Original Article

Solubility of Three Luting Cements in Dynamic Artificial Saliva

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Abstract:

Objective: The purpose of this study was to evaluate the solubility of three luting cements in artificial saliva.

Materials and Methods: Twenty disks (10×4 mm) of polycarboxylate, zinc phosphate and glass ionomer cements were prepared according to manufactures' instructions. After setting, they were desiccated and each ten specimens were immersed in artificial saliva with special pH (3 or 5), circulated with magnetic field for 10 days. Then disks were again desiccated and weighed. Solubility values were deduced from these different measures.

Results: For the two pH, solubility were significantly lower in glass ionomer luting cement, and polycarboxylate showed the most weight loss of all the materials tested ($P<0.05$). The solubility values were more in acidic environment ($P<0.05$).

Conclusion: The pH of the environment strongly affected the solubility of the materials. Cement type also has significant effects on solubility values.

Key Words: Solubility; Glass Ionomer Cements; Zinc Phosphate Cement; Polycarboxylate Cement; Saliva, Artificial

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INTRODUCTION

Solubility is an important feature in assessing the clinical durability of luting cements. Consequently, solubility of luting cements has been widely evaluated both *in vitro* and *in vivo* [1-8]. Water sorption and solubility may cause degradation of the cement, leading to debonding of the restoration and recurrent decay [1,9]. To account for the acidic environment of the oral cavity, the Jet Test method for solubility has been utilized by some investigators [10]. Other modified methods were developed to copy more clinical situations [11]; however, most of these tests are static solubility tests, unrelated to the conditions found in the oral environment, and in particular, apply only to short-term solubility. In the mouth, luting cements constantly come into contact with oral flow causing dissolution. Thus, this study was performed to compare solubility feature of three luting cements in current clinical use in artificial saliva media with two different pHs, circulated with magnetic field.

MATERIALS AND METHODS

Three luting cements currently in clinical use were tested: zinc phosphate (AriaDent, Asiachemi Teb Mfg, under the license of Doridenta-Austria, Tehran, Iran), polycarboxylate (AriaDent, Asiachemi Teb Mfg, under the license of Sankin-Japan, Tehran, Iran) and glass ionomer (AriaDent, Asiachemi Teb Mfg, under the license of Doridenta-Austria, Tehran, Iran). All cements were mixed according to manufac-

tures' instructions (Table 1).

A modified ADA specification test was used to obtain a better clue of the genuine solubility of luting cements. All mixed luting cement was placed in moulds to form thin flat disks 10mm in diameter and 4mm thick. The specimens were placed in an environment with a relative humidity of 100% at 37˚C for 24h.

The samples were then transferred to a desiccator for one hour and weighed using an electronic analytic balance (GR-200, A&D Company, Tokyo, Japan) and immersed in one of the two following media at 37˚C for 10 days (n=10): artificial saliva (composition: $CaCl_2$, NaH_2PO_4 $2H_2O$, NaCl, CH_3COONa_3 H_2O, KOH) at pH=5.0 and artificial saliva (same composition) at pH=3.0. Using a magnetic field, the media was circulated around the specimens. The media were not changed during the immersion period.

The specimens were dabbed with blotting paper to remove visible moisture and loose debris from decomposition after the immersion period before being stored in a desiccator and weighed to a constant mass until the loss was less than 0.1 mg. The amount of weight loss was calculated as the difference between the initial weight of the specimen and its final constant weight measured after the storage in the desiccator. The data were analyzed by two-way ANOVA and Post-hoc tests at $P<0.05$.

RESULTS

ANOVA results indicated significant differences between the three cements and the two media and independent sample test revealed that cement type had a significant effect on solubility ($P<0.05$) (Table 2). Glass ionomer exhibited the lowest solubility both media. Post-hoc test revealed that in the two media, solubility of polycarboxylate was significantly more than zinc phosphate ($P<0.05$).

DISCUSSION

Solubility or leaching of cement components has a potential impact on both its structural stability and biocompatibility. The rate of dissolution can be influenced by the conditions of the test. Other factors may include time of dissolution, concentration of the solute in the dissolution medium, pH of the medium, specimen shape and thickness, and powder/liquid ratio of cement [1,3]. The method utilized in this study was a modification of ANSI/ADA specification#27 [12]. The specification requires that the specimens first be placed in a desiccator after a 10-minute bench curing. Kanchanavasita et al [2] suggested this modification to the specification. The rational behind this modification is that water is a requirement for the setting reaction of cements and that initial desiccation of the specimens could remove the water essential for the setting reaction. In this study, ANSI/ADA specification #27 was modified by waiting 24 hours before placing the specimens in the desiccator to ensure complete set of each material [12]. It was felt that desiccation of the specimens immediately after fabrication could possibly affect the solubility results due to an incomplete set.

Although glass ionomer cements are hydrophilic and Knobloch et al [4] showed high water sorption of this type of material, this cement showed the least amount of solubility. The result of this study exhibited improved solubility of glass ionomer compared to zinc

Table 1. Cement formulations used in the present study.

Product	Powder	Liquid	P/L (wt/wt)	Batch No.
Zinc Phosphate	Zinc Oxide	Orthophosphoric	1.5 / 1	ZP017
Polycarboxylate	Zinc Oxide	Polyacrylic Acid	1.0 / 1	ZP026
Glass ionomer	Alumino Silicate	Polyacrylic acid	1.8 / 1	GI016

P/L=Powder/Liquid ratio

phosphate and polycarboxylate cements, which is in agreement with a study conducted by Hersek and Canay [5]. This improvement is probably credited to the setting reaction between the fluoroaluminosilicate glass and the polyacrylic acid [6].

Clinical significance of the standard laboratory solubility test utilizing distilled water or lactic acid as a medium has been criticized by some investigators [3,7]; therefore, in this study circulating normal and acidic saliva medium was chosen. Beech et al showed that rankings obtained from acidic solubility tests were in better agreement with clinical rankings of distilled water [7]. In the present study, luting cements were more soluble in acidic saliva solution than in neutral saliva, in agreement with the findings of previous studies [1,3]. During dissolution, zinc and magnesium are leached from both zinc phosphate and polycarboxylate cements, also, aluminum and silicon are lost from glass ionomer cement [1], thus, the pH of the two media is altered rapidly and tends to inhibit the solution of luting cements over a prolonged storage period.

As the environmental temperature could affect the density of the bathing medium, which in turn may affect the rate of solubility, a limitation in this study was the constant temperature of the medium. Another limitation was that the commonly used resin cements were not compared. One explanation is that there is not a well-known Iranian resin cement available to be compared with other common Iranian made cements yet.

CONCLUSION

Weight changes of polycarboxylate cement were greatest, and there were significant differences among all the materials ($P<0.05$). Solubility of the cements in the two medium decreased in the following order: polycarboxylate, zinc phosphate and glass ionomer. Solubility of the cements were more in the acidic medium ($P<0.05$).

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Table 2. The mean solubility of specimens.

Tested Mediums	Mean solubility (SD)		
	Zinc phosphate [b]	Polycarboxylate [b]	Glass ionomer [b]
Medium[a] 1 (pH=3)	0.152 (0.02) gr	0.198 (0.04) gr	0.078 (0.02) gr
Medium[a] 2 (pH=5)	0.035 (0.008) gr	0.061 (0.008) gr	0.022 (0.008) gr

* Identical letters (a, b) indicated that values are significantly different at $P<0.05$ (One-way ANOVA followed by Post hoc test).

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