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Research Article

EFFECTS OF THREE BRANDS OF COMMERCIALLY AVAILABLE TOPICAL SURFACTANTS ON THE SURFACE HARDNESS OF DENTAL STONE PRODUCED FROM POLYVINYLSILOXANE DUPLICATING MATERIAL - AN INVITRO STUDY

Nitin Rastogi[1], Tarun Gaur[2], Manish Kumar[3*], Alok Kumar[4]

[1]Reader, Department of Prosthodontics & Crown and Bridge, Institute of Dental Sciences, Bareilly, Uttar Pradesh, India.
[2]Ex Senior Resident, Department of Dentistry, J L N Medical College & Hospital, Ajmer, Rajasthan, India.
[3]Senior Resident, Department of Dentistry, S. P Medical College & Hospital, Bikaner, Rajasthan, India.
[4]Reader, Department of Prosthodontics & Crown and Bridge, Institute of Dental Sciences, Bareilly, Uttar Pradesh, India.

ABSTRACT

Background and objective: A serious problem with the use of Polyvinyl Siloxane material (PVS) is their low surface energy which renders them difficult to wet with gypsum slurries. Laboratory applied surfactants as well as so called hydrophilic elastomers, are effective in reducing the hydrophobic nature of elastomers and increase the probability of obtaining a void free gypsum cast. With the above background the present study was aimed to investigate the changes in the surface hardness of a dental stone poured in polyvinyl siloxane moulds following the application of three brands of commercially available topical surfactants.

Materials and methods: A cylindrical master model was made from an acrylic resin rod 20 mm in diameter and 35 mm in length. It was placed on a plastic sheet and seated centrally at the base of a casting ring former to create moulds. PVS duplicating material, Ecosil (Dentaurum) was mixed according to the manufacturer's instructions and poured into the casting ring former to create four moulds. Fifteen specimens were poured into each of the moulds for each model material/ surface treatment combination, yielding a total of 60 specimens for testing. Brinell hardness test was performed using a universal testing machine and the results were compared using one way ANOVA and Post-hoc Tukey's test.

Results: Within the group 1, the surfactant Aurofilm (Bego) greatly increased the surface hardness of dental stone (BHN-69.2) when compared to the control group. The surfactants Debubblizer (Prime dental) and Waxit (Dentsply) increased the surface hardness of dental stone to a certain extent when compared to the control group.

Conclusion: The surfactant Aurofilm was found compatible with PVS duplicating material (Dentaurum) and dental stone (Kalrock). The surfactants Debubblizer and Waxit were found compatible in dental stone group without significantly increasing the surface hardness.

Keywords :-Polyvinyl Siloxane duplicating material (PVS), Surfactants, Dental Stone.

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INTRODUCTION

An accurate void free impression is an integral part of predictable fixed prosthodontics. The wettability of dentine surfaces by impression materials depends on the hydrophilicity and viscosity of the material. Additional factors in detail reproduction include the rheological characteristics of the impression material,

Corresponding Author **Manish Kumar** Email: - drmanishagarwalmds@gmail.com

rate of setting and other handling characteristics of the impression materials [1].

PVS impression materials have now been used for 30 years and despite their accuracy, the production of voids free models has been problematic. The impression materials are offered in a number of viscosities from low to putty like consistency, however, the duplicating materials have a very low viscosity and are designed for pouring. PVS materials are hydrophobic which may encourage formation of surface voids affecting the surface hardness and accuracy of resultant cast [2].

Surfactant applied to an impression may reduce the number of voids in resultant cast or die. A topical surfactant had been developed for clinical use (Hydrosystem, Zhermack). This was a modified poly methyl siloxane wetting agent that can be sprayed onto prepared tooth surfaces before impression recording. An in vitro study revealed a significant reduction in the number of surface defects in impression materials and in dies from the impressions when this surfactant was used [3].

Recent works has shown that many chemical and physical methods are effective for increasing the surface energy of elastomeric impression materials, including the application of surfactants and glow-discharge treatment [4].

METHODOLOGY:

This study was performed to investigate the change in surface hardness of a dental stone poured in polyvinyl siloxane moulds following the application of three commercially available topical surfactants **.**

I. METHODOLOGY:

a. Preparation of cylindrical master model and casting ring:

A precisely machined steel cylindrical master model was made 20 mm in diameter and 35 mm in length for the fabrication of PVS moulds. A precisely machined casting ring former 40 mm in diameter was made and the master model was mounted centrally on a plastic sheet. A shallow circular groove was given on the plastic sheet for the orientation of casting ring former . A slight amount of petroleum jelly was applied on the plastic sheet for the easy removal of PVS moulds.

b. Preparation of PVS duplicating material moulds:

PVS duplicating material was kept at room temperature according to the manufacturer's instruction**.** PVS duplicating material was mixed according to the manufacturer's instructions i.e. 1:1 base and catalyst ratio and poured into the casting ring former to create the eight moulds. These moulds were divided into group I.

Dental stone was mixed according to the manufacturer's instruction and a total of 60 specimens were poured into the PVS moulds. Specimens were divided into four subgroups i.e. A, B, C and D, each group containing 15 specimens. Sixty specimens were poured with each material- fifteen without surfactant (group A), fifteen using Aurofilm (group B), fifteen using Debubblizer (group C) and fifteen using Waxit (group D). The specimens were removed from the mould one hour after pouring, excess was removed and the surface that was exposed to air while the specimens were setting, was smoothened with sandpaper to produce a flat surface for the table of the hardness testing machine.

Groups

GROUP A	Without surfactant
GROUP B	With surfactant- Aurofilm(Bego)
GROUP C	With surfactant – Debubblizer(Prime Dental)
GROUP D	With surfactant – Waxit(Dentsply)

c.Calculation of BHN number of dental stone models using travelling microscope:

Each specimen was tested for surface hardness using Brinell hardness tester at 24 hrs. from the time of mixing of a Dental stone. A 5mm diameter hardened steel ball was forced into the flat surface of the specimen under a load of 150Kg, which was maintained for 10 seconds**.** Indentation was identified by drawing the side of a surveyor lead over the surface. A travelling microscope was used to measure the diameter of the indentation. Each indentation was measured in the X and Y axis. A total of ten readings were recorded for each specimen and the mean value calculated. All measurements were executed by a single operator and the readings were tabulated and used for the statistical analysis.

d. BHN was calculated from the formula:

$$0.102 \times 2F / \pi D\,(D-\sqrt{D^2 - d^2})$$

F = force in Newtons (N)

D = diameter in millimeters of indenter ball

d = mean diameter

RESULTS

This study was performed to investigate the change in surface hardness of dental stone poured in Polyvinyl siloxane moulds following the application of three commercially available topical surfactants.

Sixty specimens of dental stone were fabricated. These specimens were divided into group 1. In group 1 sixty specimens of dental stone were poured following the application of 3 commercially available surfactants. Surface hardness of Final specimens were checked for BHN number.

Table 1:

The mean BHN numbers of the tested dental stone specimens are displayed in table 1. The maximum BHN number was noted for subgroup B.

Table 2:

Table 2 depicts mean difference of BHN numbers of dental stone subgroups (group B, group C and group D) with control group (group A). The maximum mean difference was found in group B.

Table 3:

Table 3 depicts the intragroup comparison (with control group) of BHN values in group 1 (dental stone). Group B that had been treated with surfactant aurofilm showed significant value. One way ANOVA was used to determine significant difference between surface hardness of dental stone of different subgroups after the application of three commercially available surfactants and Post-hoc Tukey's test for groupwise comparison. ANOVA revealed P< 0.001 and hence was statistically significant.

Table 4:

Table 4 depicts multiple comparison of BHN values of subgroups A, B, C and D in group 1. The comparison between group A and group B, group A and group C, group B and group C, group B and group D was found statistically significant. The statistical analysis showed P< 0.001 which was highly significant.

Table 1. Dental Stone Group - BHN Values

Groups	Mean	SD
Group A (Control)	58.1	2.5
Group B	69.2	5.2
Group C	62.2	7.0
Group D	59.4	5.5

Table 2. Mean Difference with Control

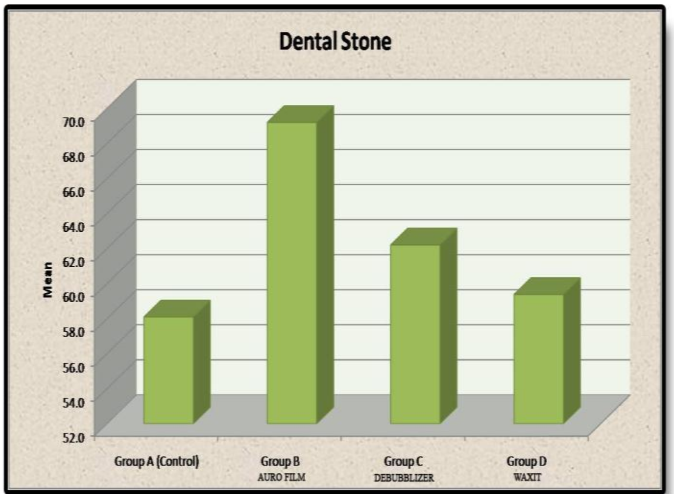
Groups	Mean	SD
Group B	-11.1	5.6
Group C	-4.1	7.4
Group D	-1.3	6.9

Table 3. Intragroup Comparison

Groups	Mean	P value, Sig	Comparison with control
Group A (Control)	58.1	P<0.001 HS	-
Group B	69.2		11.1 S
Group C	62.2		4.1 NS
Group D	59.4		1.3 NS
Repeated measures ANOVA test			
Tukey's post hoc test			

Table 4. Multiple Comparison among Sub groups

Groups	Mean	P value, Sig	Group A (Control)	Group B	Group C	Group D
Group A (Control)	58.1	P<0.001 HS	-	11.1 S	4.1 NS	1.3 NS
Group B	69.2		-	-	6.9 S	9.8 S
Group C	62.2		-	-	-	2.8 NS
Group D	59.4		-	-	-	-



Graph 1. Mean BHN values of subgroups of group 1 (Dental Stone).

DISCUSSION

The fit and ultimate success of a cast dental restoration is dependent upon the accuracy and completeness of the die reproduction. Polyvinyl siloxane impression materials have been found to be the most stable impression materials. A serious problem with the use of silicone elastomeric impression materials is that their low surface energy renders them difficult to wet with gypsum slurries. This poor wetting leads to air entrapment at the surface of cast and dies. The detail reproduction potential of a material is influenced by several factors, such as wettability, viscosity, and compatibility with gypsum. Surfactant applied to an impression may reduce the number of voids in such dies [5].

Polyvinyl siloxane (PVS) duplicating materials are increasingly used in dental laboratories in place of agar for duplicating casts. The impression materials are offered in a number of viscosities from low to putty like consistency, however, the duplicating materials have a very low viscosity and are designed for pouring. PVS materials are hydrophobic which may encourage formation of surface voids affecting the surface hardness and accuracy of the resultant cast. Surfactants are surface agents, which lead to a reduction in the surface tension of a material. The effect of surface energy alteration of impression materials has advantages in both the recording of the impression as well as in the production of any resultant gypsum base model.

Millar.BJ et al investigated that hydrosystem surfactant appeared to be particularly effective in reducing the number of surface voids when it is used with Elite polyvinyl siloxane impression material for which it is designed for use [6]. Perhaps less surprisingly, no benefit was found when hydrosystem was used with polyether and polysulfide materials. The variation in the number of surface voids for the materials may be explained by the different flow properties of the materials [7].

Other investigators have reported that the wettability of vinyl polysiloxane impression materials can be increased by coating the surface with acrylic acid in a glow-discharge reactor. However, Specific brands of VPS impression materials have different wetting properties. Glow-discharge treatment generally increases the surface energy of polymerized VPS impression material to a greater extent than applying topical surfactants.

In the present study, change in surface hardness of a dental stone poured in polyvinyl siloxane moulds was investigated following the application of three commercially available surfactants. In the group 1 (dental stone) application of all three surfactants increased the surface hardness of stone when compared with the control group ($P<0.001$). All pair wise multiple comparison procedures (Tukey's Post hoc test) confirmed the differences between treatment subgroups of group 1. Dental stone (Kalrock) gave the highest BHN with the Aurofilm treated surface (BHN-69.2) >debubblizer treated surface (BHN-62.2) >Waxit treated surface (BHN-59.4) > surface with no treatment (BHN-58.1).

Norling and Reisbick stated that the choice of the most effective surfactant is critical and differs not only between types of elastomers, but also brands of single type [8]. In the present study, wettability of PVS duplicating material was different with three commercially available surfactants. Among the surfactants Aurofilm greatly increased the wettability of PVS duplicating material while others either had no effect or decreased the wettability of the PVS duplicating material.

The surfactant Aurofilm was found compatible with dental stone when poured in PVS duplicating material and increase in the surface hardness was observed.(Graph-1).

CONCLUSION

This study investigated the change in surface hardness of a dental stone (Kalrock) poured in polyvinyl siloxane (Dentaurum) moulds following the application of three commercially available surfactants (Aurofilm, Debubblizer and Waxit).

Among the (Dental stone group), subgroup B had significant value that is application of surfactant (Aurofilm) increased the surface hardness of dental stone when compared to the control group.

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