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Research Article

Mechanical Properties of Surface-Charg(Methyl Methacrylate) as Denture Resin

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Abstract

The aim of this study was to examine the mechanical propertie
suitability as denture base material. This experimental resin is ma
poly(methyl methacrylate) (PMMA) to produce a negative charge.
Dental Resin (DENTSPLY Caulk) as a control and three groups of m
of methacrylic acid (5 : 95, 10 : 90, and 20 : 80 MA : MMA).
Testing Machine (Instron Corp.) measured force-deflection curve
calculate the transverse strength, transverse deflection, flexural
Variance and Scheffe Post-test were performed on the data. Resin
lower strength values for the measured physical properties. The m
acid content was increased to 20% *m*PMMA. No significant differe
between the Control and 5% *m*PMMA.

1. Introduction

Denture stomatitis is a common form of oral Candidiasis, which is
to denture base surfaces [1 - 4]. *Candida* is a commensal organis
Introduction of predisposing factors such as systemic disease, in
result in fungal infections [5, 6]. Candidiasis has been associa
particularly on the tissue-fitting surface of maxillary complete
susceptible to *Candida* infections since the denture base serves a
Low salivary flow rates, low buffering capacities, and low pH valu
oral mucosa and denture surfaces by *Candida* [7 - 12].

Development of pathogenesis is preceded by the initial attachme
surface of the denture. Surface characteristics resulting from ch
Candida to the denture resin and offer an opportunity for further b
net negative surface charge, providing an environment of elec
charge interactions with the polymer. Understanding the effect
albicans to poly(methyl methacrylate) (PMMA), our previous re
charged denture base materials can prevent adhesion of *C. albica*
stomatitis [16].

Poly(methyl methacrylate) (PMMA) is the resin of choice for fabri
excellent physical properties and clearly defined polymerization pr
have been made to modify PMMA taking advantage of the broad sc
In our previous study [16], the experimental resin had a nega
methacrylic acid to methyl methacrylate. Results showed that the
the ratio of methacrylic acid increased in vitro. A significant dec
$P < .0001$) existed when the methacrylic acid was present at 10%
the new surface-modified denture resins attractive for future denta

An optimized resin material should exhibit a positive biologic res
maintaining the desired physical properties. Physical and mechan
clinical success and longevity of complete dentures fabricated. In
compressive and tensile strengths; elongation; hardness; thermal
shrinkage; solubility; dimensional stability; and dimensional accur
a denture base resin is strength. The denture base must be able to
masticatory forces.

Denture base fractures have been examined using different
compressive, shear, tensile, transverse, impact, and fatigue str
properties that warrant further investigation. Microcracks were
modified PMMA samples that had higher methacrylic acid content
acid may compromise the physical properties of the resin [16]. In
the physical properties of these surface-modified resins.

The aim of this study was to investigate the mechanical proper
transverse strength, transverse deflection, flexural strength, and
base resin.

2. Materials and Methods

2.1. Synthesis of Modified PMMA Polymers

Modified PMMA polymers were synthesized by polymerization
methacrylate (MMA) and methacrylic acid (MA) as monomers. Th
10% *m*PMMA (10% MA and 90% MMA), and 20% *m*PMMA (20% M

monomer or the monomer mixture was stirred with 1.2 g of ben
paratoluidine was added and stirred briefly. The mixture was pou
alcohol) at pH 3 and stirred well to prevent separation of two laye
was allowed to continue for 15 minutes after the rise in tempe
washed with distilled water, and dried. All chemicals were o
Milwaukee, WI.

2.2. Characterization of Modified PMMA Polymers

The synthesized PMMA and modified PMMA polymers were analy
Richmond, CA) for the incorporation of carboxylate group. The ch
spectra of carboxylated polymers showed significant broadening of
that of PMMA. In addition, the appearance of new IR bands at 292
suggested the incorporation of carboxylate group.

2.3. Preparation of Resin Samples

Three groups of modified PMMA (5% *m*PMMA, 10% *m*PMMA, 20
resin, Orthodontic Dental Resin (DENTSPLY Caulk, Milford, DE), w
were designated as the following: Group 1(Control)-Dental Resin
Group 4–20% *m*PMMA. Orthodontic Dental Resin was fabricate
samples in Groups 2–4 were polymerized using chemicals in th
Chemical Co., Inc., Milwaukee, WI).

Table 1

Five plates per each experimental group were fabricated. Polym
$55 \pm 1^{\circ}$ C in a pressurized chamber (22 psi) for 15 minutes. Eac
25 samples per experimental group. These oversized strips were n
(W) × 65 mm (L) × 2.5 mm (D)] and polished to mini
with distilled water to remove any residual monomer and then
before testing.

2.4. Mechanical Testing

Utilizing a 3-point flexural test, the samples were mounted in a ca
Corp., Canton, MA). Each plastic strip was supported on each end
rod applied a load until fracture occurred at a uniform crosshead
a complete stress versus strain history for each test were obta
calculate the transverse strength, transverse deflection, flexural
curves along with the means and standard deviations for each exp

2.5. Statistical Analysis

The mean, median, and mode were calculated for each experim
normality and One-way Analysis of Variance (ANOVA) and Scheff
groups.

3. Results

A representation of the difference in mean transverse strength is the highest mean force required to fracture the specimens. A cor significant difference between the Control and the 5% *m*PMMA gro the transverse strength decreased. The 20% *m*PMMA group sh statistically significant compared to the 5% *m*PMMA group ($P < .05$

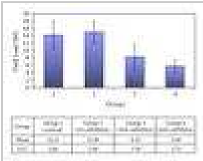

Figure 1: The bar graph represents the me strength or force at fracture for each of the ex

The transverse deflection measurements and the mean values are specimen was, the farther the crosshead needed to travel to transverse strength, the material with higher transverse deflectio of methacrylic acid:MMA increased, the transverse deflection de comparison of mean transverse deflection revealed significant diffe except the 5% *m*PMMA group.

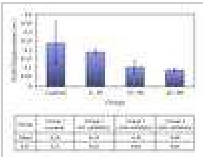

Figure 2: The mean and standard deviation experimental groups.

Figure 3 shows the mean and standard deviation values for flexura higher the load or force required to fracture the specimens, th methacrylic acid:MMA increased, the flexural strength decreas difference in flexural strength from all other groups ($P < .05$) excep

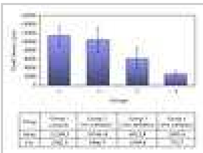

Figure 3: Representation of the mean and s each of the experimental groups.

Figure 4 shows the mean and standard deviation values for Young' groups. The elastic modulus is a measure of the stiffness of the m the material will exhibit a lower elastic deformation per unit of modulus of elasticity of the Control and the 5% *m*PMMA group re group exhibited the lowest modulus of elasticity, which was signif the commercially available Dental Resin ($P < .05$). Thus, the 20 modulus, translating into the least stiff material. The 10% *m*PMMA the Control or the 5% *m*PMMA group.

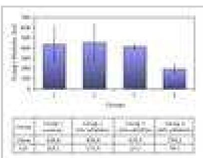

Figure 4: The mean and standard deviation v the experimental groups.

4. Discussion

Correlation existed between the physical properties and the ant
present study, the greatest decrease in transverse and flexural st
content was increased from 5% to 10% *m*PMMA ($P < .05$). Intere
the most significant reduction in adhesion of *C. albicans* occurred
increased, the adhesion of *C. albican* to resin surfaces decreas
consequence.

The 5% *m*PMMA group was comparable to the Control (Dental Re
any parameter tested. The 5% *m*PMMA group produced a higher
the Dental Resin; however, it was not statistically significant. Thi
the modified resin samples. The experimental resins were not opti
been produced specifically to enhance these physical characteris
although not designed for dental use, still had high transverse an
the Dental Resin.

In the present study, prepolymerizing or mixing two different type
produced a copolymer. Methacrylic acid is a small molecule with a
physiologic pH. Steric interactions can be postulated as the free
new polymer, thereby affecting its physical properties. By creating
repelling forces within the resin material. The influence of these i
subjected to physical testing such as compressive and tensile
decreased the flexural and transverse strengths of the resin sam
internal repulsive forces. The negative internal forces also affect
represents the basic response of a material to a force. Fundamen
existing interatomic forces of the material. The present study in
lowest modulus of elasticity and had the greatest ionic charge.

The overall negative charge may also affect the solubility of the
showed that an increase in methacrylic acid content correlate
inferring increased hydrophilicity [16]. Umemoto and Kurata [
decreased water sorption. In that study, they produced copolyme
methacrylate) and methyl methacrylate. Increasing the hydro
sorption with no decrease in mechanical properties. These hydrop
bending strength and similar modulus of elasticity compared to P
understanding of the effects of methacrylic acid on the resin's p
PMMA with methacrylic acid altered the physical properties of resin

In the present study a cold-cured method of resin polymerization
a heat-cured acrylic form. Studies have shown that there is no diff
cold-cured acrylic resins [18, 19]. For the purpose of investig
adhesion, it is reasonable to assume that the present results are e
methods.

Further modifications may be needed for the modified resins to im
beneficial antifungal characteristics. A range of methods have b
through chemical modification of PMMA and through incorporation
[20 - 23]. High-impact acrylic is produced from the incorporation
polymerization. Rubber graft copolymers obtained from this proce
base by as much as 50% [24]. These resins use a monomer that

crosslinkers are said to provide the craze resistance in a dentu
inhibiting effect due to the incorporation of rubber. Fiber reinfc
improving flexural strength of PMMA [26, 27]. Effective fiber reinf
the fiber type, number, distribution, and orientation. However, co
albicans to fiber-reinforced denture resin bases have been raised.
surface roughness and provide mechanical retention in vivo [28].
can be further modified to increase its physical strength to achiev
research includes continued elucidation of the ideal ratio of metha
properties for clinical applications.

5. Conclusion

Surface-charged resins demonstrate to be promising as a biom
response by decreasing Candidal adhesion. The results of the pre
with methacrylic acid changes the physical properties of the resin.
group were comparable to the commercially available Dental Resin

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