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Evaluation The Effects of Ethylmethacrylate and Isobutylmethacrylate on Transverse Strength Of Heat-Polymerized Acrylic Resins

Hiba Manuf Hadi [(1)]
Ayad I. Haddad [(2)]
Firas Abd Kati [(3)]

[1,2,3] Department of Prosthetic Dental Technologies, College of Health and Medical Technology, Middle Technical University, Baghdad, Iraq.

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Corresponding Author:
Name: Ayad I. Haddad
E-mail:
ayadhaddad2000@mtu.edu.iq
Tel: 07801102325
Affiliation:
Assist prof, department of prosthetic dental technology, college of health &medical technology, middle technical university, Baghdad, Iraq

Abstract

Background in order to regain esthetic, patients are given an ocular prosthesis. The majority of them are made of poly methyl methacrylate resin (PMMA), which is a popular material for maxillofacial prostheses including ocular prostheses, Fracture of poly methyl methacrylate occurs due to several reasons involving careless handling and falling of ocular prosthesis on hard surfaces, it is essential to strength the acrylic to improve the transverse strength of the resin. **Materials &methods** :50 samples were constructed from heat cured acrylic resins and divided into three groups (1control and 2 experimental group) Each group had ten specimens. The two experimental groups comprised the IBMA, EMA monomer at 1% and 2% concentrations, respectively. Such samples were prepared with dimensions of 65 mm x 10 mm x 2.5mm ± 0.1 length, width and thickness respectively according to (ADA specification, No.12, 1999). All the samples were tested for transverse strength. All data were analyzed using SPSS version 20. Tukey test was used for comparison between the groups.
Results: There were highly significant differences (P<0.001) on the transverse strength between the control group and EMA, IBMA copolymers. **Conclusion**: The scleral acrylic resin incorporation with 1% and 2% wt % EMA, IBMA copolymers showed insignificant increase in transverse strength.

Introduction:

The eyes are the most prominent feature of a person's face [1, 2]. trauma, tumors and congenital absence of orbit are the main causes of the defects [3]. Eye loss creates functional, aesthetic and psychological gaps in an individual's personal and professional life [4, 5]. Rehabilitation of ocular defect can be done by a custom-made eye prosthesis is not only necessary for cosmetic reasons, but it also

aids in social and psychological rehabilitation [6, 7]. Artificial eyes can preserve the volume of the eye socket, give the patient confidence in public, and restore the patient's natural appearance[8].
Acrylic resin is the material of choice in the manufacture of prosthetic eyes because it is lightweight, easy to apply and adjust, stronger, transparent, easy to manufacture, capable of coloring internally and externally, and inert to cavity secretions [9, 10]. To produce a PMMA artificial eye, an impression of the ocular cavity is initially taken with a custom tray manufactured with Poly methylmethacrylate self-polymerization using contours of a stock eye, Fabrication of scleral wax pattern by molten baseplate wax was heated over flame and poured into the mold, the wax pattern was retrieved and tried into the eye socket to checking for appropriate fit and adjusting to produce satisfactory contours of eyelids; investing the wax pattern; production the iris and processing it with acrylic resins [3, 11]. Artificial eye in soft tissue change the life of most people is not just restoring esthetics but also restoring remaining structures of eye and prevents psychological trauma. The main challenge is to replicate all the unique properties of living natural tissues using the prosthesis. Furthermore, with exposure of Artificial eye to UV rays, salt water, makeup, and skin secretions, it is essential to understand and control the physical, chemical, biological, and aesthetic changes in polymers over time to ensure that patients are provided with the best possible and to improve their quality of life[9, 12]. To strengthen acrylic resin and lengthen the service life of prostheses, Polyamides, epoxy resin, polystyrene, vinyl acrylic, rubber graft copolymers, polycarbonates, and nylon have all been created to solve some of the mechanical shortcomings of poly(methyl methacrylate) (PMMA) Several types of monomers have been added to MMA and PMMA to strengthen the acrylic structure [13-15]. The objective of this study was to evaluate the effect of adding the isobutyl methacrylate (IBMA) and Ethyl methacrylate(EMA)in different concentrations to MMA and PMMA to improve the transverse strength of the acrylic resin.

Materials and Methods:

Materials

In this study, 50 samples of acrylic resin (Spofadental, Czech Republic) were produced. These samples were divided into three groups and each group had 10 samples. The first group was considered as the control without any addition; the second group (experimental) included the addition of 1 %,2% of IBMA (ALDRICH, USA); and the third group (experimental) included the addition of 1%,2% of EMA (Sigma-Aldrich, Brazil). The dental stone (Zhermack, Badia Polesine, Rovigo, Italy) was utilized to make the moulds, the petroleum jelly (Hebei, China) and Dental pumice (Bilkim LTD, TURKY).

Fabrication Of Acrylic Samples

Acrylic samples were made using plastic models with dimensions of 65 mm x 10 mm x 2.5 ± 0.1 in length, width, and thickness, respectively according to (ADA Standard No 12.,1999) as shown in Fig.(1) [16-18]. Before using the sample patterns, Vaseline was applied on them to remove the acrylic samples from the stone mold, the lower and upper parts of the metal flask were coated with Vaseline. Hand-mixing the dental stone and water was carried out according to the manufacturer's recommendations, at creamy state, the mixture was put in the lower half of the metal flask, the plastic pattern was positioned carefully in the center. Considering that half of them should be visible so that they can be easily removed from the stone mold, After the stone surface has been completely set, the separating medium was applied; The upper part was then positioned in its proper location. A new batch of dental stone was mixed and applied to both the patterns and the stone surface, left for one hour to set. the flask was open carefully to remove the pattern from the mold carefully[19, 20] as the Fig. (1)

Proportioning, Mixing Ratio and Incorporation Of Copolymers (EMA, IBMA) With Heat Cured Acrylic Resins

To make the control acrylic specimens, 22 g of acrylic powder was added to 10 ml of monomer and mixed according to the manufacturer's instructions. When the mixture had formed a dough, it was packed into the mold, the flask was placed under the hydraulic press, and the flask was then cured. The flask was allowed to cool after curing. acrylic samples were carefully removed, finished and polished [19]. The experimental groups with addition of copolymer IBMA in 1% concentration, on the other hand, were made by mixing 22 g acrylic powder, 9 ml monomer, and 1 ml IBMA or EMA with MMA Monomer and the experimental groups with addition of copolymer IBMA in concentration 2% were made by mixing 22 g acrylic powder, 8 ml monomer, and 2 ml IBMA with MMA Monomer, When the mixture reach to dough stage it was packed into the mold and cured, after that, all of the acrylic samples were placed in water. All specimens were stored in distilled water at 37° C for two weeks before testing [13].

Testing procedure:

Transverse Strength test

The strength was measured using formula: [18, 21]

Transverse strength= $3PL/\ 2b \times d^2 \frac{N}{mm^2}$

Where:

P: The Peak load (N)

L: the Span length (mm)

b: is the Specimen width (mm)

d: is the Specimen thickness (mm)

Results:

The study data was analyzed statistically. The transverse strength values depending on the adding of copolymers were yielded the highest mean value of transverse strength test was in the control group followed by EMA 2% group While the EMA1% group had the lowest mean value as Fig. (3). The results of One-way ANOVA demonstrated highly significant differences (P<0.001) among all tested groups, On the other hand, highly significant differences (P <0.001) were observed between these groups (IBMA 1% and IBMA 2%; IBMA 1% and EMA 2%; EMA 2% and EMA 1%; and IBMA 2% and EMA 1%). However, no significant differences (P>0.05) were found between these groups: IBMA 1% and EMA1%, IBMA 2% and EMA 2% (Table 1).

Discussion:

The current search was performed for evaluation of the effect adding EMA and IBMA on the transverse strength to the clear acrylic resin. According to the findings of the current study, the addition of copolymers (IBMA, EMA) to MMA monomer and PMMA a high significant difference between the control group and experimental groups, a high mean values of transverse strength test was obtained in control group as shown in Table (1) and Fig.(3).These findings were supported by a study which carried out by [22]that found that using copolymers reduced the transverse strength of acrylic resin. The reason for this can be explained by the chemical structures of the polymers. The alkyl groups on the acrylic resin polymerized with ethyl methacrylate or isobutyl methacrylate may be dispersed unevenly or at different densities within the polymer matrix. Such a case could be indicated by the results of the bending test for the polymers, which showed that the highest flexibility was shown with the control group and that ethyl methacrylate had the most adaptability. These results disagree with a study which carried out by [20, 23]. that found that the transverse strength was increased compared to the control group, and one possible reason for the changes in transverse strength was the residual monomer content, which can lead to resin plasticizing. reducing inter chain force resulting in deformation under load. Another factor is that MMA-IBMA and MMA-EMA have a strong van der attraction. Both IBMA and EMA contain more carbon than MMA, which may improve the flexibility and durability of the copolymer structure.

Conclusion:

The current research concluded that the addition of isobutyl methacrylate (IBMA) and ethyl methacrylate (EMA) significantly reduced the flexural strength of acrylic resins.

Figure (1) Two part of mold with dental stone and plastic pattern

Figure (2) Sample under testing device

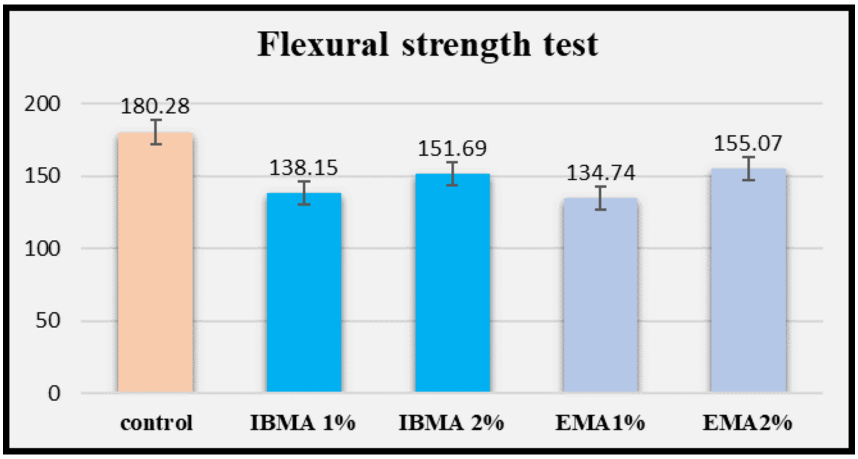

Figure (3): Bar chart representing mean values of Transverse strength test for the studied group

Table (1) Multiple comparisons of Transverse strength between groups using Tukey test

(I) groups	(J) groups	P Value	*Sig.*
Control	IBMA 1%	.000	P=0.00 Highly sign. (*P* <0.001)
	IBMA 2%	.000	
	EMA 1%	.000	
	EMA 2%	.000	
IBMA 1%	IBMA 2%	.000	H.S
	EMA 2%	.000	
	EMA 1%	.426	N.S (*P*>0.05)
IBMA2%	EMA 1%	.000	H.S
	EMA 2%	.435	N.S (*P*>0.05)
EMA 1%	EMA 2%	.000	H.S

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