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Effect of Three Different Types of Gloves on the Setting Time of Addition Silicone and Condensation Silicone Putty Impression Materials

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Abstract

Addition silicone and condensation silicone impression materials have been used as impression material for more than 20 years. Although they are among the most expensive impression materials, they became popular during the past decade as they have excellent physical properties.

Prevention of infection is an important aspect in dental treatment since dental professionals are routinely exposed to the wide variety of microorganisms present in saliva. Gloves are the most common protective measure used during dental treatment. The gloves are mostly made of latex.

In this study, we examine how the setting time of two type of elastomeric impression materials (addition silicone and condensation silicone) putty were affected by the use of three different type of gloves (latex gloves, nitrile gloves and vinyl gloves). Each material was first mixed without wearing gloves according to the manufacturer's instructions. After the stipulated mixing time, the setting time was measured using the Vicat needle. The setting time is measured from the time of mixing till the time that the needle does not produce any indentation on the surface of the material. The putty material was then mixed with three different types of gloves like (latex, nitrile and vinyl) and the setting time was measured.

Keywords: elastomeric impression materials, silicone impression materials, polymerization, setting time

Introduction

An accurate reproduction of impression is of critical importance in the field of prosthodontics, implant, and restorative dentistry. With proper material selection and manipulation, accurate impressions can be obtained for fabrication of tooth- and implant- supported restoration. At the same time, the possible exposure to the transmission of infectious agents has given rise to concerns with cross-infection control to prevent cross-contamination. Among the adopted precautions, the routine use of disposable gloves, mainly latex ones, is an essential measure to break the chain of infection. Latex gloves contain a sulphur compound, zinc diethyldithiocarbamate, used during latex glove fabrication, is a preservative and vulcanizing accelerator, which can completely inhibit polymerization of elastomers in concentrations as low as 0.005%.

Materials And Methods

In this study, two different brands of putty: A-silicone putty impression material (AFFINIS® COLTENE, SWITZERLAND) and C- silicone putty impression material (SPEEDEX® COLTENE, SWITZERLAND); three different type of gloves: latex , nitrile and vinyl were used. Base and catalyst putty material were dispensed and mixed according to the manufacturer's directions. First, the putty impression materials were kneaded with clean dry hands till a homogenous mix was obtained; we ensured that mixing was completed within the mixing time recommended by the respective manufacturer. After that, the putty impression material was mixed wearing latex, nitrile and vinyl gloves.

Figure 1: Armamentarium

For each type of glove, the A-silicone and C-silicone putty material were mixed four times. Elastomeric impression materials are divided in two groups: 1- addition silicone group and 2- condensation silicone. In this study each group is further sub-divided into four groups: control group (as washed ungloved hands), latex group, nitrile group and vinyl group. The specimens were obtained by a standardized square mould 5x5x5 cm diameter. The Vicat needle, 1mm in diameter, 5cm long, and 300gm in weight, was used to determine the setting time. A stop watch timer was used to note the setting time. The values were then subjected to statistical analysis.

Figure 2: Addition silicone putty mixed with ungloved hands

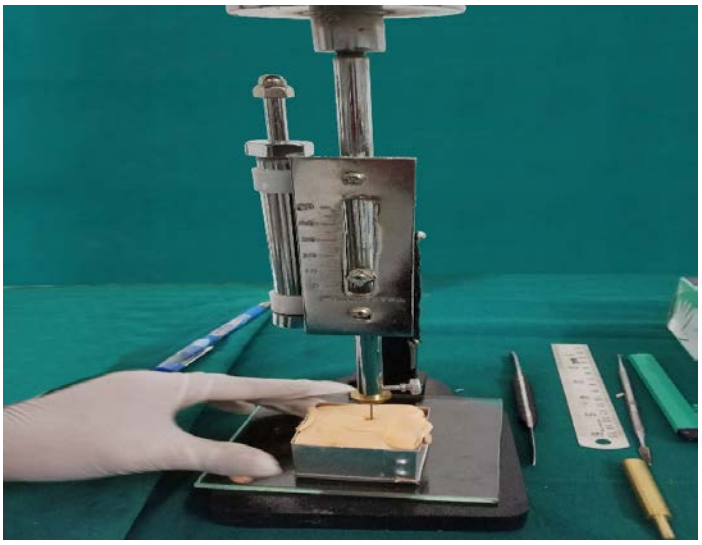

Figure 3: Addition silicone putty mixed with latex gloves

Figure 4: Addition silicone putty mixed with nitrile gloves

Figure 5: Addition silicone putty mixed with vinyl gloves

Figure 6: Condensation silicone putty mixed with ungloved hands

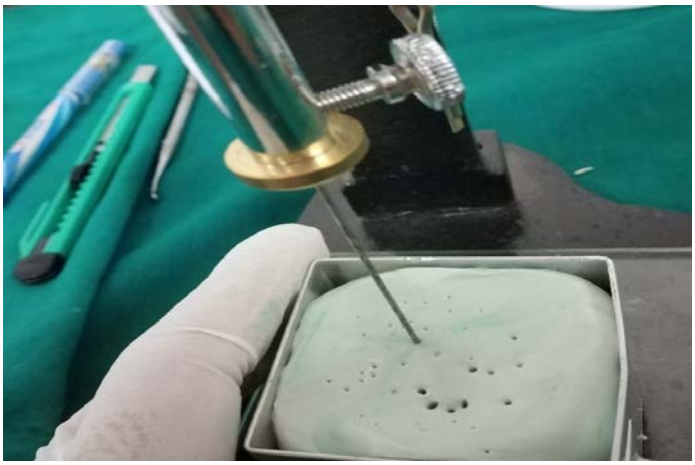

Figure 7: Condensation silicone putty mixed with latex gloves

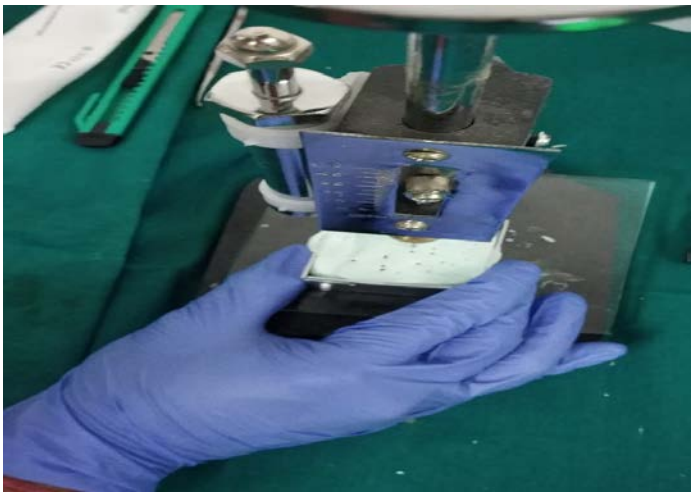

Figure 8: Condensation silicone putty mixed with nitrile gloves

Figure 9: Condensation silicone putty mixed with vinyl gloves

Results

Statistical Analysis: The data were collected, coded and entered in Microsoft excel 2010. The data was described in mean and standard deviation. One way ANOVA was applied to compared the mean difference among different groups. The post hoc Tukey test was used for multiple comparisons between groups. Statistical Package for Social Sciences (SPSS) IMB version 22 was used for statistical analysis. The level of significance was set at 5%.

Table 1: Comparison of setting time for Additional Silicone impression material among various gloves

Groups	N	Mean ± SD	P Value
Control group	4	2.75 ± 0.20	0.001*
Latex group	4	6.88 ± 2.59	
Nitrile group	4	3.33 ± 0.47	
Vinyl group	4	2.18 ± 0.15	

Data is presented in Mean ± SD and the mean value were compared by using Oneway ANOVA test; *P<0.05 statistically significant

Table 1.a: Multiple comparison among various gloves for Additional Silicone impression material

Groups	Mean Difference	P Value
Control group vs Latex group	-4.13	0.004*
Control group vs Nitrile group	-0.58	0.92
Control group vs Vinyl group	0.57	0.93
Latex group vs Nitrile group	3.55	0.01*
Latex group vs Vinyl group	4.70	0.001*
Nitrile group vs Vinyl group	1.15	0.62

*P<0.05 statistically significant

Table 2: Comparison of setting time for Condensation Silicone impression material among various gloves

Groups	N	Mean ± SD	P Value
Control group	4	4.15 ± 0.24	<0.001**
Latex group	4	9.75 ± 1.71	
Nitrile group	4	4.83 ± 0.89	
Vinyl group	4	4.26 ± 0.08	

Data is presented in Mean ± SD and the mean value were compared by using Oneway ANOVA test; **P<0.001 statistically highly significant

Table 2.a: Multiple comparison among various gloves for Condensation Silicone impression material

Groups	Mean Difference	P Value
Control group vs Latex group	-5.60	<0.001**
Control group vs Nitrile group	-0.68	0.76
Control group vs Vinyl group	-0.11	0.99
Latex group vs Nitrile group	4.92	<0.001**

Latex group vs Vinyl group	5.49	<0.001**
Nitrile group vs Vinyl group	0.57	0.84

**P<0.001 statistically highly significant

The setting time of two different types of putty (AFFINIS and SPEEDEX) materials when mixed with different methods (different gloves) are shown in Table-1, Table-1a and Table-2 and Table-2a. Tables 1 and 2 show the mean setting time of putty material when mixed with ungloved hands, and with different gloved hands.

The setting time of AFFINIS and SPEEDEX putty material when mixed with ungloved hands was 2.75 min and 4.15 min respectively. Similarly, the setting time of AFFINIS and SPEEDEX putty material was 2.18 min and 4.26 min respectively when mixed with vinyl gloved hands. There was no significant difference in mean setting time of putty mixed with ungloved hands and putty mixed with vinyl gloved hands. There was a significant difference in setting time when it was mixed with latex gloves. Results indicate that when putty is mixed with latex gloved hands, the polymerization of addition silicone and sometime condensation silicone is either completely inhibited or delayed setting of the material occurs.

In Table-1a and Table-2a, the comparison of mean setting time of AFFINIS and SPEEDEX with different groups (ungloved hand as control group, latex group, nitrile group and vinyl group) show the significant difference in mean setting time between groups.

Discussion

Various substances have the potential for interaction with polyvinyl siloxane impression material during the setting reaction. Polymerization inhibition reports were not widespread until expanded infection control guidelines were implemented as standard of care in dentistry. Latex gloves and rubber dam are two prominent infection control barriers within the scope of these guidelines. Contraindication for making impression with rubber dam in place was first noted in the private practice by Noonan et al. [1] When addition silicone impression material was used with a rubber dam in place, it was seen that the surface of the impression did not set wherever it touched the rubber dam.

In this study we found that latex gloves affected the setting time of polyvinyl siloxane impression materials and also condensation silicone. The setting time of polyvinyl siloxane with latex gloves is delayed or the setting is completely inhibited.

The mechanism of inhibition of polymerization is likely to be contamination of the platinum catalyst in the polyvinyl siloxane impression material by the sulphur-containing compound present in latex gloves. As the vinyl gloves does not show any significant effect on the setting time of addition silicone, they should be worn during the dispensing and mixing of putty. [2,3]

The inhibition of the setting reaction of addition-cured silicones has wrongly been attributed to the use of various donning agents, such as corn starch and talcum powder, while other authors suggested interactions with haemostatic agents. [4]

Various studies have shown that sulphur and sulphur-containing compounds used in the manufacturing process of latex gloves are responsible for the retarding effect on polymerization. [5,6,7,8]

Manufacturing latex gloves is a multi-stage process. Glove formers, which are moulds in the shape of the hand, usually constructed from a ceramic material, are dipped into a coagulant bath and then allowed to dry. The coated formers are then dipped into the latex mixture. The latex film is vulcanized by treatment with sulphur or sulphur-containing compounds under heat or pressure in a process to improve its elasticity and mechanical properties. [8]

Preservatives are also commonly added to the latex mixture to extend its shelf-life. A frequently used preservative is zinc dithiocarbamate, with zinc dimethyldithiocarbamate being commonly used in the rubber vulcanization process; both are sulphur containing. Zinc dithiocarbamate inactivates a platinum catalyst (chloroplatinic acid) in the accelerator of the impression material and is considered to be responsible for the retarding effect, with as little as 0.005% of dithiocarbamate completely inhibiting setting. [9]

Further, this inhibition may be either direct or indirect. Direct inhibition occurs when high viscosity putty materials are hand mixed with gloved hands with sustained contact for the duration of mixing. Indirect inhibition occurs when impression material fails to set against teeth and intra-oral soft tissues that have been previously touched and contaminated with latex gloves. [10]

Kahn and Donovan, in 1989, evaluated the potential polymerization inhibition of three brands of low viscosity addition-cured silicone impression material by indirect contact with latex gloves. To simulate the clinical situation, a stainless-steel plate rubbed with latex gloves for 20 seconds was used as a test surface. This is more akin to a clinical situation where sustained contact between latex gloves and impression material is not normally encountered. A clean, untreated stainless-steel plate was used as a control surface. Impression materials were expressed on to the contaminated surface and allowed to set. All three brands of addition-cured silicone impression material in contact with the contaminated stainless-steel surface failed to set. [11] Kimoto et al, in 2005, showed elemental sulphur as well as sulphur compounds to be present on the surfaces of vinyl gloves and gingival retraction cords after a 5-second light rubbing motion with latex gloves simulating a normal clinical situation. [12]

Conclusion

Two type of putty impression materials and three types of gloves were used in this study. The following conclusions were drawn:

1. AFFINIS and SPPEDEX putty impression materials show significant variation in the setting time when mixed with latex gloves.
2. There is no significant variation in setting time when mixed with vinyl gloves and ungloved hands.

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