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The Effect of Zirconium Oxide addition on Heat Cured Temporary Acrylic Resin Restoration of Fixed Dentures towards Flexural Strength and Surface Hardness

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Abstract

Purpose: The fabrication of temporary restorations is aimed to protect oral tissues, aesthetical purposes and maintaining the function of mastication until a permanent restoration is finished. The purpose of this study is to determine the effect of adding ZrO_2 nanoparticles with concentrations of 5% and 7% to HCAR material of fixed dentures on its flexural strength and surface hardness. The design of this study is an experimental laboratory.

Materials and Methods: HCAR temporary restoration material samples without the addition of reinforcing agents, with the addition of ZrO_2 nanoparticle reinforcement (5%, 7%) for flexural strength test (10 x 65 x 2.5 mm) and surface hardness test (10 x 30 x 2.5 mm). Each sample is tested for flexural strength and surface hardness and then analyzed with a univariate test to determine the mean value and standard deviation of each group. T-test to determine the effect of the addition of ZrO_2 on flexural strength and surface hardness of the HCAR on fixed dentures. The data were normal and homogeneous p = 0.65 (p> 0.05).

Results: Flexural strength test on the HCAR temporary restoration material without the addition of reinforcing material and HCAR temporary restoration material with the addition of 5% ZrO_2, p = 0.001 was obtained; in the HCAR temporary restoration material without the addition of reinforcement material and HCAR temporary restoration material with the addition of 7% ZrO_2, p = 0.001 was obtained, so there were significant differences in the flexural strength values of the three groups. In the surface hardness test of the HCAR temporary restoration material without the addition of reinforcing materials and on the HCAR temporary restoration material with the addition of 5% ZrO_2, p = 0.887 was obtained. In the surface hardness test of the temporary restoration of HCAR temporary restoration material without the addition of reinforcing material and HCAR temporary restoration material with the addition of 7% ZrO_2, p = 0.044 was obtained.

Conclusion: The addition of 5% ZrO_2 and 7% ZrO_2 can reduce the flexural strength of HCAR temporary restorations but can increase the hardness value of the HCAR temporary restoration surface with the addition of ZrO_2 7% so that the HCAR temporary restorations of fixed dentures becomes stronger and is not easily fractured and lose its wear resistance when it is given specific load especially in cases of fixed denture fabrication which requires a long laboratory process such as long span and multi-unit fixed denture.

Keywords: Temporary Restoration, Zirconium Oxide, Flexural Strength and Surface Hardness

1. Introduction

Fixed prosthodontic treatments involves complete or partial coverage of teeth or implants. A fixed denture will need 8 – 10 days to manufacture which is why a temporary restoration will be needed to protect the abutments that has been preparated. [22,24]. Temporary restoration can be custom made (self-made) or by preformed material (factory made). Preformed temporary restorations are made of polycarbonates, cellulose acetate, aluminium, tin silver and stainless steel. Custom temporary restoration can be made from a few types of resin. Polyethyl methacrylate, polyethyl methacrylate, polyvinyl methacrylate, bis-acryl composite resin andvisible light- cured (VLC) urethane dimethacrylate are a few general materials that has been used in the past few years. These materials can also be classified according to its polymerization methods which are self-polymerization, heat polymerization, light polymerization and dual polymerization[22,24]

One material that is used in a lot for temporary restiorations is heat cured acrylic resin (HCAR) that has a similar color with teeth. Heat cured acrylic resinis developed in 1930 and used in dentistry for the first time in 1940. This material is non-toxic, easy to manipulate, insoluble in oral fluids, has low absorption power, affordable, polishes well, and has very good aestethic, but its disadvantages are low impact and transverse strength, low resistance to fatigue and abrasion. One of the drawbacks of this material is its weak mechanical strength [20].

Temporary restoration is an essential part of a fixed denture treatment. This restoration has to fulfil biologic, aestethic and mechanical requirements such as resistance towards functional loads and wear, especially when used in long term, long span cases on areas with heavy occlusal loads in parafunctional cases. From this description, a research is needed to study the effects zirconium oxide addition with different concentrations, and to find out the right amount in temporary restorations of heat cured acrylic resin for fixed dentures towards mechanical strengths of temporary restorations, especially on flexural strength and surface hardness.

2. Materials and Methods

2.1 Research Design

This study uses Laboratory Experiment research method. This study experiments to reveal an effect that occurs as a result of certain treatments (Budiharto 2008).

2.2 Research Sample and Sample Size

2.2.1 Research Sample

Samples on this study is heat cured acrylic resin without any addition of ZrO_2nanoparticles as a control group and heat cured acrylic resin reinforced with ZrO_2 5% andZrO_2 7% nanoparticles. The size of the test plates made for this research are:

1. Flexural strength test, test plate sized 65 mm x 10 mm x 2,5 mm (International Standards Organization no 1567)

Flexuran strength tests are done using Universal Testing Machine (Tensilon).This device has a press speed of 1/10 mm per second. The distance between both supports is 50 mm.

Flexural strength test method

Samoles are numbered in each edges and a line on the middle and placed in a way so the device will press on the sample until it breaks. The energy donned on the testing device is then read and recorded, transversal strength cound is then done. The unit used on this device is MPa.

2. Surface hardness test, test plate sized30 mm x 10 mm x 2.5(International Standards Organization no 1567)

Vickers Hardness Tester is calibrated.

The test is done by giving a 300 gf load for 15 seconds with corner peaks of 136^0 using pyramid shaped diamond loads on samples that has been polished. Samples are pressed with the pyramid load on 3 indentations, in 3 different locations for each samples. The diagonal curve result is viewed under a microscope, recorded and the average value is taken.

2.2.2 Research Sample Size

On this study, the minimum sample size is estimated based on the following formula:

$$(t-1) (r-1) > 15$$

Explanation:

t = number of treatment

r = number of repetitions

In this study there are three treatments (t), which are heat cured acrylic resin without addition of zirconium oxide, heat cured acrylic resin reinforced with 5% Zirconium oxide, and 7% Zirconium oxide. The number of repetitions (r) for each group is detirmened as:

$(t-1)(r-1) \geq 15$

$(3-1)(r-1) \geq 15$

$2(r-1) \geq 15$

$(r-1) \geq 7,5$

$r \geq 8,5$

From the result, minimum sample size for each group is 8,5 samples, in this study each group's samples are 9 samples. The total of samples for 6 groups are 54 samples.

Table 3.1. Test Group Classification

Test	**HCAR and Zirconium Oxide**
Flexural strength	HCAR (control) (Group A) HCAR + Zirconium Oxide 5% (Group B) HCAR + Zirconium Oxide 7% (Group C)
Surface Hardness	HCAR (control) (Group A') HCAR + Zirconium Oxide 5% (Group B') HCAR + Zirconium Oxide 7% (Group C')

Sample amount (n) = 9 /Group

3. Result

3.1 Flexural Strength

3.1.1 HCAR Reinforced with ZrO_2 5%

A homogenic data is obtained from the result where flexural strength in the HCAR control group is 76,57 MPa as the highest value and 51,49 MPa as the lowest value. Flexural strength on HCAR reinforced with 5%ZrO_2group reached 58,97MPa and 31,95 MPa as the lowest value.(Table 4.1.1)

Table 4.1.1 Flexural Strength Value on Heat Cured Temporary Acrylic Resin Temporary Restoration Material for Fixed Denture without Enforcement of ZrO_2 5% Nanoparticles

Sample	**Temporary Restoration Flexural Strength (MPa)**	
	Pure HCAR	**HCAR + ZrO_2 5%**
1	59,91	36,81
2	53,31	47,28
3	**51,49***	33,50
4	64,72	41,71
5	65,69	**58,97** **
6	58,70	44,76
7	**76,57** **	**31,95***
8	58,23	51,26
9	65,75	56,23
	$\bar{X}$= 61.59	$\bar{X}$= 44,71
	SD = 7,59	SD = 9,65

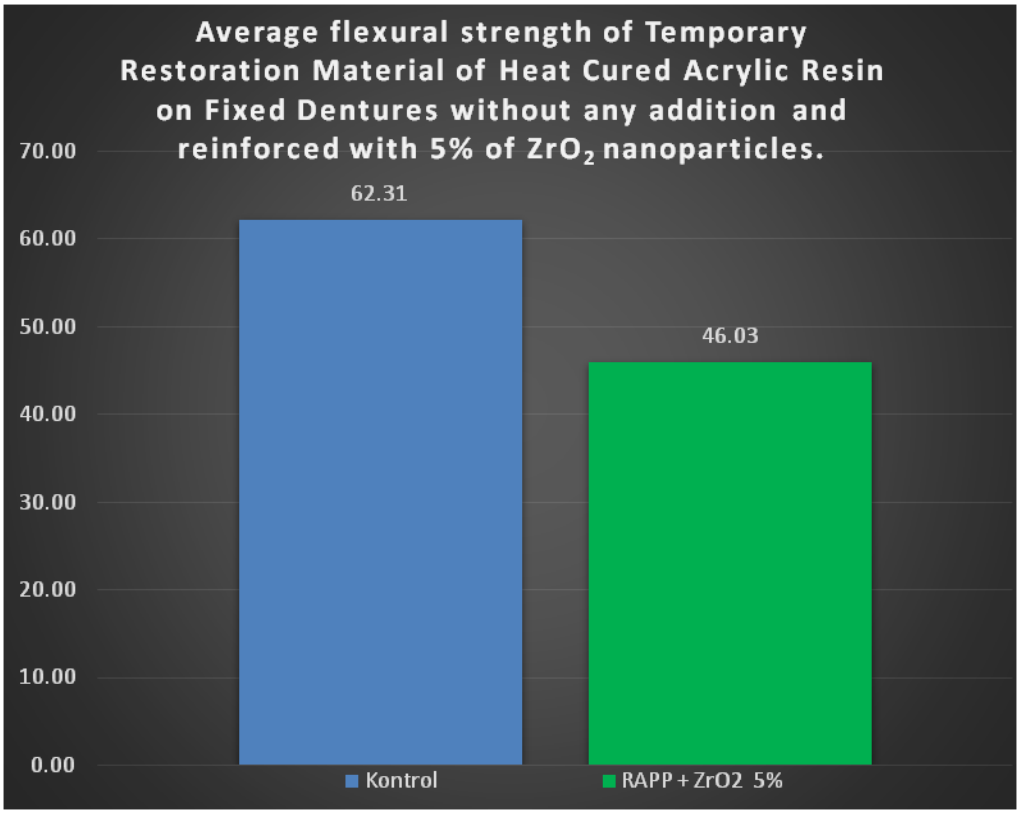
Explanation : * Lowest Value

** Highest Value

These results shows that the average flexural strength of HCAR with no enforcement reached the highest value of 61,59 ± 7.59 MPa. The average flexural strength of HCAR reinforced with 5% ZrO_2nanoparticles is lower compared to the control group and only reached 4,71± 9,65 MPa. This

average value data shows that flexural strength of HCAR temporary restoration reinforced with $ZrO_2$is lower than the value of HCAR temporary restoration for fixed denture without any enforcements. (Graph 4.1.1)

Graph 4.1.1. Average Flexural Strength of Temporary Restoration Material of Heat Cured Acrylic Resin on Fixed Dentures without any Addition and Reinforced with 5% of ZrO2 Nanoparticles.



The effect of flexural strength on each test group is done with t-test. Normality and homogeneity tests are first done on this study and homogenity showed a value of p=0,65 (p>0,05) which means the data obtained is homogenous. Normality test value on this study is p>0,05 which means all the data are normal.

The tests are then continued usingt-testto obtain the effect of values between each group. The data showed that the average of flexural strength on HCAR temporary restorations reinforced with ZrO_2 5% is44,71± 9,65 MPa showing there is an effect of addingZrO_2 5% on flexural strength with a value of p=0,001. The result showed that pure HCAR has significantly different flexural strength compared to HCAR reinforced with ZrO_2 5% nanoparticles. (Table 4.1.2)

Table 4.1.2. The effect of adding 5% of Zirconium Oxideon Heat Cured Acrylic Resin (HCAR) Temporary Restorations for Fixed Dentures to Flexural Strengthusingt-Test

Group	**Flexural Strength**		
	n		**P**
Pure HCAR	9	$\bar{X}$ ± SD = 62,59 ± 7,59	0,001*
HCAR+ ZrO_2 5%	9	$\bar{X}$ ± SD= 44,71± 9,65	

* terdapatperbedaansignifikan

3.1.1 HCA Rreinforced with 7% ZrO_2

Flexural strength value is tested by pressing a load on samples that causes HCAR temporary materials for fixed dentures break using Torsee's Eletronic System Universal Testing Machine and has a unit of MPa.

The results in this study indicates that in the HCAR temporary restoration material group for fixed dentures without reinforcement, the lowest flexural strength value is 51.49 MPa, and the highest flexural strength value is 76.57 MPa. The HCAR temporary restoration material group for fixed dentures reinforced with 7% of ZrO2 nanoparticles lowest flexural strength value is 21.55 MPa and the higher flexural strength value is50,33 MPa (Table 4.2.1).

Table 4.2.1. Flexural Strength Value of Heat Cured Acrylic Resin Temporary Restoration Material without and Reinforcing Agents and with Addition of ZrO_2 7% Nanoparticles.

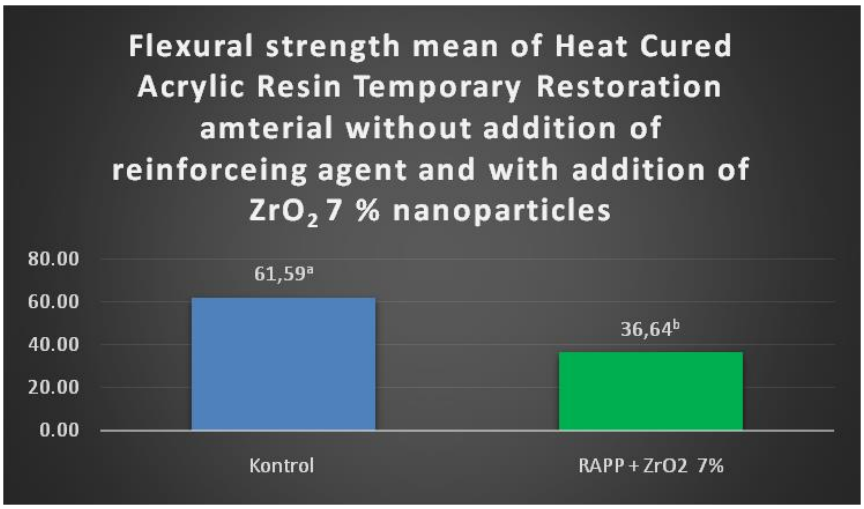
Sample	**Flexural Strength of Temporary Restoration (MPa)**	
	Pure HCAR	**HCAR + ZrO_2 7%**
1	59,91	36,90
2	53,31	41,52
3	**51,49***	36,33
4	64,72	**50,33****
5	65,69	**21,55***
6	58,70	30,56
7	**76,57** **	35,47
8	58,23	32,84
9	65,75	44,26
	$\bar{X}$ ± SD = 61,59 ±7,59	$\bar{X}$ ± SD= 36,64 ± 2,76

Explanation: * Lowest Value
** Highest Value

The results of this study indicates that the average flexural strength in HCAR without enforcements has the highest value of 61.59 ± 7.59 MPa. The average flexural strength of HCAR

reinforced with 7% of ZrO2 nanoparticles was lower than the control value and only showed 36.64 ± 2.76 MPa. This average value data shows that the flexural strength value of HCAR temporary restorations reinforced with ZrO2 is lower than the flexural strength value of the HCAR temporary restoration for fixed denture without enforcements. (Graph 4.1.1)

Graph 4.2.1. Flexural Strength Mean of Heat Cured Acrylic Resin Temporary Restoration Amterial without Addition of Reinforceing Agent and with Addition of $ZrO_2$7 % Nanoparticles



Huruf yang berbedamenunjukkannilaisignifikan (^{a,b})

The effect of flexural strength on each test group is done with t-test. Normality and homogenity tests are first done on this study and homogenity showed a value of p=0,65 (p>0,05) which means the data obtained is homogenous. Normality test value on this study is p>0,05 which means all the data are normal.

The tests are then continued usingt-testto obtain the effect of values between each group. The data showed that the average of flexural strength on pure HCAR is 61,59 ± 7,59 MPa showing there is an effect on adding $ZrO_2$7%where the value is p=0,001. The study result showed that pure HCAR has a significantly different flexural strength compared to the group reinforced with $ZrO_2$7% nanoparticles. (Table 4.1.2)

Table 4.2.2. Pengaruhpenambahan Zirconium Oxide 5% Pada Restorasisementara resin Akrilikpolimerisasipanas (HCAR) Pada gigitiruancekatterhadapflexural Strength menggunakan*t-test*

Group	**Flexural Strength**		
	n		**P**
Pure HCAR	9	$\bar{X}$ ± SD = 62,59 ± 7,59	0,001*
HCAR+ ZrO_2 5%	9	$\bar{X}$ ± SD= 44,71± 9,65	

* obtained significant difference

3.1 Surface Hardness

3.1.1 HCAR Reinforced with ZrO_2 5%

To figure out test sample hardness value, the average diagonal of each distance has to be measured with a microscope beforehand. Vickers hardness value can be optained by dividing test load used with the trace surface area.

The result data shows that surface hardness on pure HCAR is 18,27 kg/mm^{2}as the highest value and 16,63 kg/mm^2 as the lowest value. The surface hadness on HCAR reinforced with ZrO_2 5 % reached 17,60 kg/mm^{2}as the highest value and 15,57 kg/mm^{2}as the lowest value.

Table 4.3.1. Nilai Surface Hardness Bahan Restorasisementara HCAR gigitiruance kattanpapenambahan Zirconium Oxide, denganpenambahan ZrO_2 5%

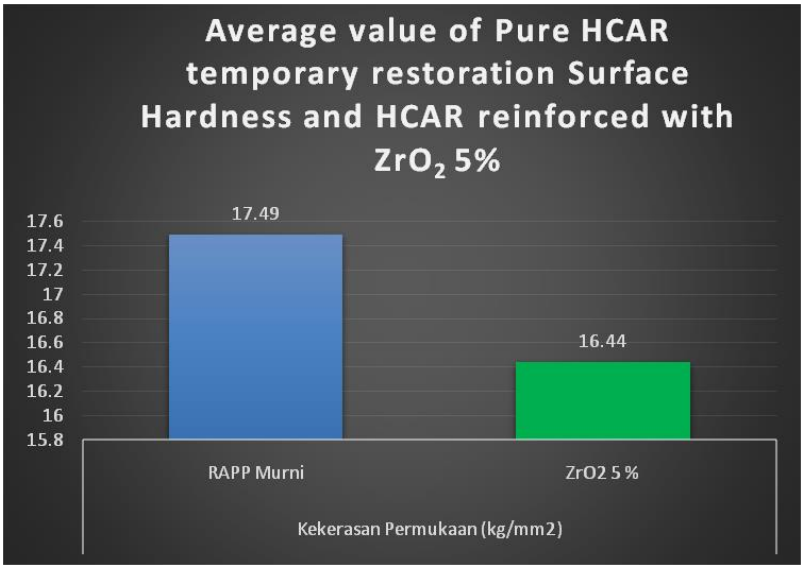
No	**Surface Hardness (kg/mm^2)**	
	Pure HCAR	**ZrO_2 5 %**
1	17,90	15,80
2	18,17	16,10
3	17,27	**17,60****
4	**16,63***	16,13
5	17,33	16,77
6	17,30	17,13
7	17,33	15,70
8	**18,27****	**15,57***
9	17,27	17,23
	$\bar{X}$± SD = 17,49 ± 0,17	$\bar{X}$ ± SD = 16,44 ± 0,25

Explanation : * Lowest value

** Highest value

The result shows that the average surface hardness on pure HCAR is at 17,49 ± 0,17 kg/mm^2. Average value of surface hardness on HCAR reinforced with ZrO_2 5% is 16,44 ± 0,25 kg/mm^2. This shos that the average surface hardness of HCAR temporary restorations reinforced with $ZrO_2$is equal or in accordance with the surface hardness standard for HCAR denture material which is 15-17 kg/mm$^{2.}$ (Graph 4.3.1)

Graph 4.3.1. Average Value of Pure HCAR Temporary Restoration Surface Hardness and HCAR Reinforced with ZrO_2 5%



The effect of surface hardness on each test group is done with t-test. Normality and homogenity tests are first done on this study and homogenity showed a value of p = 0,887 (p>0,05) which means the data obtained is homogenous. Normality test value on this study is p>0,05 which means the data is normal.

The test is continued using t-test to determine the effect of values from each groups. The data shoes that average surface hardness on Pure HCAR is 17,49 ± 0,17 kg/mm^{2}compared to (HCAR + ZrO_2 5%) group, 16,44 ± 0,25 kg/mm^{2}which shows a significant value p= 0,089. The result shows that Pure HCAR has a different surface hardness although not significant towards the group that are reinforced with ZrO_2 5% nanoparticles (Table 4.3.2).

Table 4.3.2 The Effect of Reinforcing Zirconium Oxide 5% on Heat Cured Acrylic Resin Temporary Restorations for Fixed Dentures towards Surface Hardness Using t-test

Group	**Surface Hardness**		
	n		**P**
Pure HCAR	9	$\bar{X}$ ± SD = 17,49 ± 0.17^a	0,089*
HCAR+ ZrO_2 5%	9	$\bar{X}$ ± SD = 16,44 ± 0.25^b	

3.1 Surface Hardness

3.1.1 HCAR Reinforced with ZrO_2 7%

Data in the results of this study indicates that the surface hardness value in the temporary restoration group without reinforcement is 18.17 kg/mm2 as the highest value and the lowest value is 16.63

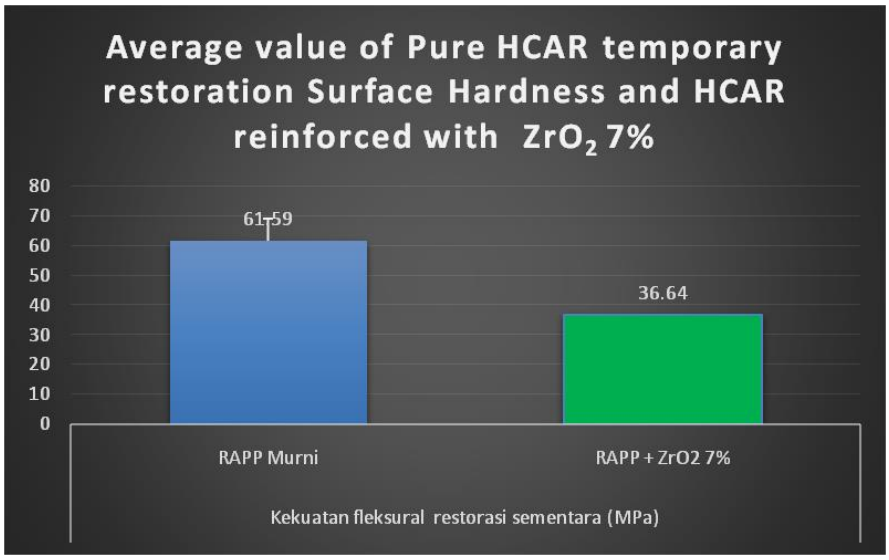
kg/mm2. The surface hardness value in the HCAR temporary restoration group reinforced with 7% ZrO2 nanoparticles showed that the highest value reached 18.73 kg / mm2 and the lowest value is 16.33 kg / mm2.

Table 4.4.1. Surface Hardness Value of HCAR Temporary Restoration Material with no Reinforcements and Addition of ZrO_2 7%

No	Surface Hardness (kg/mm^2)	
	Pure HCAR	**HCAR + ZrO_2 7 %**
1	17,90	18,67
2	**18,17****	17,13
3	17,27	18,57
4	**16,63***	**18,73****
5	17,33	16,67
6	17,30	**16,33***
7	17,33	17,43
8	18,27	17,87
9	17,27	18,37
	$\bar{X}$ ± SD = 17,49 ± 0,51	$\bar{X}$ ± SD = 17,75 ± 0,90

The results of this study shows that the highest average value of surface hardness for Pure HCAR is 17.49 ± 0.51 kg / mm2. The highest average value of surface hardness in HCAR temporary restorations for fixed dentures reinforced with 7% ZrO2 reached 17.75 ± 0.90 kg / mm2. From the results it can also be seen that the HCAR temporary restoration reinforced with ZrO2 is harder than the standard surface hardness of the HCAR denture material which has a hardness value of 15-17 kg / mm2.(Graph 4.4.1).

Graph 4.4.1. Average Value of Pure HCAR Temporary Restoration Surface Hardness and HCAR Reinforced with ZrO_2 7%



Normality and homogenity tests are first done on this study and homogenity showed a value of p = 0,200 (p>0,05) which means the data obtained is homogenous. Normality test value on this study is p>0,05 which means all data are normal.

The test is then continued using t-test to see the difference between groups. The data shows that average surface hardness value of Pure HCAR is17,49±0,51kg/mm^2, compared to (HCAR + ZrO_2 7%) group17,75 ± 0,90 kg/mm^{2}showed a significant value of p = 0,044.The study result shows that Pure HCAR has a significantly different surface hardness with the groups that are reinforced with ZrO_2 7 % nanoparticles (Table 4.4.2).

Table 4.4.2. The Effect of 7% Zirconium Oxide Addition on Heat Cured Acrylic Resin Temporary Restorations for Fixe Dentures to its Surface Hardness using t-test

Kelompok	**Surface Hardness**		
	n		**P**
Pure HCAR	9	$\bar{X}$ ± SD= 17,49 ± 0,51	0,044*
HCAR+ ZrO_2 7%	9	$\bar{X}$ ± SD= 17,75 ± 0,90	

*significant difference is obtained

4. Discussion

The study design is use is laboratory experiments, an experiment that is done to reveal a symptom or an effect that happens as a result of certain treatments. The type of research design used is post test only control group design, where flexural strength dan surface hardness value of the samples are depenent variables that are given treatments (post test) and without treatment (pre test). The aim of this study is to see the possibility of an effect on a few experimental group with treatments on one or a few experiments groups, and the result will be compared with Pure HCAR.

Zirconium Oxide is oxidized metal that has a few adavantages on mechanical strength, fracture strength, surface hardness, wear, chemical resistency, and stability towards high temperature that is advantageous in dentistry as a reinforcement material. Reinforcement materials in HCAR is affected by a few factots like polymer surface particles, particle size, producing methods, particle distribution in the resin matrix. Zirconia as a filler can be affected by a few aspects, some of them are the size and shape of fillers, concentrations and interactions with polymer matrix.

In clinical situations, fixed dentures undergoes various functional load. To judge if temporary restoration materials are strong enough to withstand these forces, flexural strength, and surface hardness must be determined. This experiment evaluates tensions as a stress where loads are applied, *tensile* and*shear*on resistant points towards applied loads (making them similar to the stresses produced by multi-unit fixed partial dentures). Materials that are harder usually has to be used because will have a good wear resistance. This reduces perforations and has an important role on maintaining the restoration's structural integrity for a longer period of time. That is why, the hardness of a temporary restoration material which is an indicator for wear resistance, should be evaluated.(Liju Jacob Jo, 2011)

4.1 The Effect of ZrO_2 5% Nanoparticles Reinforcement on Heat Cured Acrylic Resin (HCAR) Temporary Restorations for Fixed Denture Flexural Strength

On Table 4.1.1 the lowest flexural strength value of HCAR temporary restoration for fixed denture without any reinforcement is 51.49 kg/mm^2, while the highest value is 76,57 kg/mm^{2}with average value and standard deviation of61,59 ± 7,59kg/mm^2. The lowest flexural strength of HCAR temporary restoration for fixed dentures with reinforcements of $ZrO_2$5% is 31.95kg/mm^2, while the highest value is58,97 kg/mm^{2}with average value and standard deviation of44,71±9,65 kg/mm^2. Normality and homogenity tests are done on the data and all data are homogenous. T-testis done on both HCAR temporary restoration groups, without reinforcement and reinforced by ZrO_2 5% a value of p=0,001 is obtained, showing a significant difference. This study's result shows that flexural strength value obtained varies in each samples, this can be caused by factors that effects polymerization process on HCAR temporary restoration materials for fixed dentures which are techniques used when mixing and stirring HCAR material with ZrO_2, residual monomer content, internal porosity of the resin matrix and polishing techniques. Vojvodicdkk recommends the use of vacuum mixer while mixing HCAR materials to prevent air bubbles being trapped on the polymer matrix. This can effect the variety of flexural strength values, where Zirconium Oxide nanofillers differences in resin matrixes caused by stirring speed that can't be controlled. The excess of HCAR temporary restorations material for fixed denture when press processing can cause more Zirconium Oxide contained in the HCAR temporary restoration material removed (Mowade H, 2014; Vojvodic D, 2008; Annusavice, 2003)

4.2. The Effect 7% ZrO2 Nanoparticles Reinforced in Heat Polymerized Acrylic Resin (HCAR) Temporary Restoration Materials Fixed Denture on Flexural Strength

The value of flexural strength on the group with 7% is the lowest between 3 test groups. Addition of 7% Zirconium Oxide shows weakness in flexural strength compared to Pure HCAR. An assumption that this happened because of the low interfacial strength that happens between nano fillers and resin matrix. The test groups that are reinforced with7% Zirconium Oxide, shows the most significant decrease of flexural strength compared to Pure HCAR. The decrease of flexural strength can be seen after normality tests is done from data that are obtained from t-test which is p= 0,001 where it shows significant difference between HCAR temporary restorations without additions of ZrO_2 7%. The result in this study is in accordance with the study done by Gulfem Ergun etc, that stated the higher ratio of ZrO_2 nanoparticles included, the flexural strength of heat cured acrylic resin will be lower. (Gulfem Ergun, 2017)

Nano filler Zirconium Oxide used as reinforcement materials on resin matrix is best on an average size that can be distributed in resin matrix without causing dissolution of continuity between the resin. The right size of nano- Zirconium Oxide can increase transversal strength of a material and if followed by a good distribution of a nano sized filler, will fill the room in between polymer bonds. But bonds between resin and nano-Zirconium Oxide fillers that exceeds 7% can cause a decrease on transversal strength of HCAR related to agglomeration or clotting of nano- Zirconium Oxide fillers. Nano particles are trusted to have a habit of aggregating that is related with touch surface factor, surface energy and chemical activities. This clustering process is believed to be responsible on the decrease of

reinforcement materials effects for HCAR. (Gulfem Ergun, 2018)

The decrease of mechanical strength can happen because of the change in shape of Zirconium Oxide from tetragonal to monoclinic. The expansion of Zirconium Oxide volumes caused by these shape changes can trigger cracks in the surface of zirconium oxide that has been through silanization process. Sample storage in distilled water before Three Point Bending Testing, is believed as the cause of the increase in water absorption which will negatively effect physical and mechanical characteristics of a amterial and trigger microcracks.

4.3. The Effects of Adding ZrO_2 5% Nanoparticles on Heat Cured Acrylic Resin (HCAR) Temporary Restorations for Fixed Dentures towards Surface Hardness

In Table 4.3 the value for lowest Surface Hardness of HCAR temporary restoration for fixed dentures without reinforced materials is 16,63 kg/mm^2, while the hightest value is 18,27 kg/mm^{2}while the mean and standard deviation value is 17,49 ± 0,17 kg/mm^2. The lowest value for Surface Hardness in HCAR temporary restorations for fixed dentures reinforced with ZrO_2 5% is 15,57 kg/mm^2, while the highest value is at 17,60 kg/mm^2 the mean and standard deviation is 16,44 ± 0,25 kg/mm^2.

The result shows that there are no effects in adding Zirconium Oxide 5% towards the heat cured acrylic resin surface hardness. Mean and standard deviation data shows that hardness value in Pure HCAR are higher than the groups that were reinforced with Zirconium Oxide 5%, this can also becaused by disturbance in interfacial bonding between Zirconium Oxide dan HCAR matrixes. Surface Hardnessis related to how much a material can withstand scratches, abrations, wear and shape shifts. Surface Hardness of a material is affected by molecular polymer mass, the ratio of monomer ratio, internal porosity of polymer matrix, contacts with chemical materials, loss of dissolving components, water resorption, tension and temperature changes. Vojvodic etc suggests using vaccum mixerwhen stirring HCAR material so no air is trapped on the polymer matrix. HCAR temporary restorations materials for fixed denture on press process can cause more zirconium oxide contentsin HCAR temporary restorations material to be removed. (Mowade H, 2014; Vojvodic D, 2008; Annusavice, 2003)

4.4 The Effects of Adding ZrO_2 7% Nanoparticles on Heat Cured Acrylic Resin Temporary Restoration Material on Fixed Denture Towards Surface Hardness

Zirconium Oxide nanoparticles are used to produce HCAR with a higher Surface Hardness. In this study thr Surface Hardness of Pure HCAR and Heat cured acrylic resin temporary restoration reinforced with Zirconium Oxide 7% groups shows a significant effect. On groups that are reinforced with Zirconium Oxide 7% there is an increase on the surface hardness compared to Pure HCAR. On HCAR temporary restorations materials reinforced with Zirconium Oxide 7% Surface Hardness is higher compared to Zirconium Oxide 5%. This may happen because the charachteristics of Zirconium Oxide strength, the high level of ionic strength inter atom that increases material charachteristics like Surface Hardness. This result is in accordance with a study by Gulfem Ergun that states the micro structure difference and shape of Zirconium Oxide or the spread of its filler and has a different shape that can increase surface hardness.

On this study, a drawback is found, a homogenous mixture between monomers and polymers of HCAR temporary restoration materials for fixed dentures, air bubbles might be trapped on the polymer matrix when mixing and an invisible internal porosity is formed which will cause the decline of strength that it could have produced. So before doing a test on each sample, a balanced bond between zirconium oxide and heat cured acrylic resin matrix should be made sure of by using SEM or FTIR device. (Vojvodic D. dkk, 2008)

5. Conclusion

This study shows that an increase in Surface Hardnesson HCAR temporary restoration for fixed dentures by adding 7% of Zirconium Oxide, better than pure HCAR temporary restoration without any reinforcement materials and HCAR temporary restoration reinforced with 5%Zirconium Oxide. This shows that HCAR temporary restoration reinforced with 7% ZrO_2 7% can be used as a temporary restoration in fixed dentures on a few cases that needs a long term wear before the defenitve denture is installed, for example in restoring a mulit unit fixed bridge denture, in patients with bruxism, and on cases that needs to withstand high chewing loads.

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