Denta, *Jurnal Kedokteran Gigi*
Accredited No. 79/E/KPT/2023
p-ISSN: 1907-5987 e-ISSN: 2615-1790

RESEARCH ARTICLE

Comparison Between Compression Strength of Composite Resin with and without Stamp Technique

Yusrini Pasril*, Chantika Azzahra Anindita Putri**
***Dental Conservation, Rehabilitative Division, Dentistry Study Program, Faculty of Medicine and Health Sciences, University of Muhammadiyah Yogyakarta, Indonesia
****Dentistry Study Program, Faculty of Medicine and Health Sciences, University of Muhammadiyah Yogyakarta, Indonesia

Online submission : 30 September 2022
Accept Submission : 23 November 2023

ABSTRACT

Background: *This study aims to determine whether there is a difference in compression strength between resin composites that use the stamp technique and those that do not use the stamp technique.* ***Objective:*** *To identify the effect of the stamp technique with occlusal matrix on the compression strength and compare it with the one without stamp technique.* ***Materials and methods:*** *This study used an occlusal matrix from a transparent impression made of silicone to print the occlusal teeth. This transparent impression was attached to the resin surface composite prior to polymerization and remained on the surface until polymerization ended. The advantage of using this transparent occlusal matrix is that the light cure can penetrate through the transparent layer of the impression. It can be used to isolate oxygen during polymerization.* ***Results:*** *The average compression strength of composite resin with the stamp technique was 128.5300 ±17.23023 MPa, while composite resin without the stamp technique was 91.2460 ±8,72802 MPa.* ***Conclusion:*** *This study showed the difference between the two test groups, where the resin composite using the stamp strength had a higher compression strength.*

Keywords: *Composite Resins, Compression Strength, Oxygen Inhibited Layer, Polymerization, Stamp Technique*

Correspondence: *Yusrini Pasril, Dental Conservation, Rehabilitative Division, Dentistry Study Program, Faculty of Medicine and Health Sciences, University of Muhammadiyah Yogyakarta, Jalan Brawijaya, Tamantirto, Kasihan, Bantul, Indonesia. Email: yusrini.pasril@umy.ac.id*

Denta Jurnal Kedokteran Gigi, Agustus 2024; Vol.18 No.2; Hal 70-76
Available at http://journal-denta.hangtuah.ac.id/index.php/jurnal/issue/view/23
DOI: 10.30649/denta.v18i2.3

Accredited No. 79/E/KPT/2023
p-ISSN: 1907-5987 e-ISSN: 2615-1790

INTRODUCTION

Composite resin is one of the restorative materials used in dentistry. Composite resin requires polymerization. This stage is crucial as it affects the mechanical characteristics of composite resin, one of which is compression strength. This strength greatly affects the composite resin since a great compression strength can withhold chewing and occlusion load.[1]

The polymerization process on composite resin is very much related to polymerization shrinkage that can affect the mechanic characteristic of composite resin. If the composite resin has low compression strength, it will easily fracture and not last long. The low hardness of composite resins can also cause a decrease in resistance to be worn-out so that the composite resin becomes more easily broken.[2]

In addition to shrinkage during the polymerization process, composite resins also experience a formation of an unpolymerized layer. The composite resin contains arranged matrix consisting of monomers with high mobility. By using a light cure, these monomers will turn solid and hard with the polymerization process. Free radicals, formed as a result of interaction between a light cure and initiator on composite resin, will react with monomers, forming a long polymer bond.[3,4] During the light-curing process, the composite resin is exposed and in contact with oxygen in the room. It causes oxygen to bond and oxidizing free radicals. The result of the oxidation of free radical is known as peroxide radical and has low reactivity to monomers, causing the reaction of the polymerization to obstructed. Consequently, a specific layer is formed called the oxygen inhibited layer (OIL).

OIL is a layer resembling a gel formed due to the delayed monomer polymerization. OIL's composition is almost identical with resin composition that is not hardened with subtraction of total initiator.[5] OIL can add the risk caused by polymerization shrinkage. It can reduce the number of monomers that become polymer called degree of conversion (DC). DC is frequently used as an indicator of mechanical characteristic endurance of adhesive materials.[6]

Stamp technique is a technique for dental restoration classes I and II with accurate occlusal anatomy. This technique is recommended for cases where caries are clearly seen during a routine clinical or radiography examination on teeth with marginal ridge and whole occlusal anatomy. Furthermore, it also can be performed in very small cavities.[7,8] By using the stamp technique, the operator doesn't need to spend time creating dental occlusal anatomy. The contours are also more accurate compared to common carving techniques. In addition to saving time in the carving technique, the stamp technique with the occlusal matrix can isolate composite resin from oxygen contamination, making the OIL layer smaller than the usual technique. It occurs since the composite resin will be polymerized with an occlusal matrix attached to teeth so that the composite resin will not be in contact with oxygen in the room. This study aims to identify the effect of the stamp technique with occlusal matrix on the compression strength and compare it with the one without stamp technique.

Previous studies show a satisfying result for aesthetic and time management among dentists, as using stamp technique can reduce the time needed to do occlusal adjustment, finishing, and polishing. Though the disadvantage of this technique is that it can be done to certain lesions and condition, it is an ideal technique compared to the conventional technique.[9]

MATERIALS AND METHODS

This study is an experimental laboratory. It included 10 samples divided into two groups with different treatments so that each group consisted of 5 samples. Sample making and measurement of compression strength were carried out at the Mechanical Engineering

Denta Jurnal Kedokteran Gigi, Agustus 2024; Vol.18 No.2; Hal 70-76
Available at http://journal-denta.hangtuah.ac.id/index.php/jurnal/issue/view/23
DOI: 10.30649/denta.v18i2.3

Laboratory of Vocational School, Gadjah Mada University. This study was conducted in November 2021.

Materials

A mold of cylinder acrylic with a diameter of 5 mm and a height of 15 mm was made to form composite resin samples. This study used a bulk-fill flowable (Bulk-Flo) as composite resin. The transparent impression was made from silicone (Any-Flex) and applied to a mica using dental cartridges.

Picture 1. Acrylic cylinder mold

Picture 2. Dental cartridge, clear impression, and composite resin

Methods

The compression strength of the 2 test groups was measured using Controlab TN20MD Universal Testing Machine (UTM) until the samples fractured. The diameter of the composite resin was re-measured because not all samples had the same size, although the available mold was all size in 5mm. The measurement was used to identify the compression strength of each sample. After all diameter samples were recorded, the compression strength measurement was conducted.

Picture 3. Universal Testing Machine

The data obtained were analyzed using the Shapiro-Wilk test to dentify whether the data were normally distributed. The statistical data analysis was processed using an independent t-test for normally distributed data, while Mann-Whitney was for the data which was not normally distributed.

Group A

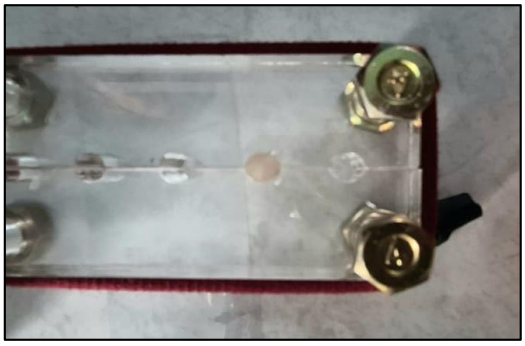
Transparent silicone used as the occlusal matrix was applied to the surface of composite resin samples. If there were remnants of the composite resin from the mold, it would be cleaned using a cotton bud. The polymerization used LED light cure for 40 seconds with matrix still on the surface of the composite resin.

Picture 4. Clear impression is applied in the surface of composite resin as an occlusal matrix

Denta Jurnal Kedokteran Gigi, Agustus 2024; Vol.18 No.2; Hal 70-76
Available at http://journal-denta.hangtuah.ac.id/index.php/jurnal/issue/view/23
DOI: 10.30649/denta.v18i2.3

Group B

The composite resin contained in the metal mold was polymerized using an LED light cure for 40 seconds with composite resin exposed to the free air.



Picture 5. composite resin placed inside cylinder mold

RESULTS

The result of the compression strength measurement using a Universal Testing Machine (UTM) can be seen in Table 1 and 2. Based on the graphic, it can be seen that the compression strength in a sample group with a stamp technique was higher than the one without the stamp technique.

Table 1. The Measurement result using UTM

Sample	Diameter (mm)	Pmax (N)
A_1	4,95	2890
A_2	5,04	2690
A_3	5,16	2180
A_4	5,02	2630
A_5	5,00	2360
B_1	5,07	1950
B_2	5,11	1720
B_3	4,97	1810
B_4	5,04	1610
B_5	5,07	2050

Sample	Compression Strength (MPa)	
	Group A	Group B
1	150.25	96.64
2	13.90	83.91
3	104.30	93.35
4	132.95	80.74
5	120.25	101.59
Average	128.53	91.246

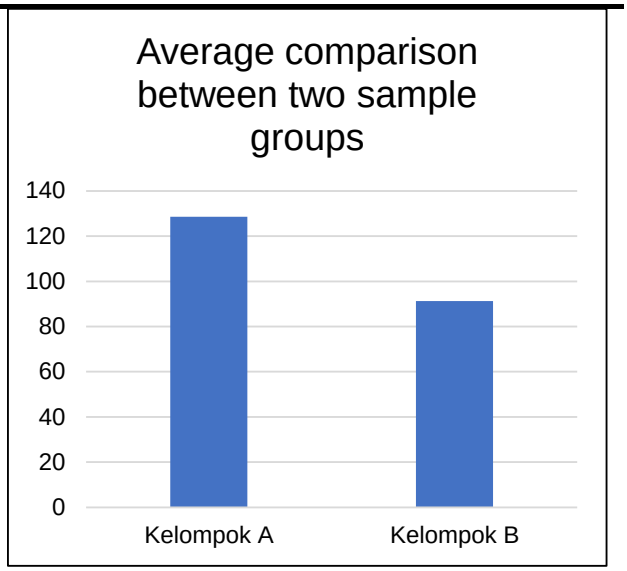


Figure 6. Average comparison between two sample groups

Normality test was conducted with method Shapiro-Wilk method listed in Table 2. The Shapiro-Wilk normality test showed that the data were normally distributed (sig>0.05).

Table 1. Normality test results

	Shapiro-Wilk		
	Statistics	df	Sig.
Group A	,978	5	,923
Group B	,941	5	,671

After the normality test was carried out, the data were analyzed statistically using an independent t-test. The results of the independent t-test can be seen in Table 3. Based on the table of homogeneity test, it was shown that the homogeneity was 0.222 > 0.05. It indicated that the data was homogeneous. Furthermore, the independent t-test showed a significance value of 0.003 (p <0.05). It indicated a difference in compression strength between group A and group B. Group A had higher compression strength with an average value of 128,5300 compared to group B with an average value of 91.2460.

Denta Jurnal Kedokteran Gigi, Agustus 2024; Vol.18 No.2; Hal 70-76
Available at http://journal-denta.hangtuah.ac.id/index.php/jurnal/issue/view/23
DOI: 10.30649/denta.v18i2.3

Accredited No. 79/E/KPT/2023
p-ISSN: 1907-5987 e-ISSN: 2615-1790

Table 2. Analysis result of the measurement of the two sample groups

		Levene's Test for Equality		T-test for Equality of Variances				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Compression Strength	Equal variances assumed	1,756	,222	4,316	8	,003	37,28400	8,63781
	Equal variances not assumed			4,316	5,926	,005	37,28400	8,63781

DISCUSSION

Compression strength is one of the important mechanical characteristics. The higher the compression strength is, the higher the filling resistance against fracture will be. Therefore, it is important for filling to have the optimal compression strength. This study aims to identify the effect of the stamp technique using the occlusal matrix on compression strength and compare it to the one without the stamp technique. Based on the results (Table 5), it can be seen that there was a significant difference between the compression strength on composite resin using the stamp technique and without the stamp technique. The statistical results of the independent t-test showed the average compression strength of composite resin with the stamp technique was 128.5300 ±17.23023 MPa, while composite resin without the stamp technique was 91.2460 ±8,72802 MPa. In other words, composite resin has a higher compression strength when oxygen is isolated during polymerization.

The result of this study is in line with the research by Robertson et al. (2016), revealing that the percentage of polymerized monomer would be higher when the composite resin was polymerized and isolated from oxygen. Although the study used the mylar strip, the function was similar to the occlusal matrix by isolating oxygen during polymerization. This aspect is caused by the involvement of oxygen in the polymerization so that there is a smaller number of modified monomers into the polymer chain. The minimal monomer residue can create the composite resin's better mechanical characteristic, making it recommended to be used on the dental surface holding the higher burden, such as posterior teeth.[10]

The monomer residue remains a controversy. Several studies revealed that the existence of monomer residue precisely increases the interlayer shear strength from a composite resin and causes more durable adhesion. Meanwhile, no OIL affects the bonding strength and causes adhesion failure. Therefore, the layer of the oxygen resistor must be left intact after polymerization.[4] Furthermore, another study also identified that OIL on the adhesive material system of single-step self-etching produces shear strength of composite resin against high dentin compared to the one without OIL.[11]

Some other studies revealed the opposite. For instance, the research conducted by Zakiyah et al. (2018) identified the effect of glycerin on the rough composite resin surface. The study explained that glycerin played a role as a blocker of oxygen on the composite resin surface so that the OIL could be minimized. The research result showed that the value of rougher surface significantly belonged to a group of composite resin applied with glycerin before the polymerization. In terms of health aspects, OIL can influence the oral cavity condition as the monomers in composite resin containing BPA can cause toxicity. The use of a rubber dam, longer radiation, and glycerin is highly recommended for reducing monomer residue.[12]

Based on the study, it can also be concluded that the stamp technique can reduce monomer residue as the occlusal matrix on the technique could play a role as a barrier between composite resin and oxygen. In other words, the stamp technique can increase the compression strength of composite resin. Apart from OIL, a case study on the use of the stamp technique with micro brush stated that the stamp technique could reduce composite resin porosity.[13] It can

Denta Jurnal Kedokteran Gigi, Agustus 2024; Vol.18 No.2; Hal 70-76
Available at http://journal-denta.hangtuah.ac.id/index.php/jurnal/issue/view/23
DOI: 10.30649/denta.v18i2.3

be linked with research that discussed the effect of porosity on composite resin. Thus, it can be concluded that macroporosity is responsible for one of the causes of fracture on the interlayer composite resin.[14]

One of the perceptible and feelable OIL characteristics is the existence of a shiny and greasy layer when the composite resin surface is touched. The characteristic was found when the surfaces between the two sample groups were compared. The sample with the stamp technique has no shiny, greasy layer, while those with the stamp technique were shiny and greasy. It aligns with a study revealing the shiny, greasy layer. It even felt a little sticky and could result in discoloration and fracture of the composite resin.[15]

Based on the study, the stamp technique is beneficial for increasing the mechanical characteristics of composite resin. Therefore, the aspects that can interfere with the mechanical characteristics of the composite resin, such as monomer residue and porosity, could be minimized by using this technique. A further study is suggested to examine whether OIL is beneficial or detrimental to composite resin and how much the ideal percentage of OIL is for composite resin, also to scrutinize unidentified confounding factors in this research and consider the factors in the data analysis. Further study is also suggested to identify whether the stamp technique can be applied to other filling materials, such as glass ionomer cement (GIC) and explore how the mechanism of the light cure can penetrate the transparent occlusal matrix. A further study is suggested to use the packable composite resin as it is more resistant against fracture.

CONCLUSION

Compression strength is one of the important mechanical characteristics of filling. The higher the compression strength is, the higher the resistance of the filling material to hold the load will be. One of the methods to increase the compression strength of composite resin identified in this study was by using the stamp technique in the occlusal filling formation. The stamp technique is an innovation aiming to shorten the occlusal formation. The composite resin with an occlusal made using the stamp technique had a higher compression strength than the one without the stamp technique.

REFERENCES

1. Mundung C, Wowor VNS, Wicaksono DA. Comparison Test Strength Compression Composite Resin Filling with Horizontal Incremental Technique and Bulk Technique. e-GIGI. 2018; 6(2): 56–60.
2. Zakiyah D, Effendy R, Prasetyo EA. The effect of glycerin on the surface hardness and roughness of nanofill composite. Conservative Dentistry Journal. 2019; 8(2):104.
3. Istinah I, Aryati Ekoningtyas E, Benjamin B. Difference Influence Hydrogen Peroxide 35% And Carbamide Peroxide 35% Against Microleakage in Nanohybrid Composite Resin. Odonto: Dental Journal. 2015; 2(1): 20.
4. Bijelic-Donova J, Garoushi S, Lassila LVJ, Vallittu PK. Oxygen inhibition layer of composite resins: Effects of layer thickness and surface layer treatment on the interlayer bond strength. European Journal of Oral Sciences. 2015;123(1): 53–60.
5. Tangkudung MU, Trilaksana AC. Glycerin for resin composite restoration: Literature Review. Makassar Dent J. 2019; 8(3): 169–72.
6. Robertson L, Phaneuf M, Haimeur A, Pesun I, França R. Degree of Conversion and Oxygen-Inhibited Layer Effect of Three Dental Adhesives. Dentistry Journal. 2016;4(4):37.
7. Tambake DrNJ, Tambake DrS, Gandhi DrN, Jadhav DrY, Madhu DrK, Burad Dr.P. Stamp technique - New perspective of Aesthetic Dentistry : A Case Report. IOSR Journal of Dental and Medical Sciences. 2017; 16(06): 49–51.
8. Moraru I, Bugal A, Gheorghe A, Popescu D, Râc AM. Why using the stamp technique in Class I cavities is a first choice filling technique. Romanian Journal of Medical and Dental Education. 2019;8(1):2–7.

Denta Jurnal Kedokteran Gigi, Agustus 2024; Vol.18 No.2; Hal 70-76
Available at http://journal-denta.hangtuah.ac.id/index.php/jurnal/issue/view/23
DOI: 10.30649/denta.v18i2.3

9. Choudhari, Sahil, and Manish Ranjan. Knowledge, awareness, and perception regarding occlusal stamp technique for composite restorations. Drug Invention Today. 2019: 2512-2517.
10. Moldovan M, Balazsi R, Soanca A, Roman A, Sarosi C, Prodan D, et al. Evaluation of the Degree of Conversion, Residual Monomers and Mechanical Properties of Some Light-Cured Dental Resin Composites. Materials. 2019;12(13): 2109.
11. Tsujimoto A, Barkmeier WW, Takamizawa T, Latta MA, Miyazaki M. Influence of the Oxygen-inhibited Layer on Bonding Performance of Dental Adhesive Systems: Surface Free Energy Perspectives. The Journal of Adhesive Dentistry. 2016; 18;18(1): 51–8.
12. Dursun E, Fron-Chabouis H, Attal JP, Raskin A. Bisphenol A Release: Survey of the Composition of Dental Composite Resins. TODENTJ. 2016; 10(1): 446–53.
13. Shamra F, Prasad K, Ghorpade B, Sajeev N. Microbrush Stamp Technique for Direct Composite Resin Restoration-A Clinical Case Report. Journal of Advanced Medical and Dental Sciences Research. 2019; 7(12): 5.
14. Santos ACMQS, Monticeli FM, Ornaghi H, Santos LF de P, Cioffi MOH. Porosity characterization and respective influence on the short-beam strength of advanced composite processed by resin transfer and compression molding. Polymers and Polymer Composites. 2021; 29(8): 1353–62.
15. Ahmed YT, Abouseedou HM, Hamza, FM, AlQalam MM, Naser YM. Awareness of oxygen inhibited layer effects on composite resins and how to prevent: A survey-based study. Journal of Applied Dental and Medical Sciences. 2021; 7(1): 78–82.

Denta Jurnal Kedokteran Gigi, Agustus 2024; Vol.18 No.2; Hal 70-76
Available at http://journal-denta.hangtuah.ac.id/index.php/jurnal/issue/view/23
DOI: 10.30649/denta.v18i2.3