# Effect of Glove, Blood, and Saliva Contamination on the Compressive Strength of Nanohybrid Composite Resin

*Annisa Widiandini[1], Endang Suprastiwi[1]*, Munyati Usman[1]*

1. Department of Conservative Dentistry, Faculty of Dentistry, Universitas Indonesia, Jakarta, Indonesia.

**Abstract**

Nanohybrid composite resin is a material of choice for restoration of both anterior and posterior teeth. One of its mechanical properties that plays important role to withstand mastication force is compressive strength. Due to a high demand of aesthetic restorations, the importance of contamination control requires special concern since composites are sensitive to contamination. The aim of this study was to determine the effect of glove, blood, and saliva contamination on the compressive strength of nanohybrid composite resin. Twenty-four specimens were randomly divided into four groups based on the type of contamination. The mean and standard deviation values (MPa) for compressive strength were as follows: Group 1= 151.57±17.97, Group 2= 159.94±18.55, Group 3= 134.91±25.53, Group 4= 151.72±17.34. All groups did not show a statistically significant difference (p>0.05) in compressive strength. In conclusion, glove, blood, and saliva contamination do not affect the compressive strength of nanohybrid composite resin.

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## Introduction

Restoration of the teeth is one of the most frequent dental treatments done in Indonesia. Based on the data from the data from Health Promotion Directorate of Indonesian Ministry of Health, the number of dental treatments performing restoration is almost 170.000 restorations and composite resins are the most commonly used material.[1] Composite resins are widely used as restoration material because they can produce a tooth-colored restoration, improving aesthetic appearance and better restoring tooth structure because of their adhesive bond.[2]

Due to the development of technology, there are various types of composite resins. One type of composite resin that is often used today is the nanohybrid composite resin, which is also referred to as the universal composite. Their ease of application and good aesthetic results make nanohybrid composite resins better suited for anterior teeth. Moreover, a mixture of nanoparticle and micro-hybrid materials makes the resin more resistant to wear. The nanohybrid composite resin has better mechanical properties than other composites, so it is also appropriate for posterior teeth application.[3] One of its mechanical properties is compressive strength, which must be considered in selecting the right restoration materials for clinical use because teeth and restoration will always receive force during mastication.[4-6]

Although composite resin has many advantages, it is very sensitive. It requires a dry working area that is free of contamination so that the resin can bind well with the tooth structure. However, there will always be contamination from blood, saliva, and the gloves used by the clinician.[2] Sometimes, dentists accidentally use their fingers to adjust the composite resin surface during the restoration procedure. Direct contact from the gloves used by the dentists can cause the restoration surface to be contaminated by powder from the gloves or blood, saliva, and other sources. This can affect the mechanical properties of composite resin restoration.

A test was done to see the influence of glove, blood, and saliva contaminations against the mechanical properties of composite resins. Based on the research done by Koppolu in 2012, it is known that blood and saliva affect the mechanical properties of composite resins and

***Corresponding author:**
Endang Suprastiwi
Department of Conservative Dentistry
Faculty of Dentistry, Universitas Indonesia,
Jl. Salemba Raya No. 4 Jakarta Pusat
**E-mail:** esuprastiwi@yahoo.co.id

that they can decrease the shear strength.[7] Martin stated in 2015 that gloves can affect the mechanical properties of composite resins.[8] Nevertheless, there is no research about the influence of glove, blood, and saliva contaminations against the compressive strength of composite resins. Further research is needed to discover the influence of these contaminations against the compressive strength of composite resins using a compressive strength test.

## Materials and methods

This study was approved by the Dental Research Ethics Committee, Faculty of Dentistry, Universitas Indonesia. Twenty-four specimens were randomly divided into four groups (n= 4) based on the type of contamination: Group 1 as the control group, Group 2 as the saliva contamination group, Group 3 as the blood contamination group, and Group 4 as the glove contamination group. A cylindrical-shaped stainless steel mold with a 4 mm diameter and 8 mm height (ISO 9917:2010) was used to test the compressive strength. This research also used powdered- latex gloves (MaxterTM), blood that was mixed with heparin, and artificial saliva made using the Fusayama Meyer method, with the composition as shown in Table 1.

| Components | Amount (gram/L) |
|---|---|
| KC1 | 1.2 |
| NaCl | 0.7 |
| KSCN | 0.33 |
| Urea | 0.13 |
| $Na_2HPO_4$ | 0.26 |
| $KH_2P_4$ | 0.2 |
| $NaHCO_3$ | 1.5 |

**Table 1.** The composition of the artificial saliva.

During the procedure, tweezers were used to avoid direct contact of the gloves with the specimens. A mixing pad was prepared, and Mylar plastic was placed above it to keep a flat surface. A microbrush applied silicon oil on top of the Mylar plastic. The mold was placed on the mixing pad and Mylar plastic. The microbrush was used to lubricate the inner part of the mold with silicon oil. The composite was incrementally poured into the mold using a plastic filling instrument and then cured with an LED Light Curing Unit for 20 seconds. Each layer had a thickness of 2 mm.

1. *Group 1* (n= 6). In this group, specimens were not given any contamination. Irradiation was done using the LED Light Curing Unit. The composite resin was pulled out of the mold using tweezers after it hardened.
2. *Group 2* (n= 6). On the last layer, artificial saliva was applied using a microbrush and left for 15 seconds. The specimen was flushed with water for 10 seconds, dried with an air spray for 5 seconds, and light-cured using the LED Light Curing Unit. After that, the same procedures as Group 1 were followed.
3. *Group 3* (n= 6). On the last layer, blood was applied using the microbrush and left for 15 seconds. The specimen was flushed with water for 10 seconds, dried with air spray for 5 seconds, and light-cured using the LED Light Curing Unit. After that, the same procedures as Group 1 were followed.
4. *Group 4* (n= 6). On the last layer, the latex glove was rubbed on the surface of the specimen for 1 second. The specimen was flushed with water for 10 seconds, dried with an air spray for 5 seconds, and light-cured using the LED Light Curing Unit. After that, the same procedures as Group 1 were followed.

After being released from the mold, all specimens were stored in a pot containing distilled water. After being released from the mold, all specimens were stored for 24 hours in a pot containing distilled water. The container had been prepared in an incubator at a temperature of 37oC to imitate conditions in the oral cavity. After 24 hours, the compressive strength test was performed using Universal Testing Machines (UTM) with a 500 KgF load and 0.5 mm/min speed.

The data obtained were analyzed statistically using a one-way ANOVA test and continued with after a Tukey's Multiple Comparison analysis with a 5% significance.

## Results

The values of compressive strength were obtained from each group and measured using Universal Testing Machines. Table 2 descriptively shows the results of the compressive strength test on the four groups.

| | N | Mean | Standard deviation | 95% confidence interval |
|---|---|---|---|---|
| 1 | 6 | 151.57 | 17.97 | 132.71-170.43 |
| 2 | 6 | 159.94 | 18.55 | 140.47-179.41 |
| 3 | 6 | 134.91 | 25.53 | 108.12-161.70 |
| 4 | 6 | 151.72 | 17.34 | 133.52-169.91 |

**Table 2.** The mean, standard deviation (SD), and confidence interval (CI) of each group (MPa). 1= control group, 2= saliva contamination group, 3= blood contamination group, 4= glove contamination group.

The data shows that there are increasing and decreasing compressive strength mean values in the treatment groups compared to the control group. Increasing values occurred in the saliva and glove contamination groups, while a decreasing value occurred in the blood contamination group. If these three treatment groups are compared, the compressive strength mean value of the blood contamination group has the lowest value (134.91 MPa). The highest value is in the saliva contamination group (159.94 MPa).

The one-way ANOVA test obtained the p value= 0.213 (significance of p value<0.05). This is strengthened by the results of the post hoc test using Tukey's Multiple Comparison Test as seen in Table 3.

Table 3 shows the significance value among the four treatment groups. From the post hoc test results, there is no significant difference in all treatment groups (significance of p value<0.05). So, it can be concluded that there is no significant difference of the nanohybrid composite resin's compressive strength among the control, saliva contamination, blood contamination, and glove contamination groups.

| Treatment Group | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1 | - | 0.888 | 0.494 | 1.000 |
| 2 | 0.888 | - | 0.170 | 0.893 |
| 3 | 0.494 | 0.170 | - | 0.486 |
| 4 | 1.000 | 0.893 | 0.486 | - |

## Discussion

This research found the mean values of compressive strength of all groups have a range of 134.91–159.94 MPa. These values are in the value range of research done by Sonwane about the compressive strength from various brands of nanohybrid composite resin (between 137.65–176.45 MPa).[4] When compressive strength is applied to specimens, the force received will spread to shear and tensile forces in specimens.[3] The compressive force will be concentrated in the center of the specimen, which will produce tensile force that causes the fracture of the specimen. The lack of a significant difference among all groups shows that the contamination of the glove, blood, and saliva do not affect the compressive strength directly. This is because the contamination was only applied to the surface of the specimens for seconds. Meanwhile, both saliva and blood need 24 hours to penetrate the matrix of composite resin.[3]

Therefore, contamination of gloves, blood, and saliva do not affect the compressive strength of composite resins. This result is not suitable with the hypothesis that stated that there is an influence of glove, blood, and saliva contamination on nanohybrid composite resins. The results of the statistical analysis also show that there was no significant difference between the control and treatment groups, with a significance value of 0.213.

Although the value of compressive strength in this research is the same as the research done by Sonwane, it is still lower compared to the research done by Hedge, et all., in which the value is 417 MPa.[9] This could be caused by several factors, such as the curing distance, filling method, and light intensity and duration. The tip of light source should be placed 1 mm away from the surface of specimen for optimal exposure.[3]

A light source placed more than 6 mm from the surface will affect the polymerization level of composite resins.[10] The polymerization level can affect the mechanical properties of composite resins.[11] In this research, the distance of the light source to each layer varied, with the farthest distance being in the lowest layer, which was more than 6 mm. This might cause the low value of nanohybrid composite resin compressive strength in this research.

It is suggested that further research be done concerning the influence these contaminations on the compressive strength of nanohybrid composite resins, with contamination in each incremental layer.

## Conclusion

The glove, blood, and saliva contaminations do not affect the compressive strength of nanohybrid composite resin. There is no difference in compressive strength among nanohybrid composite resins contaminated by gloves, blood, or saliva. There needs to be further research about the influence of glove, blood, and saliva contaminations on mechanical properties of composite resins such as shear strength.

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