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POROSITY EVALUATION OF A THERMOPLASTIC NYLON DENTURE BASE MATERIAL

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ABSTRACT

Objective: This study was conducted to evaluate the porosity of a thermoplastic nylon denture base material and comparing it with conventional heat-cured acrylic resin. **Material and methods**: Two different types of commercially available denture base materials were used in this study. Group I: Heat cured acrylic resin denture base material . Group II: Thermoplastic nylon denture base material. Specimen Preparation:Metal Pattern Preparation According to ADA specification NO.12, and Astem D256, (1985, 1988), and BS specification2482, the following five metal patterns were constructed for acrylic resin specimen's preparation: Rectangular shaped metal pattern of 65 mm x 10 mm x 2.5 mm , length, width and thickness, respectively, were constructed to test transverse strength, porosity and surface hardness. **Results:** The t-test showed that the thermoplastic nylon has a lower significant mean value than the conventional heat-cured acrylic resin (P-value > 0.05). **Conclusion:** Thermoplastic material was more porous than the conventional one**.**

KEYWORDS: Thermoplastic resin, acrylic resin, complet denture, porosity.

INTRODUCTION

Polymethyl methacrylate (PMMA) has been the most popular material used for denture fabrication since its introduction in 1937 [(1)].

It has several advantages such as an excellent esthetic characteristic, low water sorption and solubility, adequate strength, low toxicity, easy repair, and a simple molding processing technique, but it has some problems such as polymerization shrinkage, weak flexural, lower impact strength, and low fatigue resistance[(2)].

These often lead to denture failure during chewing or when fall out of the patient's hand. In order to enhance some properties of PMMA, various efforts have been taken including addition of metal wires or plates, fibers,[(3)]metal inserts,[(4)]and modification of chemical structure.

Heat activated PMMA Resins:

These materials are widely used for the construction of removable complete or partial dentures. In heat-cured materials, the polymerization process is initiated by the release of free radicals from BP on supply of heat energy.[(3)] These free radicals react with the monomer molecules and continue till the monomer is available[(5)].

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These materials are supplied in the form of powder and liquid. Powder contains finely divided pre-polymerized PMMA beads and liquid contains methyl methacrylate (MMA). Liquid is supplied in adark brown colored bottle to avoid accidental polymerization when exposed to visible or U.V. radiation during transport and storage. Bottle should be kept closed to prevent evaporation[5].

Flexible denture base materials are excellent alternatives to conventionally used methyl methacrylate dentures, which not only provide excellent aesthetics and comfort, but also adapt to the constant movement and flexibility in partially edentulous patients[6].

The development of polymer chemistry produced alternative materials to PMMA such as polyamides (nylon plastics), acetal resins (polyoxy methylen based materials), epoxy resins, polystyrene, polycarbonate resins. All of these new types of resins are suited for thermoplastic processing[7].

The prosthesis fabricated from these materials requires a minimum or no mouth preparation and provides a good retention. It is thin and light in weight so it is comfortable for the patient. As well as, its good aesthetic because of the translucent and pink shade that matches the natural tissues. Being flexible, the denture bases adapt well in the undercut areas and not cause sore spots. They also have almost no porosity and lower elastic modulus[8].

A flexible denture base material generally is not used for long term restorations and is intended only for provisional or temporary applications, because of various problems, including fractures of the resin clasp, roughening of the polished surface of the denture base, or discoloration of denture base resin[9].

Polyamide resin was proposed as a denture base material in the 1950s.Nylon is a generic name for certain types of thermoplastic polymers belonging to the class known as polyamides. These polyamides are produced by the condensation reactions between a diamine NH2-(CH2)6-NH2 and a dibasic acid, CO2H-(CH2)4-COOH[10-11].

Nylon is a crystalline polymer, whereas PMMA is amorphous. This crystalline effect accounts for the lack of solubility of nylon insolvents, as well as high heat resistance and high strength coupled with ductility[12,13].

Moreover, it was claimed that nylon materials have other advantages including higher elasticity than common heat polymerizing resins,[14]toxicological safety for patients with resin monomer and metal allergy, use of heat-molding instead of chemical polymerization to control the polymerization shrinkage and its related deformation[15].

On the other side, it is reported that this material has several problems such as water sorption, surface roughness, bacterial contamination, warpage, color deterioration, and difficulty in polishing[16].

MATERIALS AND METHODS

A. Specimen preparation:

Two different types of commercially available denture base materials were used in this study.

Group I: Heat cured acrylic resin denture base material (Vertex™ Rapid Simplified, Vertex-Dental B.V. Headquarters The Netherlands.)

Group II: Thermoplastic nylon denture base material (Dentiflex, Roko dental system, Poland.

A total of 20 specimens were prepared for the current study. Ten specimens in each group were used to evaluate surface hardness

Rectangular shaped metal patterns of 65mm length, 10mm width, and 3 mm thickness were constructed to test porosity.

Molds were fabricated then the specimen were prepared following the manufacturer`s recommendations According to ADA specification NO.12,

B. Porosity evaluation:

Specimens of 65mm length, 10mm width, and 3 mm thickness were used for this test. The specimens were immersed in a solution of permanent black ink for 30 min., then washed for 10 sec and finally, they were dried with an absorbent paper. A surface area of 1cm^2 was marked in the center of each specimen and observed under 40 x magnification in a stereo light microscope. The number of pores per area was determined for each specimen, and an average value was calculated for each group.

The resulting data were collected and tabulated by using Microsoft Excel ® 2010 and statistically analyzed by using Statistical Package for Social Science (SPSS) ® Ver.20. The results were analyzed using the Statistical Package for Social Science (SPSS) ® Ver.20 software for windows after taken a photography.

RESULTS

A value of $P < 0.05$ was considered statistically significant. Continuous variables were expressed as the mean and standard deviation. After homogeneity of variance and normal distribution of errors had been confirmed, student t-test was done for compared pairs.

The results of the porosity of the investigated acrylic resin denture base materials are shown in Table (1) and figure (1) represented graphically. The mean and standard deviation values of porosity were 7.6 ± 1.01 for conventional heat cured acrylic resin and 4.3 ± 1.6 for thermoplastic nylon.

The t-test showed that the thermoplastic nylon has a lower significant mean value than the conventional heat-cured acrylic resin (P-value > 0.05), as shown in Fig. (1).

TABLE (1): The porosity values of the tested acrylic resin denture base materials Conventional Heat-CuredAcrylic Resin

Conventional Heat Cured Acrylic Resin	The flexible cured acrylic resin	P-value
Mean ± SD	Mean ± SD	0.001*
7.4 ± 1.01	4.8 ± 1.6	

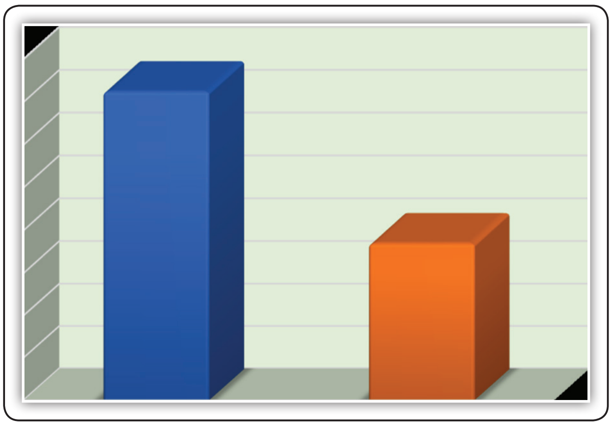

FIG (1) The porosity mean values of the tested groups

DISCUSSION

Porosity of acrylic resin specimens has been observed under stereo light microscope after being immersed in a solution of permanent black ink. This technique has been preferred due to its simplicity and providing more detailed information than calculating the porosity from the specimen's weight. Furthermore, it has been proved that this technique is less destructive than the mercury porosimetry one. This was due to its toxicological concern and the fact that mercury tends to form amalgam in case of metal and alloy specimens[17] .

The current contemplate's results revealed that the porosity of the flexible cured acrylic resin denture base has been lower than the conventional one. This might be related to different polymerization techniques as flex curing has major advantages over the conventional water bath technique. Such advantages are the rapid rise in temperature accompanied with almost equal heating both inside and outside the substance, while hot water bath involves a period of boiling which is close to the boiling temperature of the methyl meth acrylate (PMMA) that is 100.3C. PMMA could be changed into a gas producing bubbles that might be entrapped in a polymer matrix. This would be exaggerated by exothermic polymerization reaction resulting in increased porosity[17].

Results of this study are in harmony with Takabayashi et al [18] who proved that no remarkable porosity has been observed in the resin designed specifically for flex polymerization while there has been severe porosity in the conventional resin specimens that has undergone polymerization. Moreover, the amount of porosity increased when polymerization is utilized and if energy level is increased as demonstrated**.** So it is important to accurately control both temperature and correct timing in order to minimize flexible energy level to decrease porosity .

On the contrary, Jagger and Harrison [19] demonstrated that flexible curing is not a factor that alters surface superficial porosity when compared between two groups, the first group was water bath-cured resin.

CONCLUSION

This study concluded that thermoplastic material was more porous than the conventional PMMA **.**

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