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Research Article

Determination of Fluoride Release and Strength of a Fluoride Treated Heat Cured Acrylic Resin

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Abstract: **Objectives:** The objective of this study was to evaluate the fluoride release and tensile strength of a heat cured denture base resin, which was surface treated with sodium fluoride. **Methods:** Total 40 rectangular specimens of poly methylmethacrylate (PMMA) resin were used in this study. Out of these, 20 resin specimens fabricated without sodium fluoride (NaF), were termed as group I, and remaining 20 specimens fabricated with 20wt% of NaF, termed as group II. All the specimens were stored individually in 10ml distilled water. From each of the specimens, 5ml water was taken to measure the fluoride release, at the time interval of 1hour, 1day and 3days. After 3days, the same specimens were used to measure the tensile strength.**Results:** There was maximum fluoride release at 1 hour and minimum at 3 days. Maximum decrease in fluoride release was observed between 1 hr and 3 days and minimum between 1 day and 3 day. All the three comparisons showed significant change ($p<0.001$).**Conclusions:** Heat-polymerizing denture base resin containing NaF filler releases significant amounts of fluoride and can act as a fluoride reservoir in the oral cavity.**Clinical significance:** There are numerous examples in dentistry where demineralization, or even frank caries, develops near or in association with restorative or prosthetic materials. A slow-release source of fluoride could help to prevent these problems and provide added protection throughout the mouth**.**

Keywords: Dental caries, Fluoride, Fluoride Release, Polymethyl Methacrylate Resin, Tensile Strength.

INTRODUCTION:

The proportion of geriatric patients wearing removable partial dentures is increasing (Zitzmann, N. U. *et al*., 2008). At the same time, the prevalence of root caries accompanied by gingival recession is increasing (Imazato, S. *et al*., 2006; Mojon, P. *et al*., 1995). Abutment teeth in particular are more likely to be affected by caries and periodontal disease than any other teeth (Drake, C. W., & Beck, J. D. 1993). Because abutment teeth anchoring removable partial dentures tend to be inadequately cleaned, preventing root caries in these teeth is crucial. A variety of vehicles can deliver fluoride into the oral cavity, including fluoride mouth-rinse, fluoride dentifrice, topical fluoride, and fluoride-releasing restorative materials, all of which effectively prevent root caries and suppress recurrent caries (Jensen, M. E., & Kohout, F. 1988; HAN, L. *et al*., 2002). The aim of this study was to evaluate the fluoride release and strength of a heat cured denture base resin, which was surface treated with sodium fluoride. It was hypothesised that it can make a significant contribution to reducing root caries in the abutment teeth of people who wear partial dentures.

MATERIALS AND METHODS:

Sodium Fluoride (NaF) filler with average particle size of approximately 4.1 µm (supplied by DNS fine chemicals and laboratories ltd., Mumbai, India) was added to polymethyl methacrylate powder (PMMA; Trevalon Heat Cured resin, Dentsply, India) at 20% by weight and dispersed with a mixing machine for 15 minutes. The resin polymers containing well dispersed NaF filler were polymerized with monomer according to the manufacturer's instructions

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(powder/liquid ratio 3:1 by volume) at room temperature and dry conditions. Rectangular specimens (60×10×3 mm) were prepared to measure the fluoride release and tensile strength. As a control group, same rectangular specimens of resin polymer were used without NaF filler (0 wt%). Total 40 specimens were fabricated for the study, which were equally divided into following two groups-Groups 1: specimens without fluoride (control group) Group 2: specimens with 20wt% fluoride (test group).

Measurement of Released Fluoride-

Each of the group2 specimens was stored individually in 10ml distilled water (DW) at room temperature (37^0C). 5ml distilled water from each of the sample was taken in 20 individual plastic test tubes and evaluated by Ion Liquid chromatography (ILC; Analytical Technologies Ltd., Gujarat, India) for the release of fluoride in the water. After each measurement the resulting solution was discarded and replaced with fresh DW. Water samples were collected at following three stages of the study,

1. After 1 hour
2. After 1 day
3. After 3 days

Fluoride concentration was measured while the solution was stirred at room temperature, and the amount of fluoride released of the resin disk was computed in µgm/Lit. Fluoride release was statistically analyzed with two-way repeated-measures ANOVA.

Tensile Strength -

After 3 days of immersing in DW, the same 20specimens which were used to measure the released fluoride were tested for tensile strength. To determine tensile strength, each of the specimens was subjected to three point bending tests using a universal testing machine (AGS-1000, Shimadzu Corp., Kyoto, Japan) at a crosshead speed of 0.5mm/min. The tensile strength was calculated from the linear portion of the load time curve up to the proportional limit obtained by the test in Kilograms (kg) which were converted into Newton (N). The value of tensile strength was calculated by the followed formula: T.S. = F/A

T.S. = Tensile strength (N/mm2)

F= Force at failure (N)

A= Area of a cross section at failure (mm)

Tensile strength (N/mm2) data were analyzed by student test (T. test). Tests were performed at a confidence level of 95%.

RESULTS:

Table 1 shows the mean fluoride release at different time intervals of 1hour, 1day and 3 days. There was maximum fluoride release at 1 hour. Change in fluoride release between different time intervals is shown in table 2. Maximum decrease in fluoride release was observed between 1hr and 3 days and minimum between 1day and 3 day. All the three comparisons showed significant change ($p<0.001$). In the control group, fluoride release was undetectable. Table 3 shows a significant decrease in tensile strength of fluoridated resin compare to the control group.

Table – 1: Mean fluoride release at different time intervals

Time interval	Mean (µg/Lit)	N	Std. Deviation
1hour	16.09	20	1.24
1day	9.07	20	0.56
3days	6.57	20	0.51

Table – 2: Change in fluoride release between different time intervals

	Mean (µg/Lit)	Std. Deviation	't'	'p'
1hr versus 1day	-7.03000	1.16264	27.041	<0.001
1hr versus 3days	-9.51850	1.46419	29.073	<0.001
1day versus 3days	-2.48850	0.63127	17.629	<0.001

Table – 3: Effect of fluoride on tensile strength of acrylic resin

Group	N	Mean (MN/m2)	Std. Deviation	Std. Error (mean)	't'	'p'
Group I	20	54.3350	2.71788	0.85947	17.718	<0.001
Group II	20	39.2010	1.91534	0.42828		

DISCUSSION:

In the present study, group 2 specimens showed 16.09 µg /Lit of fluoride release on 1hr. By day3 the fluoride release decreased to 6.5 µg/Lit (table 2). Many dental professionals recognize that restorative resin composite containing fluoride filler have excellent fluoride release (HAN, L. *et al*., 2002; Itota, T. *et al*., 2004; Han, L. *et al*., 2006). Han *et al., (*2002*)*. Reported that resin composite containing fluoride filler released 9.32 µg/cm^2 fluoride on day 1 and continued to release fluoride for over 60 days. The difference in the results between the present and the Han's study is likely to be

due to the filler content. The level of filler content clearly affected the initial amount of fluoride release.

Studies into the anticariogenic effects of fluoride releasing restorative materials have shown that fluoride is released from glass-ionomer cements, resin modified glass-ionomer cements and resin composite (Xu, X. *et al*., 2003; CILDIR, S. K., & SANDALLI, N. 2005; Shaw, A. J. *et al*., 1998). According to Shaw *et al*., (1998), the initial amount of fluoride release by a conventional glass ionomer was 105 μg/cm^2 on day 1 and 33 μg/cm^2 on day 10, after which it gradually decreased. In compomers, fluoride release decreased from 8 μg/cm^2 on day 1 to 5μg/cm^2 on day 10 in the same study. In the present study, the highest value obtained was 16.09 μg/Lit on 1hr and 9.06 μg/Lit on day1.

According to ten Cate *et al*., (1983) demineralization inhibition depends on fluoride concentration, and microradiographic data showed that 2 ppm fluoride in artificial saliva containing calcium and phosphate at pH 4.5 inhibited demineralization of enamel lesions, while dentin demineralization was inhibited in clinically relevant percentages (40％) at fluoride levels above 1 ppm. However, these fluoride concentrations would be toxic in clinical situations (Ten Cate, J. M. *et al*., 1998). In our study, the total amounts of fluoride released were sufficient to prevent dentin lesion formation in the narrow space between dentures and abutment teeth without causing toxicity.

The experimental acrylic resin containing 20 wt% NaF filler used in the present study releases fluoride ions on contact with water. 20 wt% NaF filler complied with requirements of ISO 1567. Previously, Kazuko Kamijo *et al*., (2009) have used 20 wt% SPRG filler in a PMMA resin and found 1.88 μg/cm2/day of fluoride release on day1. An increase in filler content correlates with a decrease in the durability and strength of the denture base resin (Kamijo, K). A significant decrease in tensile bond strength was observed after exposure to fluoride in test group (39.20) compare to the control group (54.33) as shown in table 3. Similar result was observed by Xiaoming Xu and John O. Burgess., (2003) who concluded that restorative materials with high fluoride release have lower mechanical properties.

Wearing a fluoride-releasing denture in the oral cavity will provide enough fluoride to inhibit demineralization and enhance remineralization around abutment teeth, thereby preventing caries. In addition to preventing caries among patients who require care and who have poor oral hygiene, such as the geriatric and person with special needs, this fluoride-releasing resin can be incorporated orthodontic retainers and night guards. It thus has the potential to improve the oral health of people of all ages.

CONCLUSION:

A negative linear correlation was found between the tensile strength and fluoride release that is, PMMA resin material with high fluoride release have lower mechanical properties. Within the limitation of this study, it can be concluded that, experimental heat-polymerizing PMMA denture base resin containing NaF filler releases significant amounts of fluoride and can act as a fluoride reservoir in the oral cavity.

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