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Effect of Ethanol Addition on some Properties of Self-Polymerized Acrylic Resins

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Abstract

Background*:* Self-polymerized acrylic resins are widely utilized in dentistry. A higher residual monomer content is seen after polymerization of denture base resins. The literature showed that the ethanol solvent could rise the leaching of residual monomer from the polymer. The purpose of the current research was to investigate the influence of ethanol addition on hardness and roughness of acrylic resins.

Materials and Methods: Sixty acrylic resin specimens were prepared and were divided into 2 main sets due to the kind of test used (surface hardness and surface roughness). There were three groups according to the ethanol concentrations. The first group was the control specimens with no ethanol, the second group was loaded with 10 ml of ethanol; and the third group was loaded with 15 ml of ethanol. The acrylic specimens were measured using the Shore A Durometer hardness and the surface roughness tester. Results*:* showed that the addition of ethanol significantly decrease the surface hardness of acrylic resins. The results indicated that there are significant differences between groups ($P<$ 0.0010). However, no significant differences between 10ml and 15 ml groups ($P>0.05$). For surface roughness test, no significant differences were found among the studied groups ($P>0.05$). Conclusions*:* The addition of ethanol to self-polymerized acrylic resins would significantly decrease the hardness and increases the surface roughness of acrylic resins.

Introduction:

In dentistry, acrylic resins have been utilized for fabrication of denture base since 1937 [1]. Self-polymerized acrylic materials are characterized by their low cost and easily manipulated by dental technician. They are, on the other hand, prone to fracture [2]. Self-polymerized acrylic resins are usually utilized in several purposes in dentistry such as repairs, orthodontic appliances, relines, maxillofacial prosthesis and crown and bridge [3]. Self-polymerized acrylic resins are basically similar to heat cured acrylic resins, but the difference is only in the way where the polymerization begins at room temperature. The chemical composition of the liquid for self-polymerized resins differs from heat polymerized resins by adding the chemical activator (tertiary amine)[4]. The interphase layer is ordinarily seen between the PMMA beads and the polymer network and in self-polymerized resin [5]. The interphase layer is a cross-linked polymer matrix has been combined in the structure of polymer of the dissolved PMMA beads. The behavior of biological and mechanical properties of acrylic resin can be determined via the amount of unconverted or unreacted residual monomer [6]. A higher residual monomer is often seen after polymerization of self-polymerized resins in comparison to heat-polymerized resins[7]. The higher residual monomer in the self-polymerized resin, affects adversely the hardness[4]. It is known to leach residual monomers during the initial days of water storage of polymerized resins. Remarkably, cytotoxicity of the resins which resulted from the residual monomer was decreased following the incorporation of ethanol deprived of any change in properties of acrylic resin [8]. Accordingly, auto-polymerized resins have extended more acceptance because of saving chair side time, easily handling, and not needing laboratory processing; Furthermore, the patients spend less time without denture during the repair process [9]. Such substances must have enough strength to endure the masticatory forces, preserves the dimensional stability, satisfactory resiliency, biocompatibility and high polish ability[10]. these materials, on the other hand, are still far from ideal due to their relatively low mechanical strength. Numerous efforts have been carried out to enhance the mechanical properties of resins over the years [11]. The surface roughness of the acrylic resins is vital since it influences the oral health of the tissue which is in direct contact with the appliance. Most microorganisms present intraoral, particularly those responsible for caries periodontal disease [12]. Hardness is defined as" the resistance of a material to indentation or penetration" [13]. The current research was, therefore, conducted to investigate the influence of ethanol on hardness of self-polymerized acrylic resins.

Material and methods:

In present study, sixty specimens of Self-cured acrylic resins (Spofadental,Czech Republic) were fabricated in total. There were two major tests and there were 3 groups and each group had 10 specimens. The control group was constructed from mixing 22g of acrylic powder and 10 ml of acrylic monomer. The first experimental group was fabricated from adding 10 ml of ethanol to 22g powder and 10ml acrylic monomer. The second experimental group included the adding 15ml of ethanol to 10ml of monomer.

Acrylic resins preparation

Specimens for hardness test were produced in wax with dimensions (15 x 5 x 2mm). The wax acrylic specimens were invested in stone mould (Spofadental,Czech Republic) and petroleum jelly (China) was utilized as a separating medium. The flask was boiled for 5 minutes to eliminate the wax and the separating medium is then applied to dental stone. According to manufacturer instructions, the powder was mixed with monomer and polymerized by Ivomat (Australia). The acrylic resin dough was cured in the Ivomat device containing water for 15 minutes (pressure 30 Pascal (ADAS, No. 12, 1975). Following curing, acrylic specimens were carefully taken away from the mould, finished and polished Fig. (1). Then, all specimens were immersed in distilled water for 2 days to adsorb any residual monomer.

Hardness test

Acrylic specimens are tested using the Shore A Durometer hardness (China) according to ANSI/ ADA No. 12, 1999) Fig. (2). A load of 50 grams was applied on the specimen surface for 10 seconds. For each specimen, 5 readings were made; and then the average reading was recorded.

Surface roughness test

Acrylic specimens are tested using the surface roughness tester (China) according to ANSI/ ADA No. 12, 1999). On each specimen surface, a load of 50 grams was applied for 10 seconds. Five readings were made for all specimens and then the average reading was calculated Fig. (3).

Result:

The SPSS V 20 was utilized to analyze specimens' data. All values of mean and standard deviation are illustrated in Table 1. For surface hardness, the results showed that the highest mean value for hardness was the control group which was (112.10), followed by 15 ml group which was (108.93). In contrast, the lowest mean value was for 10 ml group which was (106.50). In addition, among all groups, significant differences (*P*< 0.001) as demonstrated in ANOVA test (Table 2).

Furthermore, significant differences (P< 0.001) between 2 groups were seen. On the other hand, no significant differences between 10ml and 15 ml groups are found (P>0.05) as illustrated in Table (3). For surface roughness, the 10 ml group had the highest mean of surface roughness followed by control group and 15 ml group (Table 4). In addition, no significant differences the studied groups are found as illustrated in Tables 5 & 6 (P>0.05).

Discussion:

In dentistry, self-polymerized resins are widely utilized in various purposes such as repairs, orthodontic appliances, relines, maxillofacial prosthesis and crown and bridge [3]. Such substances are easily handled by the dental technician, chemically activated, and reasonably priced[4]. Acrylic resin materials have been proven to be affected by ethanol in terms of surface hardness and surface roughness[14]. The hardness property indicates" the ease with which the material is scratched or abraded, dental prostheses made of acrylic resins with low surface hardness will probably be damaged by mechanical brushing" [15]. There were no published articles about the effect of ethanol on self –polymerized acrylic resins. Therefore, the aim of current research was to evaluate the impact of ethanol on self-polymerized acrylic resins in terms of surface hardness. There were three groups (control, 10 ml and 15 ml ethanol) and each group had 5 specimens. The findings presented that the addition of ethanol significantly decreased the acrylic resins' surface hardness. The reason was due to a greater amount of residual monomer after polymerization which act as a plasticizer which negatively affect the acrylic resins' hardness [16 ,17].

These results disagree with Basavarajappa *et al*., [7] found that the ethanol has enhanced the nano hardness of heat-polymerized acrylic resin. This could be partly explained by the differences in methodology utilized. It was clear that the dissolving effect of ethanol was seen to occur in the interpenetrating polymer network (IPN) layer between the matrix polymer and the beads. Regarding surface roughness, the results agree with Basavarajappa *et al*., [7] found that the ethanol has improved the acrylic resins in terms of surface roughness. According to present results, it is concluded that the addition of Ethanol would significantly decrease the hardness; but improved the surface roughness of acrylic materials. It is suggested to evaluate the influence of Ethanol on flexural strength of self-polymerized acrylic resins.

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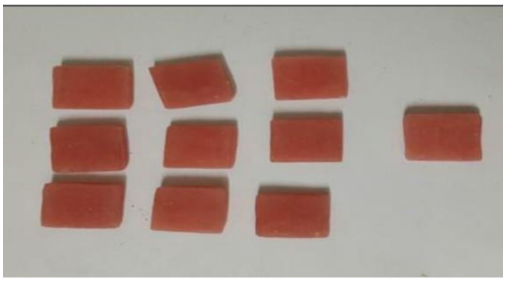

Fig. (1): acrylic specimens.

Fig. (2): specimen under hardness tester.

Fig. (3): specimen under roughness tester.

Table (1): Mean and standard deviation for all groups for surface hardness

Hardness	No	Mean	Standard. Deviation
control	10	112.10	1.51
10ml	10	106.50	3.75
15ml	10	108.20	2.28
Total	30	108.93	3.47

Table (2): Comparison among all groups for surface hardness

hardness	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	82.433	2	41.217	5.718	.018
Within Groups	86.500	12	7.208		
Total	168.933	14			

Table (3): Comparison between two groups for surface hardness

Groups		P value	Sig.
Control	10ml	.006	H.S*
Control	15ml	.040	S
10ml	15ml	.337	N.S*

H.S. : Highly significant (P< 0.001)
N.S : No significant P>0.05

Table (4): Mean and standard deviation for all groups for surface roughness

Surface roughness	No	Mean	Standard Deviation
control	10	.70	.29
10ml	10	1.02	.46
15ml	10	.70	.30
Total	30	.80	

Table (5): comparison among all groups for surface roughness **ANOVA**

Surface roughness	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.706	2	.353	2.642	.090
Within Groups	3.607	27	.134		
Total	4.312	29			

Table (6): Comparison between two groups for surface roughness

Groups		P value	Sig.
Control	**10ml**	.144	N.S*
Control	**15ml**	.997	N.S*
10ml	**15ml**	.125	N.S*

No significant P>0.05

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