المجلة الإلكترونية الشاملة متعددة التخصصات
العدد الخامس والعشرون شهر(6) 2020

Appraise the different types of polymer used in denture base Through their physical property (water sorption)

Dr. MayHamza, MazenAlsolam, MusaadOudah A Alanazi Abduljalil Bader Alhadi and Alwaleed Alarjan
Department of Prosthodontics College of Dentistry, Jouf University
E-mail: mayosman1978@gmail.com

Abstract

PURPOSE. The aim of this study was to evaluate the effect of the engagement periods on physical property (water sorption) on the conventional heat cure acrylic resin and thermoplastic resins(Biodentaplast).

MATERIALS AND METHODS. Tow types of resin, which are conventional heat-cured acrylic resin thermoplastic polyamide resin (Biodentaplast),were used as materials for this study. Ten specimens were prepared according to ADA specification No 12 for polymers Specimens were immersed in the distilled water for 7 days and remaining specimens immersed for one month.

RESULTS . IN water sorption test, thermoplastic polyamide resin (Biodentaplast) showed lower values than conventional heat-polymerized acrylic resin

CONCLUSION.. Based on the results obtained from the present study the following conclusions could be drawn:

1. The thermoplastic resin materials fulfilled the requirement of A.D.A regarding the water sorption.
2. Thermoplastic resin materials (Bioddentaplast) is considered as a good alternative to the conventional heat cured acrylic resin .

3. Thermoplastic poly amid resin showed acceptable water sorption. So that means the strength of material not affected by water sorption

Key words: Thermoplastic resin**,** heat cure acrylic resin and water sorption

INTRODUCTION

A denture is a removable replacement for missing teeth and surrounding tissue. There are two types of dentures, complete and partial dentures. Wearing a denture to replace missing teeth provide natural appearance ,support for lip and check and correct the collapse appearance that occur after loosing teeth. Additionally, mastication as chewing ability and pronunciation, are enhanced.

There are several types of removable denture which are made from metallic and/or acrylic denture (Saleh Abdullah Al-Ghamdi1, 2018).

Denture base acrylic resins are exhibit dimensional changes during processing. According to type of curing methods. The causes for the dimensional changes are the ratio of polymer powder to monomer liquid, type of denture base resin, polymerization conditions and investment (Ammar Kh Al-Nori, 2007) (Mohammed, 2010)Denture base polymer absorbs water slowly over a period of time. This imbibition is due primarily to the polar properties of the polymer molecules. High equilibrium uptake of water softens denture base polymer because the absorbed water acts as a plasticizer of the polymer (Barsby, 1992).and reduce the strength of the polymer. Water sorption also affects the color stability and effect the mechanical properties, such as the Young's modulus Therefore, in order to ensure satisfactory long term use of dentures, it is crucial to use denture base materials that can maintain color stability against external pigmentation factors in various oral environments. And maintain strength through low water sorption

AIM OF STUDY AND OBJECTIVES

The purpose of the study was to evaluate the effect of the engagement periods on physical property (water sorption) on the conventional heat cure acrylic resin and thermoplastic resins.

Objectives:

- To evaluate the water sorption of the conventional heat cure acrylic resin
- To evaluate the water sorption of the thermoplastic materials (Biodentaplast)
- To compare between water sorption value of conventional heat cure acrylic resin
- And thermoplastic materials (Biodentaplast)

Literature Review

Water sorption:

(PMMA) is one of the most widely used materials in prosthetic dentistry (Haroon Rashid, 2015)it has been successfully used in construction of denture bases. Sorption of material represents the amount of water adsorbed on the surface and absorbed into the body of the material during fabrication or whiles the restoration is in service. Since both adsorption and absorption are involved the term sorption is usually used to include the total phenomena. Usually a serious warpage and dimensional change in the material are associated with a high percentage of water sorption. Water sorption has detrimental effect on the color stability and the wear resistance (Ammar Kh Al-Nori, 2007).Acrylic resin polymer absorbs water over a period of time.

This due to primarily to the polar properties of resin.

The absorbed water stays in gaps among the inter-polymeric chains that form acrylic resin structure. The magnitude of these inter-polymeric gaps determines the amount of water to be absorbed .Within the establish limit water sorption can be considered a desirable property because it compensates resin polymerization shrinkage, beyond these limits water sorption value can lead to undesirable dimensional alteration .

The absorption of water by acrylic resins is a phenomenon of considerable importance since it is accompanied by dimensional changes, a further undesirable effect of absorbed water in acrylic resins to reduce the tensile strength of the material (Mohammed, 2010). Therefore, water sorption of these materials should be as low as possible, the water sorption was determined according to the International Standards Organization (ISO) standards 1567:1999. According to this specification, water sorption should not exceed 32 $\mu g/mm^3$ for heat-cured or self-cured materials, due to the importance of these properties in the clinical and mechanical performance of an acrylic material; we have to study the physical properties that affect the durability of acrylic denture (Mohammed, 2010)

(Ammar Kh Al-Nori, 2007)evaluated the effect of the different curing methods, conventional water bath heat curing and microwave curing method and different immersion periods on the water sorption of the different types of heat–cured acrylic resins. Two different commercial heat–cured acrylic resins Major Base 2 and Quayle Dental resins were used in this study.

Thirty two specimens were prepared, eight specimens for each material in each group. Specimens were immersed in distilled water, and then subsequently removed at one week and 1 month of immersion for valuation. The result of this study showed that the curing method and immersion period have a significant effect on the water sorption ratios of the resins.

Therefore they concluded that the curing method, immersion period and types of the acrylic resin have an effect on the water sorption ratio.

However (Suleyman Hakan Tuna, 2008)evaluated the water sorption on various acrylic resins. Ten acrylic resin-based materials were evaluated: two heat cure acrylic resins and eight self cure acrylic resins. To evaluate water sorption, thirty square-shaped specimens (20×20×1.5 mm) were fabricated. Specimens were kept at room temperature for 30 min. This weight value was considered the initial weight of the specimen (M1) All specimens were weighed daily at 37°C, until a constant weight (M2) was achieved. The specimens were dried in vacuum oven at 37°C to constant weight and weighed again (M3). The values for water sorption for each of the specimens were calculated using the following equations: Wsp=M2-M3/V .The result of the test showed that the water sorption of both self-cured and heat-cured acrylic resins were in accordance with the ISO specification

(Takabayashi, 2010) compared between six thermoplastic resin and conventional acrylic resin to characterize physical properties such as water sorption. Three disk specimens (50±1 mm dia., 0.5±0.1 mm thick) were prepared.

Specimens were stored in container of silica gel. Desiccation was repeated until mass changes decreased the weight to 0.2 mg or less.

The specimens were then immersed for seven days in distilled water at 37±2°C. Then the mass of each specimen was weighted (designated as*m*1).

Desiccation of the specimens was performed again, and then the mass at a constant weight (*m*2) was measured. The water sorption of each specimen was calculated using the formula: *W*sp= (*m*1-*m*2)/*V*

The result of this study showed that the water sorption of Thermoplastic resins exhibiting low water sorption when compared to acrylic resin .therefore they concluded that the water sorption of all tested material met the ISO standard for type 3 denture base materials.

(Tülin N Polat, 2003)evaluated the water sorption, solubility and dimensional stability of injection and compression-molded polymethyl methacrylate based denture base polymer that was reinforced with various concentrations and lengths of E-glass fibers. For water sorption and solubility, 20 test groups with different fiber contents and lengths of fibers were prepared. Test specimens without fibers were used as a control. The water sorption and solubility was measured after 90 days water storage. For dimensional stability, rhombic test specimens were prepared and the dimensional changes were measured after processing, drying and storing in water for 4 days and 30 days and were compared with those on the brass model. The water sorption and solubility of injection-molded denture base polymer was lower compared to compression-molded specimens

(Rimple, 2011)investigated the effect of water sorption on the dimensional stability of acrylic resin denture bases, to quantify the interference to occlusion due to the vertical dimensional change caused by water sorption and to assess the time required for the water sorption related dimensional changes to stabilize.: The sample consisted of tooth bearing specimens of heat cured acrylic resin .This study was undertaken to determine the dimensional change in heat cure acrylic resin denture bases over a period of 28 days on immersion in water. Micrometer and a comparator were used to record the dimensional change. Measurement for the change in dimension in the vertical direction were recorded on zero, first, second, seventh, fourteenth, twenty first and twenty eighth day of water sorption and the mean dimensional change over this time period was calculated. Results: For statistical analysis the six days of measurement-day 1,2,7,14,21 and 28 were taken as six different treatments. Very little change occurred during the 21-28 day interval and was statistically not significant. The results indicated that the water sorption related dimensional change stabilizes and saturation or equilibrium is attained in 21 days or three weeks

MATERIAL AND METHODS:

Table 1: Materials used in this study

Materials	Trade name
Conventional Heat-Cured acrylic resin (M1)	Acrostone
Thermoplastic Material(M2)	Bio dentaPlast (polyamide)

Specimens Preparation:

The specimens were processed according to the ADA specifications No. 12 for denture base polymers. Ten specimens for each materials were prepared using disk (dimensions of 50 mm in diameter 1mm thick) as reference material .

Conventional Heat-Cured Acrylic Resin Specimens:

The material was mixed and packed following the manufacturer's recommendations. A powder: liquid ratio of 3:1 by volume of the conventional heat-cured acrylic resin (Acrostone) was mixed with a stainless

steel spatula and kept in a sealed glass jar during the initial stage of reaction to avoid the loss of the monomer by evaporation. When the mix reached the dough stage, where the mixture separated cleanly from the walls of the glass mixing jar (15minutes), the material was packed into the dental stone impressions of the required water sorption specimens dimensions·Then, the metal flask was compressed with the hydraulic press and placed into the water bath for one hour and half 74°C and extended for another one hour at 100°C for heat-curing.After curing, the flask was removed from the water bath and was allowed to bench cool to room temperature to avoid the development of thermal internal stress within the specimens upon premature opening of the flask·After de-flasking, the specimens were finished and polished

Thermoplastic resin(Bio Dentaplast):

As the materials were supplied in a granular form so after mold construction as for the conventional heat cured acrylic resin, the material were injected into the mold using thermos press injection mold machine. The investigated materials were placed into the machine that they was adjusted at processing temperature280° C for 2-3min then the molten material was injected into the mold under a very high temperature, flask were cooled down for 20 minutes after cooled down the specimens were de-flasked, finished and polished

water sorption Test:

The weight of each specimen was measured with an electronic digital balance after storing the specimens in a drying chamber for 24 hours. The weight was recorded when the digital reading remained at a constant value (W0). After measuring the baseline volumes and weights, we stored the specimens in a constant-temperature water tank (37ºC) filled with distilled w. Then the weights were measured after 1 week and I month of immersion, whereupon 5 specimens for each type were removed from the tank, dried with tissue paper, and left to stand on the electronic digital balance for 30 seconds before reading the indicated value (W1). We performed a second measurement after the specimens had been stored in a drier for 24 hours after the first measurement was taken; the value was read when the balance remained at a constant value for 30 sec (W2).

$$Water\ sorption\,\% = \frac{weight\ gained - original\ weight}{original\ weight} \times 100$$

Mean values wear compared statistically with ANOVA analysis

RESULTS:

The results of the water sorption of the investigated acrylic resin denture and thermoplastic material represented graphically on figure 1 and 2

Type of material	Water sorption after 7 days		Water sorption after 1months interval	
	Mean	±SD	Mean	±SD
Acrylic resin	4	0.04	10.7	٠,٣
Thermoplastic materials	0.5	0.005	3.7	٠,2

P=0.001

Table (2): water sorption after 7 days and 1month

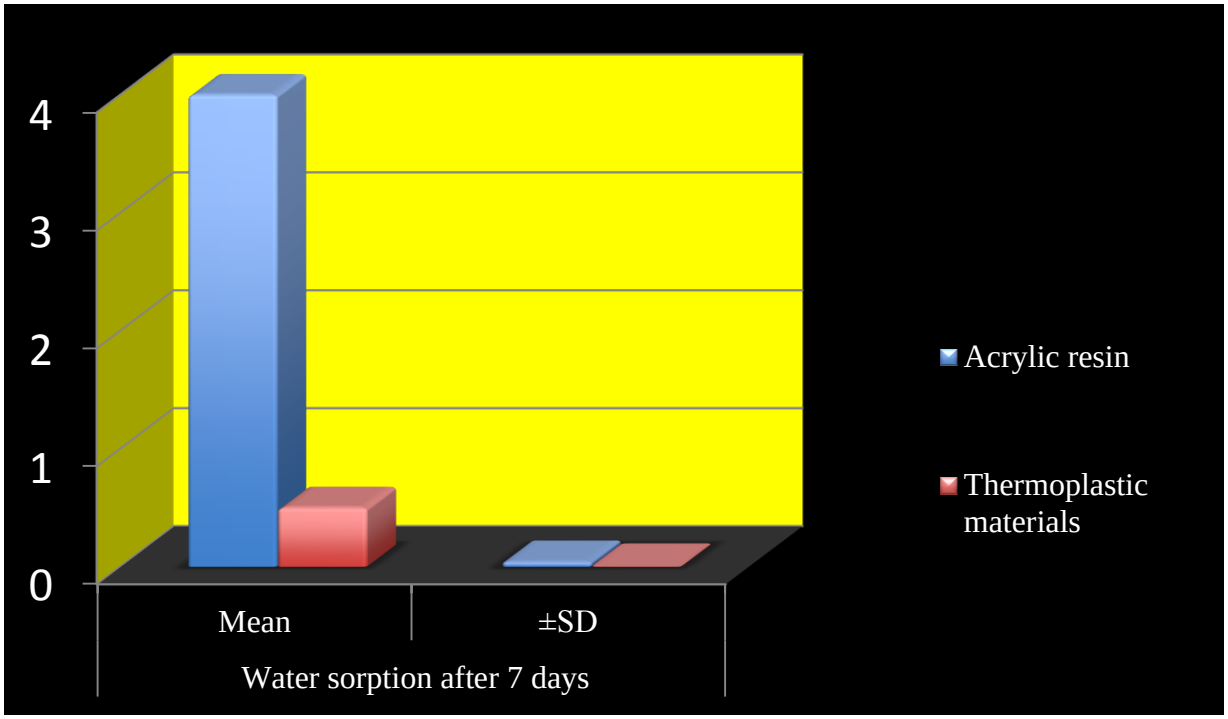

Figure 1: A bar chart of water sorption after 7 days tested conventional heat-cured and thermoplastic resin bio-dentaplast.

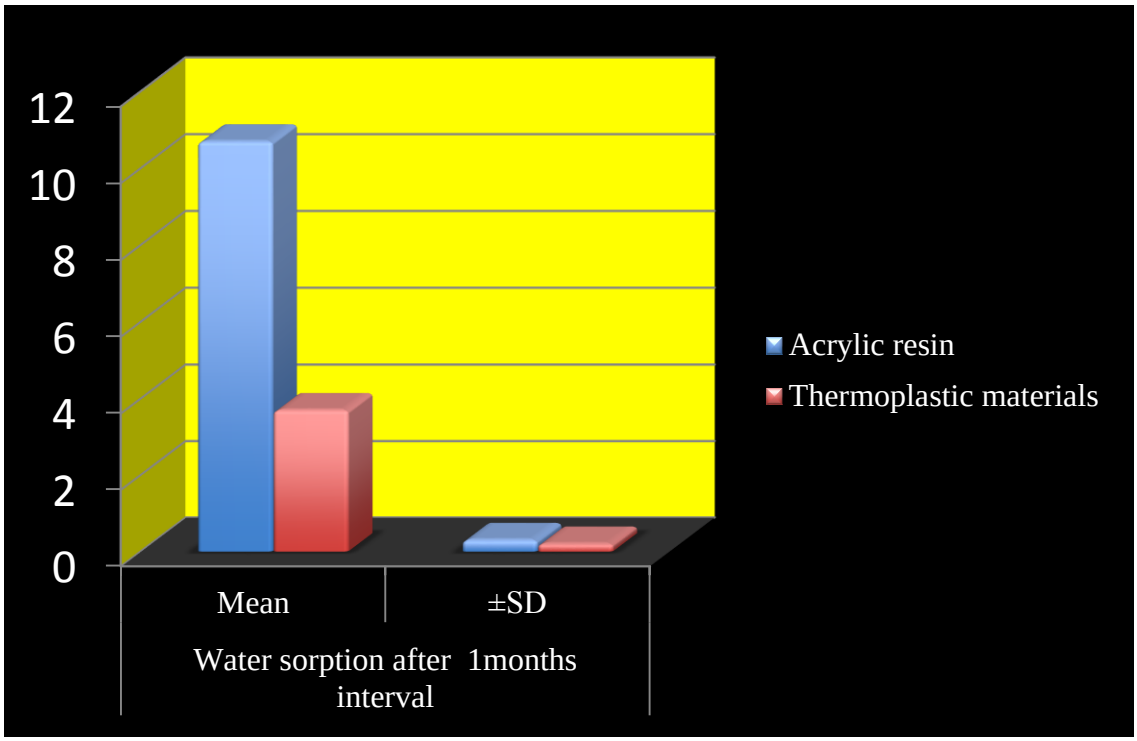

Figure 2: A bar chart of water sorption after one month tested conventional heat-cured and thermoplastic resin bio-dentaplast.

The mean and standard deviation values of water sorption after 7days at 37C°is 4 %±0.04, 0.5%±0.005 of the conventional heat-cured, and thermoplastic bio-dentaplast .

The mean and standard deviation values of water sorption after 1month at 37C°is 10.7%±0.3 and 3.7% ±0.2 for conventional heat-cured and thermoplastic resin bio-dentaplast respectively.

The conventional heat-cured showed the higher statistically significant of water sorption within 7 days and 1month than thermoplastic resin materials ,

DISCUSSION

.In this study used the method according to ISO evaluating water sorption was used. The water sorption was evaluated by calculated the increase of the total mass. According to acrylic resin chemical structures and its polar property ,it has capacity to absorb a little amount of water in the first few days

High water uptake lead to soften of acrylic resin because absorbed water act as plasticizer which lead to decrease the strength of acrylic resin material (Barsby, 1992)

The increase of water absorption of acrylic resin and polymer materials are determined by the saturation of materials by polar sites (Juliana Malacarne, 2006) (Masako Unemori, 2003)This is agree with (T Arima, 1996)Suggested that the chemical structure of the polymeric materials controlled the percentage of water uptake and water sorption and the main distinctive for this is a polarity characteristic of polymer .

In present study the thermoplastic materials explained the lower water sorption than heat cure acrylic resin this is agree with (Saleh Abdullah Al-Ghamdi1, 2018) suggested that the recently polyamide resins (thermoplastic materials explained lower water sorption rates than unmodified or earlier polyamide which is subjected to water sorption between molecular chains due to the hydrophilicity of the many amide bonds that form the main chains of the resins, resulting in high water sorption rates.

CONCLUSIONS :

Based on the results obtained from the present study the following conclusions could be drawn:

1. The thermoplastic resin materials fulfilled the requirement of A.D.A regarding the water sorption .

2. Thermoplastic resin materials (Bioddentaplast) is considered as a good alternative to the conventional heat cured acrylic resin.

3. Thermoplastic poly amid resin showed acceptable water sorption. So that means the strength of material not affected by water sorption

References

1-Ammar Kh Al-Nori, A. M. (2007). water resorption of heat cure acrylic resin . *Al–Rafidain Dent J*.

2-Barsby, M. J. (1992). A Denture Base Resin With Low Water Absorption. *J Dent*.

3-Haroon Rashid, Z. S. (2015). Allergic effects of the residual monomer used in denture base acrylic resins. *Eur J Dent.* .

4-Juliana Malacarne, R. M. (2006). Water sorption/solubility of Dental Adhesive Resins. *Dent Mater*.

5-Masako Unemori, Y. M. (2003). Water Absorption of Poly(methyl Methacrylate) Containing 4-methacryloxyethyl Trimellitic Anhydride. *Biomaterials*.

6-Mohammed, N. Z. (2010). The Effect of Thickness of Heat Cured Acrylic Resin with Additives on Water Sorption and Solubility. *Al-Rafidain Dental Journal*.

7-Rimple, G. K. (2011). An Evaluation of the Effect of Water Sorption on Dimensional Stability of the Acrylic Resin Denture Bases. *Int. Journal of Contemporary Dentistry*.

8-Saleh Abdullah Al-Ghamdi1, O. A. (2018). Dimensional Changes and Water Sorption of Vertex Thermosense Versus a. *Acta Scientific Dental Sciences*.

9-Suleyman Hakan Tuna, F. K. (2008). The Evaluation of Water Sorption/Solubility

on Various Acrylic Resins. *Eur J Dent.*

10-T Arima, H. M. (1996). The Effects of Cross-Linking Agents on the Water Sorption and Solubility Characteristics of Denture Base Resin. *J Oral Rehabil*.

11-Takabayashi, Y. (2010). Characteristics of Denture Thermoplastic Resins for Non

Metal Clasp Dentures. *Dent Mater J*.

12-Tülin N Polat, O. K. (2003). Water Sorption, Solubility and Dimensional Changes

of Denture Base Polymers Reinforced With Short Glass Fibers. *J Biomater Appl*.