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Research Article

Differences of room temperature vulcanized silicone and dimensional accuracy towards silicone PVS light body impression: Study experimental

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ABSTRAK

Introduction: Dental impressions are materials used to accurately replicate. Silicon Room Temperature Vulcanized (RTV) impression material is known to have good ultimate tensile strength and flexibility. Polyvinyl siloxane light body impression (low viscosity) which has the same viscosity as RTV material. Dimensional accuracy is used to see the accuracy of the impression material. Objective to investigate the optimal ratio of base, catalyst, and filler for RTV silicone to achieve the setting time and working time. To investigate is a difference between treatments using fillers and not using fillers. To investigate the difference in dimensional accuracy between the two materials. **Methods:** This research is pure experimental researches with randomized post-test only control group design. The control group was PVS light body silicone and the treatment group was RTV silicone. RTV silicones were categorized into 6 treatment groups. The treatments were increasing the amount of catalyst and adding talc filler. Each treatment group had 4 replications. Based on data analysis, there was no difference in the average. **Results:** The results showed that RTV silicone had significant difference with $p < 0.05$. At the ratio of RTV treatment groups without fillers by using fillers had a real difference with $p < 0.05$. In terms of dimensional accuracy, RTV silicone and silicone with light body impression viscosity did not have significant difference with $p > 0.05$. **Conclusion:** The optimal ratio for RTV silicon is 10:2 with the addition of 10 grams of talc filler. In the treatment using filler and without filler, having original fabrics with faster results was found in the filler treatment group. There is no significant difference in dimensional accuracy between RTV silicone and silicone with light body impression viscosity, so that both materials have the same accuracy.

KEY WORDS: room temperature vulcanized (RTV) silicone, light body impression, dimensional accuracy

Perbandingan silikon room temperature vulcanized *dan akurasi dimensi terhadap silikon PVS* light body impression *dalam kedokteran gigi : studi eksperimental*

ABSTRAK

Pendahuluan: *cetakan gigi adalah bahan yang digunakan untuk membuat replika atau tiruan yang akurat. Bahan cetak Silicon Room Temperature Vulcanized (RTV) diketahui memiliki ultimate tensile strength serta kelenturan yang baik. Bahan polyvinyl siloxane (PVS) light body (viskositas rendah) yang memiliki viskositas sama dengan bahan RTV. Akurasi dimensi digunakan untuk melihat keakuratan bahan cetak.* ***Metode:*** *Penelitian ini bermetode eksperimental murni dengan desain penelitian Randomized post-test only control group design. Kelompok kontrol adalah Silikon PVS light body dan kelompok perlakuan adalah Silikon RTV. Silikon RTV dikelompokkan menjadi 6 kelompok perlakuan, dengan perlakuan menaikkan jumlah katalis dan penambahan filler talc. Setiap kelompok perlakuan dilakukan pengulangan sebanyak 4 kali. Akurasi dimensi dari silikon RTV dilakukan pengecoran, dan diukur menggunakan dental caliper. Pengulangan dilakukan sebanyak 4 kali. Berdasarkan analisis data didapatkan tidak terdapat perbedaan rata-rata.* ***Hasil:*** *Hasil penelitian menunjukkan bahwa silikon RTV dengan PVS light body memiliki perbedaan yang nyata dengan nilai $p<0.05$. Pada akurasi dimensi antara kedua bahan silikon RTV dengan silikon PVS berviskositas light body impression, tidak memiliki perbedaan yang nyata dengan nilai $p>0.05$.* ***Simpulan:*** *RTV didapatkan rasio perbandingan yang paling optimal adalah katalis dan base (2:10) dengan penambahan filler talc sebanyak 10 gram. Pada akurasi dimensi silikon RTV dengan silikon berviskositas light body impression tidak memiliki perbedaan yang nyata/signifikan, sehingga kedua bahan memiliki keakuratan yang sama.*

KATA KUNCI: *silikon room temperature vulcanized (RTV), light body impression, akurasi dimensi*

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INTRODUCTION

Dentures are a substitute for missing teeth in the oral cavity. The purpose of making dentures is to improve esthetics, masticatory function, and speech function and protect the supporting tissues under the dentures. Good denture care is very important to improve oral health which has implications for improving one's quality of life. To get good dentures, it is necessary to get accurate impressions. Dimensional accuracy in the molding process refers to how close the actual dimensions of the molded object are to the designed dimensions. This level of accuracy is influenced by a variety of factors, including the molding technology used, the process parameters, and the materials used. To know the accurate impressions, it is necessary to know the impression stage, which is very important for the success of making dentures, where accurate impression results will produce dentures with good adaptation. There are many variables that affect the impression results including the impression technique and impression materials used by the operator.[1]

The material used to make a replica or imitation of the condition of a person's oral cavity which includes hard tissue and soft tissue in the oral cavity is called the Dental impression process. Elastic and non-elastic impression materials are types of impression materials. Elastic impression materials consist of hydrocolloids and elastomers, while non-elastic impression materials consist of impression plaster, impression compound, and zinc oxide eugenol.[2-5]

One of the elastomeric impression materials is silicone in the form of polyvinyl siloxane (PVS) or commonly called silicone PVS impression material has four types of viscosity that can be adjusted according to needs. One is the light body impression, it has the smallest viscosity and serves to record exact information of the tooth preps.

ration surface on hard and soft tissues. Nevertheless, the light body has insufficient dimensional stability to keep its shape throughout casting manufacturing work. Heavy bodies have a greater viscosity and are often used in mold trays to sustain light body impression materials for crown and bridge moldings. Putty does have a high filler content and considerable polymerization shrinkage.[6,7]

One type of silicone light body impression material is silicone rubber in the form of Room Temperature Vulcanized (RTV) silicon which is resistant to high temperatures. The addition of filler talc on silicon can increase the hardness of silicon RTV.[8]

RTV having similarities with PVS silicone impression materials consisting of siloxane containing vinyl and hydride RTV has good color stability, biological inertness, elastic strength, and tear strength, ease of manipulation and ease of coloring, and can be used for the manufacture of die stone. Was developed as an elastomeric impression material in dentistry and will increase the usability and serviceability of RTV silicone which has so far been limited to use in the creative and manufacturing industries. In making dental impressions, the operator needs to know how the material works, so he needs to know the working time and setting time of the material, so that he can get accurate dental impressions.[9,10]

Working Time is the time measured from the time the ingredients are mixed, then manipulated until they are homogeneous. The impression material must have adequate setup time so that both the operator and the patient can execute the impression appropriately.[11] Setting time is the time measured from the time of manipulation or mixing of the impression material powder with water until the impression material hardens. To find out the setting time is by observing the timeframe between the start of stirring until the substance is no longer rough or sticky when touched with clean, dry fingers and wearing gloves.[12]

Thus in this study, researchers tried to compare PVS materials with RTV, with PVS as the control group and RTV as the treatment group. Combining RTV silicone with base materials, catalysts, and the addition of fillers in the form of talc at certain ratios to obtain optimal setting time and working time, and continued with testing the accuracy of the dimensions of the print results which will later provide important information and as a choice of materials for light body elastomeric molds. So that the results later to find out this RTV material can be juxtaposed or replaced by PVS.

This research has a high level of novelty, because in dentistry RTV material is only used as a dental molding, so further research is needed regarding the toxicity of this material. Researchers tried to compare PVS materials with RTV, with PVS as the control group and RTV as the treatment

group. Combining RTV silicone with base materials, catalysts, and the addition of fillers in the form of talc at certain ratios to obtain optimal setting time and working time, and continued with testing the accuracy of the dimensions of the print results which will later provide important information and as a choice of materials for light body elastomeric molds. So that the results later to find out this RTV material can be juxtaposed or replace PVS. So it can be an alternative choice at a more affordable price with the same quality as PVS. Objective to investigate the optimal ratio of base, catalyst, and filler for RTV silicone to achieve the setting time and working time. To investigate is a difference between treatments using fillers and not using fillers. To investigate the difference in dimensional accuracy between the two materials.

METHODS

This is a pure experimental study with a research design. Design of a Randomized Post-Test Only Control Group. The population of this sample is RTV silicon material. In this study, control and treatment groups were used. The control group was PVS silicone while the treatment group was RTV silicone. The sampling method was carried out by grouping the treatments. The treatment consisted of 6 treatment groups, groups 1-3 without using talc filler and groups 4-6 using additional talc filler.

The first was a comparison of catalyst and RTV silicone base (1:10), the second was a comparison of catalyst and RTV silicon base (2:10), the third was a comparison of catalyst and RTV silicone base (3:10), the fourth was a comparison of catalyst and RTV silicon base (1:10) with the addition of 10 grams of filler talc, the fifth ratio of catalyst and RTV silicon base (2:10) with the addition of 10 grams of filler, and the sixth ratio of catalyst and RTV silicone base (3:10) with the addition of 10 grams of filler. Each treatment group has 4 samples, with the measurement of sample size using the Federer formula.

Measurement of dimensional accuracy was carried out by casting from RTV material molds which had obtained the most optimal treatment group among the 6 treatment groups. Then compared with the light body impression silicone mold that has been casting. The experiment was carried out 4 times. Casting was carried out at 12 hours, 24 hours, 36 hours and 48 hours.

The research instrument consists of research tools and research materials. The research tools included maxillary tooth models, maxillary impression spoons, small and large rubber bowls, spatulas, digital scales, stopwatches, caliper, printed samples, and rubber base. Then the research materials are, RTV silicone impression materials (base and catalyst), PVS light body impression impression materials, cast materials (dental stone), and Vaseline.

The time of the research was conducted from April to December 2022. The research location was carried out at the Dental Materials Laboratory, Major of Dental Medicine, Faculty of Medicine, Mulawarman University. Data analysis using SPSS and Microsoft Excel. The statistical analysis used was the One Way Anova test with the Tuckey Post Hoc Test, and the Independent T-Test.

RESULTS

In the early stage of the statistical test, it is necessary to carry out homogeneity and normality tests. In the homogeneity test, it aims to find out whether there is an inequality of residual variance, with a homogeneity value ($p>0.05$), from the data obtained the values obtained for working time and setting time are 0.222 and 0.100. In the normality test to find out whether the data is normally distributed or not with a value ($p>0.05$), and the normality test values for working time and setting time are obtained, the overall value is more than 0.05.

Table 1. The results of statistical analysis of One Way Anova with the average setting time and working time of Room Temperature Vulcanized (RTV) silicone impression materials

Comparison Group	*Setting Time(minutes) : Working Time(minutes)*	*One Way Anova (p-value)*
RTV catalyst and base (1:10)	52.5 : 2.07	
RTV catalyst and base (2:10)	6.25 : 1.47	
RTV catalyst and base (3:10)	6.5 : 1.42	
RTV catalyst and base (1:10) Add filler talc10 gr.	35.9 : 2.05	0.0001*
RTV catalyst and base (2:10) Add filler talc10 gr.	4.22 : 1.27	
RTV catalyst and base (3:10) Add filler talc10 gr.	8.38 : 1.27	

From the results of the homogeneity and normality tests, it was found that the data was homogeneous and normally distributed, so that it was continued with the One Way Anova test. The One Way Anova test was conducted to find out whether the data had significant differences or not. The difference is said to be real if the p value <0.05. The results of the One Way Anova test obtained p <0.05 (Table 1), so that the data has a significant difference.

Further tests were carried out using Post Hoc with Tukey to find out whether or not there were differences between treatment groups. From the data obtained, there were differences between the groups. In the setting time Table 1, it can be seen that group 5 has the fastest average setting time compared to other treatment groups, while the working time in group 5 has no difference with group 6, so it can be used in groups 5 or 6. It is found that group 5 is the treatment group with time performance fastest.

Table 2. The results of the comparison of the Independent T-Test analysis of the RTV silicon treatment group using filler and without filler

Comparison Group	Mean (m) Working time and Setting Time	Independent T-Test (*p-value*) Working time and Setting Time
RTV Silicone without Filler	1.52 and 21.39	0.001 dan 0.04*
RTV Silicone with Filler	1.4 and16.06	

Based on the test results in table 2, the treatment groups without filler talc and using filler talc have differences. In each group, the average treatment group without filler (groups 1, 2 and 3) was working time (1.52m) and setting time (21.39m). Whereas in the treatment group that used filler (groups 4, 5, and 6) had a lower or faster time with an average value of working time (1.4m) and setting time (16.06m).

Table 3. Results of the Independent T-Test analysis with the average Room Temperature Vulcanized (RTV) silicone and Light Body Impression silicone

Material Type	Mold Section	Mean (mm)	Independent T-Test (*p-value*)
RTV	On	19,725	0.181
	Middle	11,36	0.391
	Lower	19,725	0.181
Light Body Impersion	On	19,75	0.181
	Middle	11,35	0.391
	Lower	19,75	0.181

Table 3 shows the average measurement results for the dimensional accuracy of the mold in the treatment of group 5 RTV silicon with light body impression silicone. Each part of the mold was compared, so that 3 times the analysis was carried out, using Microsoft Excel statistical analysis with

an independent t-test. This test is carried out to see whether there is a difference in the measurement of the dimensional accuracy of the mold.

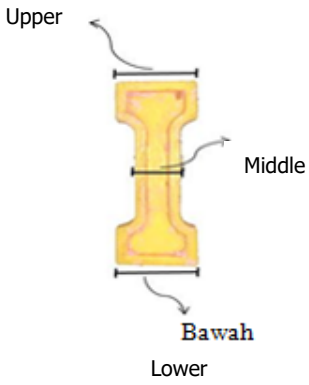

Figure 1. Measurement of a mold sample

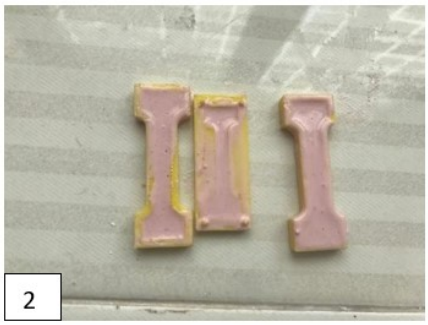

Figure 2. Measurement of setting time and working time

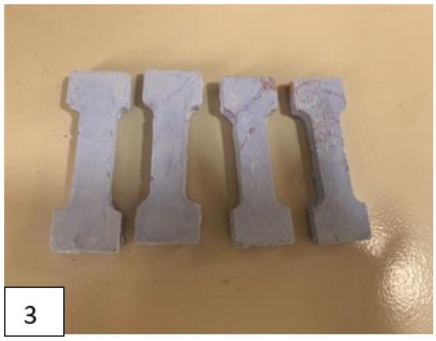

Figure 3. Mold dimension accuracy measurement

From the results of the Independent T-Test analysis, the value (p> 0.05) reveals that there is no discernible distinction between those two materials, the results obtained from each part of the mold are top (0.181), middle (0.391), and bottom (0.181).

Figure 4. stopwatch for measuring setting time

Figure 5. Dental calliper for dimensional accuracy and working time

DISCUSSION

Dental Impressions or dental impressions are materials used to make an accurate replica or imitation of a person's oral cavity situation which includes hard tissue and soft tissue in the oral cavity. Several dental tools, such as partial dentures, complete dentures, orthodontic devices, as well as

crowns and bridges are made outside the oral cavity, so impression materials are needed. Elastic and non-elastic impression materials are the two types of impression materials. Hydrocolloids and elastomers make up elastic imprint materials, while impression plaster, impression compound, and zinc oxide eugenol make up non-elastic impression materials. The impression materials commonly used are irreversible alginate and elastomer impression materials.[2-5] Dimensional stability of printed materials is the ability of materials to maintain the accuracy of printed results within a certain period of time.[13]

The working time calculation is obtained from the results of observing the time when the ingredients start to mix and then manipulate them until the materials become homogeneous. From the results of these calculations it was found that the sixth and fifth treatment groups became the treatment group with the fastest time.

The addition of the amount of catalyst and filler mixture causes the average setting time of RTV silicone impression material to be faster setting. This can be seen from the observation of the time that occurs from the fused material until the impression material solidifies or becomes more elastic. Based on the independent t-test statistical test also showed that the two ingredients had a difference with the average time value being faster in the treatment group that used fillers.

The results showed that the RTV silicone impression materials in groups 6 and 5 had the same average working time, namely (1.27m), with the fastest average time compared to the other treatment groups. This can be seen in the SPSS statistical test with the Post Hoc Tuckey test in the One Way Anova test. In this test, the treatment group 1 was the most significantly different, but in this test the fastest working time was desired, so the treatment group with the lowest average, namely groups 6 and 5. In table 1, the setting time section shows the results of the treatment Group 5 is the treatment group with the fastest setting time. So this states that RTV silicone has the setting time and working time closest to the gold standard of PVS silicone.

The addition of filler powder to the base and catalyst can improve setting time in impression materials fillers are small particles of inert material that strengthen or enhance the physical properties of many materials.[8] The filler is chemically different from the main ingredient. In such cases, the filler particles are referred to as the core and the surrounding materials as the matrix. Powder filler added to reduce the plasticity of the matrix material by friction action.[14]

The filler used in this research is talc filler. Filler talc, composed of hydrated magnesium silicate or Mg3Si4O10(OH)2, has a wide variety of industrial applications, including paints, coatings, cosmetics, medicines, paper, plastics, composites, and as flame and ignition retardants. Talc is distinguished by its unusual platy particle form, and three-layer structure, with octahedral magnesium oxide, sandwiched between hydrophobic tetrahedral silica layers. The aspect ratio of the talc particles is high (particle diameter/thickness of 20:1), referring to the micron-sized length and breadth parameters and the nano-sized thickness dimensions. Talc, in comparison to other industrial minerals including calcium carbonate (CaCO3), qualifies as an excellent reinforcing and filler because of their special attributes.[15,16]

Silicone, or silicone elastomer, typically refers to polydimethylsiloxane (PDMS). Silicone is produced when water is added to dimethyldichlorosilane, a compound formed by the reaction of silicon and methyl chloride. The resulting fluid polymer can then be cross-linked to form a solid. The unique properties of silicone are a result of its chemical structure which is composed of an inorganic backbone of alternating silicon and oxygen atoms (siloxane structure) to which organic side groups, typically methyl (CH3), propyl ((C3H7) or phenyl (C6H11) groups, are bonded.Room temperature vulcanising (RTV) systems involve crosslinking by either condensation or addition polymerization using a catalyst and crosslinking agent. As the reaction occurs at room temperature, low-cost plaster and gypsum (dental stone) can be used in the fabrication of the mold into which the silicone can be cured.[17]

Casting of molds using gypsum, which is done by mixing gypsum powder with water, which is then manipulated, after the mixture is homogeneous, then put into the available mold. This casting was repeated 4 times, with repetition times of 12 hours, 24 hours, 36 hours and 48 hours. From the printing results, measurements were taken using a dental caliper. The results of these measurements

were then entered into statistical analysis using an independent t-test. The data that has been tested demonstrates that there is no discernible distinction between those two materials.

Gypsum which is usually used in dentistry comes from pure dihydrate calcium sulfate with the chemical formula CaSO4.2H2O.[18] Gypsum-based products are widely used throughout dental procedures. The dimensional accuracy of the gypsum object with the setting entails dissolving the powder and forming gypsum crystal.[19] During manipulation, the gypsum mixture can undergo dimensional changes in several phases. In the manipulation phase, the gypsum dough decreased in volume during the initial setting phase when the dough was still liquid, but as the reaction continues, gypsum crystals will begin to form and the expansion phase when hardening can be observed even though the gypsum dough has hardened completely. The nature of dimensional changes that can occur in gypsum dough will affect the accuracy of the resulting working model, and automatically affect the accuracy of the diagnosis.[20]

In the research that has been done, the results of the independent t-test obtained p> 0.05, which reveals that there is no discernible distinction between the dimensional accuracy of RTV silicone molds and light body impression silicone viscosity. With the average results in each section, namely the top (19.725), middle (11.36), and bottom (19.725) RTV silicon, while the top (19.75), middle (19.35), and bottom (19.75) silicone light body impressions. So this indicates that RTV silicone has the same good dimensional accuracy as PVS silicone.

The limitation of this study is that the material testing was carried out on a phantom, so further research is needed on the toxicity of RTV silicone, therefore this material can be known to be used directly in the human oral cavity or not. Thus, the researcher strongly recommends that this study be continued, and it is hoped that the information provided by the researcher can be useful for further research.

CONCLUSION

There was no difference between the two RTV silicone materials and PVS silicone with a light body impression viscosity. From this study it can be seen that between the two materials the accuracy of the mold dimension is accurate, so that it can be used in dental impressions. Differences of RTV silicone catalyst base ratio and dimensional accuracy of silicone light body impressions in dentistry can be concluded. First, the treatment group with the most optimal setting time and working time was the group 5 with catalyst and base ratio 2:10 with the addition of 10 grams of filler talc powder. Second, in the dimensional accuracy of the mold, which was measured using a dental caliper, This study also needs to be considered to be continued further research so that it is more accurate. The implications of this research are that theoretically it will increase knowledge regarding dental materials and clinically it can help and be an alternative choice for operators or dental technicians in using dental materials.

Author Contribution: research articles with several authors, a short paragraph specifying their individual contributions must be provided. The following statements should be used "Conceptualiza-tion, K.S.A and M.; S.D.A.; A.V.; and I.I methodology, K.S.A and M.; S.D.A.; A.V.; and I.I software, K.S.A and M.; S.D.A.; A.V.; and I.I validation, K.S.A and M.; S.D.A.; A.V.; and I.I formal analysis, K.S.A and M.; S.D.A.; A.V.; and I.I investigation, K.S.A and M.; S.D.A.; A.V.; and I.I resources, K.S.A and M.; S.D.A.; A.V.; and I.I data curation, K.S.A and M.; S.D.A.; A.V.; and I.I writing—original draft preparation, K.S.A and M.; S.D.A.; A.V.; and I.I writing—review and editing, K.S.A and M.; S.D.A.; A.V.; and I.I visualization, K.S.A and M.; S.D.A.; A.V.; and I.I supervision, K.S.A and M.; S.D.A.; A.V.; and I.I project administration, K.S.A and M.; S.D.A.; A.V.; and I.I funding acquisition, K.S.A and M.; S.D.A.; A.V.; and I.I All authors have read and agreed to the published version of themanuscript.", please turn to the CRediT taxonomy for the term explanation. Authorship must be limited to those who have contributed substantially to the work reported.

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Informed Concent Statement: This study did not involve humans, so it did not require informed consent.

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