Effect of Recurrent Heating on Mechanical Properties of Artificial Teeth: A Review

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Abstract—Nowadays lots of material is produced to increase the re-mineralization of tooth enamel. The eggshells are one of materials that can also increase the re-mineralization of tooth enamel. Eggshells are one of calcium carbonate sources with levels of 95%. The egg produces waste in the form of eggshells. One of the alternatives in tackling the eggshells is to turn it into a calcium compound. It is the main ingredient of bones and enamel tooth. This paper is proposed to investigate the effect of recurrent heating on mechanical properties of artificial teeth. This review was described some study experimental that was performed to heat the specimen with 20°C, 40°C, 100°C, and 120°C. The heating result of specimen was observed to determine the hardness using Brinnel and Vickers scale. It was concluded that the higher of heating temperature will decrease the hardness of denture base acrylic.

Keywords—Recurrent Heating, Hardness, Mechanical Properties, Artificial Teeth.

I. Introduction

There are three types of removable partial dentures that can be distinguished according to their denture base materials: (1) denture metal framework, (2) acrylic, and (3) thermoplastic material often called Flexi or Valplast [1]. Since the mid-1940s, most of the prosthesis bases were made by using methyl methacrylate poly resins. The resins are plastic bending formed by combining multiple methacrylate metal molecules. The pure methyl methacrylate polyet is colorless, transparent and solid. To facilitate its use in dentistry, polymers are colored to obtain color and degree of silence. The color and optical properties remain stable under normal oral conditions, and its physical properties have been shown to be suitable for dental applications [2].

Acrylic resin is one of the dentistry materials that has been widely applied to the manufacture of the base denture, orthodontic plate, spoon special printing, and restoration of crowns and bridges with satisfactory results, both in aesthetic terms and in terms of their function [2]. Acrylic resin is very sensitive to heat, its hardness will be reduced if it has recurring heating. While the heat acrylic resin hardness value of polymerization is 20 VHN or 15 kg/mm^2 (ASTM E18-20). The value of the hardness indicates that acrylic resin is relatively soft and causes the acrylic resin to tend to thin out. In this paper, it was evaluated some investigation to determine the effect of recurrent heating on acrylic-based acrylics.

II. Artificial Teeth

Artificial teeth (denture) is a device to replace the mastication surface and the accompanying structures. Denture base gets support through close contact with the tissues of the mouth underneath. Although the denture base can be made of metal or metal alloys, most denture bases are made using polymers. The polymer is selected based on its existence, dimensional stability, handling characteristics, color, and compatibility with the mouth tissue. Acrylic resins have been used as denture bases for more than 60 years [3]. There are three types of removable partial dentures that can be distinguished according to their denture base materials:

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A. Metal Frame

It consists of a metal toothpick with a tooth made from acrylic or porcelain. Because the metal material is strong enough, the artificial toothpick of the metal frame can be made thinner and smaller so that the patient will be more comfortable. Denture making is done outside the practice room and should be done in dental laboratories [4].

B. Acrylic Resin

Acrylic resin is a material that is still used in the field of dentistry. More than 95% of denture base is made from acrylic resin material. The base denture base material often used is a heat cured acrylic polymethyl methacrylate resin [5]. Acrylic resin is used as the base of the denture because it has non-toxic, non-irritating, insoluble in oral fluid, good aesthetic, easy to manipulate, easy reparation and small dimensional changes. Disadvantages of acrylic resin are easily broken when falling on hard surfaces or due to fatigue of materials due to prolonged use and color change after a certain amount of time is used in the mouth [6].

C. Thermoplastic Nylon

Thermoplastic nylon is the first flexible denture in the world. This material has no metal clutch and is lightweight [7].

III. Research Methodology

A. Materials and Tools

The experimental study was performed by Ramlan [8]. The materials used in this study are heat acrylic heat acrylic resins, acrylic Liquid resins, and CMS. The tool used is the hardness test tool (AFFRI Hardness Tester). This tool can measure the hardness of the acrylic denture base after repeated heating. The other review by Takamata et al [9] was found that have investigated the accuracy of acrylic and other types of resins for making dentures using the known range of fabrication methods. Another experiment by Hendri et al. (2014), they was testing the thermal properties of bioceramic as dental material in 800, 900 and 1000^{o}C.

B. Research Design

In the study, Ramlan [8] was performed using some stage as follows:

- Make a sample of denture acrylic base.
- Provide four containers of water each of 600 ml.
- Turn on the stove, then place the first container and measure the temperature to 20 ° C, the second group at 40 ° C, the third group at 100 ° C, the fourth group at 120 ° C.
- Heat the sample for 20 minutes, and then remove the sample from the container.

IV. Results and Discussion

An experimental study has been conducted on the effect of recurrent heating on denture base hardness of acrylic base. This experimental study used four heating temperatures to compare, i.e. 20^{o}C, 40^{o}C, 100^{o}C, and 120^{o}C.

A. Results

Research results have been obtained from the testing of artificial dentifrice material sample which is heated repeatedly. The result is the hardness test data that can be seen in Fig. 1.

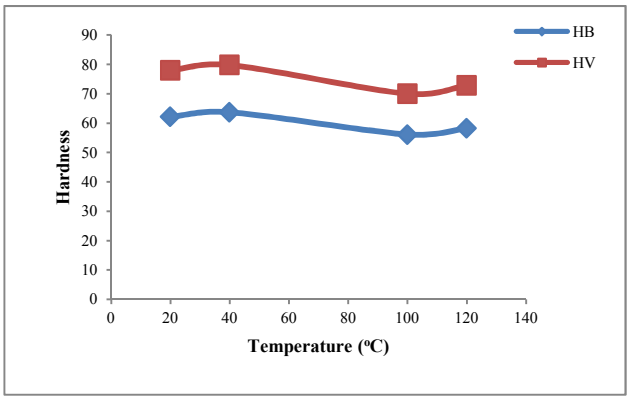

Figure 1. Result of Hardness testing

Fig. 1 shows the distribution and difference in mean values of denture base hardness measurement results between heating temperatures of 20^{o}C, 40^{o}C, 100^{o}C, and 120^{o}C. Hardness test results are described in Brinell hardness (HB) and subsequently converted into Vickers hardness (HV). The results of the study showed that both Brinell hardness and Vickers hardness, It was obtained the highest value in the group that was heated twice with a temperature of 40^{o}C, namely 63,72 HB and 79,83 HV. Meanwhile, the lowest average Brinell and Vickers hardness values were found in groups soaked and heated to 100°C. The Brinell and Vickers violence in this group

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only reached 56,133 HB and 70 HV. At a temperature of 20°C heating, the hardness value reached 62,150 HB and 78 HV. In the group with a heating temperature of 120°C, the hardness value reached 58.22 HB and 72.83 HV.

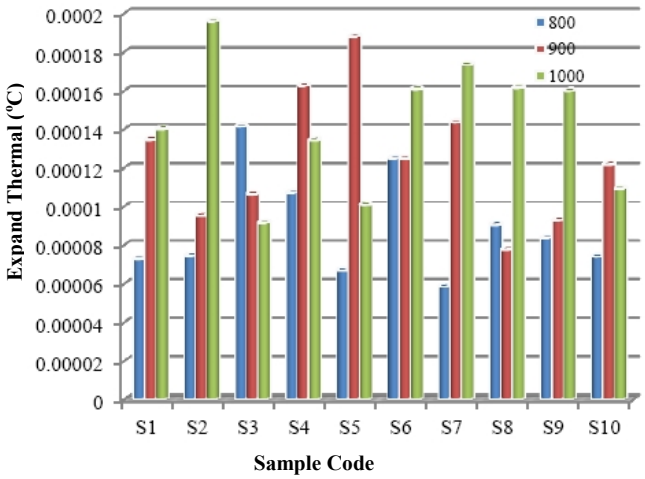

Figure 2. Results of measuring the thermal expand

Figure 2 show that thermal expand was depend on changing the sample volum to be dry condition. Sintering will be happen in temperature range to 800 – 900°C. It can be decreased the porous in sample.

B. Discussion

Based on these results it is known that heating greatly affects the hardness of the acrylic base denture. The results of the hardness test are described in Brinell hardness (HB) and subsequently converted into Vickers hardness (HV). The results showed that both Brinell hardness and Vickers hardness obtained the highest value in the group that was heated twice with a temperature of 40°C, that is 63.72 HB and 79.83 HV. Meanwhile, the lowest average Brinell and Vickers hardness values were found in groups soaked and heated to 100°C. The Brinell and Vickers hardness rates in this group only reached 56.13 HB and 70 HV. At a temperature of 20°C heating, the hardness value reached 62.150 HB and 78 HV. In the group with a heating temperature of 120°C, the hardness value reached 58,22 HB and 72.83 HV. This means that there are significant differences in Brinnell and Vickers hardness values between the heating temperature groups 20°C, 40°C, 100°C, and 120°C. Table 1 shows the distribution and difference in the mean values of the denture base hardness measurements between the heating temperature of 20°C, 40°C, 100°C, and 120°C. Hardness test results are described in Brinell hardness (HB) and subsequently converted into Vickers hardness (HV). The results of the study showed that both Brinell hardness and Vickers hardness, it was obtained the highest value in the group that was heated twice with a temperature of 40°C, namely 63.72 HB and 79.83 HV. Meanwhile, the lowest average Brinnell and Vickers hardness values were found in groups soaked and heated to 100°C. The Brinnell and Vickers violence in this group only reached 56,133 HB and 70 HV. At a temperature of 20°C heating, the hardness value reached 62.15 HB and 78 HV. In the group with a heating temperature of 120°C, the hardness value reached 58.22 HB and 72,83 HV [10].

The conclusion that can be drawn is: there is an effect of material thickness and there is influence duration of time of irradiation of resin composite of light to hardness of material surface; the quality of hardness and the strength of the light composite resin material decreases with the thickness of the material at the time of saturation if not accompanied by the addition of the irradiation time. This happens because the polymerization of materials cannot take place properly. Based on the research data also clearly shows that maximum hardness is obtained on resin composite ray sample with a thickness of 2 mm and 60 seconds of irradiation time. In general, radiation time should be between 40 – 60 seconds, while the thickness of the material is not more than 3 mm at a single irradiation. While in the study authors concluded that can be taken is: there is the influence of temperature and thickness of acrylic base denture, the hardness of acrylic material decrease at temperature 100°C and 120°C [11].

Thus, the greater the temperature given during heating will further lower the hardness of the acrylic base denture. In general, a good normal temperature on acrylic denture is 30 – 40°C.

v. Conclusion

Based on the results of research on the effect of recurrent heating on the hardness of the acrylic base denture can be concluded that:

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- There were significant differences in Brinnell and Vickers hardness values between the heating temperature groups 20°C, 40°C, 100°C, and 120°C.
- The higher the heating temperature, the lower the hardness of the acrylic base denture.

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