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Research Report

Different curing methods on transversal strength of acrylic resin

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ABSTRACT

Background: *Acrylic resin were first used in dentistry for denture bases. The basic knowledge of acrylic resin curing method should be known by the dentist. Because the improved performance of acrylic resin depends on the curing method.* ***Purpose:*** *This study was aimed to find the most effective curing method to produce the highest transverse strength of acrylic resin.* ***Method:*** *The tested master model material was embedded in denture flask made of brass, which was divided into three sample groups based on three different curing methods: conventional Japan Industrial Standard (JIS), 24 hour boiling water, and microwave. Each of those sample groups was divided into six samples and tested for its transverse strength.* ***Result:*** *The result of this study showed that conventional JIS method has the highest mean and deviation scores (60.8467 MPa ± 2.0971) compared to those of 24 hour boiling water method (55.7650 MPa ± 2.0939) and of microwave method (56.5983 MPa ± 1.4493).* ***Conclusion:*** *The highest transversal strength is derived from the conventional JIS curing method.*

Key words: *resin acrylic, curing method, transversal strength*

ABSTRAK

Latar belakang*: Resin akrilik pertamakali dipakai dalam bidang kedokteran gigi untuk basis protesa gigi. Pengetahuan dasar berbagai metode polimerisasi resin akrilik harus diketahui oleh dokter gigi karena penyempurnaan penampilan resin akrilik perlu diketahui oleh dokter gigi karena penyempurnaan penampilan resin akrilik tergantung dari berbagi metode polimerisasi.* ***Tujuan****: Penelitian ini bertujuan memperoleh kekuatan transversal resin akrilik yang paling besar melalui berbagai metode polimerisasi.* ***Metode****: bahan model utama yang diuji ditanam dalam kuvet yang terbuat dari kuningan, yang dipisahkan dalam 3 kelompok sample berdasarkan metode polimerisasi yang berbeda yakni metode Japan Industrial Standar (JIS) konvensional, air mendidih selama 24 jam, dan microwave. Tiap kelompok dari metode sampel terdiri dari 6 sampel dan diuji kekuatan transversalnya.* ***Hasil****: Hasil dari penelitian ini menunjukkan bahwa rerata dan angka deviasi metode polimerisasi JIS konvensional adalah yang terbesar (60,867 MPa ± 2,0971) dibandingkan dengan metode air mendidih 24 jam (55,7650 MPa ± 2,0939) dan metode microwave (56,5983 MPa ± 1,4493).* ***Kesimpulan****: Kekuatan transversal yang paling besar diperoleh dari metode polimerisasi JIS konvensional.*

Kata kunci: *akrilik resin, metode polimerisasi, kekuatan transversal*

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INTRODUCTION

There are many kinds of denture materials used for denture base, such as cellulose, phenol formaldehyde, resin vinyl, and vulcanite. However, those materials have many weaknesses, only acrylic resin which has been used since mid 1940 is still commonly used as denture base material. The reason is because this material meet certain criteria such as: possessing natural character, high strength, stable dimension, good thermal conductivity, radiopaque,

relatively not expensive, resistance from oral liquid or saliva, and bacterial growth, relatively easy to manipulate and clean.[1–4]

Acrylic resin used for removable denture base are available in powder and liquid. The powder consists of prepolymerized spheres derived from poly (methyl methacrylate) and little benzoyl peroxide. Benzoyl peroxide is used as initiator in the early curing process. The liquid consists of nonpolymerized methyl methacrylate with little hydroquinone. Hydroquinon is used as inhibitor that can prevent both unexpected curing and setting derived from liquid during storing process. Furthermore, cross-linking material, glycol dimethacrylate, is also added into the liquid. In this case, glycol dimethacrylate is usually used as cross-linking material in poly (methyl methacrylate) acrylic resin denture base. Actually, glycol dimethacrylate is chemically and structurally the same as methyl methacrylate that can be combined with polymer bond growth.[4]

Acrylic resin curing method has developed due to the development of science, technology, and dental materials. The commonly curing method technique are evaporation, pressure dry-heating, dry air oven, infrared heating, induction technique, and microwave radiation. Each of those curing techniques has both advantages and weaknesses.

This acrylic resin curing methods for denture base can also be conducted by some techniques such as activated heating, compression molding, chemically activated, and light activated.[4,5] Many studies even showed that those curing techniques had the similar result as conventional curing method in evaluating transverse strength. Nevertheless, for choosing the right curing method of acrylic resin is still very important in order to obtain acrylic resin suitable with physical and biocompatible characters of mouth cavity tissue.[6]

The acrylic resin with microwave curing method has actually been evaluated by many researchers and produces electromagnetic wave from electric generator known as magnetron. The microwave used has 2450 MHz and 12 cm wave length. Methyl methacrylate molecule facing the microwave electromagnetic area even can be changed its direction, about 5 billions/ second. As a result, this condition causes many intermolecular collisions which can produce heat quickly. In short, the curing method with microwave has some advantages such as saving more time, producing cleaner result, and causing more similar dimension change than conventional curing method.[7]

However, acrylic resin must meet a mechanical character, which is about transverse strength relating with its use as denture base. The denture base resistance during chewing process actually is analogous with that of test bar during receiving transverse load. In USA, acrylic resin used as denture base should be evaluated for its transverse strength.[8]

The acrylic resin transverse strength actually depends on the curing method. Unfortunately, the curing method is influenced by certain factors such as temperature, mass, humidity, and environment like air or water is still not much discussed in many studies. Therefore, it is assumed that all kinds of curing methods with many kinds of variable cause different transverse strength. For the reason, this study was aimed to analyze how the different curing methods can influence the acrylic resin transverse strength. The significance of this study is to find the right acrylic resin curing method that can possibly cause the highest transverse strength.

MATERIAL AND METHOD

Materials used in this study are acrylic resin (Bioresin, Shovu Japan, Acron MC, GC Japan), and hard gypsum. Tools used in this study consist of special denture flask for microwave, vacuum mixer, hydraulic bench press (Yoshida Japan), rubber bowl, spatula, vibrator, square plate with 65 × 10 × 2.5 mm size, and autograph AG-10TE (Shimadsu, Japan).

Samples were made through the following procedures: first, master model made on brass was polished with vaseline, put in the middle of the denture flask filled with hard gypsum, and then left over in press until the gypsum was set. The denture flask was opened, and the master model made was taken of the gypsum surface and polished with separator (cold mould seal), and the separator was left until dry. Then the flask filled with acrylic resin after mixing the powder and liquid based on the direction according to the crylic producer (10 grams powder : 4.5 ml liquid). After around 10 to 15 minutes, the mixing of the powder and liquid become to the dough stage then it is ready for pouring to the flask. Mould in which the surface was polished with the separator filled with the dough acrylic resin. Before the denture flask was closed, the dough stage acrylic covered with plastic cellophane and pressed slowly with hydraulic press. After that, the denture flask was reopened and the over dough of resin acrylic was cut. Afterwards, it was closed again and pressed with 2200 psi pressure or 50 kg/cm^2. Those procedures must be redone approximately two to three times. Then, it was moved into flask press, and left over for about 24 hours before curing process was conducted. Meanwhile, samples cured with oven microwave were made of 10 grams of powder: 4.3 ml of liquid (based on the direction from the producer).

The sample was divided into three groups. The first group, acrylic resin was cured with 70° Celsius boiling water for about 2 hours, which then was continued into 100° Celsius boiling water at the temperature of 100° Celsius for about 30 minutes. The second group, acrylic resin was cured with a heating technique using 70° Celsius boiling water for about 24 hours. And, the third group, acrylic resin was cured with a heating technique using microwave oven (500 watt) for about 3 minutes. After all the curing process was conducted, those treatment groups were abandoned until they were cold. Each of those treatment groups then was divided into six samples, so the total became

18 samples. Before being tested, those samples were immersed into distilled water at the temperature of 37° Celsius for about 48 hours.[9]

The testing method of samples was conducted with ADA no. 12 specification. First, samples were put in the center palate of Autograph tool, 50 mm between both buffers. Afterwards, the mass was reduced with cross head speed 1/10 mm/minute until the sample was broken. Number resulted from the test tool then was noted and analyzed with transversal strength formula, 3 IP/2/bd 2, 1 = length of distance among buffers; P = mass; b = width of sample; d = depth of sample.[6]

RESULT

Mean and standard deviation of transversal strength of resin acrylic cured with different methods can be seen in Table 1.

Table 1. Mean and standard deviation of transversal strength of resin acrylic cured with different methods (MPa)

Treatment Group	Sample Number	Mean + Standard Deviation
Conventional JIS	6	60.8467 ± 2.0971
24 Hour Boiling Water	6	55.7650 ± 2.0939
Microwave	6	56.5983 ± 1.4493

Since the data result shown in Table 1 are homogenous and has normal distribution, the data then were tested with one sample Kolmogorov-Smirnov test. Furthermore, in order to find the difference of acrylic resin transverse strength processed by different curing method, One-Way ANOVA test was conducted. The result then showed that there was significant difference with score $p < 0.05$.

In other words, the result showed that resin acrylic cured with conventional JIS method had the highest mean score of transverse strength, meanwhile the cured with 24 hour boiling water method had the lowest mean score on the transverse strength. Moreover, in order to find the difference among those treatments, LSD test was conducted, as shown in Table 2.

Table 2. LSD test on transversal strength of acrylic resin cured with different methods (MPa)

Curing Method	Conventional JIS	24 Hour Boiling Water	Microwave
Conventional JIS		B	B
24 Hour Boiling Water			TB
Microwave			

Note: B: Significant, TB: Not Significant

Finally, the result showed that there was significant difference between transverse strength cured with conventional JIS method, compared with 24 hour boiling water method, and microwave method. But, there was no significant difference between transverse strength cured with 24 hour boiling water method and microwave method.

DISCUSSION

Poly (methyl methacrylate) used as denture base material actually can be produced through some curing methods. Thus, all of those curing methods evaluated in this study were aimed to find an easier technique, to reduce denture manufacturing time, and to acquire better resin acrylic character in the terms of hardness, porosities, and monomer discharge.[5,10] Due to the development of technology, moreover, curing method with water-bath and pressure is still used until now even though the use of microwave energy usually used in food industry has more advantages in dentistry since it can be used for acrylic resin curing process for denture base. The study on the activation system of acrylic resin with microwave energy was conducted not only for laboratorial needs, but also for clinical needs.[10]

In supporting the treatment success, the resistance of the acrylic resin denture base must be examined through the height of transverse strength. It means that in this examination, all of three pressure points working together on the denture base during chewing process will be compared.[11] In this study the acrylic resin transverse strength obtained through those three different kinds of curing process were examined. This study found that the acrylic resin transverse strength obtained from 24-hour boiling water curing method at the temperature of 70° Celsius degrees, for instance, was lower than that obtained from conventional JIS curing method and microwave curing method (Table 1). This condition was caused by the fact that there still was remaining monomer which did not reacted since acrylic resin cannot reach the boiling point of monomer at the temperature of 100.8° Celsius. The remained monomer then will make acrylic resin more plastic because of the reduced transverse strength. As a result, the residual monomer will play as potential tissue irritant which can make acrylic resin biocompatibility.[4]

If the curing process were conducted in water-bath at the low temperature for long period without increasing the temperature at the end of the process, the residual monomer obtained will be three times as high as that with the increasing temperature at the end of the process. The residual monomer then cause plasticizing effect, reduce acrylic resin strength, and cause many alteration because of pressure.[12] Similarly, another researcher also found that acrylic resin cured in water-bath for long period can cause acrylic resin to react as plasticizer, can reduce glass transition temperature (tg), and can make its mechanical character decreased.[13]

Moreover, the cycle of curing process was successfully conducted for making the acrylic resin denture base in many sizes, forms, and depths when the curing process of the acrylic resin at 74° Celsius for less than two hours and then continued at the temperature of 100° Celsius for more than one hour. The result obtained will show the strongest transverse strength.[4]

Acrylic resin curing method with microwave does not depend on thermal conduction, is one of the advantage compared with the conventional boiling method. Some researchers have concluded that the physical character of acrylic resin cured with microwave was the same as cured with conventional curing method. Nevertheless, the acrylic resin denture base cured with microwave energy has more positive effects on the strength and resistance of acrylic resin denture base since the microwave energy can potentially save time during the curing process of acrylic resin.[10] As a result, it is important to choose the right curing method in order to acquire high physical and mechanical characters of acrylic resin. Based on the result of this study, it can be concluded that the different curing methods of acrylic resin can influence acrylic resin transverse strength. The strongest transverse strength was derived from Japan Industrial Standard curing method.

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