] and Filho et al.[19] who stated that the mean ST of PVS was 4.8 (±0.6) minutes. Maize starch used during the manufacturing procedure to powder the outside of gloves has been shown to be the source of contamination in the setting reaction of PVS impression material when manipulated with powdered gloves. Hence powder free gloves should not cause polymerization inhibition of PVS. However, the results were contradictory to the study conducted by Kahn et al.[12] who stated that all the powder free gloves caused polymerization inhibition of PVS impression material.

When surgical gloves (Group IIc) were employed for manipulation of PVS, the mean ST was found to be 9.95 (±0.15) minutes. These results were in accordance with the studies conducted by Pajares et al.,[18] Rosen et al.,[13] Reitz et al.,[11] Kahn et al.,[12] Qahtani et al.[24] and Tomaszewska.[25] Likewise, Baumann[17] and Ravikumar et al.[23] reported the mean ST of PVS, when manipulated with the surgical gloves, as 8 to 10 minutes and 7.01 (±0.7) minutes respectively.

The most frequently accepted hypothesis of polymerization inhibition of PVS when manipulated with latex gloves is that sulfur is incorporated during the process of vulcanization of latex gloves.[21] Therefore, by analogy, sulfur found in the sulfate radicals (diethyldithiocarbamate) interacts with the catalytic sites of addition silicone materials.[7] This leads to contamination and poisoning of the chloroplatinic acid metal catalyst.[26,27] As little as 0.005% of diethyldithiocarbamate has been documented to completely inhibit setting of PVS.[21,28-30] However, owing to varied chemical structure and structural composition, and differences in level of zinc dithiocarbamate, all brands of latex gloves do not inhibit the polymerization of addition silicone impression materials in the same way.[4,21,27,31,32]

In control group, based on the mean ST of PVS impression materials reported as 4.2 (±0.007) minutes, it was inferred that ungloved hands did not cause polymerization inhibition of PVS. Similar results were documented in the studies conducted by Qahtani et al.,[24] Rosen et al.,[13] Ravikumar et al.[23] and Neissen et al.[9] whereby it was stated that ungloved hands did not interfere with the setting reaction of PVS. However, Tomaszewska,[25] Mundathaje et al.,[33] Retiz et al.,[11] Matis et al.,[22] Cook[34] and Baumann[17] reported that mixing the PVS with bare hands, after removal of latex gloves, showed inhibitory effect on the polymerization of PVS.

When all three groups were subjected to comparative evaluation, it was seen that least setting time was reported in control group 4.20 (±0.007) minutes followed by non-latex gloves 4.28 (±0.002) minutes and maximum in latex gloves 6.86 (±0.05) minutes. Statistically significant differences ($p<0.05$) in mean ST were reported when control group and non-latex gloves were compared with latex gloves. However, no significant difference in mean ST was reported between control and non-latex gloves ($p>0.05$). Similar decreasing trends in the setting time of PVS has been seen in the studies conducted by Neissen et al.,[9] Ravikumar et al.,[23] Qahtani et al.[24] and Kahn et al.[12] Likewise, Rosen et al.[13] reported that the setting time of PVS was delayed when putty was mixed with the natural latex gloves but there was no significant difference in the setting time when synthetic latex gloves and /or ungloved hands were used for its manipulation. However, conflicting findings were observed by Moon et al.[5] and Machado et al.[26] who reported that gingival retraction cord handled with the latex gloves did not show any inhibitory potential over the PVS impression materials.

Clinical implications of the results of the present study are that dental professionals and assistants should take precautionary measures while manipulating PVS impression materials. This is because putty material is mixed by hand rather than by spatulation for homogenization of the base and catalyst pastes. Therefore the type of gloves worn may affect its polymerization and setting time. As there is risk of contaminant transfer from latex via direct or indirect contact, it may be prudent to completely avoid contact with latex in any area in which PVS is to be used. It is clinically inappropriate to use bare hands for dispensing and mixing of PVS as it may violate the norms of barrier techniques and cross-infection control. Rather, usage of non-latex gloves is recommended as they do not retard polymerization and setting time of PVS. Manufacturers of VS putty impression materials should label their products with the effect of latex gloves on the setting time. Moreover, it is imperative and advised to test the specific brand of gloves against the PVS impression material that is going to be used to make the impression. Also other barrier materials made of non-contaminating materials with desirable physical properties and costs similar to latex should be developed.

However, there are certain limitations of the present study. Only one commercially available brand of PVS impression material and only one batch of gloves were employed for the study. Future research should be expanded to include a broad array of powdered and non-powdered gloves from multiple batches from several manufacturers. This is because variability exists between gloves from different manufacturers and differences may exist even between batches of a single manufacturer. Also, inclusion of different commercially available brands of PVS impression material is suggested to evaluate any possible alteration of their setting time or physical properties during their interaction with various types of gloves. Moreover, the exact nature of the inhibition requires further investigation using more sensitive methods.

V. CONCLUSIONS

Within the limitations of the study, it was concluded that all three types of non-latex gloves (neoprene gloves, nitrile gloves and polyisoprene gloves) tested had no significant effect on the mean ST of PVS impression material. Two out of three latex gloves (examination gloves and surgical gloves) tested delayed the mean ST of PVS putty impression material significantly. However, powder free latex gloves had no significant effect on the mean ST of PVS putty impression material.

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