Original Article

Effects of fluconazole, chlorhexidine gluconate, and silver-zinc zeolite on flexural strength of heat-cured polymethyl methacrylate resin

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Abstract

Aim: We evaluated the effect of incorporating Fluconazole, Chlorhexidine Gluconate, and Silver-Zinc Zeolite as bioactive materials (10% of mass) on the flexural strength of commercially available heat-cured polymethyl methacrylate (PMMA; Travelon). **Materials and Methods:** The following four groups were compared; Group 1: Control group with pure PMMA, Group 2: Antibacterial drug group with chlorhexidine gluconate in powder form + PMMA, Group 3: Antifungal drug group with fluconazole in powder form + PMMA, Group 4: Antimicrobial agent group with silver zinc zeolite in powder form + PMMA. After processing, the specimens were subjected for flexural strength testing using three-point bending test in a universal testing machine. **Results:** A significant ($P < 0.0001$) decrease in flexural strength following incorporation of Fluconazole, Chlorhexidine Gluconate, and Silver-Zinc Zeolite to heat polymerized acrylic resin was observed when compared with the control group. The decrease in mean flexural strength was minimal in the fluconazole group. **Conclusion:** Although the addition of a bioactive material to PMMA acrylic is desirable, it is not practical as it reduces flexural strength of the acrylic base.

Key words: Bioactive compounds, chlorhexidine gluconate, flexural strength, fluconazole, polymethyl methacrylate, silver-zinc zeolite

INTRODUCTION

The treatment of stomatitis[1-3] caused by candidal infection[4] in denture wearers has always been a challenging task to the prosthodontist. Although topical application of the drugs can be used, however, the purpose is defeated due to the copious flow of saliva. Persistent fungal presence on the denture's fitting surface often leads to cross infection and recurrence of the mucosal lesions.[5] Chlorhexidine gluconate and silver-zinc zeolite are reported as active agents against a broad spectrum of organisms including *Candida*. Hence, the feasibility of using drug delivery system by incorporation of antifungal drugs or antimicrobial agents, with denture acrylic resin or soft liners is explored.[6-8] These formulations are claimed to have fewer side effects compared with the conventional forms, because of the continual presence of the drug at the site of action and less amount of drug required to achieve a therapeutic effect.[5] However, it is important to determine whether denture cleansers or incorporation of such antimicrobials alter the properties of acrylic resins. Indeed repeated use of denture cleanser[9] and presence of the drug particles[10-13] are reported to affect the physical properties of denture base resin. In addition, immersion in denture cleansers and disinfectant solutions also further decreases the flexural strength of acrylic resins.[14,15] Hence, the present study was designed to evaluate the effect of incorporating fluconazole, chlorhexidine gluconate, and silver-zinc zeolite as bioactive materials on the flexural strength of heat cured polymethyl methacrylate (PMMA) resin.

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MATERIALS AND METHODS

A master model was prepared and duplicated to create specimens [Figure 1]. The specimens were fabricated according to ADA specification no. 12 (measuring 65 mm × 10 mm × 2.5 mm), using heat-cure acrylic resin and chemicals as indicated in Table 1. The sample size calculation was performed using data from a previous study.[13] Total number of 40 specimens were fabricated. The specimens were divided into following four experimental groups:

- Group 1: Group pure PMMA.
- Group 2: Antibacterial drug group chlorhexidine gluconate powder form.
- Group 3: Antifungal drug group fluconazole powder form.
- Group 4: Antimicrobial agent group silver zinc zeolite powder form.

Ten specimens were allocated to each group. Resins were mixed according to the manufacturer recommendation of polymer and monomer ratio (3:1 by volume). Using a precise digital scale, every effort was made to ensure that the powder to liquid ratio remained at 3:1 by volume. Group A was kept as a control group. Samples for Group B, C and D were prepared by adding 10% of drug (in powdered form) by mass in each group. Polymerization of the specimens was carried out using a standard processing cycle. The specimens were rinsed and stored in sterile distilled water for 24 h before use.

Mechanical testing

Using a 3-point flexural test, the samples were mounted in a calibrated Instron Universal Testing Machine (Instron Corp., Canton, MA) [Figure 2]. The peak load (fracture load) was recorded in chart recorder.

$$S = 3PL/2bd^2$$

S = Flexural strength (N/mm^2), P = Load at fracture, L = Distance between jig support, b = Specimen width, d = Specimen thickness.

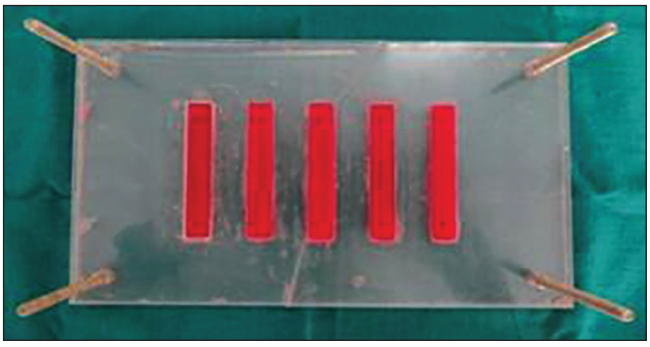

Figure 1: Wax strips made from fiber stencil as per ADA specification no. 12

Statistical analysis

The data are represented as mean ± standard deviation. One-way analysis of variance (ANOVA) and Scheffe's *post-hoc* test were used to compare means between groups.

RESULTS

A representation of the difference in mean flexural strength is shown in Table 2. The highest and lowest flexural strength value was observed in groups 1 and 4 respectively. Comparatively less variation was observed between group 1 and group 4. A comparison of mean flexural strength indicated a significant difference between the control and

Table 1: Materials used in the study

Material	Trade name	Material type
Denture base resin	Trevalon	Heat cure denture base polymer and monomer
Drug fluconazole	AF-400 by systopic laboratories	Antifungal drug
Chlorhexidine gluconate	From college pharmacology laboratory	Antibacterial drug
Silver zinc zeolite antimicrobial	Iraguard b5000 Reena organics Pvt. Ltd.	Antimicrobial agent

Table 2: A representation of the difference in mean flexural strength

Group/material	Mean flexural strength
Group 1: Group pure PMMA	133.30±28.39
Group 2: Antibacterial drug group chlorhexidine gluconate powder form	112.56±21.61*
Group 3: Antifungal drug group fluconazole powder form	83.84±11.43*
Group 4: Antimicrobial agent group silver zinc zeolite powder form	116.45±25.40*

Mean ± SD, *Significantly ($P < 0.0001$) different from group 1 (ANOVA), SD: Standard deviation, PMMA: Polymethyl methacrylate, ANOVA: Analysis of variance

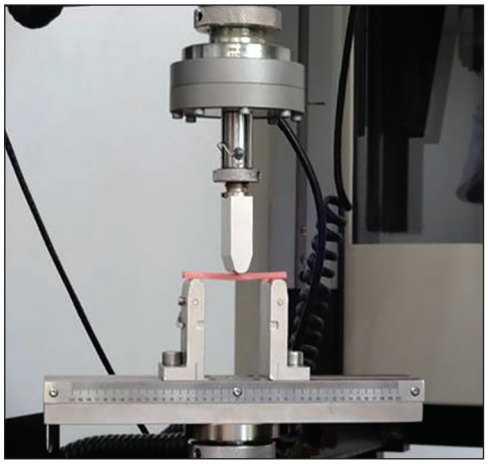

Figure 2: Testing of specimen on three-point universal testing machine

the Fluconazole drug group. One-way ANOVA analysis demonstrated a highly significant difference ($P < 0.0001$) between the control and the test groups (Groups 2-4).

DISCUSSION

The addition of bioactive compounds to heat cure acrylic denture base resin material is consistent with the current trend of incorporating antimicrobials into dental materials. However, the physical properties of the resin were affected due to the presence of the drug particles, which may dissolve and result in porosity in the acrylic base.[10] The flexural properties of denture base materials are of importance for the prediction of their clinical performance upon loading.[16-18] Hence, if the addition of bioactive compounds results in a significant decrease in the flexural strength of acrylic resins, this may increase the possibility of a fracture occurring inside or outside the oral cavity. Our study presents the results of flexural strength assays performed with heat-polymerized acrylic resins containing 10% mass of chlorhexidine gluconate, fluconazole or silver zinc-zeolite antimicrobial agents. Reduction in flexural strength was the consistent outcome of the test performed on the three adulterated heat cure PMMA groups when compared with the control group. Reduction in the flexural strength may be attributed to the fact that zeolite crystal is porous in nature, and the conversion degree of these materials relating to the amount of residual monomer may influence the values obtained.[12,19] In the samples containing silver-zinc zeolite, increase in the opacity of the resin was found, which was also consistent with previous reports.[11]

There was a reduction in flexural strength on addition of chlorhexidine gluconate to the heat-cure PMMA resins. Chlorhexidine is soluble in water but insoluble in both methyl methacrylate and plasticizer. As such, they do not appear to interfere with the polymerization or plasticization processes. However, by their physical presence within the matrix, they may interrupt the physical form of both polymers and plasticized materials.[10] Among the three antimicrobial agents, the fluconazole group showed minimum flexural strength values, this result could be correlated with the larger particle size of the Fluconazole drug. The result in our study is however contradictory to the previous study reporting a significant difference on flexural strength on addition of fluconazole to heat-cure acrylic resin material.[13] Further, chlorhexidine-modified samples were more yellow while the samples modified with fluconazole looked identical to the control group. The obtained result was consistent with previous reports.[13] Within the limitations of the study, we conclude that the inclusion of 10% (mass) of the bioactive compounds has an adverse effect on the flexural strength of modified PMMA resin.

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