J Oral Res
oral and craniofacial sciences

Conference paper

Tensile and transverse strength of novel copolymers for denture base.

Ahmed Asim Saeed Al-Ali.[1]
Ammar K. Al-Noori.[1]
Amer A. Taqa.[2]

Affiliations: [1]Prosthodontics Department, Dentistry College, Mosul University, Iraq. [2]Basic Science Department, Dentistry College, Mosul University, Iraq.

Corresponding author: Ahmed Asim Saeed Al-Ali. Mosul, Iraq. Phone: (964) 77018 24535. E-mail: daasaa1975@gmail.com

Conflict of interests: No conflict of interests.

Ethics approval: Approved by ethics committee of University of Mosul under license number 8 at 13-012019.

Funding: The research is self-funded.

Authors' contributions: All authors contributed to the manuscript.

Acknowledgements: None.

Cite as:
Al-Ali AAS, Al-Noori AK & Taqa AA. Tensile and transverse strength of novel copolymers for denture base.
J Oral Res Special Issue. 2019;S1:7-10.
doi:10.17126/joralres.2019.082

Abstract: Objectives: Compare tensile and transverse strength of new copolymers for denture base. Materials and methods: The specimens were prepared from heat cured acrylic resin with three types of additives: Acryester B, Ethoxycarbonylethylene, and Propenoic acid at a percentage of 5% and 10%. The tensile and transverse strains were tested, recorded and compared. Results: The analysis of variance display statistically significant difference. The *p*-value was 0.001 for each of tensile and transverse strain tests. Conclusions: The tensile strength of the novel copolymers increased. The transverse strength of some of the novel copolymers increased.

Keywords: *Tensile strength; transverse strength; copolymer.*

INTRODUCTION.

Poly methyl methacrylate is considered the most common material used to fabricate denture base. However, it has some disadvantages like low strength and low toughness.[1]

Among the desired mechanical properties of denture base material, high tensile and transverse strength are particularly important to meet the required performance during function.[2]

Numerous attempts have been made to enhance durability and strength of dental acrylic resin by metal wires or plates. The chief disadvantage of metal wire is the weak adhesion between the resin and wire. In case of metal inserts, stress concentration around the embedded insert lead to failure. The inclusion of fibers has various problems such as tissue irritation, difficult placement and orientation, and adhesion between resin and fibers. Some attempts have been made to increase the strength of the denture acrylic by chemical modification through copolymerization and cross- linking.[3,4]

The aims of this research are to evaluate tensile and transverse strength of new copolymers of poly methyl methacrylate to be used as materials for denture base.

MATERIALS AND METHODS.

Specimens preparation were accomplished by heat- cured acrylic resin (VDBV, Holland) and liquid additives. The liquid additives used are: Acryester B, Ethoxycarbonylethylene, and Propenoic acid. The liquid additives were used at 5% and 10%. The control specimens preparation were achieved by heat- cured acrylic resin (VDBV, Holland) with no additives.

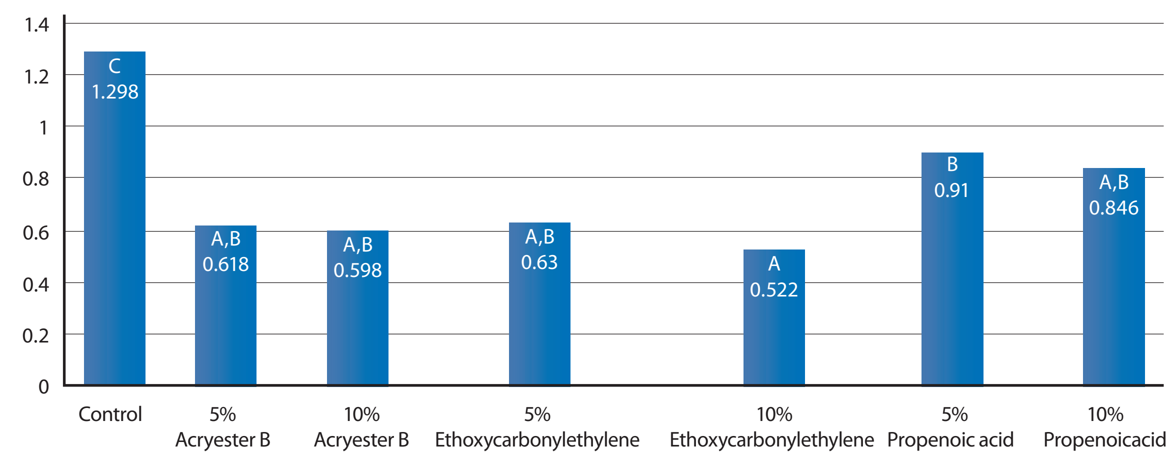
For each group, each liquid additive was added to the acrylic monomer, then mixed together until a homogeneous liquid mixture was achieved. Then, the powder was added to the liquid. Mixing, curing, and finishing were done according to the manufacturer instructions.

The specimens for tensile strength (90x10x3mm) were constructed according to ANSI/ADA standardization. For each group, the number of specimens was five. A universal tensile testing machine (KYOTO, JAPAN) was used. A tensile load of 100 newtons (which resembles the chewing and swallowing forces) was applied to the specimen. The resultant tensile strain was recorded.[5]

The specimens for transverse strength (65x10x2.5mm) were constructed according to ANSI/ADA standardization. Testing was carried on as described above, and the resultant transverse strain was recorded.[6]

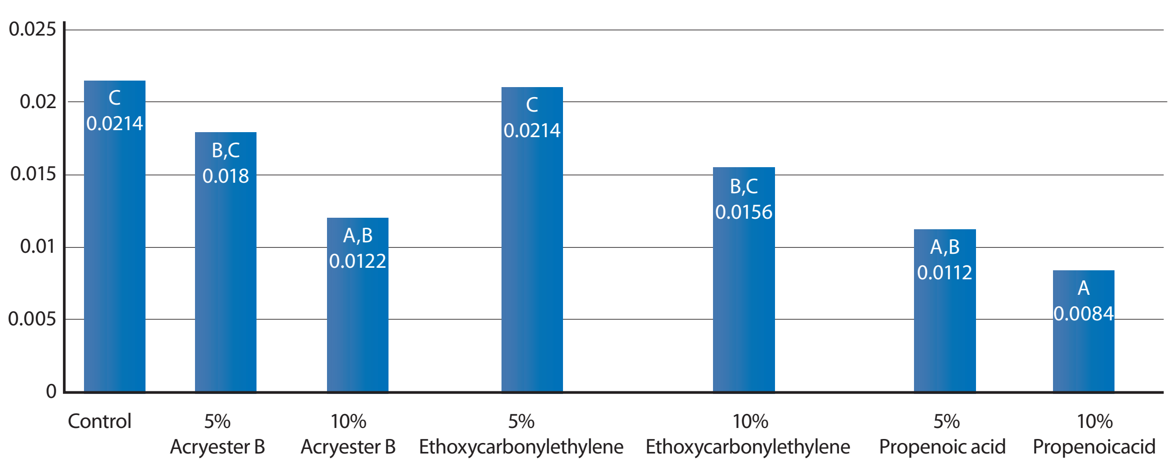
The data were analyzed using SPSS software to obtain the means, one way ANOVA, and Duncan multiple range test.

Figure 1. Comparisons of tensile strain of the tested groups.



The results are considered statistically significant at $p \leq 0.05$. Values with different letters are significantly different.

Figure 2. Comparisons of transverse strain of the tested groups.



The results are considered statistically significant at $p \leq 0.05$. Values with different letters are significantly different.

RESULTS.

One-way ANOVA for the tensile strain showed statistically significant differences (p-value=0.001). Means and Duncan multiple range test illustrate the comparison of tensile strain among all groups. (Figure 1)

As the tensile strain decreased, the tensile strength increased. The tensile strain of the control group is statistically significantly increased compared to the other group, which means that the tensile strength of control group is significantly lower than the other groups.

The tensile strain of the 5% Propenoic acid is significantly higher than that of 10% Ethoxycarbonylethylene. There is no significant difference among the remaining groups.

The one-way ANOVA for the transverse strain showed a significant difference (p-value=0.001). Means and Duncan multiple range test (Figure 2), show the comparison of transverse strain among all groups. As the transverse strain decreased, the transverse strength increased.

The transverse strain of control group showed a statistically significant increase compared to 10% Acryester B, 5% Propenoicacid, and 10% Propenoicacid; this mean that the transverse strength of the control group is significantly lower than that of these groups. There are no significant differences in transverse strain between control group and 5% Ethoxycarbonylethylene, 10% Ethoxycarbonylethylene, and 5% Acryester B.

The transverse strain of 5% Ethoxycarbonylethylene is significantly higher than that of 10% Acryester B, 5% Propenoicacid, and 10% Propenoicacid. The transverse strain of each of 5% Acryester B and 10% Ethoxycarbonylethylene is significantly higher than that of 10% Propenoicacid.

DISCUSSION.

Microscopically, a cured acrylic resin has two phases in its internal section. The first is poly methyl methacrylate particles based upon powder and the second is poly methyl methacrylate matrix that results from the polymerization of the monomer. In internal sections, molecular weight distribution is different. Another problem is that acrylic resin has macro interface within its internal section. The presence of flaws, interfaces, or cracks introduce concentration of stress in the inner-section of the denture or on the surface, and denture fracture is propagated.[7,8]

In this research an attempt was made to dissolve the micro-structural behavior to prevent fracture initiation.

The changes in the chemical properties of acrylic resin may affect its mechanical properties. The latter depend on the cross-linking density of polymer matrix and the interface between the matrix and powder. Mechanical properties are also influenced by the unreacted residual monomer.[7,8]

Copolymerization of poly methyl methacrylate promotes an increase in tensile and transverse strength because of different intermolecular distances between polymers chains. The elasticity of a material depends on the existing inter atomic forces. The effect of internal forces appears as the denture is prone to mechanical tests like tensile and transverse loads.[9]

The improvement of tensile and transverse strength could be due to proper dispersion of liquid additives, which interstitially fill the matrix. The percentage of additive must be in amounts that disperse equally within the resin matrix with no interruption of continuity.

The well-distributed additive transfers stresses from weak poly methyl methacrylate matrix to the strong filler, thus improving the mechanical interlocking and allows change in the copolymer properties by increasingin poly methyl methacrylate matrix ductility.[10]

CONCLUSION.

The new copolymers that are formed by poly methyl methacrylate and Acryester B, Ethoxycarbonylethylene, or Propenoic acid have higher tensile strength than the poly methyl methacrylate denture base material.

Copolymers of Acryester B and Propenoic acid have higher transverse strength than poly methyl methacrylate. There are differences in tensile and transverse strength among the new copolymers.

REFERENCES.

1. Jiangkongkho P, Arksornnukit M, Takahashi H. The synthesis, modification, and application of nanosilica in poly methyl methacrylate denture base. Dent Mater J. 2018;37(4):582–91.
2. Durkan R, Oyar P. Comparison of mechanical and dynamic mechanical behaviors of different dental resins polymerized by different polymerization techniques. Niger J Clin Pract. 2018;2:1144-9.
3. Abdallah RM. Evaluation of poly methyl methacrylate resin mechanical properties with incorporated halloysite nanotubes. J Adv Prosthodont. 2016;8:167-71.
4. Gad MM, Fouda1 SM, Al-Harbi1 FA, Näpänkangas R, Raustia A. PMMA denture base material enhancement: a review of fiber, filler, and nanofiller addition. International J Nanomedicine. 2017;12:3801–12.
5. Ghahremani L, Shirkavand S, Akbari F, Sabzikari N. Tensile strength and impact strength of color modified acrylic resin reinforced with titanium di¬oxide nanoparticles. J Clin Exp Dent. 2017;9(5):661-5.
6. Yoshida K, Takahashi Y, Sasaki H, Hamanaka I, Kawaguchi T. Flexural strengths of reinforced denture base resins subjected to long-term water immersion. Acta Biomater Odontol Scand. 2016;2(1):20–4.
7. Basavarajappa S, Alkheraif AA, Alhijji SM, Matinlinna JP, Vallittu PK. Effect of ethanol treatment on mechanical properties of heat-polymerized poly methyl methacrylate denture base polymer. Dent Mater J. 2017;36(6):834–41.
8. Ozkir SE, Yilmaz B, Unal SM, Culhaoglu A, Kurkcuoglu I. Effect of heat polymerization conditions and microwave on the flexural strength of poly methyl methacrylate. Eur J Dent. 2018;12:116-9.
9. Cierech M, Osica I, Kolenda A, Wojnarowicz J, Szmigiel D, Łojkowski W, Kurzydłowski K, Ariga K, Nastalska E. Mechanical and Physicochemical Properties of Newly Formed ZnO-PMMA Nanocomposites for Denture Bases. Nanomaterials. 2018;8:305.
10. Gad M, Abualsaud R, Rahoma A, Al-Thobity AM, Al-Abidi KS, Akhtar S. Effect of zirconium oxide nanoparticles addition on the optical and tensile properties of poly methyl methacrylate denture base material. Int J Nanomedicine. 2018;13:283–92.